Emergence and Causal Powers

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Abstract

This thesis is concerned with the theory of ontological emergence; a theory that posits a new kind of entity – usually an emergent property – that occurs in complex systems and can explain some system-level behaviour. The theory holds that these emergent entities are dependent on, but novel with respect to, the components of those systems. Such entities have been invoked to explain behaviours as diverse as symmetry breaking in molecular physics to the possibility of personal agency. As a metaphysical theory it is useful wherever there is a lack of understanding about how system-level behaviour can occur based on what we know about the parts of that system. Besides its usefulness, the theory, if true, would profoundly impact our understanding of fundamental ontology.

The first half of this thesis aims to do three things: first, identify a problem that emergence can explain; second, identify what emergence must do in order to solve that problem; third, identify a theory of emergence capable of doing it. The first and second of these aims will require us to outline issues in fundamental ontology and metaphysical methodology that are critical to any assessment of the possibility of emergence. They both also require making some commitments on these issues. Among such commitments will be a commitment to an ontology of properties as causal powers.

I argue that emergence is a theory of macro-properties and that the primary problem it solves is the Problem of Reduction. I thereafter defend the theory of causal powers emergence against charges that it is incoherent and inconsonant with science and natural unity; these and other conflicts are shown to be unproblematic once the theory is properly explicated. In these respects, this thesis finds no fault with the coherence of emergence. The key claims in the second half of the thesis instead pertain to the necessity of emergence to solve the problem that I have identified. The argument is that even if causal novelty, holistic effects and top-down causation are apparent in a system, a properly developed causal powers ontology can account for them without positing new fundamental properties. I develop an option called non-reductive inherence based on a theory of powers admitting a plurality of compositional principles. The thesis ends by expounding this alternative to emergence and setting out some of the trade-offs between the positions.

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Statement of Copyright

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This is dedicated to my parents.

Introduction

Emergence is a scientific and philosophical term of art. It can be roughly characterised as the theory that some entities (the emergent ones) 'arise' out of more fundamental entities (the emergent base) and yet are 'irreducible' or 'novel' with respect to those entities. The theory was popular in the 19th century when emergentists were primarily concerned with theories of vitalism. They believed that life was a 'macro-level' phenomenon that emerges from the more 'fundamental' entities studied by chemistry and physics. Nowadays there is no question of vitalism, but the notion of emergence is still employed to explain how various 'macro-level' phenomena emerge from the same 'lower level' entities, wherever that connection is ill-understood. The potential uses of the theory include, but are not limited to, theories in physics such as symmetry breaking, the renormalisation group, the quantum Hall effect; and features of mental life like consciousness, mental causation, and personal agency.

The first difficulty with the concept of emergence is that it is used to refer to wildly different theories. Most especially these differences occur at the intersections between physics, metaphysics, and the philosophy of science. Even the most avid emergentist in the Department of Physics can regard metaphysical theories of emergence as absurd and impossible. Similarly, a fascinating and novel phenomenon to a philosopher of science might be considered of no metaphysical import to their metaphysician colleagues within the philosophy department. Even when one gets more specific about the type of emergence to which one refers, the problem remains. What a physicist calls 'strong' emergence is often deemed 'weak' by someone who theorises about fundamental ontology.

This is a thesis about metaphysics. There are two aims: the first is to develop a metaphysically robust theory of emergence and to evaluate it; the second is to develop a new alternative to emergence based in the theory of causal powers. This does not mean that this investigation will be useful or relevant to an emergentist in the physics department; and that is okay. While the conclusions reached here cast doubt on the existence of emergence, the alternative proposed is capable of providing metaphysical explanations for the same phenomena. Surprising and novel macro-phenomena are, in all important respects, just as surprising, novel, and macro under one theory as they are under another. It is true that the different branches of science and philosophy all incorporate – implicitly or explicitly – ontological claims; but I hope and believe that the results of our enquiry into emergence and

causal powers do not imply any adjustments to the terms of our scientific theories, or whether we think they are true.

This thesis advances new criticisms of several different theories of emergence throughout, but especially in chapters 4, 7, 10 and 11. Also, the alternative to emergence that is advanced in chapters 9 and 10, the view about the composition of powers that I call non-reductive inherence, while based in the work of Mumford and Anjum, is largely my own. It departs significantly from Mumford and Anjum's view in its analysis of the implications of a causal powers theory of causation. It also differs from Shoemaker's latent dispositions view and constitutes a more powerful epistemological problem for emergence than previously dealt with in the literature.

When it comes to emergence as a metaphysical theory, we have to make choices regarding our fundamental ontology, our theory of properties, and our theory of causation. The central issues in the debate about emergence all turn on these choices. Arguments about emergence that divorce themselves from ontology or which are based on ad hoc metaphysical reasoning are unlikely to succeed. Therefore the first part of this thesis – The Problem of Reduction - examines what it is that a theory of emergence explains about macro-phenomena. The first three chapters in particular play an introductory role by defining the motivations, the methodology, and many of the core concepts in the thesis.

Chapter 1 starts by setting out the plan for the first part. I then describe some of the macro-phenomena we are talking about – chaotic systems, causal novelty in Conway's Game of Life, holistic effects in quantum mechanics, top-down causation, complexity theory, and some problems in the philosophy of mind like the combination problem. Some of these are often held up as examples of emergence, while some are only rarely the target of emergent explanations. All are instructive.

Chapter 2 presents the background picture. This is a chapter about our methodological assumptions and here we make some important choices about fundamental ontology. These choices include: atomist foundationalism; fundamentalism, or the no-levels view; a two-category ontology of substance and mode; deflationism about derivative entities; and a sparse account of properties that essentially involves causal powers. In this chapter I provide some brief reasoning behind these choices. To be clear, these background assumptions are compatible with either the truth or falsity of powers emergence. Some of the time this reasoning is intimately tied up with the very possibility of emergence - or to generate the situation where emergence would have an explanatory function - other times the choices are made for independent reasons. Along the way I argue against some theories of emergence

that do not make the above assumptions on the grounds that they must assume a theory of properties that renders emergence superfluous.

Chapter 3 investigates the success conditions for a theory of emergence, or any theory attempting to do the same job. A variety of different problems the theory is supposed to solve are analysed within the ontological framework established, and the problems are found to gain varying amounts of traction within that framework. There then follows an analysis about the nature of philosophical explanation and a general statement of the problem to be solved in this thesis – the Problem of Reduction. This takes a somewhat novel form compared with the explananda of emergent theories more commonly found in the literature. Correspondingly, there is an analysis about what a solution to this problem must look like.

Chapter 4 is a rundown of the features of different theories of emergence. These are analysed within the ontological framework we've established, and compared with the settled-upon explananda and our requirements for an explanation. In the process I closely analyse some of the key features of a theory of emergence and make some novel observations about their implications. We also dismiss many theories that are either incompatible with our background picture or insufficient for our explanatory requirements.

Chapter 5 presents a coherent and sufficiently specified theory of emergence - Causal Powers Emergence - and explicates how this theory meets our requirements. It is this theory upon which the second half of the thesis is based; it provides a foil for our argument in favour of an alternative to emergence. Chapter 6 elaborates on the theory of emergence by comparing it with some of the failed theories from chapter 4 and demonstrates how Causal Powers Emergence avoids these pitfalls.

Chapter 7 is the turning point of the thesis. We develop and evaluate a critical problem for Causal Powers Emergence called the Epistemological Problem. In this chapter we will advance a new, underexplored form of this problem and its implications as well as covering some of the major metaphysical arguments that emergentists have employed to defend their theories against the problem. I argue that the epistemological problem is not merely an epistemic problem. In this chapter we're not seeking to prove that the theory of emergence is incoherent or incongruous with any established theories, the aim is show that there is an alternative to emergence. The final three chapters of the thesis are all about this alternative, which we shall call Causal Powers Inherence.

Chapter 8 takes us back to our theory of properties as essentially involving causal powers. Here we analyse causal powers and say more about what they are and the epistemic issues

involved with their individuation. We make some choices about our theory of causal powers in line with the major proponents of Causal Powers Emergence.

Chapter 9 is all about how powers work and what they can do. This is crucial to evaluating the force of the Epistemological Problem and the responses to it. We learn that the problem is very serious and the responses to it wholly inadequate. I also make an original powers-based analysis of P. W. Anderson's classic example of a macro-phenomenon using vector diagrams. Additionally, in the course of this investigation it's argued that our theory of causation must include a range of compositional principles, which has the effect of further compounding the problem.

Chapter 10, the final chapter, brings together some of the threads in the previous chapters to present the new theory of Causal Powers Inherence as a viable alternative to emergence. A clearer explication of this view is attempted, with important implications for the individuation conditions for powers and our theory of causation.

In the end I conclude that, given this metaphysical background, emergence is unnecessary. When the two competing theories are compared, according to some selected criteria for theory choice, emergence loses. This is largely because the theories of powers and causation that we have assumed (and that I believe are implied by the choices made in developing a theory of emergence) are necessary to explain a vast range of macro-phenomena ranging from the simplest interactions between powers. The emergentist is faced with a dilemma: they must either assume that emergence is ubiquitous, or they must accept a theory of causation that undermines the need for emergence. My aim is not to settle the debate, but merely to show that there is a strong competitor to emergence that is underexplored and worthy of further consideration - to come to a settled conclusion would require me to address meta-philosophical questions about the relative weighting of different theoretical virtues, which would probably require a thesis in itself. The thesis ends with some thoughts on the epistemic values evidenced in the theories of emergence and inherence. It is also indicated that with more work we might discover other applications for this view of causal powers in the same areas in the philosophy of mind that invoke emergence.

The Problem of Reduction

1. Motivations

One of the aims of this thesis is to give an answer to the question “What is emergence?” The chief difficulty in answering this question is that apart from the vaguest definitions there isn’t a settled idea about what ‘emergence’ means. There are several different theories of emergence, without a consensus about their comparative success.

A potential strategy would be to catalogue the different theories and give a taxonomy. If one were to pursue this strategy, one would notice as soon as starting that the theories are often radically different to each other in their basic ontological features (like their theory of causation or theory of property individuation). One could seek to judge the success of each theory within that theory’s metaphysical framework, but if each theory is internally consistent with respective to each of their metaphysical frameworks it is a much more difficult task to evaluate such theories with respect to each other. The varying accounts of emergence rest on these frameworks, and the success of each theory often turns on the success of their ontologies in terms of wider ontological considerations; the evaluative criteria for an ontology brings in a whole host of other metaphysical issues. Theories of emergence can pack a lot of ontological baggage.

All this makes it very difficult to respond to the question “What is emergence?” with a definitive investigation that could conclude that *this* is emergence. Putting aside the comparative exercise, this first half aims to define the most general features of emergence in a coherent and plausible way. Some of these features are not shared by all theories of emergence, which reflects the variety of such theories. Sometimes theories that have been called ‘emergence’ will simply turn out not to be such.

What is in common between the theories of emergence? I argue that they broadly fulfil certain criteria for dependence and novelty, as we shall see in chapter 4, and they do so in similar ways. What similarities there are is the direct result of the main motivating factors that lead one to posit a theory of emergence – for instance, in philosophy of mind, an attempt to resolve conflicts or to do justice to certain intuitions about mental properties – and of emergence’s proposed position within this debate relative to other theories that seek to solve the same problems.

If we look just at the theories of emergence involving mental properties, we find that the point of these various theories is to provide an explanation for (mostly) the same basic set of explananda. So, while finding the set of evaluative criteria for competing ontological systems, when looked at as a whole, is a vexed question, finding the set of evaluative criteria for theories of emergence, within their respective ontological systems, is much more manageable, and such judgements can go beyond mere internal consistency. As such, this thesis begins by setting out a metaphysical background picture that will be used to assess the proposed theories of emergence and to develop some problems that such a theory must resolve. This is the task in chapters 2 and 3.

Before that it will be useful to get a better handle on what we mean when we talk about 'macro-phenomena' and give some examples of the system-level behaviour for which we're seeking to provide an explanation. The first point to make in this vein is that it does not suffice for this behaviour to be strikingly 'new', as is the case, for instance, with liquidity or life. We can illustrate this using the example of the Game of Life, the cellular automaton devised by the mathematician John Conway.[1] The universe of this game is a 2D infinite grid, with one of two basic properties occurring at each position: **live** or **dead**. The universe has an iterative time progression governed by three rules of causation: *birth*, *survival* and *death*. These rules govern which of the two properties a particular position will have in the next time slice according to whether that position currently has too many or too few **live** properties occurring in neighbouring positions.

With just these three basic rules the Game of Life is capable of producing an extraordinary variety of system-level behaviour and macro-phenomena. These include stable 'living' entities that oscillate in complex recursive patterns and life-like cellular automata that travel across the universe spawning gliders and other moving 'organisms', or even exact replicates of themselves using instruction tapes. This is extremely novel behaviour given the simplicity of the rules governing the universe. Yet no emergent explanation is necessary.

In this case we already know all of the rules that govern the universe. There is nothing that emergence is required to explain. We can take a complex self-constructing pattern of living properties occurring across millions of positions and we can analyse it time slice by time slice and observe that the only rules required to explain its behaviour are *birth*, *survival* and *death*. All of the behaviour observed will reduce to those rules and the pattern of occurrent properties.

[1] Gardiner 1970

Yet still, it might be very useful once we start analysing the patterns in the Game of Life to refer to general rules that govern certain patterns – like those patterns that produce movement. These rules are patterns of behaviour that hold at a system-level rather than at the level of the positions and properties themselves; but we know that we can always revert to the brute-force method to demonstrate that *birth*, *survival* and *death* are the only rules necessarily involved in the evolution of this universe. The rules holding at the system-level are causally redundant.

One way of getting a handle on the type of macro-phenomena that necessarily involves an explanation like emergence is to imagine an alternative Game of Life where *birth*, *survival* and *death* are not the only rules. In this alternative universe we would be able to observe a divergence from these rules wherever the additional rules affect behaviour. From one time slice to another, we would see instances where positions have the properties **live** or **dead**, in a way that violates the rules *birth*, *survival* and *death*. If we do not know all of the rules governing this universe, we must find an explanation for this behaviour.

If, let's say, these rule violations are associated with certain system-level patterns, we might reasonably identify the rule violations with these system-level patterns. Let's call those rule violations system-level behaviour. Hence we have a novel macro-phenomenon – the rule breaking behaviour - that motivates an emergent (or an inherent) explanation. It raises the question: is it the case that the rules of this alternative Game of Life are themselves more complicated than in the original game?; or are they incomplete (so that *birth*, *survival* and *death* are different in this universe, or not the only rules at work)? As we shall see, these could both be considered forms of inherence.

Alternatively, perhaps it is the case that the system-level pattern identified with this behaviour is a new property, in addition to **live** and **dead** - a macro-property that might feature in its own rules. A property that is had by a whole region consisting of many positions that are **live** and **dead**, but which somehow does not merely consist in them. This is a form of emergence. In effect, the arguments in this thesis are about how we should figure out the rules to this game.

Now let's give a few examples of macro-phenomena in our own universe.[2] Here are three to get us started: correlated particles in quantum mechanics;[3] non-linear dynamical systems in

[2] There will be other examples given throughout the thesis.
[3] We'll mostly be relying on the arguments in Silberstein and McGeever 1999

chaos theory, complexity studies or connectionist modelling;[4] and the nonstructurality of conscious experience.[5]

Let's start with EPR–Bohm systems:

> A simple example is as follows. If two spin-half particles (an electron and a positron) are produced by the decay of a single spin-zero particle at some central point and move directly outwards in opposite directions, by conservation of angular momentum the spins of the electron and positron must add up to zero, since that was the angular momentum of the initial particle. Therefore when we measure the spin of the particles in some chosen direction, the particle spins will always have opposite values. This is true (for both correlated and anticorrelated particles) regardless of how far apart the particles are. It is clear that such anti-correlations are not mere coincidence, for the 'change' in the particle's spin will occur every time. Constant-correlation guarantees that if the two measurement events on separate parts of an EPR–Bohm system should employ the same types of measurements, their outcomes will be opposite. [6]

Silberstein and McGeever go on to argue that this correlation can only be explained by the particles interacting non-locally – which would seem to be ruled out by special relativity – or by the emergence of some sort of holistic correlation property. They argue that entanglement between parts and wholes in quantum field theory contradicts philosophical atomism and also "completely explodes the ontological picture of reality as divided into a 'discrete hierarchy of levels'",[7] which they take to imply emergence.[8] I admit that quantum entanglement is a motivating phenomenon for a theory of emergence, but I think the argument in Silberstein and McGeever's paper is invalid. In chapters 2 and 3 I argue that it is necessary to assume fundamentalist atomism in order to motivate a theory of emergence. Silberstein and McGeever's ontology is unclear, but if evidence from quantum field theory really did imply the rejection of atomism – and I don't think that it does – then not only does this not imply emergence, it seems to render emergence unnecessary.[9]

The second example we are going to cover in this chapter is chaos theory. Chaos theory is a form of dynamical systems theory focussing on systems with chaotic behaviour. It studies

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[4] See e.g. Wolfram 1994
[5] This is just one of the combination problems presented in Chalmers 2016
[6] Silberstein and McGeever 1999, p. 187
[7] See chapter 2 for explanations of both these ideas.
[8] Silberstein and McGeever 1999, p. 189. Indeed, they even say that the spin properties of the individual particles "literally no longer exist at the same time as the emergent property instance" – the real property is the property of the whole system.
[9] My arguments to this conclusion start in section 2.2.

unstable aperiodic behaviour in deterministic non-linear dynamical systems.[10] But it does not study the system in basic causal terms, or try to quantitatively predict the next time slices in the system's evolution. Instead, chaos theory provides qualitative and structural characterisations of classes of systems and predicts the general kinds of behaviour that these kinds of systems would be expected to produce. The non-linearity of the systems studied by chaos theory practically prohibit explicit causal understanding, so they can appear random. But even aperiodic dynamical behaviour can be described as trajectories in phase space[11] that converge on certain complex shapes, usually a fractal with a non-integer dimension. These convergences on certain 'strange attractors' in phase space are a universal feature of certain kinds of chaotic systems consisting in otherwise physically disparate properties. Yet the multiple realisability of these macro-phenomena is rarely advanced as a motivation for emergence.[12]

The reason it is rarely taken as motivation is that it is broadly acknowledged to be compatible with the reductionist situation we saw in the original Game of Life:

> It is important to clarify that chaos theory argues against the universal applicability of the method of micro-reductionism, but not against the validity of the philosophical doctrine of reductionism. That doctrine states that all properties of a system are reducible to the properties of its parts.... Chaos theory gives no examples of 'holistic' properties which could serve as counter-examples to such a claim.[13]

Indeed:

> chaos theory introduces no new postulates about the physical world at all. Chaotic models are built in a strictly 'classical' world, using modelling equations ... in a thoroughly Newtonian manner.[14]

Other dynamical systems are amenable to this philosophical interpretation too. Connectionism is an example. It attempts to model cognition using complexity theory by treating the brain as a dynamical system exhibiting self-organisation. The modelling of the reinforcement of individual neural connections is supposed to explain how relatively simple individual parts can achieve self-organising criticality without much prior structure or

[10] See, e.g. Kellert 1993
[11] The abstract space comprising the possible values of the variables of a system.
[12] Silberstein and McGeever do attempt such an argument, see Silberstein and McGeever 1999, pp. 194-8. And Newman 1996 also argues that being in the basin of a strange attractor is an emergent property.
[13] Kellert 1993, p. 90
[14] Ibid, p. 41

organisation. But this and other applications of complexity theory, while they seek to discover universal rules that apply to the behaviour of all systems of a requisite complexity, are again, in many respects, like the models of cellular automatons in the original Game of Life. They achieve the formation of meta-rules for complex systems, but are at least compatible with the causal redundancy of those rules.[15]

We are just starting to see the relevant considerations when approaching a case of novel system behaviour. Only those cases that are incompatible with our extant metaphysical picture are relevant to the question of ontological emergence. This is why we must first develop a metaphysical framework, as we do in chapters 2 and 3. Indeed it is only by developing the finer points of that metaphysical picture – as we do in chapters 8 and 9 – that we can come to a principled final judgement about the truth of emergence. The motivation of this thesis is the observation that this issue turns on our metaphysical theories about fundamental ontology.

In the previous two cases we have made quick assessments based on the criterion of 'causal non-redundancy'.[16] But there are other motivations for emergence. An instructive example is the case of the non-structurality of conscious experience. If one supposes that the direct acquaintance we have with the intrinsic character of conscious experience indubitably reveals to us the existence of meta-properties that are non-structural, then this seems to be a problem for all accounts of conscious experience that are micro-constitutive, since those micro-constitutive parts of experience must somehow come together.[17]

It might be the case that inherence in a complex object gives emergent properties an advantage when it comes to solving the combination problem. We already seem to be half-way to explaining subjective experiences if we can talk about radical new kinds of properties of the subject of experience, rather than the properties of the simples comprising that subject. But even if emergence has no power to explain combination-type issues, it can still provide an explanation for the existence of mental properties, if they are thought to be a radically different kind of entity; furthermore, it does so in a way that guarantees those properties causal efficacy, which is a perennial problem in the metaphysics of mind, as we will discuss in chapter 3. The problem of mental causation has been perhaps the most important motivation for work on emergence in this area – the causal closure argument and its variants are analysed in sections 3.2, 3.3, 5.1, 5.2, and 6.1. This has been a brief warm

[15] See Wolfram 1994 for more on complexity theory and the Game of Life.
[16] Wilson 2013 includes a more sophisticated critical analysis of chaos theory and the Game of Life vis-à-vis ontological emergence which includes other criteria for reduction. In chapters 3 and 4 we will make similar points.
[17] This is a version of the combination problem for panpsychism, see e.g. Seager 1995

up to the subject, and an outline of what we mean by macro-phenomena and the putative macro-properties of emergence. Our conclusion at first blush is that we are motivated to posit a theory of emergence where there are system-level features for which our best evidence apparently contradicts our metaphysical background picture.

2. The Background Picture

2.1 Fundamental Ontology

A key commitment of this thesis is that work in fundamental ontology is required to develop and evaluate the theories trying to explain the phenomena described in chapter 1. To get started we will make some assumptions. Some of these assumptions will be simply stated, others will be short expositions of major positions countenanced in various metaphysical debates.

It is a common contention that, in metaphysics, one thing leads to another. Theses that are independently attractive might be incompatible or incommensurable and so cannot always be bolted together. For this reason I have chosen to make assumptions now that will constrain the possibilities to come. Since the congruence of the overall picture of reality is critical to the success of any particular metaphysical theory, at least some of the rest of the picture needs to be set out.

This picture is realist (the universe is not mind-dependent) and naturalistic (reality is exhausted by nature).[18] The realist methodology of the thesis precludes explanations that are about mere concepts rather than reality itself. Conceptual analysis is required, but the theories employing these concepts are descriptions of how we think the world is, not how we think about the world. Metaphysics should not conflate the epistemological issues that bear on explanations with truths about the nature of the universe. More specifically, this means that the categories of being that will be explored and defined, while being guided by what is required to be able to think intelligibly about the universe, are not mere constructs.

We are primarily concerned with the reality that is represented by the language, not with the representations themselves. A metaphysical theory of emergence is taken so seriously because it is supposed to be about the way the world actually is. If the dispute can be resolved by conceptual analysis alone then the dispute has become relatively trivial.[19] The

[18] This will be fleshed out as we proceed through the chapter.
[19] For discussion, see, e.g. Lowe 1998, Ch. 1; Hirsch 2005

methodology followed by most metaphysicians is quasi-scientific rather than conceptual-linguistic. Sider describes it so:

> They treat competing positions as tentative hypotheses about the world, and assess them with a loose battery of criteria for theory choice. Match with ordinary usage and belief sometimes plays a role in this assessment, but typically not a dominant one. Theoretical insight, considerations of simplicity, integration with other domains (for instance science, logic, and philosophy of language), and so on, play important roles.[20]

Epistemic worries may arise about the criteria for theory choice and there are different positions concerning how realist metaphysics should be done,[21] but broadly this is the ontologically realist position to which we adhere.

The naturalistic methodology of the thesis precludes explanations that are supernatural or magical. Insofar as appeals to intuitions and everyday experiences are used as guides, they will be used only where it seems that they cannot be debunked by cognitive scientists, experimental philosophers or other work on, for example, cognitive biases. The work here will be constrained by science, since what knowledge anyone has of the universe is tempered by scientific enquiry. The fundamental ontology developed here will constrain science only in the sense that, if it is true, it will set limits on scientific theorizing that could not in any case be crossed, because for the universe to be any other way[22] would be metaphysically impossible. The only time this would seem to be a limiting constraint for, say, a physicist, is when the physicist has, in their work, slipped into doing metaphysics. And once it is metaphysical theories that are being posited, it is quite right that metaphysical reasoning should constrain those theories.

A theme of the thesis will be the tendency for the elision of physics and metaphysics to pass unnoticed, or for metaphysical claims to be made based on straightforward translation from scientific theory. There will be several examples of when metaphysical implications are posited based solely on scientific evidence and without the reflexive equilibrium between that constraining empirical evidence and the metaphysical reasoning that is necessary for implications of that sort to be discovered. The above commitment to naturalism does not mean that fundamental physics is a royal road to fundamental ontology. The requirements

[20] Sider 2009, p. 385
[21] See, e.g. Manley 2009, pp. 4-8
[22] In terms of the general categories of being.

for truth in the two types of theory are not the same.[23] Perhaps most importantly they differ in modality: the truth of metaphysical theories is that they are true with metaphysically necessity; scientific theories are not required to meet this standard to be true. And so, given the above, if any scientific theory is true then our fundamental ontology should be true. At least that is the aim. Metaphysics is required to tell us about the fundamental ontological categories and also the ontological status of whatever putative entities are posited by scientific theories.

For the purpose of an investigation into the metaphysics of emergence, it is assumed that properties are real and that they are one of the fundamental categories of being. If this were not the case it would be difficult to motivate a theory of emergent properties.[24] It will also be assumed that substance is a fundamental category of being.[25] It would be an error to assume that we can achieve clarity on a phenomenon like emergent properties without first achieving clarity on the fundamental ontology of property and substance. I am going to assume that there are such things as properties, where, speaking generally, properties are understood as ways things are. Unless otherwise stated, 'entity' should be understood as meaning either an object, a property inhering in an object, or a property-entity (e.g. tropes). The term 'property' is used to denote the additional something that makes the fact of similarity true. This allows for a discussion of properties without adopting a position on whether they are universals, particulars, tropes, etc. It is assumed that when two ways of being differ, that difference is a difference in the properties that are present. The special sciences - and many other human enterprises - are often interested in these difference and similarities. It is of particular relevance to this thesis that one of the aims of fundamental physics is to discover the fundamental properties in nature.

2.2 Fundamentality and Dependence

2.2.1 Ontological Dependence

The ideas of fundamentality and dependence are central to the concept of emergence.[26] Often this is a matter of ontological dependence – of one entity depending for its existence on other entities. When entitiy x is dependent on entities $y_1 \ldots y_n$, this can mean several things. One form of dependence is where, had it been the case that some of the entities $y_1 \ldots y_n$ had not existed, x would not exist now - in the same manner as my existence now is

[23] See also Paul 2012.
[24] Because emergent properties are a subset of properties.
[25] It is possible that this assumption is not necessary for us to proceed; it is nonetheless made for convenience. It may well be the case that substances are really bundles of tropes, for example. I do not think that this has much bearing on the discussion, and where I think it does it is noted.
[26] Sometimes these ideas are essential, e.g. Barnes 2012. But there are also varieties of emergence where fundamentalism is not assumed.

dependent on my parents existing at some point in the past. This is not ontological dependence. The idea is that *x* is *continually sustained* by entities $y_1 \ldots y_n$. My continued existence is not sustained by my parents' continued existence (except perhaps in some loose financial sense.)

Maintenance is required, but ontological dependence means something stronger still, something like the dependence of a complex object on its parts. One key difference is that an ontologically dependent entity, *x*, is dependent on the current existence of some entities $y_1 \ldots y_n$, synchronically, rather than being merely counterfactually dependent on the past existence of $y_1 \ldots y_n$. Another is that this relation is stronger than causation.[27] Here is a working definition:

> (OD) An entity *x* is dependent iff for all possible worlds *w* and times *t* at which a duplicate of *x* exists, that duplicate is accompanied by other concrete, contingent objects in *w* at *t*[28]

The key is that it is impossible for *x* to exist by itself, as a matter of metaphysical necessity. It is part of the intrinsic nature of *x* that it bears this relation to certain other objects. But note that (OD) does nothing to explain the dependence of x on entities $y_1 \ldots y_n$: it merely stipulates the dependence of *x simpliciter*. One cannot duplicate x without having at least something else, but (OD) does not explain why *x* is dependent on any particular *y*,[29] nor what the necessary and sufficient existence conditions are for *x*. This reflects the fact that *x* is necessarily dependent, but not necessarily dependent on the particular set of entities $y_1 \ldots y_n$. Duplicates of *x* could exist in other worlds with some or all of the entities $y_1 \ldots y_n$, or with some other entities entirely.

(OD) also reflects that while x is not dependent on any particular entities as a matter of necessity, it is necessarily dependent on *some* entities such that if those entities were taken away, *x* would no longer exist. In contrast, an ontologically independent entity could have a duplicate existing in a world by itself, i.e. they are capable of 'lonely existence'.[30]

2.2.2 Foundationalism

If one entity is dependent on a second entity, one could plausibly claim that the second entity is more fundamental than the first.[31] If one then proceeds to follow this chain of dependence

[27] For more on the relationship between counterfactuals and causation, see section 8.2. Causation is, however, still a candidate for the emergence relation, see sections 4.6 and 6.2.
[28] This is from Barnes 2012, p. 880.
[29] Or *z,* or anything else for that matter.
[30] Langton and Lewis 1998
[31] For example, the part-whole relation is considered a paradigm of ontological dependence.

one might expect to 'bottom out' somewhere by discovering an entity that is ontologically independent. There are theories that call themselves metaphysical emergence that do not assume a bottom level. I will propose that these are not theories of ontological emergence, but rather theories of properties that do similar explanatory work.[32]

Why should we suppose that there is a fundamental level? There is the problem of an existential regress. If one entity existentially depends on another that means that it would not exist without it. The existence of any entities at all therefore seems to require the existence of some entities that do not existentially depend on another.[33] If fundamentality and ontological dependence are linked like this then a clearer understanding of how some entities are ontologically independent and some dependent will help us to understand the putative hierarchy of being that terminates in the bottom level.

Identifying ontological independence and fundamentality lead some,[34] to reject the possibility of emergence.[35] But making this assumption does not in itself rule out emergence. And so long as supporting arguments about the nature of substances - like those in section 6.5 - are successful, the possibility of emergence remains open. Others argue that the ontologically independent objects and the fundamental objects are not necessarily coextensive.[36]

Those that believe that the chains of ontological dependence must have a well-founded termination in entities that are ontologically independent hold a view called metaphysical foundationalism. Usually it is thought that the "bottom level" is at the smaller end of the scale, like it is in ordinary mereology. This is the atomist view (though the fundamental objects are not atoms but subatomic particles, presumably whatever would be identified at bottom by a perfected fundamental physics.)

Atomism is not the only form of metaphysical foundationalism. The fundamental level might not be at the bottom but rather at the top. Jonathan Schaffer has defended the view that the universe as a whole is fundamental and is a substance in its own right.[37] The proponents of

[32] A theory of emergence that does not assume a bottom level may be possible, but such 'emergence' would be unexceptionable because without a bottom level there would be no Problem of Reduction, see chapter 3.
[33] For more on this see, for example, Campbell 1976, 1990; Lowe 2006a; Robb 2009.
[34] e.g. Heil 2012
[35] The reasoning is slightly more complicated. It follows from positions regarding the nature of ontological independence, i.e. that substance is the category of ontological independence and that substances are simple. Therefore the properties of complex objects cannot be ontologically independent. See section 6.5. and Heil 2012, Ch. 3. Heil does hold a theory of 'emergence' that is compatible with these positions, which is discussed in chapter 4. However I contend that this is also not emergence.
[36] See section 4.6.
[37] Schaffer 2010a, and also Trogdon 2009 for a discussion.

foundationalism that see the direction of ontological dependence as running from the top to the bottom (larger objects depending on smaller ones) are pluralists, the proponents of foundationalism that see the direction reversed are monists. I will assume an atomistic pluralism because emergence seems both unnecessary on a monist view – monism certainly encounters no problem of reduction as described in chapter 3 - and also, more pertinently, impossible by definition: to be a monist is to believe that there is only one fundamental entity, the universe.[38]

There is speculation that the chain of ontological dependence does not need to end in a foundation of ontologically independent entities. It might be possible for the chain of dependence to go on ad infinitum without threatening the existence of all the entities in the chain; in other words, the regress identified above might be real but not vicious.[39] Let's call this view metaphysical infinitism. If the direction of dependency runs from the big to the small, then this infinitism violates atomism – atomism posits an ontologically independent foundation of simple entities at the bottom of the chain of dependency. One illustration of a universe of endless complexity is David Lewis's universe of 'atomless gunk'[40], or, as D.C. Williams puts it:

> The universe might have been the same size that it is, and included exactly the same number of individuals, variously discrete, overlapping, and included, in the same way, and yet have been perfectly homogeneous throughout, one great blob of blanc-mange, say (i.e., of stuff which really is the way blanc-mange seems to be).[41]

There might be good reasons to suppose the actual universe includes simples, and therefore is not infinitely divisible.[42] But even if this were not so, the possibility of this kind of metaphysical infinitism is at least relevant - given what is said above about the methodology of metaphysics - to our metaphysical picture. For instance, the possibility of an infinitely divided,[43] gunky, universe might alone provide support for priority monism.[44] This – reversing the direction of dependence - would be one way to bring non-dependent existence into our picture of the universe in a way that would not seem to be threatened by infinite divisibility.

[38] Schaffer would disagree with this (see 2010a), but that is because of a difference in his position on inflationism vs deflationism about derivative properties, see section 2.4.
[39] See Bliss 2013 and Morganti 2014 for more on this possibility
[40] Lewis 1991, p. 20
[41] Williams 1986, pp. 3-4
[42] See Cameron 2008a
[43] Divided in the sense of substantial division rather than spatial division.
[44] Schaffer 2010a

Nonetheless, we do not need to consider the possibility of an endlessly divided universe when examining ontological emergence. This is because in a universe without simples – or with only one simple, a la priority monism – there is no need for ontological emergence to account for the presence of putatively 'emergent' phenomena. This is because without atomic simples there is no ontologically privileged set of objects that might in turn privilege certain properties. In other words, without an atomistic foundation of simple substances, there isn't the same strong motivation for restricting the reification of properties, so the problem of chapter 3 does not arise.

What is called 'emergence' in a non-atomic universe would be comparatively unexceptionable; and furthermore, no special theory is needed. Whatever the theory of properties developed under the alternative positions on foundationalism, it is unlikely to motivate a metaphysically deep distinction between emergent properties and any other kind of property.[45] I will argue later that a theory of properties which holds that all properties are emergent is not a theory of emergence, so we assume atomism for our discussion. This will become clear in sections 3.5-9. We will also return to consider the possibility of metaphysical infinity in a different category in section 8.4, an analogy to which the possibility of infinitism here will be useful.

2.2.3 Fundamentalism and Levels of Being

In the previous section the notion of fundamentality was fleshed out in terms of ontological dependence and the positions within the metaphysical foundationalism vs metaphysical infinitism debate. I will maintain that a variety of foundationalism – namely, atomism - is a necessary assumption in developing ontological emergentism.

There is another way of fleshing out the notion of fundamentality; a way that many who employ it (but not all) would argue is necessarily linked to the first. The crucial distinction here is not between entities for which existence is dependent and entities for which existence is independent, but rather between entities that exist derivatively and entities that exist fundamentally.[46] Alternatively, as Kit Fine characterises the present, latter, division, the distinction is between what exists and what exists in reality.[47]

The two distinctions, dependent/independent and derivative/fundamental, seem closely related. Ontological dependence is at least one way that we might analyse what we mean by

[45] As I mentioned in chapter 1, this observation renders the argument in Silberstein and McGeever 1999 invalid. I take Contextual Emergence (see Silberstein 2014) to also suffer from this lack of motivation.
[46] e.g. Williams 2010
[47] Fine 2001

derivative (arguably ontological dependence is the best way of analysing the derivative/fundamental distinction[48]). But since there are some conceptions of emergence that rely on a separation between the two,[49] it will be given a separate treatment here.

This second kind of fundamentalism posits that there is a single division in nature between what exists at a fundamental level and everything else. It does not admit degrees of existence. The relevant contrast to this conception of fundamentalism is a picture where the distinction between the fundamental and the derivative is, at the very least, less sharp. A non-fundamentalist might admit degrees of fundamentality, for instance, or describe reality as comprising 'levels of being'. If a non-fundamentalist were also a metaphysical foundationalist in the context of the previous debate, we might imagine that they believed that there are levels of being with a foundation at bottom but with a relation other than ontological dependence operating between the levels of being. That the relation could not be ontological dependence is necessary so that the resultant/fundamental distinction does not collapse into the dependent/independent distinction.

Alternatively, Barnes argues[50] that one might conceivably hold entities to be ontologically dependent but still fundamental, i.e. a philosopher who was a metaphysical foundationalist and a fundamentalist might also posit a relation other than ontological dependence which can be used to analyse the distinction between fundamental and derivative entities. Barnes postulates that such an ontologically dependent but fundamental entity would count as emergent. Her arguments will be examined in section 4.6., where we will conclude that the greatest obstacle for a theory of emergence along these lines is to give an analysis of the relation between fundamental and derivative entities that would make possible that ontology.[51]

In the meantime let's provide a naïve, first-blush description of fundamentalism that is independent of the notion of ontological dependence. Fundamentalism in this case is the view that things are not more or less fundamental, but rather things are either fundamental or they are not. And everything that is not fundamental has its existence derivatively from the fundamental things.

One way to get a handle on the fundamental/derivative distinction is by appeal to God. The theological metaphor goes like this: the fundamental entities are all and only those entities

[48] See, for example, Heil 2012
[49] e.g. Barnes 2012
[50] Barnes 2012
[51] Note, however, that this does not preclude the possibility of emergence - it will also be argued that is not necessary for an emergent entity to be ontologically dependent to count as emergent.

that God needs to create in order for the world to be how it is. God would not need to create the derivative entities of that world. The existence of the fundamental entities of any world, *w*, are necessary and sufficient for that world to exist, and any differences between that world and a different world, *w'*, are differences in the fundamental entities (and possibly the way that they are arranged, depending on what composition relations are set.)

2.3 Properties

2.3.1 Real Properties

Properties are postulated in order to account for apparent similarity between objects.[52] As an example, there is a similarity shared by two blue chairs that they do not share with a red chair; in addition, there is a similarity shared by all three chairs that none of them shares with a table. We might say that all the chairs have the property of *being a chair*, and two of them have the property of *being blue.* David Armstrong takes that there are real similarities in the world to be a 'Moorean' fact,[53] that is, following G. E. Moore, the fact of "sameness of type" is a common-sense truism which philosophers should not deny, though they might argue about the philosophical account of these facts.[54] This is not supposed to be a logically necessary or indubitable truth, but nonetheless a compulsory question of which any comprehensive philosophy must give some account. Without similarity between things, we would be living in a world devoid of structure; an amorphous lump.[55] If we take similarities between things to be a feature of the world, then we should have some way of accounting for them. That is: we must give some account of how numerically different particulars, like chairs, can have the same properties, like *being blue*, or *being a chair*. The question also arises for relations, for instance, standing in the relation of being between two chairs, which can also belong to numerically different particulars. In realist metaphysics the result of this accounting for similarity is a theory of properties.

This function of a theory of properties can be given the following formulation: "what ontological structure, what array of real entities, is necessary and sufficient to account for the likeness among different objects which ground the use on different occasions of the same general term".[56] Although Campbell stresses that the problem is primarily an ontological rather than a semantic issue, this formulation is vulnerable to misunderstanding because it seems to suggest that our task is a semantic one: to explain how 'general terms'—or

[52] It should be noted that properties are not just unifying but also characterising entities. This second function will become clear once we start looking in more detail at theories of properties.
[53] Armstrong 1984, p. 250; 1997b, p. 102
[54] Moore 1925; 1939, p. 295
[55] Note the differences between this and the picture of reality as atomless gunk, as in Section 2.2.2; see Eklund 2007.
[56] Campbell 1981, p. 483

predicates—are grounded. Nelson Goodman's 'grue' and Wittgenstein's 'games' show us that predicates are not necessarily grounded in a single feature of the world, i.e. they do not necessarily share a single property.[57] In the terminology of David Lewis,[58] *being grue* and *being a game* are prime examples of 'abundant' properties, which may be "as extrinsic, as gruesomely gerrymandered, as miscellaneously disjunctive" as one pleases; they "pay no heed to the qualitative joints, but carve things up every which way. Sharing of them has nothing to do with similarity."[59] When we are giving an account of the actual similarity between things we are concerned with the 'sparse' or 'natural' properties that most closely carve nature at the "qualitative joints". We will assume that, contra Goodman,[60] the similarity accompanying the sameness of such sparse properties is ontological and objective: it has nothing to do with the language or system of representation we use.

2.3.2 Fundamental Properties

Similarly, there is an idea going back to at least Plato that it is the business of science to 'carve nature at the joints'. If one is able to wield the scalpel at will, the number of different ways of 'carving nature' is potentially endless, but most of these ways of carving are arbitrary and of no use or interest (including arbitrary conjunctions, like the part of nature that is the Eiffel-Tower-and-my-right-arm.) Other ways of carving are functional for certain purposes; they capture similarities between parts of nature that are important or useful, and the decision about which ways are important and useful depends on your perspective and what interests you.

The first step to a realist criterion for property identification is to show how structure can and should determine meaning, because of the advantages of our language carving nature at the joints. In so far as we seek truth, the groupings we use in our language should reflect nature's structure. Like Lewis, we shall think of the structure of the world as the distribution of 'natural' properties and relations.[61] These properties and relations determine similarity and therefore the natural groupings. If parts of nature being carved up are similar, then they share some properties.[62] If this is true then there are some other groupings in the world that are better than others: similarity is not flexible.[63] On the atomistic picture assumed above, if the carving is done at those joints which themselves have no joints, then the parts of nature

[57] Goodman 1983: 74; Wittgenstein 1953, pp. 66-71
[58] Lewis 1983, pp. 346-7; 1986, pp. 59-63
[59] Lewis 1986, p. 59
[60] Goodman 1972, p. 438
[61] Lewis 1986, pp. 59-69
[62] This assumption is stretched for complex systems – where system-wide similarities can occur without much in the way of underlying similarity, but it is assumed that there is underlying similarity, *in some respects*, in all such circumstances.
[63] Contra Goodman 1972: 443-4

carved thusly will be fundamental properties. One kind of fundamentality for a property is thus defined as the indivisible natural divisions in the world that can be made on the basis of natural similarity.

2.3.3 Structural Properties

Armstrong's 'structural property' is a useful term of art in metaphysics when talking about derivative properties, where: A property, S, is structural if and only if proper parts of particulars having S have properties not identical with S and jointly stand in relation R, and this state of affairs is the particular's having S.[64] S is constituted by the properties of the parts of the composite and their relation to one another. [65] A fundamental property, identified by carving nature at the joints that themselves have no joints, inheres in an object that by definition has no proper parts and so cannot be constituted this way. Structural properties inhere in objects that stand in the relation of mereological products to the objects having fundamental properties. They are therefore, since mereological products are ontologically dependent on their parts, ontologically dependent on their parts having fundamental properties (and standing in certain relations). Structural properties are had by ordinary mereological complex objects, which are prima facie derivative entities. This is an example of how fundamentality is commonly defined in contrast to ontological dependence. Whether or not structural properties can be fundamental will depend on whether mereological products are necessarily derivative, which will determine whether the mereological relation is a good candidate for the emergent relation.[66] There are three options for someone wishing to maintain a distinction between fundamentality and ontological independence: either deny that indivisible natural divisions are sufficient for fundamentality, deny that mereological products are necessarily derivative, or affirm a non-mereological relation of ontological dependence between objects.

2.4 Deflationism about Derivative Entities

I want to be clear that this is a thesis that both the emergentists and non-emergentists can accept. It is crucial that these background assumptions do not rule out emergence from the start. So before discussing deflationism I just want to emphasise that emergent entities would not be derivative in the sense discussed here.[67]

[64] Armstrong himself thought that structural properties corresponded to genuine universals and are non-mereologically composed.
[65] Armstrong 1978
[66] See chapter 4
[67] For instance, for the emergentist, emergent properties will be non-structural properties.

2.4.1 The Ontological Status of Composite Objects

Here I'll briefly mention the debate about the ontological status of composite objects. This will be essential background for assessing the compositional view of inherence developed later in chapters 8-10 in opposition to emergence. It is also useful background for the discussions about existence and identity conditions throughout the thesis.

On one side there is Willard Van Quine and David Lewis, who argue that if there are some objects nothing need be done to make another object with those objects as parts.[68] On the opposite extreme are the mereological nihilists, who say that there is nothing you could do to make a new object using the others as parts; composite objects (e.g. tables, chairs, molecules) simply don't exist: there are only simples. Proponents of this view include Cian Dorr and Peter van Inwagen,[69] among many others. That van Inwagen is a mereological nihilist and yet accepts the addition of living things in his ontology is a clue to the compatibility of mereological nihilism and the existence of entities outside the domain of fundamental physics.[70] To abruptly parse the debate, Lewis says "There exist tables", and the nihilist says "There do not exist tables, there exists only simples arranged table-wise".

2.4.2 The Ontological Status of Derivative Entities

Not all derivative entities are necessarily composite objects or structural properties. There is a wider debate about the ontological status of derivative entities. Like with composite objects, we can be either inflationary or deflationary about derivative entities. Inflationary accounts[71] have it that both derivative and fundamental entities really exist, but there is a difference between how they exist, or there is a difference in the nature of their existence. Deflationary accounts have it that both derivative and fundamental entities can be truthfully said to 'exist', but in some metaphysically privileged sense only fundamental entities really exist. One way to cash out the deflationary claim is that we can say true things about derivative entities, but the only things that make up the world are the fundamental entities. We'll look at this distinction in section 3.8. Ross Cameron[72] goes further and argues that we can not only say true things about a derivative entitiy, *x*, without an ontology that includes *x*, but even the truth of the proposition '*x* exists' does not require an ontology that includes *x*.

[68] Quine 1976; Lewis 1986: 212-3
[69] Dorr 2003, 2005; van Inwagen 1990
[70] van Inwagen 1990. Another strong clue is, for instance, O'Connor arguing that emergent properties are not structural properties. See, e.g. O'Connor 1994, 2000b; O'Connor and Jacobs 2003; O'Connor and Wong 2005; O'Connor and Churchill 2010
[71] E.g. Schaffer 2010a, 2010b
[72] In Cameron 2008a, 2010

This brings us to another position in the debate about the ontological status of fundamental and derivative entities: an appeal to equivocation about the term 'exists' that dissolves the debate. We might argue that the deflationary and inflationary positions are using the term 'exists' in different ways without there being a corresponding difference in reality. This is not an inflationary claim because, while the inflationist believes that the proposition '*x* exists' has multiple meanings, the inflationist also believes that at least some of those meanings correspond to differences in the nature of the existence of entities. It is not a deflationary claim because, while the deflationist might hold that the true proposition '*x* exists' does not imply that x really exists, and so also believes that the proposition '*x* exists' has multiple meanings, the deflationist also believes that some of the entities that the inflationist believes really exist (namely the derivative ones) do not, in fact, exist.

The trouble is, given our commitment to realism, equivocation about the meaning of the proposition '*x* exists' could make it difficult to have a real debate about the ontological status of derivative entities (and thereby emergent entities.) Equivocation threatens to dissolve the debate between inflationary and deflationary claims if the key term at issue is equivocal not just between the multiple senses of the term 'exists' held by the two positions, but also between the two positions themselves.

Equivocation is intuitively appealing, it can seem that the term 'exists' is equivocal in this debate; the inflationary and deflationary positions above are just different ways of describing the same reality.[73] To conduct a metaphysical investigation into the ontological status of derivative entities, we need to be able to make meaningful truth claims that correspond to differences in that ontological status.

2.4.3 Equivocation About the Term 'Exists'

Let's call this intuition about the equivocal meaning of metaphysical terms like 'exists', 'Equivocation'. Equivocation amounts to a denial that anything is really at issue between the disputants of a metaphysical debate. The apparent opposition is like that of the 'verbal' or 'terminological' disputes encountered in ordinary conversation. The actual, substantive situation posited by the two opponents is really the same; they have merely found different ways to describe it. Eli Hirsch advocates for a form of Equivocation, he describes the intuition as follows: "The first thought... is this: There can't be anything deep or theoretical here. The facts are, so to speak, right in front of our eyes. Our task can only be to remind ourselves of relevant ways in which we describe these facts in our language".[74] The task then becomes a matter of conceptual analysis, to 'command a clear view of the use of our

[73] Which would be contrary to the proclaimed methodology in section 2.1
[74] Hirsch 2002, p. 67

words'.[75] The dispute is 'merely verbal'. David Manley argues that a dispute is verbal just in case, when holding the facts the same, the closest world in which they do not semantically deviate is the one in which they agree.[76] Equivocation is strongly revisionary because it denies the professed aims of the disputants.

To use the debate about composite objects as an example, someone who was subject to the Equivocation intuition may suspect that, since the table-related facts before Lewis and, say, Dorr, seem so obvious and well established, they must be "talking past each other"; they simply mean different things when they say "There exist tables". For instance, perhaps for Lewis the proposition 'There exist tables' means the same as what the proposition 'There exist simples arranged table-wise' means for Dorr; each makes claims that are true given what he means; so the debate is merely verbal. The argument will dissolve by resolving the differences in the way the disputants use certain terms of their propositions.

To defend this discussion of the ontology of mereology - and realist metaphysics in general - we must examine what Equivocation could mean. If Equivocation is true then the dispute between Dorr and Lewis is merely verbal; the propositions they express regarding the existence of tables must mean different things: "There exist tables" means something different in the mouth of Lewis than it does in the mouth of Dorr. So where does this disagreement lie?

Holding the quantifier 'there exist' the same, for the proposition "There exist tables" as spoken by Lewis to mean "There exist simples arranged table-wise"—a proposition accepted by Dorr—the predicate 'table' in Lewis' mouth, '$\text{table}_{\text{LEWIS}}$', must mean 'simples arranged table-wise'. However, this misses the point of the debate over composite objects, which is concerned with whether mereological collections exist. '$\text{Table}_{\text{LEWIS}}$' might instead mean 'collection of simples arranged table-wise',[77] but then it is clear that the disagreement persists. Furthermore, it is possible to retain the substance of the debate even when it is recast in terms of a world in which there exists only two simples. In this world, would there be just two objects, the simples, or three objects, the two simples plus a mereological collection? Since the disagreement between Lewis and Dorr persists, we can see that Dorr and Lewis also mean the same thing by the predicate 'table': $\text{table}_{\text{DORR}} = \text{table}_{\text{LEWIS}}$.

[75] Wittgenstein 1953
[76] Manley 2009, p. 14
[77] As long as 'collection' is understood to mean mereological collection rather than set-theoretical collection, see Sider 2009, p. 389

Equivocation must instead imply that the quantifier varies between the two propositions.[78] In the languages of Lewis and Dorr, $\text{exists}_{\text{LEWIS}}$ means something different to $\text{exists}_{\text{DORR}}$. Specifically in this example it might be tempting to say that the domain of the quantifiers differs as follows: $\text{exists}_{\text{LEWIS}}$ is unrestricted, whereas $\text{exists}_{\text{DORR}}$ is restricted to simples. This would make it possible for both propositions to be true, making the debate merely verbal. However, note that, while Lewis would accept Dorr's proposition when 'exists' = $\text{exists}_{\text{DORR}}$ because it does not contradict 'exists' = $\text{exists}_{\text{LEWIS}}$, the same cannot be said for Dorr, who would seem to have no reason to accept a restricted domain for his quantifier. Furthermore, it seems to do unnecessary violence to the point of the debate over mereological parts. Dorr is not referring only to simples when he says that 'There do not exist tables'. His quantifier is in some sense unrestricted. It is a mistake to think about quantifier variance here in terms of the domains, like restricted and unrestricted. Also, we cannot say that one unrestricted domain is larger than another, because this would mean that something could somehow exist outside everything.[79] In what sense can unrestricted quantification vary?

David Chalmers shows that at least two senses of unrestricted quantification can be distinguished: these are heavyweight and lightweight quantification.[80] The difference between the two is that lightweight existential assertions are trivially true (or false) whereas heavyweight existential assertions aren't. Again, this doesn't seem to help us; Dorr and Lewis will presumably both be using heavyweight quantification. The problem is that Dorr and Lewis think they have a substantial dispute on their hands because they intend to mean the same thing with their terms; they intend to use the same quantifier. Various candidate meanings for unrestricted quantifiers do exist, but the speakers in this case seem to want to refer to the same existential quantifier.

The Equivocationist accepts that the metaphysicians are trying to fix on a single distinguished quantifier meaning, but, the Equivocationist argues, the metaphysicians' equivocation needn't be transparent to them.[81] The key problem for us is if there are multiple (inferentially and materially adequate) interpretations of quantifiers[82] and these candidate meanings for quantifiers are not sufficiently metaphysically distinguished. As we shall see, we need a realist content-determiner to show that in this is not the case.

[78] As per Hirsch 2002, 2009
[79] Sider 2007
[80] Chalmers 2009, p. 95-7
[81] Though the hostility of this interpretation makes it clear that ontological equivocation is unlike other forms of merely verbal dispute.
[82] see Chalmers 2009; Sider 2007, 2009, pp. 391-3

Whether the debate is substantial or not turns on whether $exists_{LEWIS}$ and $exists_{DORR}$ really mean different things. If we assume that such candidate meanings exist we can explore another premise of the Equivocation position: the denial that some of the candidate meanings are better than others in terms of their fitness to the world. We need metaphysically realist criteria for choosing among the potential domains. If the realist criteria are available and strong enough, then the correct quantifier is fixed within the linguistic community. Let's call this meaning '$exists_N$'. This is the candidate meaning that Lewis and Dorr are referring to. Their actual usage of 'there exists' might not fit with '$exists_N$', but nonetheless '$exists_N$' is what they mean. The best candidate meaning is such because of its intrinsic eligibility based on naturalness.[83] This outweighs ordinary usage as a determiner of meaning. If such a content determiner is available then the quantifier is invariant and the dispute must be substantial.

We've already argued that there are advantages to our language carving nature at the joints.[84] More than this, Lewis argues that the natural properties and relations are a factor in determining content. In order to decide what Dorr and Lewis's words mean, we have to look at more than just their past usage, or the usage of their community, in order to fix their references. Past usage is consistent with a range of possible interpretations of the meaning of their words and some of these possible interpretations could be true while others plainly false. However, the problem disappears if one of the candidate meanings is metaphysically distinguished. Lewis argues that the best candidate is distinguished by its 'naturalness'. In this sense natural properties and relations act as 'reference magnets' that can fix the meaning of our words where there is uncertainty. In our example, the candidate meaning distinguished by naturalness is '$exists_N$'.

This reference magnetism goes over and above past language use, so it can help explain why, when old words are applied to new situations, we think of language users as "going on in the same way". They are like Wittgenstein's "rails invisibly laid to infinity".[85] A semantic sceptic might deny these sorts of natural criteria, but this creates difficulties for realist metaphysics. Without something like the "rails invisibly laid to infinity", there is nothing about past usage of the predicate 'exists' that would ensure that it will behave in the future the same way it has behaved in the past.[86] There are too many candidate meanings that are consistent with past use for us to be able to judge the truth value of a new proposition ("too many" insomuch as the past usage criteria are consistent with both a set of meanings that

[83] See Manley 2009, pp. 30-1
[84] Section 2.3.
[85] Wittgenstein 1958, p. 218
[86] Hirsch 2002, p. 53

would render the new proposition true and a set of meanings that would render it false). Furthermore, consistency with the inferences of true statements made in the past will also be insufficient. Sure, consistency with past usage and inferential adequacy are requirements for selecting among the candidate meanings, but we need something more.[87] With the past usage and inferential adequacy requirements alone, quantifier variance remains trivially correct.

Returning to Lewis's doctrine of reference magnetism based on naturalness: If naturalness is to distinguish a single quantifier meaning, $exists_N$, the force of reference magnetism must be strong enough to outweigh a failure of $exists_N$ to match the use of 'there exists' in English.[88] The realist can make an assumption about content determination such that the naturalness receives a greater relative weight compared with use.[89] A strong reference magnet would be sufficient for '$exists_{DORR}$' and '$exists_{LEWIS}$' to actually mean $exists_N$, even if this does not fit Dorr or Lewis's usage. This would be sufficient, but it is not required to defend realism. Even if the magnetic force is too weak to compensate for any significant mismatch with English usage, it is possible to recast the debate between Dorr and Lewis so that naturalness will sufficiently determine content.

If the force of reference magnetism is weak, the realist can concede to the proponent of Equivocation that naturalness does not outweigh other considerations in determining the meaning of 'there exists' in English. However, the debate between Dorr and Lewis is not about the meaning of the English term 'there exists', it is a quasi-scientific search for what actually exists.[90] To avoid some of the irrelevant considerations involved in ordinary English usage we can introduce a new language in which to conduct the debate. While this new language must obey the core inferential role of quantifiers in English, other sources of mismatch with naturalness will be given a low weighting in content determination. Highly natural meanings that are broadly in line with core inferential roles will be given a strong weighting, strong enough to accommodate weak magnetism.[91] We could call this new language 'Ontologese'.

Breaking from ordinary usage seems justified here in order to anchor the debate to let us get on with the substantive questions that ordinary usage might obscure. It also seems to better reflect the quasi-scientific methodology being employed in realist ontology. As described

[87] This is the argument in Sider 2007
[88] See Sider 2009, p. 413
[89] See Sider 2004
[90] As per section 2.1.
[91] See Dorr 2005

above, in realist metaphysics, theoretical insight, considerations of simplicity and integration with other domains are more important considerations than the fit with ordinary usage. In Ontologese we appeal to the actual structure of the world for the meaning of our terms. If the world has a distinguished quantificational structure, then the meaning of quantifier terms will reflect that structure.

Returning to Cameron's deflationary account of derivative entities,[92] he argues that the truth of the proposition '*x* exists' does not require an ontology that includes *x*. The basis for that distinction is that the proposition '*x* exists' is a natural language proposition, not a proposition in Ontologese. In this case use has trumped naturalness; the quantifier expressed does not correspond to the non-linguistic structure of reality – it does not carve nature at the joints. We are interested only in true sentences in Ontologese, so we assume that derivative entities on the deflationary account do not, in fact, exist. It is still possible to cash out the deflationary position by saying that we can say true things about derivative entities, but the only things that make up the world are the fundamental entities;[93] however, for a derivative entity, *x*, whatever else we can truthfully say about it, we cannot say '*x* exists'.

It is crucial for a theory of emergent properties that derivative entities do not exist. If our existence conditions really are equivocal, or if they imply an inflationary account of derivative properties, then emergence is a relatively trivial matter. This discussion moves us some way towards the necessary existence and identity conditions for a sparse property ontology in a realist metaphysics. We will go on to refine these conditions and to argue that the existence conditions for properties, while involving considerations about integration with our best scientific theories, are, like with the truth of natural language propositions, not a matter of quantification over scientific usage.[94] A property ontology suffices to explain observed scientific macro-phenomena, or to be congruent with the terms in our best scientific theories, wherever truthmakers exist for propositions involving those phenomena and theories.[95] We will also argue that the existence and identity conditions for properties are such that they involve the causal profiles of properties, but much more fine-spun argumentation concerning our theory of causation is required to individuate causal properties.[96]

[92] In Cameron 2008a, 2010; referred to in section 2.2.4.2.
[93] As in section 2.4.2, see section 2.5.
[94] This thread runs through sections 2.4.4, 2.6, 3.1, 3.7.
[95] See section 3.8.
[96] This thread runs through 2.6, 4.4, and chapters 8-11

2.4.4 The Relevance of Derivative Entities

There is more natural structure in the world than that provided by the joints demarking fundamental entities. Investigating this larger structure involves other, derivative groupings sharing similarities.[97] It is assumed that, while fundamentalism implies that ontologically there is one distinction in nature - between the fundamental and the derivative – this distinction does not imply that all derivative entities are equal in their interest or usefulness. There are derivative entities that have a greater or lesser fitness to the world.

Sider argues that, while we can use arbitrary groupings and in so doing we might be able to get at the truth, truth-seeking is best served by adopting the best groupings; progress is more difficult using ill-chosen concepts. In any case, the truth-seeker wants more than to merely believe many true propositions and few false ones. They want to discern the structure of the world. If we lack the appropriate groupings we cannot be said to have properly understood this structure.[98] Sider is making this link in relation to the basic logical structure of quantification and terms like 'exists'. And in the domains of logic, metaphysics and fundamental physics, we might expect the best groupings, the most indispensable concepts, to correspond to not just the structure of the world, but to the fundamental structure of the world, i.e. the existence of fundamental entities, and this is what we should want, since these domains of enquiry are concerned with fundamental structure. However, the ideal criteria for the terms used by the truth-seeker will not necessarily be the same in all domains and it is not at all clear that this link between fundamental structure and truth-seeking holds more generally.

The truth-seeker in metaphysics and fundamental physics may well be best served by concepts that correspond to fundamental entities. (Though even in fundamental physics there are concepts that are gainfully employed that do not correspond to fundamental entities.) In the special sciences beyond fundamental physics, as Jerry Fodor helped point out,[99] there are many non-fundamental concepts that are indispensable. And if we accept Sider's link between usefulness and correspondence to real structure, their explanatory indispensability is a good clue that they do correspond to real structure in the world. We might be tempted to go further than this, as Fodor does, and argue that not only does explanatory indispensability indicate a correspondence with real structure in the world, it also indicates the existence of real entities.

[97] The view espoused in this section owes a lot to Heil 2003
[98] Sider 2009, pp. 400-2
[99] Fodor 1974

Fodor argues that some who have accepted “the generality of physics vis-à-vis the special sciences: roughly, the view that all events which fall under the laws of science fall under the laws of physics”[100] have mistakenly assumed that this implies “that every property mentioned in the laws of any science is a physical property, where a physical property is one mentioned in the laws of physics”.[101] Here it’s clear that Fodor takes properties to be more-or-less implied by their mention in laws of science.

The realist methodology of this thesis[102] involves various criteria. Integration with other domains is an important criterion, but there are others. And integrating a metaphysical theory with special science domains does not in any case require a match with the usage in those domains, or taking those concepts seriously as claims about fundamental ontology. He argues that special science concepts are not replaceable by concepts belonging to fundamental physics. But this is a thesis about predicates, not a thesis concerning properties or groupings of properties. At first blush, the explanatory indispensability of concepts within the special sciences should not be taken as a threat to deflationism about derivative entities.

If we take Fodor’s claims ontologically seriously, we might portray him as holding that the special sciences each concern themselves with separate domains of real properties. Some of which form a hierarchy of levels which depend on each other, but also possess some degree of autonomy with respect to lower domains. This is the levels-based picture that we rejected in section 2.2.3.

Given a fundamentalist interpretation, Fodor’s argument amounts to the claim that explanatory indispensability is a good clue to the correspondence of concepts with fundamental properties. But even if we hold something like the reference magnetism of Sider and Lewis, this need not be the case. This section started with the assumption that in domains not concerned with fundamental properties, explanatory indispensability might indicate correspondence with natural structure, but that that structure could be either fundamental or derivative - derivative structure, while never being more or less fundamental, can still be more or less natural. There is more natural structure in the world than that delineated by fundamental entities. Concepts can correspond to groupings of fundamental entities that are more or less gerrymandered. The choice is not between concepts that pick out only arbitrary groupings and concepts that pick out only fundamental properties.

[100] Ibid, p. 97
[101] Ibid, p. 100
[102] See sections 2.1 and 2.4.3.

Fodor's argument will be mentioned again in chapter 3. While such observations do not commit us to a particular ontology, like, say, an inflationary position on derivative entities or a levels-based conception of reality, the basic insight in Fodor – that there is seemingly irreducible causal behaviour - is used to formulate some explananda for a deflationist ontology. We will there see that, with our background, there are two broad categories of explanation available to a deflationist in this regard – they are emergence and inherence. While emergence is of course inflationist when it comes to emergent properties, emergence is compatible with deflationism in general.

In summary, there are many other ways of carving and many other parts of nature that have striking similarities that are hidden from the perspective and techniques of fundamental physics. While the special sciences are not precluded from discovering fundamental properties,[103] unless metaphysical emergence is widespread,[104] these non-fundamental natural groupings are the standard domains of the special sciences. Observations like Sider's about the correspondence between the concepts most useful for truth-seeking and the naturalness of those concepts do not pose a threat for our background picture.

We have so far assumed foundationalism, the existence of ontologically independent entities; fundamentalism, the existence of a clear dichotomy between fundamental and derivative entities; and deflationism about derivative entities, here defined as the claim that derivative entities do not, in fact, exist. We have distinguished between arbitrary structural properties, which are not distinguished by Lewis's 'naturalness' and whose identification is not useful to the truth-seeker; natural structural properties, which have a greater fitness to the world's structure and references to which are useful to the truth-seeker in the special sciences; and fundamental properties, which carve nature at the joints which themselves have no joints. The distinction between fundamental properties and structural properties is perhaps a subset - and at least analogous to - the distinction between fundamental and derivative entities. The relation between fundamental properties and structural properties is one of ontological dependence. But we have not ruled out that there may be other relations of ontological dependence that are unlike that underlying structural properties and therefore could be the relation of Barnes's emergence.[105] To say more about ontological dependence and about the difference, if any, between properties and entities, we will first have to say a little bit about substances.

[103] This would beg the question against emergentism.
[104] To be clear, Fodor 1974 could imply ether non-fundamentalism, inflationism about derivative entities, or widespread emergence.
[105] Barnes 2012

2.5 Substance

Like property, substance is a category in fundamental ontology. The idea of substance is derived from the notion of individual things or objects. These are the things in which properties inhere, or which exemplify or instantiate properties. But substances have also performed other roles, depending on whether substances are the fundamental entities or whether they depend on something else.[106] Kim defines substance as the 'constitutive object' of an event, the category that exemplifies properties.[107] There is debate as to whether the fundamental entities are substances or something else (in Kim's case, events). At issue is the nature of objects, and whether objects are a basic entity, or one that is characterized by more fundamental entities, like states of affairs, events or a bundle of property-entities. The ontological status of objects in relation to events and whether substances are necessary for objects are both important questions for fundamental ontology. The following are some options in that debate.

2.5.1 Objects as Bundles of Properties

Do substances have to be ontologically additional entities? One of the main supposed functions of substances is to give objects particularity. Campbell[108] argues that if properties themselves are particulars then substances are not needed at all, and if substances are not needed, then the desire for ontological economy would suggest against substance as an ontological category. Objects would instead be entirely constituted by bundles of their properties.

However, Armstrong argues[109] that it is a category mistake to substantialise properties. Properties are just incapable of independent existence. And this problem remains whether properties are tropes,[110] as held by Campbell, or universals, as held by Armstrong. The central idea here is that properties are the way that things are, properties are not things in themselves. Substances function not just to individuate individual objects: they also enable the existence of the property instances exemplified by an individual substance. The significant feature of a substance is that it is capable of independent existence in a way that properties are not. While an individual substance can exist independently of the property instances it bears, those property instances cannot exist without the individual substance of which they are properties.

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[106] We'll establish a less liberal notion by the end of this section, which will be relevant to the arguments in section 4.5.
[107] See 'Events as Property Exemplifications' in Kim 1993
[108] 1990
[109] 1989 pp. 114-5, 1997 p.99
[110] 'Module' tropes, as opposed to 'modifier' tropes.

2.5.2 Substances as Thin Particulars

Armstrong instead argues that substance is a substratum or thin particular. The fundamental entity here is a state of affairs comprising a thin particular and the properties it exemplifies. The thin particular possesses properties, but it is distinct from those properties. In Armstrong's ontology, it is the thin particular that particularises the property-universal's individual objects, but the thin particular, while exemplifying the properties it possesses, does not, in itself, have any properties. On this account thin particulars and property instances are separate and distinct entities.[111]

One implication of Armstrong's theory of substance is that it requires an additional category – states of affairs. This is because there must be something in the world in virtue of which the thin particular and its properties are 'welded' together. For Armstrong this can't be either the thin particular, the property instance, or the two together, because there is nothing intrinsic about these categories that would guarantee the relationship of instantiation of that property by that particular at that time. The instantiation of the property by the substance is the state of affairs, which is a form of non-mereological composition, and a new category of being.

The idea of states of affairs as ontologically additional entities is problematic. Some have criticised the idea of thin particulars.[112] The worry is whether the idea of an entity lacking any properties is incoherent, and to what extent it is an issue that such an entity is beyond experience. To elucidate the idea, Armstrong refers to the Fregean notion of the unsaturatedness of concepts: he says that a state of affairs has 'blanks as part of its nature' that are filled by thin particulars and property instances.[113] Furthermore, a thin particular can only exist within a state of affairs, a thin particular seems strange when considered by itself only because it cannot exist independently. This explains why the notion is strange, since the thin particular cannot be experienced, the only way we can know of it is through the particularity of the properties that it instantiates as part of a state of affairs.

Problems remain for this account however, for instance, how can one thin particular be distinguished from another thin particular – something that would seem to be necessary for them to function as particularisers - without there being any properties by which to do so? Armstrong argues that the numerical distinctness of thin particulars is sufficient for this task.

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[111] In a formal sense rather than capable of independent existence.
[112] e.g. Campbell 1990
[113] 1997, p. 29

2.5.3 Aristotelian Substance Ontology

Another theory of substance[114] is that properties are ways that substances are, and, as such, properties and substances are so intimately connected that they do not need any additional entity like a state of affairs to 'weld' them together. This is because, when properties are taken seriously as ways that substances are, the two aren't separate and distinct in the way that they are in Armstrong's account. Substances are property bearers; properties are ways substances are.[115] The two categories of being are complementary. Every substance is *itself* some way or another - often many ways - and there is no need for there to be anything that binds a substance to its properties. For a substance to possess a property is just for that substance to be a certain way; properties do not make up a substance – they are not parts of a substance. When we consider the substance absent its properties, or we consider any of the properties absent its substance, we are abstracting – this is what Locke called 'partial consideration'. According to this view the categories of substance and property are fundamental and inseparable. A substance must have some properties – it cannot be no way at all. And a property must be a property of a substance.

On the Aristotelian view there is no more fundamental category than substance and property – like states of affairs or bundles of tropes - from which either of the categories can be derived. There is no relation equivalent to the instantiation relation between Armstrong's universals and substances on this view. But the two categories are inseparable and cannot exist without each other. In section 2.2.1 we gave a minimal definition of ontological dependence (OD) as follows:

> (OD) An entity *x* is dependent iff for all possible worlds *w* and times *t* at which a duplicate of *x* exists, that duplicate is accompanied by other concrete, contingent objects in *w* at *t*[116]

It should be clear from this that while substances cannot exist independently of any properties, this is not a form of ontological dependence. Whether properties are entities or not, they are certainly not objects on the Aristotelian account.[117] This leads us back to the characterisation of a substance as an ontologically independent entity.[118] Since substances

[114] As put forward in, for instance, Martin 1980.
[115] For more on properties as ways, see Levinson 1978, 1980; Seargent 1985; Armstrong 1997a, pp. 30-1; Heil 2003, 2012 Ch 2.
[116] This is from Barnes 2012, p. 880
[117] It is noted here that this also implies that, if properties are entities, then their inseparability from substances makes them ontologically dependent on them. It might be argued that they are fundamental and ontologically dependent entities. This will form part of our discussion about the relationship between ontological dependence and fundamentality in sections 4.5-6.
[118] See, for example, Campbell 1976, 1990; Robb 2009.

are objects on the Aristotelian account, they're inseparability from properties does not make them ontologically dependent; it is they that can have the ontological independence necessary to guarantee the existence of all other entities. They could be the existential foundation we committed to in section 2.2.2. The world would be a world of objects.[119] In order to perform this role, if complex objects depend on their parts, substances seem to have to be simple. We will return to this in section 3.1.

2.6 Causal Powers

In the next few sections we'll set out some options on what the relationship between causal powers and properties might be. There are a range of different theories, but in the background here is Plato's Eleatic Stranger:

> I suggest that anything has real being that is so constituted as to possess any sort of power either to affect anything else or to be affected, in however small a degree, by the most insignificant agent, though it be only once. I am proposing as a mark to distinguish real things that they are nothing but power.[120]

Here the idea is that there is nothing to a concrete entity but its power to affect and be affected. Properties confer powers to the objects possessing them – they are 'pure powers'. This means that properties make a difference to the way the world unfolds and the truth of any counterfactuals in which they feature is due to the powers that properties confer.

Many philosophers have been attracted to the idea that properties are powers.[121] There is the Eleatic Principle[122] and Alexander's Dictum[123], both of which express roughly the same principle that to be real is to possess causal powers. The Eleatic Principle posits that all properties make a difference to the causal powers of something. Alexander's dictum is stronger, it posits that all properties must contribute causal powers to objects.[124]

Similar ideas are also at work in the distinction between genuine properties and 'mere Cambridge properties', which are arbitrary and not real. An example of the latter is Fodor's *H*-particle.[125] A particle has the property, *being an H-particle*, just in case it is a particle and a

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[119] Rather than 'a world of states of affairs' as per Armstrong 1997
[120] Plato, Sophist 247d-e
[121] I'm going to us the terms 'power' and 'disposition' interchangeably. Philosophers who have held that properties are powers include the following: Boscovich 1763; Priestley 1777; Harrè 1970; Harrè and Madden 1975; Mellor 1974, 2000; Shoemaker 1980; and Swoyer 1982.
[122] Oddie 1982
[123] Kim 1993, p. 202
[124] Strictly speaking, it is to this dictum, not the Eleatic Principle, to which we must appeal to rule out non-power properties. See Molnar's positional properties for an example of properties that make a causal difference but are not properties: Molnar 2003, pp. 158-60.
[125] Fodor 1988, p.33

coin tossed by Fodor lands heads. We do not consider these properties to be genuine because they are obviously gerrymandered and possession of them is dependent on distal objects, but another reason that we think these properties are not genuine is that an object's having of them makes no difference to the way that object behaves. One reason to favour such a view of properties is the worry that, if properties were causally impotent, then they would be undetectable and therefore unknowable (insofar as detectability requires some kind of causal interaction with something). There is a problem of epistemic access to non-dispositional properties. Another, stronger, reason to favour the view that properties are powers is that, if a property did indeed make no difference to the powers of its possessor, then it would seem to make no difference at all.[126]

2.6.1 Pure Powers

The theory of properties as pure powers goes further than the dictum that all properties must bestow powers. To give a more precise definition of the thesis: proponents of the pure powers theory believe that intrinsic properties of concrete objects are distinguished by distinctive contributions they make to powers or dispositionalities of their possessors.[127] Here is Shoemaker, a prominent advocate of the view that properties are powers, providing reasons to suppose that not only do all properties make a causal difference, they are also distinguished by causes:

> Suppose that the identity of properties consisted of something logically independent of their causal potentialities. Then it ought to be possible for there to be properties that have no potential whatever for contributing to causal powers, i.e., are such that under no conceivable circumstances will their possession by a thing make any difference to the way the presence of that thing affects other things or to the way other things affect it. Further, it ought to be possible for there to be two or more different properties that make, under all possible circumstances, exactly the same contribution to the causal powers of things that have them. Further, it ought to be possible that the potential of a property for contributing to the production of causal powers might change over time, so that, for example, the potential possessed by property *A* at one time is the same as that possessed by property *B* at a later time, and that possessed by property *B* at the earlier time is the same as that possessed by property *A* at the later time. Thus a thing might undergo radical change with respect to its properties without undergoing any change in its causal powers, and a

[126] These arguments are examined more closely in chapter 8.
[127] This definition is from Heil 2003, p. 76. Note that Heil and Martin, while being powers theorists, are not pure powers theorists.

> thing might undergo radical change in its causal powers without undergoing any change in the properties that underlie these powers.[128]

From considerations like these we might draw the following theory of property identity:

> (PI) Necessarily, if *A* and *B* are properties, *A* = *B* just in case *A* and *B* make the same contribution to the causal powers of their possessors.[129]

A possible objection arises. The basic thought is that if a property did indeed make no difference to the powers of its possessor, then it would seem to make no difference at all, the above principles are embellishments of that. But perhaps properties that are causally irrelevant are still relevant—they make a difference—in some other, non-causal, way. What sort of property might make a non-causal difference?

2.6.2 Categorical Properties

One reason to think that not all properties are powers is the plausibility of categorical or qualitative properties. These include the qualities of conscious experience and also the qualities of ordinary physical objects. Here is an example of a line of argument against a theory of properties as pure powers:

> On the face of it, a qualitatively empty world is indistinguishable from the void. The worry here is not just that a world barren of qualities would be dull and listless. A weighty tradition, going back at least to Berkeley, has it that the notion of a world without qualities is incoherent: a wholly non-qualitative world is literally unthinkable.[130]

> The real difficulty lies not in the threat of a regress, but in the fact that qualities play a central role in the identity and individuation of powers. Strip away the qualities, and it is no longer clear what, if anything, you are talking about.[131]

The existence of categorical properties is a counterexample to a theory of properties as pure powers in so far as these properties are not identified by their contribution to the causal powers of their possessor. This would be true if such properties were purely categorical, or if a property were both categorical and dispositional, but it was possible for its qualitative

[128] Shoemaker 1980, pp. 214-5
[129] We will look a lot more closely at considerations of property identification in chapter 8 and 9. For now the purpose is just to outline our basic assumptions about properties.
[130] Heil 2003, p. 76
[131] Heil 2012, p. 71

features to vary independently of its dispositional ones. What can we say about the distinction between categorical and dispositional properties?

Drawing the distinction is difficult. Some have argued that properties are both dispositional and categorical.[132] But there is also a tendency in usage for 'categorical' to refer to any non-dispositional property, making the two mutually exclusive and exhaustive.[133]

I will use the terms 'categorical' and 'qualitative' interchangeably to refer to intrinsic qualitative properties and the term 'dispositional' to refer to properties that bestow powers, where certain powers are bestowed on an object solely by that object having a certain property. "Dispositional properties, if there are any, have their powers 'built in'."[134] This last sentence is to be contrasted with properties that bestow powers only indirectly. For instance, Armstrong argues that properties bestow causal powers on their possessors only in virtue of laws of nature.[135] On this picture, properties are intrinsic and qualitative and it is the relations that hold between those properties that determine the powers that are conferred.

2.6.3 Intrinsic vs Relational

This leads us to one of the ways in which the distinction between dispositional and categorical properties can be drawn: the notion of intrinsicality. Let's define an intrinsic property as "nonrelation[al] in the sense that its possession by an object does not (logically or conceptually) require the existence of any separate object or the existence of that same object, or a part of that same object, at some other time. An object, o_1, is separate from an object, o_2, just in case o_1 is not identical with o_2 or with any part of o_2."[136] We can distinguish categorical properties from 'mere Cambridge properties' on this basis. Categorical properties are intrinsic, they are possessed by objects independently of other objects; but the possession of mere Cambridge properties is dependent on other, separate objects, like the flipping of Fodor's coin.

Here there is an analogy with Locke's distinction between primary and secondary (and tertiary) qualities.[137] Secondary and tertiary qualities on Locke's account are powers to produce certain sorts of effects in conscious observers and the qualities of other objects respectively. An example of a tertiary quality would be the sun's power to melt wax. An example of a secondary quality would be a tomato's power to produce the experience of

[132] See the limit view of Martin, e.g. 2008
[133] See Mumford 1998
[134] Heil 2003, p. 79
[135] See e.g., Armstrong 1997
[136] Heil 1992, p. 24
[137] Locke 1690: II. viii

seeing red. Primary qualities, which include 'solidity, extension, figure, motion, or rest, and number'[138] as well as bulk and texture,[139] are intrinsic qualities.[140] They could be possessed by a lone object in virtue of that object alone. In contrast, the tomato, which while ripe always possesses the necessary primary qualities in its surface - the necessary topography or texture, let's say - to produce in an observer the experience of seeing red, can only possess the secondary quality of 'looking red' in virtue of the relation between its primary qualities and the observer. The secondary and tertiary qualities of the tomato are characterised by their possible effects on an observer or on other objects, while the primary qualities are ways the object *is* independently of observers or other objects.

Locke thus employs the notion of intrinsicality to distinguish different sorts of property; however, his distinction does not match up with the distinction between categorical and dispositional properties. Primary qualities on Locke's account, like the round shape of the tomato, also bestow powers, like the power to produce the experience of 'roundness' in an observer, or the power to produce a round indentation in a soft surface. Because Locke's intrinsic primary qualities also bestow powers, they are also dispositional properties, so using Locke's notions of primary qualities and secondary qualities to distinguish between categorical properties and dispositional properties is a non-starter—relational secondary qualities are dispositional, but intrinsic primary qualities are both qualitative and dispositional.

There are at least two ways that we can alter Locke's distinction between primary and secondary qualities for it to illuminate the categorical/dispositional distinction. We can push the relational nature of dispositions and maintain that categorical properties and only categorical properties are intrinsic. Or we can push the thought that dispositional properties depend and are determined by underlying categorical properties, just as the dispositional property to 'look red' is possessed in virtue of intrinsic properties of the tomato. We'll take the first of these options first, and say more about the second option in the section below about grounding dispositions.

Conceiving of dispositions as relations naturally follows from how we commonly identify dispositions, which is in terms of their manifestations. For instance, the dispositional property to 'look red' bestows the tomato with the power to produce the experience of redness when an observer is present. The manifestation in this case is the experience of redness (which may, of course, never occur if the tomato is never placed in front of an observer). Likewise, a

[138] Ibid, 9
[139] Ibid, 10
[140] Note, these are Locke's examples not mine.

vase has the dispositional property of fragility, which bestows the vase with the power to shatter if forcibly struck. The manifestation in this case is the vase shattering, and the conditional nature of these definitions is critical. We shall look in a later section at whether an account of dispositions as conditional statements or in terms of conditional statements is workable; what is clear here is that the conditionality of the dispositional property with respect to its manifestations does not constitute a relation.

Going back to the red tomato, on the present account its being red is a matter of it having the power to produce a red experience if confronted by an observer. But this conditional does not mean that the tomato possesses this power because it stands in some relation to the experiences of potential observers. Indeed, it would be an unintuitive result if it were the case. As an example, imagine a universe in which only the tomato existed, and the having of a dispositional property meant standing in some relation to other objects; in that universe the tomato would not be red. It seems reasonable to assume that objects can have dispositions that never manifest. If not, then we must admit that an object's actual properties are changed by the occurrence or removal of distal objects just whenever the latter are necessary for the manifestation of the former. Imagine the fragile vase and consider whether or not it would stop being fragile just because it were floating in a region of deep space where no other object could reach it. If one admits that a vase is fragile even if it never happens to be shattered, and if one admits that such a vase is still fragile even if it could not in practice be shattered, then it seems intuitive to admit that such a vase is still fragile even if it is in a world where, all else being equal, it could not possibly be shattered.[141]

In contrast, one might think that the powers of an object are contingent with respect to its properties. For instance, a vase is fragile because it possesses a certain molecular structure, an amorphous arrangement of silica, which makes it susceptible to breakage at very little force of impact. However, one might suppose, if things were different, (if, say, we think that there are independent laws of nature), then it could be possible for the vase to have the exact same properties—being an amorphous solid, etc—and yet not be fragile: not have the power to break at very little force of impact. By this I do not mean that the glass vase would not break if it were in different circumstances, like being a different temperature, or undergoing tempering or lamination, but rather that the exact same vase could survive being hit with the exact same force, with nothing about it having changed except for the ability to break. If properties *are* powers then this would not be possible. Glass—an amorphous solid of the relevant kind—necessarily breaks easily in the right circumstances; if we were in a

[141] Heil 2003 contains a similar view that the power of a key to open a lock is not dependent on the existence of the lock.

world where the vase no longer did this, then some of its properties must be different; the properties and powers of the vase could not vary independently.

2.6.4 Grounding Dispositions

Pushing the relational conception of dispositional properties was our first option for drawing the distinction between categorical and dispositional properties. Our second option was to push the thought that dispositional properties depend and are determined by underlying categorical properties. In that vein, we might instead postulate that all powers are 'higher-level properties' that are possessed by objects in virtue of that object's primary, categorical properties. Categorical properties 'ground' the dispositional properties, they are the 'bases' of the dispositions, or their 'realizers'.

The idea that dispositions are 'higher-level' properties 'grounded' in 'lower-level' qualitative properties is separate from the idea that categorical properties are intrinsic and dispositional properties are relational: these grounding and realization relations do not rely on distal objects; they are not external relations.

Functional properties might be a sort of dispositional property on this account. Certainly 'higher-level' dispositional properties would be 'multiply realizable'. Household glass, ordinary ceramics and eggshells are all fragile, but each of them is fragile in virtue of a different micro-structure. For example, these objects might possess the following: an amorphous silica structure for glass, a semi-crystalline clay structure for ceramics, and a crystalline calcium carbonate structure for eggshells. In virtue of possessing each of these different material properties, the vase, the dinner plate and the chicken egg respectively, all have the power to break easily when struck—they are all fragile.[142] The differences in the micro-structures of these fragile objects prevents identification of the shared dispositional property 'being fragile' with any single micro-structural property.

One option is to say that the higher-level dispositional property is realized by, or grounded in, each of these distinct lower-level properties. Prior, Pargetter and Jackson[143] give an argument in support of this thesis, which is based on the following characterisation of the nature of dispositions:

> For each disposition we can specify a pair of antecedent circumstances and manifestation which together determine the disposition under discussion. In the case of fragility, the pair is (roughly) {knocking, breaking}, in the case of water solubility the

[142] All through this section I've used examples that would count as structural rather than fundamental properties, i.e. they are not, in fact, real properties. The examples are purely for illustration.
[143] 1982; contingent laws of nature will also have a role in explaining dispositions on this account.

> pair is {putting in water, dissolving} and so on for the other familiar cases. By 'a causal basis' we mean the property or property-complex of the object that, together with the first member of the pair – the antecedent circumstances – is the causally operative sufficient condition – for the manifestation in the case of 'surefire' dispositions, and in the case of probabilistic dispositions is causally sufficient for the relevant chance of the manifestation.[144]

The properties that ground dispositions – the 'causal basis' – are then argued to be distinct from dispositions themselves.[145]

What is clear from the above definition is that Prior, Pargetter and Jackson assume that dispositions are analysable as conditional statements; however, we shall see in chapter 8 that this is not always possible.[146] Even when such conditional statements are complicated beyond the simple characterisation given above, dispositions cannot be analysed this way.[147]

The conclusion itself is also problematic: dispositions on the grounding thesis are causally impotent.[148] Now, it should be clear that proponents of this view are not making the same ontological assumptions with regard to fundamentalism, since dispositions are regarded as 'higher-level properties', which, if they were not causally impotent would imply 'a curiously and extravagant kind of overdetermination'.[149] Nonetheless, according to our assumptions, dispositions should properly be held, according to this argument, as a derivative entity. References to such properties might figure in explanations and counterfactuals, but we are committed to realism and it seems that the only explanation for causation required in the grounding thesis is the presence of the underlying categorical properties and the conditions for manifestation. Postulating additional epiphenomenal dispositional properties to accompany the categorical ones seems otiose. But if we were to do away with these epiphenomenal powers and explain the fragility of the vase simply by the 'causal basis' for its breaking, it seems that such a causal base would itself amount to properties as powers.[150]

We will proceed with the assumption that powers are either identical to, or figure into the identity conditions of, the properties of objects. We assume this broadly on the grounds of

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[144] Prior, Pargetter and Jackson 1982, p.251.
[145] Ibid pp. 253-4.
[146] Because of e.g. finks.
[147] Again, see chapters 8 and 9. These reformed conditional statements in any case assume that which is to be proven – that dispositions are distinct from their causal bases.
[148] Prior, Pargetter and Jackson 1982, p.255.
[149] Jackson 1997, p. 202
[150] This argument is from Heil 2002, pp. 87-9. For more on the idea of powers being grounded in categorical properties, see Mellor 1974 and Molnar 2003, Ch. 8.

epistemic access and because, if it were not the case, then it would seem that intrinsic properties could not make a causal difference.[151] Looking into the finer detail about the nature of properties will be reserved for later when it will become more important to the argument.

This concludes the background picture. We have assumed a realist and naturalistic metaphysics. We have argued that there exists an ontologically independent and atomist foundation to reality. Reality also comprises a single, fundamental level, though we have so far resisted the temptation to say that the fundamental level *is* the foundation of reality, and we have said that all derivative entities do not really exist, once that term is understood in the relevant way.[152] Properties on the other hand *are* real, at least the fundamental ones, and all properties are either powers or bestow them. Whether or not properties qualify as entities, we have assumed that properties inhere in substances – our atomistic foundation is one of objects. These assumptions and the considerations that have gone along with them will be critical in the next stage of the thesis. We are going to take the motivating observations discussed in chapter 1 and develop a problem for this background picture. That will be the topic of the next chapter.

3. The Explananda of the Problem of Reduction

This chapter looks at macro-phenomena that supposedly motivate emergent explanations. In each case we shall analyse whether these phenomena really do require an emergent explanation, as per chapter 1, because they contradict one of our background assumptions. The discussion begins with a look at the notion of reduction, the failure of which is often taken as an explanandum of emergence. After looking at what kind of reductive failure would motivate emergence, we go on to look at other potential explananda and settle on a general problem that should be solved by a theory of emergence.

[151] Of course there are other ways of abiding by the Eleatic principle without going as far as to say that properties are metaphysically individuated by their causal profile. Armstrong for instance has categorical universals that through laws of nature will always make a causal difference without the properties being essentially causal.

[152] Prima facie, if Barnes's emergence exists, then there are fundamental entities at different levels, which conflicts with this assumption. But there is no reason to assume that ontological dependence will generate levels, or that the fundamental emergent properties on Barnes's view are any less fundamental than other fundamental properties. Once again to emphasise that these assumptions are consistent with emergentism.

3.1 The Reduction of Natural Kinds

3.1.1 Boyd on Reduction

In this section we're going to raise supposed problems for the view above. These are candidate problems that a theory of emergence might be supposed to solve. Let's begin with another look at the problem of the conceptual reduction of special science terms. Richard Boyd,[153] like Fodor,[154] starts with the insight that the special sciences employ categories that are not recognised by fundamental physics. Like Fodor, Boyd has reasonable doubts that there can be a type-type correspondence between natural kind predicates in a completed fundamental physics and natural kind predicates in the completed special sciences.

Boyd, however, is not dealing only with predicates. For Boyd, these 'natural kinds' are clusters or families of real properties: "definitions of natural kinds are reflections of the properties of their members that contribute to that aptness" in explanation.[155] It is in virtue of natural kinds that the special sciences have a certain degree of explanatory autonomy with regard to more 'basic' sciences.[156] The autonomy of the 'natural kinds' – their aptness in explanation – is indicative of their naturalness.[157] "The naturalness of natural kinds consists in their aptness for induction and explanation."[158] An important part of the explanatory aptness for Boyd is the use of natural kind terms in induction – they are projectable to predict behaviour in new circumstances.

It's clear that Boyd does regard natural kinds as clusters of real, powerful properties, and he makes a distinction between these 'homeostatic property clusters' and mere 'nominal kinds'.[159] Natural kinds make contributions to the powers of their objects and do causal work. His natural kinds nonetheless exhibit only family resemblances and they cannot be precisely characterised in terms of the members of these property clusters.

Is this something that needs to be explained by the fundamentalist, deflationist view espoused above? The question depends on whether natural kinds are supposed to be new fundamental properties themselves. If this is the explanation for the failure to reduce natural kinds to their members, then that is a problem for our fundamental ontology and demands explanation. It should be clear from Boyd's definition that this is not the case. Natural kinds are not themselves properties, but merely homeostatic clusters of properties exhibiting family

[153] See, e.g. Boyd 1980, 1999
[154] As mentioned in section 2.4.4.
[155] Boyd 1999: 410
[156] As an aside, we aren't necessarily talking about a neatly nested hierarchy of sciences, but perhaps a messy, overlapping, dappled one, like that portrayed in Cartwright 1999
[157] Compare Sider 2009
[158] Boyd 1999: 410
[159] Ibid: 407.

resemblance. Boyd's idea amounts to the claim that there is no finite cluster of properties definitive of (at least some) natural kinds. Natural kinds instead comprise a vaguely defined sufficiency of necessary properties. This of course may imply a failure of one sort of reduction, but it does not imply the existence of a new property.

Natural kinds as indefinite groupings of properties is no more a problem for our background picture than irreducible predicates. Without something to substantiate these groupings, we can accept that the aptness of natural kind terms is indicative of their naturalness by pointing to the same observations we did with Fodor: there is more natural structure in the world than that given by the fundamental joints in nature. Not all science is involved in carving 'the' joints. Reality has endless joints and different sciences circumscribe different joints that are significant for reasons other than their fundamentality. It is an interesting and important insight that different scientific domains commemorate different and incommensurable taxonomies, but this insight alone is not sufficient for an explanandum in fundamental metaphysics.

3.1.2 Van Gulick on Varieties of Reduction

If not the failure of conceptual reduction, what other problems of reduction might be a problem for us? What would be sufficient for an explanandum given our background picture? Let's have a look at some varieties of reduction. The basic idea of reduction is that, if Xs reduce to Ys, then Xs are, in some way, nothing more than Ys. The notion of reduction is used in a variety of ways. In order to differentiate these notions of reduction we need to be specific about two things:

1. The relata: What sorts of things are Xs and Ys.
2. The relation: How must the Xs and Ys be related in order to count as reduction.[160]

Now, clearly one of the problems with Fodor's anti-reductionism as far as we're concerned was that the relata were theoretical or conceptual, so that a failure for reduction to hold was not a problem for the fundamentalist ontological picture. Van Gulick calls this Representational Reduction, or REP-Reduction.[161] This is as opposed to Ontological Reduction, ONT-Reduction, which is a relation between real-world items such as objects or properties.

Our contention in the preceding section on Boyd was that, since natural kinds are mere collections, there is no failure of reduction. The Xs are a collection of objects and the Ys are

[160] My approach here broadly follows Van Gulick 2001.
[161] Van Gulick 2001, p. 3

objects; therefore, since the relata are real world items, Boyd's is a claim about the failure of ONT-Reduction. It is not, however, a successful claim. This is because when we move to the question of the relation between these items, we have a ready answer to the question of how the Xs are related to the Ys. The answer is composition.

There are other possible relations that could satisfy ONT-Reduction. Van Gulick identifies five possible candidates: elimination, identity, composition, supervenience, and realization.[162] The candidate that will be most interesting to us is composition.[163] If the Xs are composed entirely by Ys, does this mean that Xs are 'nothing more than' Ys? One of the advantages of composition over a straightforward claim of identity is that composition can perhaps more readily accommodate the family resemblance and vaguely defined sufficiency conditions of natural kinds. A composite X can outlive the component Ys which compose it at any given time. This also seems an apt characterisation of what is happening with Boyd's natural kinds as mere clusters of properties.

A problem arises, however, when we want to move to sufficiency conditions for reduction more generally. Van Gulick introduces a complication for a simple compositional analysis of ONT-Reduction.[164] The problem is that the composition relation – defined as the Xs' being composed entirely of Ys – is insufficient for the reduction of the Xs to the Ys - defined as the thesis that all of the Xs' parts are entirely Ys. This does not apply to Boyd's natural kinds because they are merely the collection of properties meeting some vague sufficiency conditions, *and nothing more.* But we note here that it might be a problem for claims of reduction in the absence of the italicised clause.

Boyd's (and Fodor's) argument proceeds from the insight that reduction has failed for theoretical concepts and imputes ontological significance to this insight. Part of their arguments is to show that there is a failure of a certain form of REP-Reduction, a form that Van Gulick calls Theoretical-Derivational reduction.[165] Theoretical-Derivational reduction is one of five candidates Van Gulick identifies for satisfying REP-Reduction; the other four being, A priori Conceptual Necessitation, Expressive Equivalence, and Teleo-Pragmatic Equivalence. If we are correct in our characterisations of Boyd and Fodor, then the failure of Theoretical-Derivational reduction is clearly compatible with the success of ONT-Reduction.

[162] Ibid, pp. 4-9. Our job is not to analyse all of these candidates.
[163] We could read Boyd as arguing that there is a failure of natural kinds to be reductively eliminated or to be straightforwardly identified with certain objects. It is not necessary for us to defend either sort of reduction here because if any sort of relation can be shown to be both a variety of ONT-Reduction and to hold between the Xs and the Ys, then Boyd is wrong about the failure of ONT-Reduction.
[164] Ibid, p. 7
[165] Ibid, p. 10

The view of Boyd (at least) can thus be properly interpreted as the belief that, while there is just one domain of reality, as best understood by fundamental physics, adequately representing all the complex features of that reality is beyond the theoretical resources of the physical sciences. Similarly, just as the fact of composition fails in itself to entail the ONT-Reduction of one set of real entities to another, the lack of a sufficiently close derivation of one set of theories to another does not in itself entail the failure of ONT-Reduction between any corresponding entities.

Are there any varieties of REP-Reduction that, if they failed to hold, would be a problem for the background picture? The last two types of REP-Reduction mentioned above, Expressive Equivalence and Teleo-Pragmatic Equivalence, can be used to highlight a relevant consideration. The two sorts of equivalence are forms of reduction where the relata are not just theories or concepts, but whole 'representational systems'. If the expressive range of the two representational systems isn't equivalent, then reduction has failed. While this seems like a broader and therefore weaker requirement, its relevance to ONT-Reduction begins with one notable failure of reduction in this area – the alleged special nature of first-person phenomenal concepts and the sorts of experiential facts that we can supposedly access only through their use.

A person's experiences seem to be radically different to the features exhibited by the behaviour of objects as observed from the third-person. And the first-person perspective seems to have a maximally direct nature, which would make us aware of those experiences in a way that makes it difficult to conceive that we could be mistaken about the intrinsic character of the experiences themselves. The familiar Cartesian intuition suggests that these experiences have fundamentally distinctive features and that there are no intrinsic features of them that we cannot directly access through subjective experience. One such feature that would seem to preclude ONT-Reduction is the supposed 'substantial unity' of our experiences, which, if we take it as veridical - as the Cartesian intuition requires - seems to preclude the possibility of our experiences being a composite product of parts or some other complex relata of reduction. Rather, it is argued by some to be indubitable evidence of a fundamental particularity in our experience.[166] If true, the implication seems to be that these representations themselves carry an ontological implication. This would be a form of REP-Reduction failure that could imply the failure of ONT-Reduction.

Many philosophers have resisted this implication and ones like it. And some have argued further that there are no facts about consciousness that cannot be adequately known from a

[166] Roughly this formulation is given as an example of the failure of reduction in e.g. O'Connor and Jacobs 2003. See also chapter 1.

third-person perspective, so there is no gap in the expressive range of the two representational systems – the first-person experiential system and the third-person scientific one.[167] Regardless of the merit of these arguments, the claim is usefully illustrated by the move to a relation of Teleo-Pragmatic Equivalence. This theory of reduction involves bringing in other parameters of representation beyond the terms in which expressive equivalence is analysed. Here representation involves other parameters such as the representation user, the context of use, and the goals of the representation. The problem then becomes to find a way to "use the contextually embedded resources of the reducing theory to do the equally contextual representational work done by the items in the theory we are trying to reduce."[168] This contextual and pragmatic relation of reduction is very likely to fail when it comes to the disparity in representational resources between third-person scientific theories and first-person experiences.

Such failure can occur and this is not considered a problem for the physicalist. It is to be expected given the differences in context and resources. It is open to them to point to independent reasons why they hold certain accounts of representation. And given that these accounts change the relata for reduction, the success or failure of the equivalence of representational systems also turns on these commitments.

Why is this relevant to our problem? The route to an implied problem for ONT-Reduction is not through the failure of expressive equivalence anyway, but rather it is caused by the apparently veridical nature of experience to represent experience itself. Since this different account of representation is contextual and pragmatic, and our first-person concepts are so directly embedded within our intra-mental processes of self-regulation, self-monitoring and self-modulation,[169] it is to be expected that the representations regarding something like the substantial unity of experience would be irreducibly different in that context than representations about the same apparent feature in an objective third-person scientific context. These representations would be inherently context and use dependent, which seems to block the strong ontological implications from conscious representation.

To someone wishing to maintain that the character of experience bears implications for ONT-Reduction, there are of course ways to defend the claim that experience is veridical about the nature of experience (such that it precludes the possibility of mistakes about its intrinsic character). One such route proceeds by pointing to supposed difficulties for a theory

[167] There is naturally a broad literature on the subject that we have no need to be delving into. See, for example, Nagel 1974, Jackson 1982, Lewis 1982, Churchland 1985, Van Gulick 1985, Levin 1986, Loar 1990, Lycan 1990, Tye 1995, Chalmers 1996.
[168] Van Gulick 2001, p. 13.
[169] Ibid, p. 15.

of empirical knowledge that maintains that we are subject to an illusion of this kind at the source of all our empirical evidence.[170] All of this serves only to sketch out some of the terrain and to justify our consideration of conscious experience as an example of a problem for reduction, so we will proceed no further.

That is the last of our coverage of representational reduction. In summary, there are several forms of representational reduction that are compatible with ontological reduction. But there is evidence here of a problem for our background picture: the possibility that phenomenological claims about experience are indubitable and transparent and represent to us real properties. Regardless of how plausible this is we will assume that it is possible and that this possibility demands an explanation involving fundamental ontology. Next we will move on to another potential problem for ontological reduction – mental causation – before settling on a common form of the problem to be explained.

3.2 The Causal Closure Argument

Emergence, like several other theories in philosophy of mind, is invoked to resolve one or more of the various problems of mental causation. [171] One such problem is set out in the causal closure argument, a popular presentation of which follows. This form of the argument uses two or three intuitively appealing, but (apparently) mutually contradictory premises. The first is the existence of psychophysical causation – that is, mental events such as my beliefs or desires are causally relevant to some events that seem straightforwardly physical, such as the movement of my body. This premise seems immediately plausible; indeed, our pretheoretical notion of human agency is seemingly reliant on this premise.

The second premise is the causal closure of the physical domain. The thought here is that physics is somehow complete, that there are no so-called 'special forces', or any other non-physical causes for physical events.[172] This premise is thought to be supported by inductive evidence from physics and physiology. For instance David Papineau[173] traces the history of purported 'special forces' – forces popular in the 19th century - that would, if they existed, appear to violate the closure of physics. These forces all proved to be apparent, and would standardly turn out to be composed of the same small set of fundamental physical forces. This track record of finding sufficient physical causes to compose apparent non-physical causes is here taken as inductive evidence that physical causes are always sufficient. Furthermore, Papineau argues, the detailed study of physical events in physiology has - in

[170] O'Connor and Jacobs 2003
[171] For example, O'Connor and Wong 2005, O'Connor and Churchill 2010.
[172] See Lowe 2000a for more precise definitions of causal closure.
[173] 2001

the end - never required non-physical causes to provide a sufficient cause for a physical event – if this is true then there is no direct empirical evidence for a physical event like the movement of my body that has not had a sufficient physical cause.

We'll see that the causal closure premise is very relevant to theories of emergence, so we will explore it more later.[174] For now it is worth noting a few things to which we will return. Firstly, as Papineau himself says, there cannot be a knock-down case for causal closure based on this kind of evidence, even if it were really as complete as he suggests. Secondly, the relevance of the evidence might depend on the account of causation assumed – it seems in his talk of 'special forces' Papineau is assuming a transference theory of causation, but there are others.[175] Thirdly, there are several purported cases from physics and chemistry of causes that are not composed of the fundamental physical forces[176], so perhaps the evidence doesn't straightforwardly support Papineau's first argument from induction. And fifthly, in order for the causal closure premise to engage with the whole causal closure argument in the way Kim and others intend, it would perhaps be necessary to give it a formulation so strong that it is not, in fact, supported by the empirical evidence Papineau presents.[177] We will examine some of the formulations and the other issues mentioned later.

These first two premises of the causal closure argument, psychophysical causation and the causal closure of the physical domain, are often presented along with a third premise, the denial of systematic causal overdetermination.[178] The necessity of this denial depends on the strength of the second premise: if the causal closure premise merely stipulates that physical events always have sufficient physical causes, then ruling out co-present sufficient mental causes is a necessary third premise required for causal closure to engage with the premise of psychophysical causation. It is simple to see why: even if sufficient physical causes were always present for physical events, one would still need for these causes to somehow exclude other causes if there is to be a contradiction between causal closure and psychophysical causation.

Note the emphasis here is on *systematic* overdetermination. There may be uncontroversial specific examples of events with multiple sufficient causes, a favourite example being the case of two independent gunshots reaching the heart of the victim at precisely the same time – each is a sufficient cause of the victim's death, and therefore the victim's death is overdetermined by the gunshots. Even given such cases, it is uncontroversially implausible

[174] See chapter 5
[175] See also Gibb 2010 on the relevance of the laws of conservation of energy and momentum.
[176] For instance, Silberstein 2006; Hendry 2006
[177] Lowe 2000a.
[178] Defined below.

that some events are overdetermined as a general rule because theories which commit to pervasive overdetermination lack the theoretical virtues of simplicity or elegance.[179]

The causal closure argument can be formulated as follows[180]:

[Psychophysical causation] – Some mental events are causally relevant in the physical domain.

[Completeness of the physical] - Every physical event, at every time at which it has a cause, has a sufficient physical cause.[181]

[Non-overdetermination] - Events are not systematically overdetermined.[182]

The premises above seem to be mutually incompatible, unless mental events are identical with physical events. Indeed, the job of any decent theory of mental events that holds that mental and physical events are distinct is to deny or disambiguate one or more of these premises or otherwise resolve this incompatibility.

Many approaches have been taken. The identity theory accepts the argument's conclusions (though identifying mental events with physical ones might also be interpreted as a disambiguation of [Psychophysical causation]).[183] Epiphenomenalism denies [Psychophysical causation]. Substance dualism denies [Completeness of the physical]. Non-reductive physicalist theories usually attempt to find some compromise that reconciles all three premises with identification, often by disambiguating [Non-overdetermination][184]. Whether non-reductive physicalist theories can do this satisfactorily is a matter of recent debate - it has been repeatedly argued that non-reductive physicalism fails to reconcile the premises, and must therefore accept identification, or else either imply overdetermination[185], or deny [Completeness of the physical][186]. Theories of emergence usually deny [Completeness of the physical].[187] More on this in chapter 4.

[179] See Sider 2003 for counter arguments.
[180] This formulation is Lowe's 2000b, 27, cf. Gibb 2013.
[181] For a discussion of the different strengths that the principle might take, see Lowe 2000a. This is not discussed here because my arguments won't turn on the strength of the formulation.
[182] For more see: Sider 2003
[183] Since mental events are not causally relevant qua mental, or because their attribution as *mental* events is de dicto.
[184] E.g. Raymont 2003; Wilson 2011
[185] O'Connor and Churchill 2010 is an example of such an argument applied to several leading nonreductive physicalist theories; more options and positions within this debate are summarised in Gibb 2013, 2014
[186] E.g. Crane 2001, and see section 3.3 below.
[187] McLaughlin 1992; Horgan 1993

Introducing the causal closure argument here is useful because it provides a framework within which to discuss how theories of emergence do some of their explanatory work. However, the causal closure argument, as presented, is itself only valid given certain metaphysical assumptions[188]. Since we are developing this problem within a powers ontology and otherwise limiting the options by only focussing on some of the potential solutions to that problem, we will skip over some potential solutions and assume the argument is valid for didactic purposes.

There are, however, some further assumptions that will be useful to make discussion easier. For instance, the theories discussed will usually be in terms of mental and physical properties rather than events. Given certain accounts of events the causal closure argument as presented above can be straightforwardly applied to properties. For the sake of convenience, we will assume a Kimian account of an event as a substance instantiating a property at a time. According to Kim's account[189], an event (s1, p1, t1) is a substance (s1) instantiating a property (p1) at a time (t1), and two events (s1, p1, t1) and (s2, p2, t2) are identical if and only if s1 = s2, p1 = p2, and t1 = t2.[190] With this assumed, the conclusion of the causal closure argument - the identification of mental and physical events – entails the identification of mental and physical properties, allowing for theories of emergence to be discussed in those terms.[191]

3.3 Kim's Supervenience Argument

Kim has published many papers with variations on the causal closure argument, mostly targeted against nonreductive physicalism and other attempts to resist the identification of mental and physical properties while maintaining that mental properties are ontologically dependent on physical properties.[192] His arguments extend beyond the causal closure argument above, with its premise about the causal efficacy of mental properties in the physical domain, to a more general problem for purely mental causation as well.[193]

The argument proceeds like so, let's say that M and M* are mental properties and M causes M*. Let's also say that nonreductive physicalism is the theory that M* is ontologically dependent on P*, its physical base. There are now two rival explanations of the existence of M* - its cause and its physical base, analogous to the two forms of dependency discussed in

[188] For example, on the nature and homogeneity of the causal relation, and the nature and homogeneity of the causal relata. See Gibb 2014 for an overview.
[189] Kim 1998
[190] Other alternatives are available, for instance 'in virtue of' events.
[191] Even if one adopted a different account of the causal relata where this entailment fails to hold, the problem of causal redundancy seems to reoccur. See, e.g. Heil and Mele 1993.
[192] Examples include Kim 1989, 1992, 1993b, 1999a, 2005.
[193] E.g. Kim 2005

section 2.2.1. Is the existence of M* due to M or P*? Again, because these are two different sorts of dependency, this is not strongly analogous to cases where one can identify multiple causes for an event. Kim argues that the non-reductive physicalist's response must be that M causes M* by causing P*; but if this is the case, the causal closure argument kicks in. M is now a psychophysical cause. And since M will be ontologically dependent on its own physical base, P, we might plausible identify P as the cause of P* and retain our commitment to [Completeness of the physical]. The rest of the argument proceeds as normal to the conclusion that the occurrence of properties like M* is systematically overdetermined.

Indeed, it seems that such an argument can generalise to all macro-properties wherever such properties are taken to be ontologically dependent on a physical base, with only a few tweaks to what is meant by 'physical base' or 'physical domain'. This includes those properties posited by the special sciences.[194] If it is possible that a distinct property is ontologically dependent on other properties, then the supervenience argument does seem to apply. Causation involving ontologically dependent properties seems to give way to causation involving their physical bases. This is the problem Ned Block calls 'causal drainage' in relation to a view of reality as ontologically dependent levels.[195] All of the causal powers of dependent entities seem to drain away to the properties of fundamental physics. Whether this problem also arises for certain forms of ontological dependence in a fundamentalist ontology will be discussed in section 5.1.

Kim does not explicitly acknowledge that his supervenience argument is reliant on a causal powers ontology,[196] but does acknowledge the argument's reliance on certain views about causation, for instance a commitment to abiding by Alexander's dictum, that all properties must contribute causal powers to objects.[197] The premise [Overdetermination] also seems to be more straightforwardly motivated in a causal powers ontology than if, say, we assume a reductive account of causation like counterfactual analysis.[198] There is something obviously otiose about positing two distinct relations of causation for every event supposedly caused by a mental event. In a nonreductive account of causation we are thereby committing ourselves to the existence of something additional. On a reductive account we are not. An

[194] This has often been taken as a weakness of a position like Kim's, e.g. in Baker 1993; Burge 1993; and more recently, Ross and Spurrett 2004. See also van Gulick 1993. The commitment to fundamentalism we have developed and the discussion of 'higher levels' will hopefully serve to illustrate that this is not necessarily a weakness.
[195] Block 2003; see also Kim 2005 and Walter 2008.
[196] Indeed, Kim is ambiguous on the point, see Kim 1998, p.43; 2005, p. 20, 41. And he has speculated that causality might variously be supervenience on laws, a Humean affair at the fundamental level, or something like a transference theory, see 2002, p. 677.
[197] For more evidence of Kim's assumption of a view of properties similar to the causal powers theory, see Kim 1998, pp 45-56; 2002, pp.674-5; 2005, pp. 17-18.
[198] See chapter 8.

explicitly causal powers formulation of the supervenience argument has been put forward by O'Connor and Churchill.[199] Their presentation contains a premise that nonreductive physicalists are committed to and which generates the problem of reduction:

> "Mental properties are realized by physical properties: a particular event M of a person S's having mental property M is either 'constituted by' (a kind of ontological posteriority) or is identical to various physical particulars—possibly including portions of the person's environment—having certain physical properties and standing in certain physical relations."

Since the argument generalizes to any properties that are 'realized', (where, in lieu of further analysis, realization is understood as a relation of ontological dependence that ensures distinctness,) we will offer the following amended premise:

[Realization] Macro-properties are ontologically dependent on foundational properties: a particular event of an instance of a macro-property is ontologically dependent on some foundational objects having certain foundational properties and standing in certain relations.

Then we can say, in parallel with the causal closure argument, Realization is not compatible with both the causal closure of fundamental physics and the causal relevance of macro-properties unless some form of ontological dependence can be found which is capable of blocking causal drainage.[200] This should suffice to illustrate the problem of mental causation as it pertains to both the identity and realization theories of mental properties.

3.4 Downward Causation

The problem emergence addresses has often been defined in terms of 'downward causation'. How can 'higher-level properties' cause things when there are no higher level substances? How can 'downward causation' occur given fundamentalism?

Emergence does not imply 'downward causation' because emergent entities are, in the important sense relevant to a causal powers ontology, fundamental. This might be because there are non-physical things that are fundamental, but if one were inclined to argue that the physical ontology exhausts all the fundamental things, then emergence still does not present a problem, since whatever definition of physicalism ties physics conceptually to the most general account of reality, would also seem to be able to admit that fundamental emergent properties are physical.

[199] O'Connor and Churchill 2010
[200] And assuming that systematic overdetermination is to be rejected.

Given our background picture, explaining downward causation is not an explanandum for a theory of emergence except insofar as we need an explanation of emergence's relation to the thesis of physicalism – the only properties are physical ones – and the notion of fundamentalism, which is investigated throughout this thesis.

3.5 Some Explananda and the Nozick Formulation of the Problem

We might give the problem for our background picture a few more general formulations. Here are a few that are not so tightly defined. We might ask to give an account of natural kinds or explain multiple realization. We might ask how apparent 'higher-level' or 'downward' causation is possible given fundamentalism. Or we might ask why dependent entities can have causal relevance seemingly beyond the causal powers of those entities on which they depend. In general these questions all ask for an account of macro-properties and this account must be consistent with our background picture. Since the background picture is fundamentalist and deflationary about derivative properties, an apparent failure of ONT-Reduction represents a problem that demands an explanation.[201] That explanation might take the form of showing how the failure of reduction is merely apparent or of how such a failure can be incorporated into our background with some new theory. We will give these general formulations an umbrella term, the Problem of Reduction, which we will use for the rest of the thesis.

Note that the Problem of Reduction does not arise for inflationary or nonfundamentalist ontologies.[202] This is because inflationary ontologies have no problem accepting the reality of macro-properties and nonfundamentalist ontologies do not entail ontological reduction. On the picture of reality as a hierarchy of levels, one level does not reduce to another. On a fundamentalist picture, in general, it must. Likewise for other aspects of the background picture. Atomistic foundationalism is necessary to generate the problem. Monism does not encounter a Problem of Reduction because reduction is also expected to fail. Without atomic simples there is no ontologically privileged set of objects that might in turn privilege certain properties. Not only does this seem necessary to motivate the causal closure argument, it provides a principled reason to limit the reification of putative macro-properties in general. Whatever the theory of properties developed under the alternative positions on foundationalism, it is unlikely to motivate a metaphysically deep distinction between macro-properties and any other kind of property.

[201] There might a danger of interpreting this background picture in a way that rules out emergentism from the start (one might think emergent properties are derivative in the sense that they are dependent entities.) To be clear, emergentism is not ruled out automatically because emergent properties would count as being among the fundamental properties.
[202] See sections 2.2.2 and 2.4 for descriptions of these alternative ontologies.

So what does accounting for macro-properties consist in? Alex Oliver points out that the sort of explanation required for a successful general theory of properties is rarely clarified, and this, combined with a conflation of substantially different explananda, changes our evaluation of the solutions.[203] By closely examining the Problem of Reduction, we will be able to readily judge the efficacies of different theories of causal powers to account for apparent macro-causation. In this part we will resolve three issues: what it is that is supposed to be explained or accounted for (the explananda), what it is about the explananda that requires explanation (the explanatory goal), and what would constitute such an explanation.

There have been different statements of the problem, only some of which have been mentioned above, which in turn have led to different solutions. Of all the various suggested explananda, it is safe to say that at least some of the problems have parallel solutions, but until we have a clear idea about what sort of explanation is required, we should not feel free to vacillate between them all.

Several of the most prominent presentations of the problem fit into a general form described by Nozick: how a certain thing, say 'X', is possible supposing certain other things.[204] We will focus on two broadly different problems in this form. The first way of putting the problem was to do with the properties of conscious experience. For example: how, if our experiences are veridical, can the 'substantial unity' of our experiences be possible given that we are complex objects, i.e. the explanandum is "how can a macro-property be simple" and the problem is to explain how a qualitatively simple property can be qualitatively simple given that it inheres in a complex object. In Nozick's form the 'X' here is the simplicity of the macro-property, which seems incoherent supposing the substantial complexity of composed entities.

A different problem is explaining how macro-properties can have causal relevance, i.e. the explanandum is "how can macro-properties make a causal difference" and the problem is to explain how a complex object can possess a fundamental property. In Nozick's form the 'X' here is the causal efficacy of macro-properties, which seems incoherent supposing the derivative nature of composed entities.

Nozick calls the "other things", the ones that are supposed to make 'X' incoherent, "apparent excluders".[205] We can remove the incoherence by showing that the apparent excluders do not exist or by explaining why the apparent excluders are merely apparent. The apparent

[203] Oliver 1996: 75
[204] Nozick 1981: 9
[205] ibid

excluder for the first Problem of Reduction is the complexity of composed entities: how can we have qualitative simplicity given this? The apparent excluder for the second Problem of Reduction is the derivative nature of composed entities: how can we have fundamentality given this?

The Nozick form of the general problem is one of eliminating an incoherent scenario. However, there are of course presentations of the problem that do not take this form, and motivate a different sort of explanation. The explananda/explanation presentation of a problem states some facts—the explananda—and then provides an explanation of those facts. The explananda in this case are something like "a complex entity is simple" and "a dependent entity is fundamental". When we characterise a philosophical problem as a motivating explanandum and an account that explains it, a lot turns on what we decide we require of the explanation. A sufficient explanation can be characterised in several ways. For instance, what is it about the explanandum that the explanation must explain? What must this explanation consist in? In Sections 3.6-9 we will discuss three lines of thought as to what a sufficient metaphysical explanation might consist in. These three types of explanation are analyses of concepts, ontological commitments and truthmakers.

In addition, there are different conditions for a sufficient explanation,[206] each of which requires the elimination of an existing, undesirable scenario. With the Nozick-form problems the undesirability of the scenario comes from the apparent incoherency of the explanandum. Another type of undesirability is a general lack of specificity in our understanding of the explanandum; this is a subtly different sort of problem. Eliminating the later scenario does not require the elimination of apparent incoherency, but rather the elimination of unspecificity. This is a non-Nozick form of the Problem of Reduction, with a different explanatory goal. We will develop and compare the two scenarios in the next section and see how this affects our analysis.

3.6 Conceptual Analysis, Specificity and Sufficient Explanations

So what does Nozick say is required to eliminate the incoherencies? We can either show that the things which appear to exclude 'X' do not exist or that they are merely *apparent* excluders. Those who employ Nozick-form presentations of a problem—how a certain thing, say 'X', is possible supposing certain other things—are seeking an explanation that does one of these two things. But unless we have a clear idea of what it means to "show that they

[206] What Oliver calls 'explanatory goals': 1996, pp. 6-7.

are merely *apparent* excluders", this criterion alone can give rise to explanations of very different kinds.

Macbride, for example, argues that, not only are there many problems that do not take the Nozick formulation, but the incoherencies in the above Nozick-form problems can simply be resolved by conceptual analysis.[207] We might show the excluders to be merely apparent by drawing a distinction between qualitative simplicity and substantial complexity such that they are compatible (e.g. by thinking of qualitative simplicity and substantial complexity as two unrelated aspects of the complex object). Different things can be the same because the respect in which they are the same is different from the respect in which they are different.[208] However, we are not just concerned with eliminating an apparent inconsistency in our concepts; we are concerned with eliminating an apparent inconsistency in our understanding of reality. Just because something is conceptually coherent doesn't make it metaphysically coherent.

To show that qualitative simplicity and substantial complexity - or derivativeness and fundamentality - are compatible we need to show why their apparent mutual exclusion is only apparent, rather than just saying that it is. The 'showing why' requires an account of what qualitative simplicity and fundamentality *consist in*, i.e. we require a metaphysical explanation of why the inconsistency is merely apparent. The Problem of Reduction is more difficult than mere conceptual analysis allows, but this is not because of incoherency per se. We can see that it is not the incoherence of the explananda that is doing the work, but our requirements for a sufficient explanation of those explananda.

The Nozick-form problem - eliminating the inconsistency – is actually motivated by the situation's vagueness.[209] In this case we would like to relieve vagueness in our knowledge of the underlying nature of reality. Again, the incoherence may be an appropriate motivation, but it is not the incoherency per se that requires a full account of apparent macro-properties. Once we see that it is really a lack of knowledge about macro-properties that is doing the work here, we can identify perfectly good alternative presentations of the Problem of Reduction. The facts to be explained remain the same, but we are asking different questions about those facts. Regarding qualitative simplicity, we ask: in virtue of what is the putative macro-property simple? Regarding fundamentality we ask: in virtue of what is the putative macro-property fundamental? There is no apparently incoherent scenario in these questions,

[207] Macbride 2002: 27; the discussion takes place specifically within the context of the Problem of Universals
[208] Compare Macbride 2002: 31
[209] This line of argument about the Nozick form of explanation is from Wieland 2008: 12-5

as there is with the Nozick form; instead the explanatory goal is to eliminate an unspecified scenario. Because of this the questions more transparently represent what is usually desired of the explanation for both presentations of the Problem of Reduction, i.e. specification of these features in reality.[210][211]

3.7 Quinian ontological commitments

Oliver identifies three sorts of solution to problems in the ontology of properties.[212] These are conceptual analysis, analysis of the ontological commitments, and analysis of the truthmakers of the explananda. We have already ruled out conceptual analysis in section 3.1. on the grounds that conceptual reducibility does not enable us to distinguish between reducible and irreducible entities. We can now add that it does not constitute a sufficient explanation. Conceptual analysis alone does not tell us anything about what exists.[213]

The other two types of explanation, analyses of ontological commitments or analyses of truthmakers, do tell us something about the world. Going back to the argument about the reduction of natural kinds in the special sciences. It might be objected that an analysis of the ontological commitments of our best scientific theories should be the primary mode of investigating the potential existence of macro-properties. Analyses of ontological commitments tell us about what exists by identifying the entities that must exist for a given sentence to be true. The commitment relation is a kind of cross-categorical entailment: just as a sentence *S* entails a sentence *T* if and only if it is not possible for *S* to be true and *T* to be false, sentence *S* is ontologically committed to entity *a* if and only if *S* implies '*a* exists'.[214] In practise, we apply semantic theories to sentences, and we must evaluate these theories in the light of a host of considerations, some of them metaphysical. We refine the apparent semantic theories using philosophical argument and they tell us what a given sentence is committed to. We can also paraphrase sentences to test to see if our apparent commitments are merely apparent. The outcome depends not just on how the semantic analysis goes, but also on the sentences we choose to analyse. The collections of sentences we take to be true are our 'best theories'. If we find the true commitments to our best theories, then we truly say that those entities exist, but this is dependent on analysis revealing which commitments are merely apparent and which are real.

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[210] Ibid.
[211] If one were to properly flesh out the requirements for a sufficient explanation of incoherency on the Nozick-form of the problem, then both explanatory goals amount to much the same requirement – a full metaphysical account of the simplicity and fundamentality of putative macro-properties.
[212] Oliver 1996
[213] The distinction between conceptual analysis and ontology is what motivates Heil's rejection of the picture theory in Heil 2003.
[214] Quine 1961; Oliver 1996: 60

In our case we might be looking to see if the apparent qualitative simplicity and fundamentality of macro-properties is ontologically committed to any entities, over and above the composing entities of the complex object, to account for these apparent facts.[215] If an entity is among the ontological commitments of our best theories, we have the best possible reason to think that they exist. Where is commitment to these entities going to be located within the sentences of our chosen theories? Oliver finds several problems with characterising problems in the metaphysics of properties as a demand for analyses of ontological commitment. The first problem is finding appropriate constructions that harbour real ontological commitment to properties.[216]

Oliver identifies three sorts of subsentential constructions that have been taken to harbour ontological commitments to properties: predicates, abstract singular terms and property-quantifiers. He then examines each. First is Armstrong's resistance to reductive analysis, which seems to imply that predicates can harbour ontological commitments.[217] This seems to be based on a necessary equivalence between sentences like '*a* is **F**' and sentences like '*a* has the property of being **F**'.[218] In this case the latter sentence contains an abstract singular term apparently harbouring an ontological commitment to a property-entity.

However, if we suppose that '*a* is **F**' is equivalent to 'a has the property of being **F**', we run into a problem. If the equivalence holds and there doesn't seem to be a principled reason why we couldn't replace the predicate **F** in '*a* is **F**' with the predicate 'red', then '*a* is red' is equivalent to '*a* has the property of being red', and we seem to be ontologically committed to the existence of the property-entity *red*, or any other predicate we chose to substitute. Now, Armstrong himself does not believe that there is a one-to-one correspondence between predicates and properties.[219] And as we said in Section 2.3, we are looking for an account of the real similarity between things; the sharing of sparse, not abundant properties. So, if all abstract singular terms harbour ontological commitments, there cannot be equivalence between '*a* is **F**' and 'a has the property of being **F**'. Armstrong requires a semantic theory

[215] Quine might object to our use of apparent facts, he would prefer our best theories be limited to scientific matters transcribed into his canonical notation (1961: 10). This is not a problem for us as long as canonically transcribed scientific theories retain the same construction - talk of simple and causally efficacious macro-properties - that gives rise to our apparent fact. It seems reasonable after discussing the implications of concepts in the special sciences in sections 2.4 and 3.1 to say that scientific theories do talk of multiply realizable and causally efficacious macro-properties, but Quine can still maintain that this is a "popular and misleading manner of speaking"(1961: 8) if the commitment disappears when the sentences are paraphrased.
[216] Oliver 1996: 54-68, 74
[217] e.g. Armstrong 1978, vol 1, p. 16
[218] For evidence of this, see Oliver 1996, pp. 54-8.
[219] Red in particular: see Armstrong 1978, vol 2, p. 8

that doesn't refuse "to take predicates with any ontological seriousness",[220] but also doesn't slip into reifying every property predicate.

Next Oliver examines the apparent ontological commitments for abstract singular terms and property-quantifiers.[221] Maybe we can solve Armstrong's problem by finding a semantic theory that can distinguish between real and apparent ontological commitments for abstract singular terms. Quine has two strategies in this regard: offer a paraphrase of the sentence that does not feature the abstract singular term, or argue that the referent of the abstract singular term is not a property, but some other entity, like a set.[222] However, Frank Jackson has demonstrated that neither of these strategies work.[223] For example, Quine, attempting to argue that 'humility' is not a property, translates 'Humility is a virtue' into 'Humble persons are virtuous'. The problem is, if it just so happens that every tall person is virtuous, then 'Tall persons are virtuous' is true, but it plainly does not follow that 'Tallness is a virtue'. Paraphrases like this are not necessarily equivalent. The same problem occurs if we take 'humility' to refer to the set of humble persons; just because every member of that set is virtuous does not entail that humility is a virtue. This argument neatly extends to apparent property-quantifiers, because if abstract singular terms like 'red' in 'red is a colour' are not sets or anything else, then 'something is a colour', which follows from the first sentence, cannot be a quantifier ranging over sets or anything else.[224] Armstrong appeals to the same point in one of his early arguments for properties as universals; he is impressed by the lack of available paraphrases for sentences containing abstract singular terms and property-quantifiers and uses this argument to challenge those who might use analyses of ontological commitment to support a nominalist solution to the Problem of Universals.[225] However, the failure of these paraphrases does not show that no such paraphrases exist. Furthermore, even if such paraphrases cannot be found, Armstrong still needs some other way of distinguishing between real and merely apparent ontological commitments that avoids reifying abundant properties.

The examination of ontological commitments here is by no means exhaustive, and it might well be possible to solve the objections discussed. But even if we could identify the real ontological commitments for sentences about properties, there is another worry about using this kind of explanation to answer our questions. The worry arises because there are some important metaphysical differences that are not decided by the semantic analyses of our

[220] Armstrong 1978, vol 1, p. 16
[221] Oliver 1996: 61-68
[222] Quine 1960: 122-3
[223] Jackson 1977: 427
[224] Oliver 1996: 65
[225] Armstrong 1978, vol 1, 58-63

best theories. Oliver uses the example of particulars: Quine argues that we are committed to particulars because we require values for the bound variables of our best scientific theories.[226] However, while this gives us an excellent reason to believe particulars exist, our best scientific theories do not decide many of the important issues about the nature of these particulars. For instance, the application of a semantic theory does not commit us one way or the other on the question of whether particulars are sui generis entities or mereological sums of tropes. We require additional metaphysical analyses involving other considerations if we want a full account.

Analyses of ontological commitment are limited by the sentences that are available. Simply analysing these sentences might not be sufficient to obtain the requisite level of specificity to answer our questions. Of course, we might be able to discern some aspects of the nature of properties by finding theory sentences that are committed to those aspects, but again, this is by no means guaranteed. It seems to be harder to find ontological commitments when it comes to questions like whether an entity is abstract or concrete (for example, the ontological status of numbers).[227] That there are questions that are not decided by sentences of our best theories does not entail that such important metaphysical differences do not exist in reality. Since our questions require specificity about the nature of qualitative simplicity and fundamentality, it is not obvious that ontological commitment will be able to constitute a sufficient explanation. This is an arena where, Oliver argues, little metaphysical information is likely to be forthcoming from our best scientific theories.[228]

3.8 Truthmakers

The discussion so far has given us a good clarification of what we require to explain the Problem of Reduction. Accounting for apparent macro-properties by finding truthmakers for our explananda seems to be the best bet,[229] so let's make a few notes about the methodology of truthmaking analysis.

There is a somewhat systematic approach to analysing ontological commitment: we transcribe sentences from our best scientific theories into canonical notation and apply a semantic theory. In practise of course, identifying which semantic theories are real and which are merely apparent is a mixed theoretical enterprise, but otherwise the methodology quite strictly informs and bounds the ensuing enunciation of an explanation—which is partly what gives rise to the doubts about it producing an adequate one. Looking for truthmakers is

[226] Oliver 1996: 59
[227] Oliver 1996: 60
[228] ibid: 58-61
[229] Schaffer would put the point in terms of grounding: i.e. in this case we should be concerned with what grounds the macro-properties. See Schaffer 2009.

an illuminating and useful way of regimenting the metaphysical enterprise. However, to paraphrase Armstrong, truthmakers are no royal road to metaphysical explanation.[230] Firstly, the distinction between one's general theory of truthmaking and particular answers to truthmaking questions is not sharp. They have to be brought into reflexive equilibrium.

But also, while viewing things from a truthmaker point of view gives one a tendency to favour some metaphysical positions over others, there are limits; choosing between competing theories of ontology requires more fine-spun argumentation. In general, finding a robust, coherent account of the truthmakers of our selected explananda is not the sum total of metaphysical theory choice. Contemporary metaphysicians generally employ a multi-faceted, quasi-scientific approach. The first stage is to construct robust and coherent accounts, which they then test and compare. We then proceed as discussed in section 2.1.

As an aside, to argue that an explanation consisting of conceptual analysis is insufficient does not mean that conceptual analysis will not be necessary for a sufficient explanation. Identifying truthmakers will not resolve our problems in the absence of a conceptual distinction. Our explanation obviously requires a conceptual distinction between qualitative simplicity and substantial simplicity. And between fundamentality and ontological independence. However, an explanation consisting of truthmakers will entail this distinction. The truth of our explananda entails the conceptual distinction—because without the distinction they would not be true. And the truthmakers for our explananda entail the explananda, thereby entailing the conceptual distinction.

Truthmaking and truthmakers are another way of explicating the division between fundamental and derivative entities.[231] Entities that make true their own existence are fundamental, the other entities for which they can also act as truthmakers are the derivative entities.[232] The substances and properties of the last few sections are fundamental. Let's suppose that object, x, comprises a substance inhering a property. So asserting the truth of statements like "object, x, exists", requires appealing to nothing else in our ontology than x itself. If x, along with other fundamental objects and relations between them, composes a complex object, y, then y exists, but in contrast to the truthmakers for x, the truthmaker for the existence of y is not y itself, but the objects and relations composing y.

[230] For discussion see Armstrong 2004
[231] Barnes 2012 says "a complete inventory of such existence facts will be sufficient for the truth of the true sentences of English (even though English quantifies over things Ontologese does not, and possibly vice versa)."
[232] See, e.g. Heil 2003, Cameron 2008a

So there is and should be an explanation for the explananda of emergence. Chapters 4-6 explore these explanations. But since we are also interested in evaluating these theories not just to see if they are coherent, but also to see how well they work, we will require emergent theories that serve as explanations both for how the main features of emergence, below, are possible, but also how the preceding problem is solved. Naturally this will involve throwing out some theories.

3.9 Concluding Remarks on the Nature of the Problem

The aim of this chapter was to explore some of the interpretations of the problems that theories of emergence are invoked to solve, and to gain a fairly comprehensive understanding of the Problem of Reduction. In this regard, there is not one, but several explananda for which we might give an explanation. We refined our definition of the explananda and will continue to do so in relation to emergence concurrently with our definition of emergence in the next chapter. Wieland[233] demonstrates that there are different questions we can ask of metaphysical explanations, including problems requiring the elimination of incoherent or unspecified scenarios. We also argued that a sufficiently specified theory about the entities involved can resolve these apparent contradictions – this should be the aim of a theory of emergence.

4. Theories of Emergence

Macro-properties are properties of complex objects. Since our background picture assumes that objects are simple and fundamental and properties inhere in their objects, we should ask how it is possible for a macro-property, which inheres in a complex object, to likewise be simple and fundamental. If not from the usual simple substances, whence does the property derive its simplicity and fundamentality? Regarding qualitative simplicity, we ask: in virtue of what is the putative macro-property simple? Regarding fundamentality we ask: what is it about the putative macro-property that makes it fundamental?

The Problem of Reduction arises because of a lack of specificity about the nature of macro-properties. These properties need to be elucidated to show how this new kind of property is capable of being simple and fundamental when it is so different to all of the micro-properties that we have defined as such. A theory of metaphysical emergence provides an answer to the Problem of Reduction. This section explores the question, what is emergence and how does it help us to answer these two questions?

[233] Wieland 2008

4.1 The Inexplicability of Emergence

The idea of 'strong emergence' has been used to characterise the way that some properties of a complex system are dependent on, distinct from, and novel with regards to, the properties from which they emerge. The set or system of properties from which an emergent property emerges is called the emergent base; in its novelty the emergent is said to be 'something new'[234], something 'irreducible', or something 'over and above'[235] these basal properties. Emergent properties are not something you 'get for free'; they are one of the things God would have to create in order to make the world how it is[236]. Emergent properties have also been described as 'going beyond' the features of their parts, of being 'different in kind'[237], of being 'non-physical' and 'sui generis' in their causal powers[238]. Facts about emergent properties have been said to not be deducible, even in principle, from facts about the base[239]. The relation between an emergent and its base has also been described as 'mysterious'[240]. And emergence has been described as simply 'unexplainable', for example in Alexander:[241]

> The existence of emergent qualities thus described is something to be noted, as some would say, under the compulsion of brute empirical fact or, as I should prefer to say in less harsh terms, to be accepted with the "natural piety" of the investigator. It admits no explanation.

On this last point, I will argue that when the notion is fleshed out, bounded by the requirement for metaphysical rigour and especially when guided by recent work in ontology, there is plenty that can be said about emergence in the central case. It is the novelty of emergence that is critical, not its mysteriousness. When Alexander, one of the original British Emergentists, says that "The existence of emergent qualities… [is] to be accepted with the 'natural piety' of the investigator. It admits no explanation."[242] it is not clear what exactly it is about emergence that is supposed to be unexplainable. I contend that it is not the case that emergence is unexplainable in some general, problematic manner. We should be able to specify their metaphysical features as we do with micro-properties.

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[234] E.g. Marras 2006 p561.
[235] E.g. Crane 2001 p7.
[236] This characterisation is used repeatedly in Barnes 2012, for example.
[237] E.g. Van Gulick 2001 p16.
[238] Horgan 1993 p560.
[239] E.g. Chalmers 2006 p244.
[240] Macdonald and Macdonald 2010, p1.
[241] Alexander 1920 p46-7. The worry about the general inexplicability – emergence as 'magic' - also seems to be the basis of the argument in Nagel 1979.
[242] Alexander 1920 p46

First of all, it is likely that Alexander has a weaker sense of emergence in mind, one stated in terms of explanations rather than in terms of ontology[243]. In many earlier theories of emergence (and some more recent ones) the arguments are ambiguous as to their ontological implications, but there are parts of Alexander that suggest that the mystery is not the lack of an ontological explanation, and that, if one's knowledge were perfect, there would be no mystery.[244]

We have already explored some of the ways in which the epistemic situation has been argued to carry ontological implications.[245] An entity's existence is explained in terms of what entities/causes/relations/laws, etc, account for that existence. In this vein, the worry about mysteriousness can be interpreted as a proposition about ontological inexplicability. It might then be seen as an argument that the existence of an emergent is utterly mysterious, i.e. that there is nothing in the ontology that can explain it. But there are other possible ontological interpretations: for instance, it could mean merely that the existence of an emergent admits no explanation in terms of some pre-determined set of acceptable entities. This pre-determined set constitutes an ontology, and since no explanation is possible within this ontology, an emergent is something additional to it. It is this kind of inexplicability that we can call 'something new'; it is an 'addition of being'.

If we allow this interpretation, other parts of Alexander might be used to flesh out what this addition involves. Earlier on in the same paragraph Alexander says that an emergent quality "emerges from the lower level of existence… and it does not belong to that lower level, but constitutes its possessor a new order of existent with its special laws of behaviour."[246] Here the 'something new' is a new set of special laws of behaviour, a set that is additional to the set of laws of behaviour governing the base. The emergent is inexplicable in the sense that its behaviour cannot be explained by means of the laws governing its base. We admit instead a new explanation or new set of explanations for that behaviour, in the form of new laws. It might be objected that these new laws of behaviour are 'nomological danglers'. But to be explicable in terms of danglers is not to be inexplicable; appealing to nomological danglers does not make emergence 'magic', as some worry[247]. What would be required is some additional reason why the set of acceptable explanations should be restricted to

[243] This is plausibly argued for in O'Connor and Wong 2012.
[244] For instance, Alexander 1920 pp327-9.
[245] See sections 2.4., 2.6., 3.1., 3.3. and 3.7.
[246] Alexander 1920 p46.
[247] See Van Cleve 1990 'Mind-Dust or Magic? It would seem that a premise of this sort is implied in the argument against emergence found in Nagel 1979, see section 4.5.5.

exclude these danglers. One such argument is the causal closure argument, which was introduced in section 3.2.

4.2 The Key Features of Emergence

Inexplicability is a notion used to characterise emergence. If emergence is neither magic nor autonomous, we might ask what is it that is unexplainable? If we are talking about just the *existence* of emergent properties, then one explanation of an entity's existence is in terms of what entities account for that existence. The truthmaker gloss would be to ask what entities are truth-determining for propositions about an emergent property's existence.

In this sense the existence of emergence might be mysterious in two ways. Either we think that the existence of an emergent property is profoundly, utterly mysterious, i.e. that there are no entities in the ontology that can account for it and it really is magic. Or, the more reasonable interpretation, the proposition that an emergent property exists admits explanation in terms of some entity or entities, but it does not admit explanation in terms of some specified, pre-determined set of entities.

In this case the best candidate for the pre-determined set constitutes the known properties of the emergent base, and indeed no explanation is possible within the ontology of the base, just because an emergent is something additional to it. It is this kind of inexplicability that we can call 'something new'. An emergent property is an 'addition of being'. And if so, then ontological emergence is certainly guilty of this kind of inexplicability, just because it involves a new entity.[248]

Emergence is a realist theory of macro-properties. This does not necessarily contradict a commitment to deflationism about derivative entities, as described in section 2.4.[249] Emergentism claims that at least some macro-properties are not derivative properties, that they are fundamental and do in fact exist. This is compatible with the inflationist belief that derivative entities exist, but the way in which they exist is different to the way in which

[248] While I've used a quote from Alexander on the mysteriousness of emergence, he almost certainly disagrees that emergent properties are additions of being, and certainly that they are novel causal powers. There are passages in Space, Time and Deity that seem to entail the negation of the proposition that emergence is an addition of being. He accepts that higher-level properties can be identified with lower-level systems; and he also argues that a Laplacean calculator could predict the whole future in physico-chemical terms, without resorting to the terms of the higher levels. So whatever his qualities are, they don't seem to have a causal effect on the lower levels. See Alexander 1920 p.47, pp.327-9.

[249] This raises the question of whether emergence requires emergent individuals, and the status of that object. Must emergent properties inhere in a substance or is there conceptual space for a view on which emergent properties are possessed by macro-entities which are mere aggregates? That kind of view might still be consistent with the background picture (where complex objects are derivative.) This is briefly discussed in chapter 6.

fundamental entities exist. It is also compatible with the deflationist belief that derivative entities do not in fact exist. There are more properties that exist on an emergence theory of macro-properties than on one that accounts for their putative existence without invoking new properties, but this does not involve changing the status of derivative entities because emergent properties are not derivative entities.

Regarding the inexplicability of emergence, most theories of emergence do not involve magic or complete autonomy,[250] and, while there are many differences among the formulations that ontological emergence has taken over the years, there are certain features that are, for the most part, held in common. The idea of emergence involving something ontologically new and additional in relation to its base is one of these ideas. The idea that emergents are dependent on their base is another.

Some of the other details here mean that the discussion won't apply to all accounts of emergence - not least, for example, because emergence is often formulated in terms of laws rather than powers - it is nonetheless likely that these considerations could be parsed in those ontologies. Inevitably however, there are also some theories with incommensurable views on the nature of an emergent's dependence and novelty. The 'emergent' theories supported by Silberstein and McGeever[251], Spencer-Smith[252], Searle[253], and Sperry[254], for instance, contain features that are divergent with most of the following discussion. Silberstein and McGeever's view of 'emergence' is 'relational holism', which is ambiguous in its metaphysical commitments vis-à-vis dependence and novelty, but also entails the denial of atomistic fundamentalism and the intrinsicality of properties that is assumed in the background picture here.[255] Spencer-Smith, Searle, and Sperry's views diverge because of their variously different ideas about the kind of novelty that suffices for emergence.

Other differences notwithstanding, the rest of this section proceeds to develop the notions of 'dependence' and 'novelty' as they pertain to emergence. Consider these to be starting points to be developed:

[Dependence] – Emergent properties are dependent on the emergent base[256]

[250] In the sense of 'autonomy' used in Searle 1992.
[251] Silberstein and McGeever 1999
[252] Spencer-Smith 1995
[253] Searle 1992
[254] Sperry 1991
[255] see Silberstein and McGeever 1999, p. 198-200; and chapter 1 of this thesis.
[256] Note the difference with Crane 2001, where the dependence premise seems to rule out certain kinds of emergent substances.

[Novelty] – Emergent properties are ontologically additional to the emergent base.

Emergent entities are dependent on their bases and yet are ontologically distinct. This is the form that the emergent answer to the Problem of Reduction takes. [Dependence] must also allow a distinction between micro-properties and macro-properties. [Novelty] guarantees that the macro-property is, in fact, a really existing property. The emergence relation to be defined must satisfy these premises. In addition, in order to solve the Problem of Reduction, the emergence relation must explain how a macro-property is the property of an apparently complex object and yet be simple and fundamental. Let's examine some theories with these explananda in mind.

4.3 The Unpredictability of Emergence

In some discussions of emergence a lot rides on the extent to which phenomena are 'unpredictable', though there are formulations of emergence that are compatible with both causal determinism and its denial.[257] There is the possibility of a new form of unpredictability that is implied as a direct consequence of the core metaphysical features of emergence; however, given what has been said about the inexplicability of emergence, the extent of that unpredictability is questionable. Here is Broad on the question of unpredictability:

> There is nothing, so far as I can see, mysterious or unscientific about a trans-ordinal law or about the notion of ultimate characteristics of a given order. A trans-ordinal law is as good a law as any other; and, once it has been discovered, it can be used like any other to suggest experiments, to make predictions, and to give us practical control over external objects. The only peculiarity of it is that we must wait till we meet with an actual instance of an object of the higher order before we can discover such a law; and that we cannot possibly deduce it beforehand from any combination of laws which we have discovered by observing aggregates of a lower order.[258]

In the world before an emergent property occurs for the first time, it would be possible to accurately observe all of the behaviour of the base entities and yet fail to predict the emergence of the new, emergent property when it occurs. A theorist whose understanding of the world was derived from theories developed entirely from observations of physical systems before emergence might not be able to anticipate the emergent property: the threshold will appear to be arbitrary. This possibility seems to follow from the inexplicability of emergence in terms of the properties of the emergent base.

[257] see O'Connor 1994 for example
[258] Broad 1925 p.79

Here is Alexander characterising this implication of emergence: “A being who knew only mechanical and chemical action could not predict life; he must wait till life emerged with the course of Time.”[259] And: “How much of the future he will be able to predict depends on the time at which his calculation begins, that is, on the state which the universe has then attained in the unfolding of its characters.”[260]

Compare this with the Laplacean demon:

> We may regard the present state of the universe as the effect of its past and the cause of its future. An intellect which at a certain moment would know all forces that set nature in motion, and all positions of all items of which nature is composed, if this intellect were also vast enough to submit these data to analysis, it would embrace in a single formula the movements of the greatest bodies of the universe and those of the tiniest atom; for such an intellect nothing would be uncertain and the future just like the past would be present before its eyes.[261]

Employing the notion of the Laplacean demon, one might say that, ceteris paribus, if emergence were true it would mean the difference between a world where the Laplacean demon is successful in its predictions and one where it is not. We should be clear that the stipulation that the demon has knowledge of “all forces that set nature in motion”, is limited to only that set of entities constituting the emergent base, before the first occurrence of emergence. It is this restriction in the epistemic viewpoint of the demon and not its limitations as a calculator that is pertinent to emergence. What Alexander has in mind is that if a Laplacean demon has complete knowledge of the universe before emergence occurs, that demon could not possibly predict that occurrence.

That the unpredictability of emergence is entailed by this restriction of one’s epistemic viewpoint (to the emergent base) even for a postulated perfect predictor like the Laplacean calculator is significant. Let’s assume the Laplacean demon is omniscient in two ways: apart from the epistemic restriction to the emergent base, it has perfect knowledge of fundamental ontology;[262] and, apart from whatever unpredictability is entailed by that epistemic restriction, it is a perfect predictor of all that that ontology entails. We’re assuming that the only kind of unpredictability that affects the Laplacean demon is one resulting from this division in fundamental ontology between the entities to which the demon has access and those that it

[259] Alexander 1920 p.327
[260] Ibid p.328
[261] Laplace 1814/1951 p.4
[262] In chapter 5 we’ll see that this does not quite work as a definition of emergence and pose a refinement.

does not. In this sense – and only in this sense - we are admitting that a restricted epistemic standpoint is the mark of emergence. With that in mind, let's look at some other formulations of emergence in terms of unpredictability.

Newman[263] argues that sensitivity to initial conditions in strange attractors and other chaotic nonlinear systems poses insurmountable measurement limitations that makes the occurrence of these macro-properties unpredictable using only the theories describing the emergent base. Newman's argument is based on similar reasoning to that which we saw in sections 3.1 and 2.4, i.e. the impossibility of creating derivational relations between theories concerning macro-properties and the emergent base. And as we've seen this does not entail the addition of being that defines ontological emergence: it is a form of weak emergence. Indeed, Newman explicitly claims that such macro-properties are identical to the properties of the emergent base and relations among them.[264] These macro-properties are structural properties and therefore do not, in fact, exist.[265] Furthermore, if it is the sensitivity to initial conditions and measurement issues that generate the unpredictability, then this does not seem to be the kind of unpredictability that a Laplacean demon would face.

Bedau[266] characterises a form of unpredictable emergence that is also based on a restricted epistemic standpoint. His argument is based on the observation that for nonlinear systems it is typically impossible to provide an analytic or 'closed' solution; the solutions must typically include boundary conditions. This is not the right kind of restricted epistemic standpoint and it does not entail ontological emergence. Our Laplacean demon is restricted only to the emergent base – which includes all entities that are not emergent macro-properties. Since both system states and boundary conditions are included in the emergent base, our Laplacean demon would have all the resources to provide solutions to these systems.[267] Bedau also stipulates that the macro-properties of these systems can only be derived by simulation; this likewise poses no problem for our perfect calculator.

Both the inexplicability and the in-principle unpredictability of emergence are implied by the ontology of emergence and the novelty of emergence has its basis in that ontology. This connects with our discussion of fundamentality in section 2.2. There fundamentality was characterised as the set of entities that God would have to create in order for the world to be the way that it is. Here we can characterise emergence as positing a difference, ceteris

[263] Newman 1996
[264] Ibid p.251
[265] See section 2.2.4
[266] Bedau 1997
[267] Assuming that the boundary conditions are not also an emergent property; if they were it would be begging the question anyway.

paribus,[268] between the possible epistemic standpoint of God and the possible epistemic standpoint of the Laplacean demon in relation to their knowledge of fundamental ontology. In other words, God, having created the universe's ontology, has full knowledge of it and therefore, for God, emergence is neither inexplicable nor unpredictable in this sense. Furthermore, according to this definition of fundamentality and the preceding description of the relevant difference between the Laplacean demon and God, the novelty of emergence – that the emergent entity is an addition to our ontology – would be fundamental.

The examples above, and others that are based on a scientistic approach to emergence, examine scientific case studies that exhibit unpredictability in nonlinear systems.[269] The unpredictability found in these nonlinear systems goes beyond the merely conceptual irreducibility explored in sections 3.1. and 2.4; over and above the general failure to explanatorily reduce special science and natural kind terms. Otherwise the examples are similar: the putative macro-properties seem, in their indispensability, to indicate some kind of a correspondence with the way the world is structured. This is another kind of epistemological emergence. These epistemological features often tell us interesting things about the world, how it unfolds, the nature of the entities in it, and so on. They do not, however, entail that those putative macro-properties really exist.[270] The naturalness of these macro-properties could indicate only correspondence to structure and not real entities. Philosophers like Jessica Wilson and Carl Gillett, just for example, describe varieties of emergence that I take to be less than ontological emergence, but that are still mind- and explanation-independent features of the world.[271] This is Wilson's 'weak metaphysical' emergence and Gillett's definition of 'Strong' emergence. Ontological emergence is something more: it *is* an addition of being. The only epistemic criterion we have identified for ontological emergence is the one that would apply to the Laplacean demon.

For any given set of observations, the difference between the two (ontological emergence and epistemological emergence) is usually a matter of metaphysical theory. Whether we think that an observed phenomenon implies the existence of a new entity is often going to turn on the most general theories we have about the entities that exist and what they can do. In this case the category of 'property' entities, and our theory about what their identity

[268] I'm not sure how causal indeterminism would affect this difference; but whether the difference fails to hold in all circumstances is irrelevant because what I am claiming is only the possibility of this difference.
[269] Note that this is more than just a special case of the failure of Theoretic-Derivational reduction mentioned in section 3.1. There are some commonalities. The putative macro-properties here are indispensable as an explanatory notion and yet aren't theoretically identified with properties in the emergent base. The macro-properties are very useful for prediction
[270] As per the discussion of ontological commitment in section 3.7.
[271] Wilson 2010; Gillett 2002

conditions are and how to identify new entities in that category. The theory of property identification that we hold is the difference between saying that there are a small set of properties, a sparse ontology, perhaps only to be identified by fundamental physics,[272] and saying that there are abundant properties, maybe even to the extent that there is a really-existing new property-entity for every meaningful predicate we have. Likewise, the theory of property identification that we hold is also the difference between saying that a phenomenon is epistemologically emergent and saying that it is ontologically emergent. We've done some of the necessary work in chapter 2. and we'll return to the question in chapters 8-10.

4.4 Novelty

We've so far characterised emergence by reference to Alexander's criterion vis-a-vis the unpredictability of emergence. The Laplacean demon is limited in his predictions until after emergence has unfolded in the course of time. "How much of the future he will be able to predict depends on the time at which his calculation begins, that is, on the state which the universe has then attained in the unfolding of its characters."[273]

We've also argued that one implication of thinking about emergence in terms of the Laplacean demon and the concept of fundamentality in terms of God's necessities,[274] is that the emergent property would be fundamental. This also seems to follow from our background commitments to deflationism in fundamental ontology and the adoption of a realist stance about emergent properties.

With this in mind, let's return to our premise with regard to novelty, which is:

[Novelty] – Emergent properties are ontologically additional to the emergent base.

This should not be understood as meaning that any new property that is an addition to the fundamental ontology is an emergent property. What is meant by the novelty of an emergent property is not merely the novelty of the first occurrence of a previously unseen property. It is not that a property has never been seen before that entails the inability to predict that occurrence; ex hypothesi, for the Laplacean demon the occurrence of never seen before (but non-emergent properties) is completely predictable. The 'emergent base' in this definition includes all possible properties of the emergent base.

[272] Though, of course, there are conceptions of sparseness that go beyond physics. This is not an implication of a commitment to sparseness.
[273] Ibid p.328
[274] As in section 2.2.

What follows is a brief survey of some of the methods of identifying the novelty of emergence and of making the distinction between an emergent property and the emergent base. There are some who regard the lack of logical entailment to be sufficient for emergence: i.e. that emergent properties are not logically implied by the properties of the emergent base.[275] We will look at some examples of this and some problems with a modal conception of the emergent relation in the next section, but it suffices to say here that the failure of a logical or some version of metaphysical 'entailment' to hold fails to rule out both mere correlations and non-emergent nomological relations of the kind that could be predicted by the Laplacean calculator.

There are also conceptions of the novelty of emergence based on the distinction between dispositional and categorical properties.[276] Chalmers, for instance, distinguishes emergent qualities in the case of consciousness from causal novelty in quantum systems.[277] Van Gulick presents emergence as being split into emergent properties and emergent powers, with different kinds of novelty.[278] And Searle's account of emergence relies on mental properties being emergent qualities but not emergent causes.[279]

It would be problematic for us to use the categorical/dispositional distinction to demarcate emergent and non-emergent novelty. This is true even if we accept the arguments that conscious experience entails a failure of reduction.[280] One problem with this is that it assumes a position on the distinction between categorical and dispositional properties that we struggled to justify in section 2.6. And we have, on the basis of those arguments, made the assumption that powers are either identical to, or figure into the identity conditions of, the properties of objects. It is not available to us to say that the difference between the novelty of an emergent property and the novelty of a non-emergent property is that one is categorical and one is dispositional.

Other conceptions of the novelty in emergence are clearer in demarcating the 'ontologically additional' emergent properties from the ontologically additional micro-properties. Even something like Horgan's 'superdupervenience' seems to fit the bill, where the macro-properties are metaphysically and scientifically basic, in much the same way that fundamental laws of physics are basic; they are unexplained explainers.[281] Non-reductive

[275] Though in some of these cases the emergent/non-emergent distinction cuts across the dispositional/categorical distinction. We might derive this from e.g. Fodor 1997; Block 1997.
[276] See section 2.6.
[277] Chalmers 2006
[278] Van Gulick 1993
[279] Searle 1992
[280] See, for instance, section 3.1.
[281] Horgan 1993 557-8

physicalism is supposed to be “nothing over and above” whereas emergence is “something over and above”. Since superdupervenience is supposed to be incompatible with nonreductive physicalism, might this not suffice? Assuming that the nonreductive thesis is a substantive ontological one, one way of characterising the difference between emergence and non-reductive physicalism is that NRP attempts to make sense of distinctness (non-identity) between macro-properties and the ‘emergent’ base, without doing so through the use of an addition to the ontology.

While fundamentality and ‘basicness’ are necessary conditions for the novelty of an emergent property, it is not sufficient to distinguish it from the novelty of the kind of ontologically additional micro-property the occurrence of which the Laplacean demon could predict. Both types of property are additions to fundamental ontology. The only relevant distinction seems to be that an emergent property is a macro-property.[282] If this is the case then not only is emergence a theory of macro-properties, it is also *necessarily* a theory of macro-properties. Emergent properties are macro-properties and, as we shall see in the next section, macro-properties are also emergent properties. It is therefore something about the novelty of a macro-property that explains the inability of the Laplacean demon to predict its occurrence.

4.5 Primitive Dependence

So emergent properties are macro-properties and they are fundamental. We also started with the following premise:

[Dependence] – Emergent properties are dependent on the emergent base

But in what ways does an emergent depend on its base? What features does this dependence have? Let’s survey the options.

First of all, there are some conceptions of emergence that rely on the failure of a primitive notion of dependence. Due to its primitiveness we have to talk about this stipulation in the abstract. One way we can do this is by employing the very general notion of dependence in the same way that Schaffer does.[283] Let’s assume that a theory of emergence on this account would simply mean a failure of dependence to hold between the emergent property and the emergent base.

[282] Note that the micro-macro boundary is at the point of the atomistic foundation: physical and molecular emergence is not ruled out by this.
[283] See, for example, Schaffer 2009 and some of the discussion about dependence in section 2.2.

A second problem is that one of the core features of emergence is that emergent properties do, to some extent, depend on the emergent base. Would a primitivist approach deny [Dependence]? Or is there some other primitive way in which an emergent does depend on its base? If so, would this involve the stipulation of a further abstract notion to preserve [Dependence]?

This will not do. One problem with employing an unspecified notion like this is that it will not help us solve the Problem of Reduction. The Problem of Reduction arises because of a lack of specificity about the nature of macro-properties. Adopting a general approach where dependence fails to hold as a matter of abstract principle does not give us any advance on this lack of specificity. This is a purely negative definition of emergence. Since a theory of metaphysical emergence should provide an answer to the Problem of Reduction, this is not an adequate theory of emergence. Why does this dependence fail to hold? We will shortly argue that there is a kind of dependence that does fail to hold – ontological dependence - and that this is what explains what it is that makes emergent properties fundamental. We will then need to rely on a different kind of dependence to explicate the [Dependence] premise. By using an unspecified abstract notion we would struggle to make this distinction and could not explain what makes a macro-property either macro or a property.

4.5.1 Ontological Dependence

We have a minimal working definition of ontological dependence from section 2.2:

> (OD) An entity *x* is dependent iff for all possible worlds *w* and times *t* at which a duplicate of *x* exists, that duplicate is accompanied by other concrete, contingent objects in *w* at *t*[284]

And we have also mentioned how ontological dependence is an important notion in defining deflationism and substance, sections 2.4 and 2.5. If we are to think of the dependence of an emergent property on its base in terms of ontological dependence, we need to be clear about what the notion means and the different ways in which one entity can ontologically depend on another. We must go beyond (OD) as a definition.

The crux of the idea is that one entity depends for its existence on another entity, and this is not in a causal sense, as already explained in section 2.2. We can also distinguish ontological dependence from the notion of logical dependence, which is a kind of dependence that can only obtain between propositions.

[284] This is from Barnes 2012 p.880. Most of the analysis in this section looks at the account of emergence in this paper.

We suggested in 2.5. that substances were ontologically independent and as such could be the foundation of reality we committed to in 2.2.2. It is common for substance to be conceived as an object that does not depend for its existence on anything else.[285] To begin exploring the different relations that might be able to do the work in the case of substance and emergent properties, let's define a simple relation of ontological dependence that would satisfy (OD):

(D1) x depends for its existence upon y $=_{df}$ Necessarily, x exists only if y exists.[286]

Here ontological dependence means that the existence of x strictly implies the existence of y. And it's worth noting that this also implies that on this definition everything ontologically depends on itself. We can then form the definition of substance in terms of ontological independence:

(Substance) x is a substance iff there is nothing y such that y is not identical with x and, necessarily, x exists only if y exists.

Now, for our purposes in providing a solution to the Problem of Reduction, and in particular the questions of how a macro-property could be simple and fundamental, it is relevant to seek the implications of these conceptions of substance for the status of the properties of composite objects.[287] We've already argued in sections 2.4. and 3.1. that a composite object does not in fact exist because it is nothing over and above the simples that constitute its proper parts and on which it existentially depends. It may however be possible to deny that a composite substance depends for its existence on its proper parts because it is possible for that substance to undergo a change of those parts without ceasing to exist. In this way we draw the distinction with a composite object that is not a true substance, but merely rather the collection of objects that composes it. The relation of ontological dependence as defined by (D1) does not hold between a composite substance and its parts.[288]

In sections 2.3. and 2.5. we defended a view of properties where they are ontologically dependent on the objects in which they inhere. Using our definition of ontological dependence we can now form the following premise about properties:

[285] For instance in Descartes 1644/1983
[286] Lowe 1998 p. 137. Most of the ensuing discussion and the definitions used here are from Lowe 1998 ch. 6.
[287] We continue this discussion in relation to simplicity in section 3.1.
[288] Though it does in a more generic sense of ontological dependence.

(Inherence) If x is a property and y is an object in which x inheres, then necessarily, x exists only if y exists.

The premise (Inherence) only seems to apply to property particulars, since x seemingly cannot 'migrate' to some object other than y when y no longer exists.

Returning to (Substance), there appears to be a problem with using (D1) to form a definition of substance. That is, if one role for substance is forming the foundation of reality as required by foundationalism, then, contrary to the background picture,[289] (D1) seems to allow the possibility of a relation of mutual existential dependency holding between non-identical things, i.e. x may bear the relation (D1) to y, and y may bear the elation (D1) to x. Rather than a chain of ontological dependency that terminates in an ontologically independent substance, it would be possible to have a chain of (D1) dependency that terminates in a mutually dependent pair x and y that do not satisfy (Substance).

The notion of ontological dependency must be asymmetrical if it is to satisfy foundationalism. One important reason why an asymmetrical relation of ontological dependence is desirable is because of its explanatory role. Our main motivation for committing to foundationalism was that it explained how existence is possible – in virtue of the ontological independence of the foundational objects. No such explanation is provided by the mutually dependent pair x and y. The explanation for the existence of x is the existence of y, but the explanation for the existence of y is the existence of x - it is circular. Whereas, if x is a substance as defined by (Substance), the explanation for the existence of x is that it is a substance and therefore capable of independent existence, and it is in virtue of this that anything that ontologically depends on x exists.

If the existence of x is supposed to be explained by the existence of y, then this gives us a possible way to define ontological dependence in an asymmetrical way. This is because the explanatory relationship and the conjunction 'because', are themselves asymmetrical. We might then replace (D1) with the following:

(D1*) x depends for its existence upon y $=_{df}$ Necessarily, x only exists because y exists.

The explanatory role of ontological dependence is also relevant if it is supposed to be appealed to in order to explain the dependence of an emergent property on its emergent base. For our purposes, the emergent relation must explicate emergence in such a way so

[289] i.e. that there exists a foundational 'level' at the bottom of reality that is ontologically independent. See section 2.2.2.

as to explain the possibility of macro-properties and solve the Problem of Reduction. This will create a conflict between the two explanatory roles of the relation of ontological emergence. In foundationalism, ontological dependence explains the existence of an entity in virtue of the objects on which it existentially depends. But [Novelty] ensures that an emergent property is ontologically additional to the emergent base. And we have argued that this novelty entails the inexplicability of emergence from the epistemic standpoint of the emergent base. How then is it possible for an emergent property to be ontologically dependent on its base, i.e. for its existence to be explained by the existence of its base, and yet for a Laplacean demon with perfect and complete knowledge of that base to be incapable of explaining its existence?

Perhaps we can resolve the contradiction by appealing to (Inherence), which, since we are talking about emergent properties rather than substances, might seem to be the more appropriate kind of premise regarding the ontological dependence of emergence. This only pushes the problem back a stage. Properties must inhere in a substance. We have made the distinction between composite objects – which are derivative entities and do not in fact exist – and composite substances. Emergent properties are macro-properties. Macro-properties must inhere in composite substances. However we have already argued that composite substances do not ontologically depend on their parts.[290]

If the dependence of an emergent property on its base is supposed to be a relation of ontological dependence, then it cannot be the relation described by (Inherence) because that is a relation between a property and its substance. If the composite substance is fundamental rather than derivative, then it is something additional to the base. The substance in which an emergent inheres is a distinct relata to the base composing it. The relation between a composite substance and its parts is not ontological dependence.

But neither can the dependence of an emergent property on its base, via a composite substance, involve the relation described by (D1*). This is because a notion of ontological dependence that could fit the bill required by foundationalism would entail the kind of explanatory reduction available to the Laplacean demon and therefore the failure to comply with [Novelty]. Furthermore, since we've explicated the notion of fundamentality in terms of the difference between the epistemic standpoint of God and the Laplacean demon, the emergent property on such an account would also fail to be fundamental. Such an entity would not count as emergent and could not solve the Problem of Reduction.

[290] Except in a generic sense. More on this in section 6.5.

We can now see that, given our background assumptions about foundationalism in terms of ontologically independent objects, and our assumptions about fundamentality in terms of the ontological necessities of God, ontological independence is the mark both of the ontological foundation of reality and also its fundamental objects.

We can describe this in reference to God and demon again The shift in epistemic standpoint from God to the Laplacean demon effectively involves the removal of the knowledge of certain possible fundamental objects. Any objects that are thus removed, but which are ontologically dependent, will, insofar as ontological dependence explains the existence of an object in virtue of the existence of another object to which it stands in the relation of ontological dependence, be epistemically available to the demon because the demon has perfect knowledge of all of the entities within the purview of its standpoint and therefore access to the explanation.[291] Thus fundamental objects must be ontologically independent. The notion of an ontologically dependent entity that is fundamental is contradictory according to our current definition of ontological dependence.

Let's return to Barnes's conception of emergence as involving fundamentality and ontological dependence.[292] She assumes that fundamentality is brute, and that ontological dependence does not bottom out in what is fundamental. [293] However, this relies on taking ontological dependence to also be brute. If, as Barnes seems to suggest, ontological dependence were some catch-all metaphysical concept like Schaffer's 'grounding'[294] capable of covering the requirements of both foundationalism and the relation holding between natural numbers and the world, then for our purposes, as we have seen, this does not sufficiently explicate emergence. It seems unlikely that whatever relation is able to do the explanatory work for mathematics (assuming that she is right about that possibility) would be able to do the same for emergence. A catch-all umbrella concept is not a brute relation. The only candidates for being brute are the specific relations covered by that umbrella.

The move to umbrella terms only obscures the real relations. What relations are there that have the force of metaphysical necessity? The relation of identity is the paradigm. But that means there is no new entity required to be created by God. If the ontological dependence of emergence is mereological, then, as we argued in section 2.4., the emergent property would not really exist. If the ontological dependence of emergence is defined by (D1*), then it also seems that fundamental entities cannot be ontologically dependent. It seems that once the

[291] This assumes that perfect knowledge of an entity includes knowledge of the propositions made true by that entity's existence, including those propositions about the existence of other entities.
[292] Barnes 2012
[293] Ibid p.876
[294] See preceding section.

existence of an object is dependent in this sense, then God would not have to create it independently of the entities on which it depends. It is in this sense that derivative entities should be understood – their 'existence' is explained by the entities from which they are derived. God would only have to create the independently existing entities.

Using the general terms of meta-ontology make the possibility of ontologically dependent emergence seem more plausible: Barnes argues that how the two concepts come apart in the opposite direction for mathematical objects is evidence of the possibility of emergence.[295] But the sense in which mathematical objects are 'ontologically dependent' and the sense in which an object or a property are 'ontologically dependent' is different, and what is true of the dependency of mathematical objects is not necessarily true of the relations above. We have plausibly argued that it is not true. The move to the generalities of meta-ontology has facilitated an equivocation on the notion of dependence.

A theory of emergence must give an account of how the emergent entity is novel and how it depends on its base. It is not necessary for emergence to be a relation that is this strong in order to do that.[296] Barnes glosses over the main problem of emergence, which is explicating the relation that makes emergence possible. Instead, by lumping emergence in with what (she argues) are two independently supported metaphysical brutes, it seems to imply that emergence comes without cost. However, the theory that both foundationalism and fundamentalism are defined by ontological dependence employs only one of those brute terms – ontological dependence. Barnes argues for two, and one of those – ontological dependence – isn't even brute.

Barnes herself admits that there were problems with coherence in the past when ontological emergence was defined in terms of a metaphysically necessary relation.[297] The appeal to meta-ontology does not help in overcoming the problems. In this regard, she appeals to the example of a gunky universe to suggest the possibility of dependent entities whose existence is not threatened by their dependence (they are dependent but fundamental). But if the emergentist wants to assume a gunky universe, they will find emergence hard to motivate. In a gunky universe there is no foundation, so there is no basis for privileging some entities over others. Every object is both fundamental and dependent. This means that every object would satisfy Barnes's requirements for emergence. Raising meta-ontological possibilities like those we considered in section 2.2 doesn't help with the Problem of Reduction because it is only in this universe with the meta-ontological background that we

[295] Barnes 2012, pp. 882-6
[296] To be fair, Barnes does not intend for her account to apply to all theories of emergence.
[297] Ibid p.897

have assumed that such a problem occurs. If the thought is that the existence of the Problem of Reduction in an atomistic fundamentalist universe gives us reason to believe that the universe is gunky, then that case should be made.

In any case, better than saying that everything in a gunky universe is emergent is saying that nothing is. What you have here is a different theory of objects and properties in general, not a theory of emergence in particular. The unique characteristics of a theory of emergence are a response to the Problem of Reduction and other similar problems that only arise in ontologies where the existence of macro-properties would require additional metaphysical commitments. The fact of 'emergence' in other ontologies is trivial.

The dependence of an emergent entity is not necessarily ontological dependence. It is not dependence in the sense defined by Barnes. We should assume that in our metaphysical framework there is no such thing as an ontologically dependent fundamental.[298]

4.5.2 Constitution

Let's first rule out some ways in which the emergent property does not depend on its base. An emergent is not constituted by its base. While the emergent depends for its existence on a composite of simples, it is not a mere aggregate of the simple properties.

An emergent property is a property of a composite object, and the emergent base comprises properties of parts of that composite. But compare this to a relation that is a mere aggregation, like the relation between the weight of a whole and the weight of its parts. The weights of the parts straightforwardly determine the weight of the whole. The weight of the whole and the weight of the parts are different, but, if the weight of the whole is a property at all, it is the same kind of property as the weight of its parts: they are both determinates of the determinable *weight*. Van Gulick calls cashing out the emergent relation as a determinable/determinate relation 'specific value emergence' but it will not suffice to give us the novelty an emergent requires.[299] In an emergent theory of macro-properties a macro-property is more than the sum of the properties of its parts – it is a genuine 'addition of being'. They cannot be constituted by the 'additive point of view', as Ernest Nagel puts it,[300] because they are not similar in kind in the respect of a determinable and a determinate. The determinable/determinate is the wrong kind of relation.[301]

[298] In this we are following the arguments in, for instance, Heil 2012, Ch. 3
[299] Van Gulick 2001
[300] E. Nagel 1963
[301] Searle calls the relation between the weight of a whole and its parts a 'system feature', which also includes other features of a whole that are straightforwardly determined by the aggregation of its parts

The next candidate for the emergent relation raised by Van Gulick is 'modest kind emergence'. When cashed out in terms of causation this matches up with what Searle calls 'causally emergent system features'[302]. The relation holds when a whole has features that are *different in kind* to those of its parts. Examples of this type of relation might include wholes characterised by solidity, transparency, and redness: none of the molecules making up a red tomato are themselves red, for example.[303] For Searle, this relation - 'emergent1' he calls it - is the relation that holds between mental and physical properties. However it would not count as an emergent theory of macro-properties according to the proscriptions of this thesis.

In terms of causal powers, as Searle puts it, a property that emerges via an 'emergent1' relation, has causal powers that are entirely explained in terms of the causal interactions of the basal properties. Furthermore, when the tomato's constituents are arranged, you *thereby* have a red tomato. In the ontology there are the properties of the base and its arrangement, and nothing more.[304] There is no addition of being necessary. Since there is nothing new in the ontology, this must be a relation where the whole is 'nothing over and above' its parts. Even an identity theorist can accept that mental properties are 'emergent1'. For example, J.J.C. Smart emphasises that 'in saying that a complex thing is nothing but an arrangement of its parts, I do not deny that it can do things that a mere heap or jumble of its parts could not do."[305] If the relata of 'emergent1' are basal properties and their arrangement on the one hand, and nothing ontologically additional to the basal properties and their arrangement on the other, then it seems hard to argue that they are not identical, which would violate [Novelty].

O'Connor and Wong would describe specific value emergence and modest kind emergence as 'structural properties', where a structural property has the following definition:

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and their arrangement, such as shape or velocity, that are features of a kind held by the parts themselves. Searle 1992 p.111-2

[302] Van Gulick 2001 p. 17; Searle 1992 p. 111

[303] Spencer-Smith 1995 'Reductionism and emergent properties' p.117 also gives a definition of this conception of emergence in contrast to the determinable/determinate relation (though 'constituent' has to be interpreted in a certain way for it to match the definitions here).

[304] Searle's account relies on a conception of mental properties as a new kind of quality in a way that doesn't require anything additional in the fundamental ontology. His argument is directed at certain other problems in philosophy of mind. He already accepts that there is no causal emergence, thus, in terms of the causal closure argument, he does not offer an emergent solution. See Searle 1992.

[305] J.J.C. Smart 1987 p248

> A property, S, is structural if and only if proper parts of particulars having S have properties not identical with S and jointly standing in relation R, and this state of affairs *is* the particular's having S.[306]

They characterise these structural properties as properties-by-courtesy. In contrast, genuinely emergent traits are 'wholly nonstructural'. This does not violate [Dependence]: emergents are caused by certain arrangements, and would cease to exist without those arrangements, whereas structural properties *are* those arrangements, they are identical.

Among the options presented by Van Gulick, the only relation that fits our basic account of emergence is Van Gulick's third, 'radical kind emergence'. As with modest kind emergence, here there is also a difference in kind between the whole and its parts. Unlike modest kind emergence, the whole's nature and existence is not necessitated by the properties of its parts, their arrangement, or "the law-like regularities governing the features of its parts."[307] The point is that, though the emergent depends on its base, the base, whatever powers it has and whatever laws might apply to it, is insufficient to cause the emergent. They are a cause but not a sufficient one.

4.5.3 Supervenience

Not too long ago it was common for philosophers to suggest that the connection between an emergent and its base should be thought of in terms of a synchronic strong supervenience. Strong supervenience would mean that an object having an emergent property at a time t would imply, of causal necessity, that it also has a certain basal property or family of physical properties. The slogan is: 'No mental difference without a physical difference.'[308]

Putting aside for the moment the question of what sort of relation explains this kind of covariance, we might legitimately ask if this is an issue. Why is it that these philosophers postulated that the relation between the emergent and its base is a supervenient relation? Part of the reason might be that these discussions of emergence were typically given contiguous with discussions of non-reductive physicalism, where supervenience was a key idea; the project in these circumstances was often to disambiguate non-reductive physicalism.

As Hong Yu Wong points out, looking through this literature, one can find only a few examples of arguments for why emergent properties must supervene on their bases.[309] Here

[306] O'Connor and Wong (2005) p.663. See also section 2.3.3.
[307] Van Gulick 2001 p. 17
[308] e.g. McLaughlin (1997), Van Cleve (1990) and Kim (1999, 2006)
[309] Wong 2010

is Crane when considering 'the notion of a property of a whole whose powers are unrelated to whatever the powers of its parts are':

> If they do not thus supervene, then it seems somewhat perverse to describe the properties as 'emergent'. Presumably part of the point of this label is to pick out the sense in which putting a thing's parts together gives you something new – but not because you have added something 'from the outside'. If emergentism is to be distinguished from dualism and vitalism (which do add something 'from the outside') then it must reject this strong notion of emergence [310]

So the argument here seems to be that supervenience is necessary to distinguish emergentism from more radical views. However, this seems inadequate, because there is no reason why the properties of substance dualisms cannot also co-vary – indeed, on a Cartesian system the best way to save appearances is for properties of the "mind" and the "body" to co-vary. The point is that, insofar as the supervenience of emergents and basal properties is for them to exhibit modal dependent variation, it is trivial in a sense. It doesn't seem to be able to separate a property emergentism from a substance dualism in a principled way.

Crane characterises substance-monist emergence as being the claim that mental properties are properties of physical objects – which he calls 'Dependence' – if the thought here is that substance monism makes supervenience more plausible, it is hard to see why this is the case. That the same object might exemplify mental and physical properties doesn't imply that those properties would co-vary. Crane's argument for a supervenient emergent relation is based on the need to reconcile the 'something additional' of the [Novelty] premise with the substance monism of his 'Dependence' premise. However, there is nothing there that needs to be reconciled.

Turning to a different example, in Being Realistic about Emergence, Kim argues that supervenience must be considered a component of emergence, because it is the only guarantee of a systematic connection between basal conditions and emergent phenomena: he says that emergent properties must supervene because otherwise the connection between a mental property, say pain, and a neural condition, would be "irregular, haphazard, or coincidental, and not to be relied upon", and he asks "what reason could there be for saying that pain 'emerges' from that neural condition than another".[311]

[310] Crane 2001
[311] Kim 2006

What Kim is arguing against in this case is what Van Gulick calls radical kind emergence, where emergent properties are: “of a kind whose nature and existence is not necessitated by the features of its parts, their mode of combination and the law-like regularities governing the features of its parts”.[312] Admittedly, this doesn’t seem to leave a lot of room for the production of emergents, at least in terms of the theory of causation we are currently using. If we are to put this in terms of laws, it seems like the confusion here is that, as opposed to the law-like regularities governing the features of its parts, an emergent property would have a separate law-like regularity that is additional to the law-like regularities of the parts.

This is the difference between C.D. Broad’s intra-ordinal laws, which govern the features of the parts, and his trans-ordinal laws, which govern the production of the emergent properties.[313] To continue with the analogy we’ve been employing: what we have here is the difference between the fundamental properties of the parts that are known to the Laplacean demon, and the properties of those parts that only God would know about, but which are necessary for the production of an emergent property.

Crane’s argument for a supervenient emergent relation is based on the need to reconcile the ‘something additional’ of the [Novelty] premise with the substance monism of his ‘Dependence’ premise. However, he does not specify what actual relation it is that would ensure supervenience would hold; substance monism does not entail supervenience of emergent properties on basal properties. It is clear though that Crane would, like Kim, reject Van Gulick’s radical kind emergence. This is implied by his statements about how emergence does not involve anything outside of the composite object.

Kim’s argument for a supervenient emergent relation is based on the need to ensure that the relation between an emergent and its base is not “irregular, haphazard, or coincidental, and not to be relied upon”, which he fears would be the case with radical kind emergence. I think this is an expression of the worry we encountered earlier about the inexplicability of emergence, and I agree that it is a problem for radical kind emergence, since it seems to preclude the possibility of there being any explanation to be found among the parts of the composite. In this case the answer to the problem is the same as we discussed in section 4.1., emergence is only mysterious from the epistemic standpoint of the Laplacean demon, not from the perspective of an ontologically omniscient being. There is always an explanation for the existence of an emergent property to be found among the entities of the universe; just not for the given set known to the Laplacean demon.

[312] Van Gulick 2001
[313] See Broad 1925

Stipulating supervenience, on the other hand, does not entail that this is the case. Nor will whatever relation explains [Dependence] necessarily ensure that supervenience will hold. Kim requires some sort of systematic connection in order to avoid inexplicability. The fact of supervenience will depend on the nature of the real relation that ensures that there is the systematic connection for which Kim is looking.

Wong raises a further worry: "In particular, it is unclear how supervenience emergentism allows for novel, downward causal powers for emergent properties whilst still guaranteeing the covariation of emergent properties with basal properties in a way consistent with the fundamental emergent laws which ensure the supervenience of emergent properties on basal properties."[314] We have already seen how stipulating supervenience in a general way, that is, without specifying the relation that ensures it, is insufficient for emergence – because it is possible that supervenience between properties holds as a matter of mere covariance. We've also seen that, if it is possible for a systematic relation to hold that would allay Crane and Kim's concerns about the danger of a "haphazard" connection between emergent and base, then stipulating supervenience is unnecessary for emergence. It is also possible, if Wong is correct, or if causal drainage is an insurmountable problem,[315] that stipulating supervenience might contradict emergence.

4.5.4 Multiple Realisability

The notion of supervenience has been used in various theories of mental properties, many of which can be characterised as non-reductive physicalist theories. While the preceding section argued that the concept of supervenience does not in itself enable us to gain adequate specificity about the emergence relation, it is still possible that the strength of the emergence relation can usefully be contrasted with both supervenience and reduction in order to demonstrate what is unique about emergence. As we have seen, emergence has often been taken as a form of supervenience, while Crane, Wong and others have variously construed supervenience as implying either reduction or emergence.[316]

In order to bracket this discussion, let's run down some other ways in which one purported property can be dependent on another and talk about their general strength. Identity is the strongest kind of dependence between emergent properties and their bases. More than that, the emergent properties just are their base - there is no distinctness at all here. It then obviously follows that there is a biconditional determination: if the emergent property is present then so is that particular base, and vice-versa. This rules out the multiple realization

[314] Wong 2010
[315] See section 3.3.
[316] See Crane 2001, Wong 2010, and, for example, Kim 1999, 2006; Chalmers 2006.

of emergent properties and also guarantees supervenience. Most importantly, identity entails reduction.

The next strongest kind of dependence is still a kind of logical determination, but here there is a one-way realization relation rather than a biconditional identity relation. This is Kim's original notion of logical supervenience.[317] The contrast between logical supervenience and identity is the denial of type physicalism, which is implied by a one-way - rather than biconditional - realization relation. Supervenience then means that, instead of being identical with its base, an emergent property is somehow 'realized' by its base. In logical supervenience the existence of a realization base entails, by logical necessity, that there is a particular supervenient property, but the existence of a supervenient property does not necessitate a particular realisation base – there may be several that could do the job. This would allow for the multiple realisability of supervenient properties.

The possibility of multiple realisability precludes identity and this might suggest that supervenient properties are distinct from their realisers. It is a strategy along these lines by which logical supervenience attempts to satisfy [Novelty], because, while a particular realisation base implies a particular supervenient property, a particular supervenient property does not imply a particular realisation base, so it seems possible to draw a distinction. Logical determination makes this dependence very strong – there are no possible worlds where the base could exist without realising the supervening property, regardless of differences in the natural laws. This, however, raises a familiar problem with specificity: is this a real relation, or merely a conceptual one?[318] What real relations are there that hold between real entities with the strength of logical determination? Kim argues that logical supervenience is in fact token identity, which entails logical determination but does not entail [Novelty], since two identical entities are not really distinct.[319]

A different kind of supervenience would be one with a realisation relation that was weaker than logical determination. Let's say that this kind of relation is nomological since nomological supervenience has been appealed to in the past to explicate emergence.[320] In this kind of supervenience the realisation is still one-way, but this time the existence of a realisation base only entails the existence of the emergent property in possible worlds that have the relevant realisation law. This would be a contingent physical law that relates the

[317] Kim 1984
[318] See section 3.5.
[319] Kim 2006
[320] E.g. Van Cleve 1990, McLaughlin 1997

base to the emergent property it realises. The law is usually posited as a physical law so that this kind of supervenience is a non-reductive physicalist theory.

Let's pause now to compare the above primitive notions with the emergence relation as we've characterised it. Firstly, as argued in sections 4.5.1-2, there do not seem to be any viable candidate relations where emergence takes the strength of ontological dependence, the emergence relation can be biconditional or one-way – i.e. it doesn't rule out multiple realisation. Broad, for example, allowed for emergent relations to be biconditional,[321] but nothing in what we've set out so far implies this. This is borne out in Kim's arguments about the implications of logical supervenience. Some kind of contingent nomological relation does seem to fit the bill; however, as argued in section 4.5.3, there do not seem to be good reasons why emergence must imply nomological supervenience. Barnes holds that it is the dependence of the emergent simpliciter. "Nothing about dependence encodes the essentiality of constitution".[322] But as argued in section 4.5.1, this approach lacks the specificity necessary for a theory of emergence to solve the Problem of Reduction. When it comes to multiple realisability of emergence, the important thing to note in our general account is that it is not on the grounds of the one-way-ness of a relation that an emergent property maintains distinctness from its base, as is the case with logical supervenience above.

4.5.5 Modality

Are there any other general things we can say about the strength of the dependence relation? Nagel, arguing against the possibility of emergence, says that explaining the properties of a complex system in terms of the properties of its parts requires some sort of necessary connection between an emergent property and its base.[323] In this context – Nagel is arguing against the possibility of emergence - Van Cleve determines that the kind of necessity Nagel has in mind must be a strict logical necessity.[324] Nagel needs for the emergence relation to be this strong in order for it to engage with a premise denying reductionism. Nagel's argument goes: the link between the emergent and its base must be explicable, therefore there must be a logical dependence, and therefore an emergent would be reducible to its base.

We can deny the second premise: that explicability requires logical necessitation. The explanatory role of [Dependence] does not require a logical connection – that requirement

[321] Broad 1925
[322] Barnes 2012
[323] Nagel 1979
[324] Van Cleve 1990

would seem to imply some form of causal rationalism, a la Spinoza, which is not an assumption we have made. Furthermore, we can also deny that the connection between the properties of a complex system and the properties of its parts can only be explained by a logical connection – this would imply mereological rationalism. Indeed, in the classical theories of emergence, explaining the emergence of one domain from another (e.g. chemistry from physics) has been a matter of using bridge principles between the truths of one domain and another.[325] These bridge principles explain the connection in terms of nomological necessity only; furthermore - regarding the relation of dependence that could do the explanatory work we require - the relata of [Dependence] are not truths but real entities. And even if Nagel is correct that the explicability of one truth's dependence on another requires a kind of logical necessitation, we have argued in section 3.1 that a failure of REP-Reduction does not imply a failure of ONT-Reduction.[326] In seeking a metaphysical explanation with adequate specificity to resolve the Problem of Reduction we are looking for truthmakers, which have different relata – the truthmaking relation is a cross categorical relation between truths and real entities.[327] Nomological necessity seems sufficient to qualify as a metaphysically explicable account. This concludes our survey of primitive and general notions of dependence.

4.6 Non-primitive Dependence

4.6.1 Bridge Laws

Abandoning the general and primitive approaches to emergence, we ask: What candidate relations are there that guarantee both [Novelty] and [Dependence]?

With the identity relation above, there is insufficient distinctness. In logical supervenience, the distinctness is due to a one-way determination enabling multiple realisability, which is insufficient to guarantee [Novelty]. In nomological supervenience, the distinctness is granted by the nomological character of the determination – since the supervenient facts follow only contingently from the basal ones, there are possible worlds where this connection fails to hold. And so far nomological supervenience, while being neither a necessary nor sufficient account of emergence, has at least seemed compatible.

We also hold, from the assumption of [Novelty] and the discussion in section 2.6, that for emergent properties to count as ontologically additional entities, they must have novel

[325] E.g. Broad 1925
[326] See also Van Gulick 2001
[327] Section 3.8

causal efficacy; furthermore, the relation between emergent and base must be sui generis with respect to its base.[328]

Now, as several theories have it, the causal efficacy of properties is related to the laws of nature into which they directly or indirectly enter. If this were true it would naturally lead to the supposition that what is required to satisfy [Novelty] and [Dependence] is a new law of nature. This assumption is there in Mill's heteropathic laws[329] and Broad's trans-physical bridge laws.[330] They are laws that connect the domain of the base with the domain of the emergent properties, laws that are new with respect to the laws and properties of the base.[331] This is why emergence cannot be predicted from the epistemic standpoint of the Laplacean demon.[332]

4.6.2 The Physical and the Mental

Another common claim about emergence, and something picked out to distinguish it from non-reductive physicalism, is the claim that emergent entities are non-physical. A simple argument to this effect can be formed: since the emergent relation is something new that is not derived from any of the laws or properties of its base, and since the base comprises physical entities in the domain of physical laws, the emergent relations cannot be in the domain of physical laws.[333] We might say that the Laplacean demon had only the epistemic standpoint of the physicist.

The argument follows from the observation that emergent bridge laws would be inexplicable in terms of the laws applying to the emergent base. Horgan argues that the laws which determine the emergence of macro-properties must therefore be

> "metaphysically and scientifically basic, in much the same way that fundamental laws of physics are basic; they are unexplained explainers. … A materialist position should surely assert, contrary to emergentism, (i) that physics is causally complete (i.e. all fundamental causal forces are physical forces, and the laws of physics are never violated); and (ii) that any metaphysically basic facts or laws – any unexplained explainers, so to speak – are facts or laws within physics itself."[334]

[328] As determined in sections 4.1-2
[329] Mill 1843/1973
[330] Broad 1925
[331] Except insofar as the properties of the base enter into those laws in relation to the emergent properties.
[332] Again, section 4.1-2
[333] Here I'm parsing arguments in, for instance, McLaughlin 1992 and Horgan 1993
[334] ibid, p. 560

See section 3.2 for a look at problems relating to a causal closure account of the Problem of Reduction and see section 3.4 for a brief discussion of physicalism. In formulating our problem for emergence we have drawn the distinction between macro-properties and micro-properties rather than between the mental and the physical. In this regard it suffices to say that a relation satisfying a non-reductive physicalism must connect the supervenient property to its realizers with respect to only those laws and properties of the base.[335]

This distinction between NRP and emergence also follows from Wilson's argument that physicalists cannot "allow that mental properties have any causal powers that are different from those of their physicalistically acceptable base properties, for this violates the physicalist thesis that mental properties are 'nothing over and above' their base properties."[336] Which brings the distinction between NRP and emergence more in line with the pertinent features we have identified as the Problem of Reduction – the features of macro-properties – rather than the distinction between mental and physical.

Either way, if NRP denies causal novelty, this would contradict [Novelty]. And our reasons for supposing causal novelty – see section 2.6 – combined with the rest of our background picture, would imply that NRP would in that case be a form of reductionism, since its macro-properties would be derivative. In similar fashion Crane, among others, argues that both emergence and NRP have to accept causal novelty, or else face reduction.[337]

Barnes argues that emergence is neutral with respect to the question of physicalism.[338] She argues that the objection by appeal to [Completeness of the physical] requires the following ancillary premises about what sorts of things are fundamental: only physical causation is fundamental, and further, all physical causation is derived from the fundamental. But whether or not these assumptions are true, neither presents a problem for emergence per se, so long as the distinction between the domain of the emergent properties and the domain of the emergent base cuts across the distinction between physical and mental – this would be the case if, say, the bridge laws relating emergent and base, were not 'psychophysical', but rather trans-ordinal laws linking domains demarcated in some other way. And this is perhaps closer to what Broad originally had in mind for bridge laws, since they were intended to be a relation between the domains of the living and the non-living,[339] but also between the domains of the special sciences: "The question: Is chemical behaviour

[335] This implies that there is some connection between the emergence/NRP distinction and the macro-property/micro-property and we will say more about this in chapters 5 and 6.
[336] Wilson 1999
[337] Crane 2001
[338] Barnes 2012
[339] Vitalism being the problem of the day.

ultimately different from dynamical behaviour? seems just as reasonable as the question: Is vital behaviour ultimately different from non-vital behaviour? And we are much more likely to answer the latter question rightly if we see it in relation to similar questions which might be raised about other apparent differences of kind in the material realm."[340]

4.6.3 The Domain of the Dependents

We have suggested elsewhere that it is not necessarily problematic if emergent properties are non-physical,[341] but it might also be unnecessary to posit that they are. The distinction between physical and mental would be one way of fleshing out the distinction between the domain of the emergent base and the domain of the emergent properties, and thereby explain the inexplicability of emergence identified in section 4.2. If emergence is not necessarily a theory of non-physical properties, how can we make the distinction between the two domains in a way that is not arbitrary? If the relation between emergent and base is sui generis and fundamental, then in virtue of what is the emergence relation inexplicable, i.e. what principled restriction might we place on the purview of the Laplacean demon, other than the physical? We must have a principled reason for saying that emergents are in a different domain to their basal properties, in a way that would require a metaphysical 'bridge' law, or equivalent.

In Barnes the distinction is explained by pulling apart the notions of derivativeness and ontological dependence.[342] While we have concluded that this approach to characterising emergence was insufficiently specified, it might be supplemented by specifying a real relation like a bridge law, and instead be relied upon merely to demarcate the domains to which the relata of a trans-ordinal law belong. In this case, the emergent property would not bear the relation of ontological dependence to its base simpliciter, pace Barnes, but would enter into a bridge law that, unlike intra-ordinal laws - which hold between independent entities - would instead hold between entities that on the one relata are ontologically independent and on the other are ontologically dependent.

Is this something to which we could appeal? It would not be if we were to make the assumption that all causation is derived from independent entities,[343] but Barnes argues that this assumption "seems to be too strong. Surely we think that there could still be causation in a gunky world, or that a mass trope can have causal powers, etc." She argues that the motivation for thinking that only the independent entities are fundamental, and thereby

[340] Broad 1925 p. 44
[341] Sections 3.2 and 3.4.
[342] Barnes 2012, see also section sections 2.2. and 4.5.1.
[343] A possibility we have suggested in section 2.2.

causal, is the assumption of an atomistic ontology, where fundamentality and independence are conflated.

Since we have assumed an atomistic ontology in our background picture, chapter 2, it would seem that we do have motivation for assuming that we cannot pull apart the notions of derivativeness and ontological dependence. Since we have assumed that a gunky universe is impossible for independent reasons,[344] there is no theoretical cost to our assuming a theory of causation that would be impossible in a gunky universe. Likewise, since we have assumed that tropes cannot exist independently of their object[345] - that properties are the way objects are – there is no theoretical cost to our assuming that causation would be impossible for an independently existing trope. We have sacrificed no possibilities by making such an assumption. We also have independent motivation for restricting causation to only ontologically independent entities: that way we do not have to introduce a brute term to define fundamentality.[346] Fundamentality can now be defined in terms of ontological independence – a notion already introduced in relation to foundationalism and substance.

It seems the only relevant distinction between the two domains left to us is the one we started with – the distinction between macro-properties and micro-properties. The relata of a bridge law are, on the one hand, the properties of complex objects, and on the other, the properties of simple objects. While a new real relation - like a bridge law – seems to be a necessary condition for the [Dependence] of an emergent property, it is not sufficient to distinguish it from the ordinary nomological relations holding between the micro-properties the occurrence of which the Laplacean demon could predict. Both types of property are fundamental and independent.[347] The only relevant distinction seems to be that an emergent property is a macro-property.[348] As noted in section 4.4. this means that not only is emergence a theory of macro-properties, it is also *necessarily* a theory of macro-properties. But not only this. Since the emergent relation is to be distinguished from ordinary nomological relations by the distinction between macro and micro – which is what makes a bridge law a bridge law - then macro-properties are also necessarily emergent properties. It is because it is a macro-property that explains the inability of the Laplacean demon to predict the occurrence of an emergent property; but since the inability of the Laplacean demon to

[344] Section 2.2
[345] Section 2.3 and 2.5
[346] An issue first raised in section 2.2.
[347] Of course, as discussed in section 2.4.5.2, that an emergent property is a macro-property implies one kind of dependence – the dependence of a complex object on its parts – but whereas with an ordinary constitution relation that kind of ontological dependence is sufficient for the existence of a structural property, with an emergent macro-property, it is necessary but not sufficient. Hence the search for another relation.
[348] In the very liberal sense of macro, equivalent to non-simple.

predict the occurrence of a property is also what makes a property an emergent property,[349] all macro-properties are emergent. If the Laplacean demon cannot see it, then it must be a macro-property. Since we have defined emergence in terms of the epistemic standpoint of the Laplacean demon, then all macro-properties must be emergent properties.

4.6.4 Synchronicity and Causal Inheritance

An emergent property is a distinct entity characterised by [Novelty], but it is also dependent for its existence, as characterised by [Dependence]. We noted in section 2.2.1 that the causal relation may also be characterised by the distinctness of its relata and a kind of dependence; but the dependence in [Dependence] seems to be different to the dependence of an effect on its cause. A cause determines the effect but thereafter the effect is not dependent on the cause. What is required for [Dependence] is the sustained dependence of the one on the other. For that reason we argued that the dependence of an emergent on its base seemed to be some kind of ontological dependence,[350] and we invoked the analogy to the dependence that a complex object has on its parts. Rather than being dependent on the existence of something in the past – as with causal dependence - the existence of an emergent is dependent on the existence of its base at that very time. We have been working with a minimal, primitive notion of ontological dependence, as follows:

> (OD) An entity *x* is dependent iff for all possible worlds *w* and times *t* at which a duplicate of *x* exists, that duplicate is accompanied by other concrete, contingent objects in *w* at *t*[351]

This is a synchronic relation: implying that an emergence base is present at time *t* just in case the emergent property is present at time *t*. We've since fleshed out the notion with the nomological dependence of a bridge law.[352] It implies that, whether such a law holds, you cannot have *x* by itself. While duplicating an ontologically independent entity involves only duplicating that entity, duplicating an ontologically dependent entity involves duplicating something else as well. Ontological dependence is stronger than causal dependence, since for something to be causally dependent on an entity does not require that entity to still exist. This seems like the right approach for a theory of emergence that seeks to explain mental properties because it seems correct to say that my mental properties could not exist at any time without my brain.

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[349] Sections 2.4.1-3
[350] Again see section 2.2.1
[351] This is from Barnes 2012 p.880
[352] Section 4.6.1

This relation of synchronic dependence encounters the problem of causal drainage that we introduced in section 3.3. If synchronically dependent properties inherit their causal powers from the properties on which they are dependent, then it would seem that the causation into which emergent properties enter would be systematically overdetermined.

As argued in section 4.6.1., given our background assumptions, [Novelty] implies that an emergent property, P, has some causal powers not possessed by its base, Q. Let's assume that P synchronically depends on Q. We have assumed, in section 2.6., that causal powers figure in the identity conditions of properties, so if a property has a power, then all bearers of that property will have that power; therefore, if P has a power, C, then the bearer of P has the power C. And we also identify the powers of P as all those powers that by nomological necessity are had by all the bearers of P.

The problem of causal inheritance arises because of the coextension of P and Q. Since they are properties of the same complex object as a matter of synchronic nomological necessity, all bearers of P are also bearers of Q and vice versa. Since all bearers of P have the power C, and we identify the powers of Q by the powers had by all of its bearers, then Q also has C. The powers of P are a subset of the powers of Q, which contradicts the assumption that [Novelty] entails causal novelty.[353]

It would then seem, in parallel with the causal closure argument and Kim's supervenience argument,[354] that unless some other dependence relation can be found which is capable of blocking causal inheritance, synchronic dependence is not compatible with both the assumptions about causal powers set out in section 2.6. and the causal relevance of macro-properties.

4.6.5 Causal Maintenance

> Though the emergent entity is 'something new', the existence of the 'new' entity must be both caused and sustained by the collective activity of other entities. Otherwise, the entity in question would not be properly characterized as 'emerging' from anything[355]

Accounts of emergence where the emergent and its base are not coextensive avoid the problem of causal inheritance.[356] This is because the powers of P will not be a subset of the

[353] As argued in 2.6.
[354] Sections 3.2. and 3.3.
[355] Barnes 2012
[356] These include accounts of emergence as fusion and accounts of emergence as a diachronic relation. Accounts of emergence as fusion do not involve the maintenance of an emergent property by its base because after emergence occurs the base no longer exists.

powers of Q, if Q is not, at each time *t*, always accompanied by P. This would be the case if, for instance, emergence was a diachronic relation where the occurrence of P at time *t+1* was caused by the occurrence of Q at time *t*, the occurrence of P at time *t+2* was caused by the occurrence of Q at time *t+1*, and so on. In general, if the occurrence of an emergent property, P, at time t_n, is dependent on the occurrence of its emergence base, Q, at time t_{n-1}, then the powers of P are not identified with a subset of Q's powers. This is because, the first time that Q occurs, say, at t_{n-1}, the bearer of Q will have the powers of Q, but not the powers of P. And if Q is no longer occurrent at time t_n, then the bearer of P will have the powers of P, but no longer have the powers of Q.

> The occurrence of an emergent property is a function of certain joint causal potentialities of underlying base properties. Consequently, the continuing instantiation of the emergent property is completely dependent on some set of properties or disjunctive range of properties in the object's microstructure.[357]

Effectively this is merely a kind of causal maintenance, and yet it seems sufficient to satisfy [Dependence], and also to satisfy the requirement that an emergent property is "caused and sustained by the collective activity of other entities". By stipulating the continued causal maintenance of an emergent property by its base, we have turned the causal relation into one that sustains a property and provides for continued dependence.

The emergent property is fundamental rather than derivative. But it is also, pace Barnes, ontologically independent. We have already argued that this is the case, since fundamentality is identified with ontological independence. Causal maintenance is also demonstrably independent, since it violates the minimal definition of ontological dependence, (OD).

It should be noted that, once we have stipulated continued maintenance, nothing in the considerations of section 2.2.1 is incompatible with the theory that the emergent property is merely causally dependent and not ontologically dependent. This does not seem to be a problem because, aside from the merest quantum of time when an emergent property exists without its base, this seems to satisfy the characterisation of macro-properties as being strongly dependent on complex objects, in the sense of being incapable of existence without them, but without encountering the problems we've seen with the assumption of strict ontological dependence. Most importantly, since the emergent property is not ontologically

[357] O'Connor 2000 p.111-2

dependent, there is no tension with the assumptions that it is fundamental, capable of satisfying [Novelty] and causally efficacious.

5. A Solution to the Problem of Reduction

Chapter 4 examined some of the ways in which we might develop a theory of emergence that was capable of solving the Problem of Reduction. In this section we will elaborate on a theory that seemed to do the job. We will call it Causal Powers Emergence.

To recapitulate: emergent properties are new fundamental properties, basic and ontologically independent like other properties. The thesis of emergence is that there are fundamental properties that are had by complex objects; there exist some macro-properties, and these are the emergent ones. The emergent properties are causally produced and continuously causally maintained by other properties in the emergence base.

Speaking generally, the theory of properties assumed in our background picture means that emergent properties have the power to make the world unfold in ways that the world otherwise would not, and this is a fundamental feature about these properties upon which all else (counterfactuals true of them, regularities and patterns that encompass them, explanations that cite them) is derivative. Properties are ontologically irreducible, and properties are individuated in terms of causal powers.

According to a causal powers account of emergent properties – at least, one like that developed by O'Connor and others[358] - the instancing of emergent properties is like the instancing of any other properties in a causal powers ontology: their production is in virtue of the manifestation of other powers. In this case, the emergent properties are produced in virtue of properties found among the constituents of the complex in which the emergent property inheres, acting together in certain complex arrangements. Furthermore, under the causal framework here, by calling the emergent property a causal consequence of the constituents, this means that, while not consisting in the micro-properties of the constituents of the complex object, the distinct emergent property is caused by the powers of those micro-properties to produce such an emergent property.

Emergence is just a normal, unmysterious, causal relation – an object instancing a property causing the instancing of another property in an object. This means that among the micro-constituents of the universe there are properties with latent powers to contribute to the

[358] See O'Connor 1994, 2000a, 2000b, O'Connor and Jacobs 2003, O'Connor and Wong 2005, 2012, and O'Connor and Churchill 2010.

production of an emergent property, and these latent powers are manifested or triggered only in organized complexes of the requisite sort. “For the emergentist, the seeds of every emergent property and the behavior it manifests are found within the world’s fundamental elements, in the form of latent dispositions awaiting only the right context for manifestation.”[359] These micro-powers are unobservable in states of lower complexity, so these latent dispositions will be powers of simple objects that are unobservable by investigating the micro-physics of the constituents.

Emergent properties are no less ontologically fundamental than perhaps, negative charge is taken to be by current physics, or rather as fundamental as the basic properties of a completed fundamental physics; however, emergent properties are different to micro-properties like negative charge because they appear in complex systems and persist if and only if the system maintains the requisite organized complexity. Importantly, going back to the idea of the property being non-structural,[360] this means that the emergent property doesn’t even partly consist in the basic properties of the constituents of that complex.

In some discussions of emergence a lot rides on the extent to which phenomena are ‘unpredictable’,[361] here that unpredictability is a consequence of the core metaphysical features. From the limited empirical standpoint below the requisite level of complexity these powers will remain unmanifested and therefore be invisible. A theorist whose understanding of the world was derived from theories developed entirely from observations of systems below the requisite complexity could not possibly anticipate the emergent property, and the threshold will appear to be arbitrary.

Of course, this means that, not only will the emergent property itself not be included in the basic properties of fundamental physics, the power of all of the micro-properties to produce an emergent property are also not among the fundamental properties seen in physics. Both the emergent property and the emergent-producing micro-powers are hidden to experiments on systems that do not exhibit the requisite macro-complexity, the sort of systems that fundamental physics investigates when trying to ascertain the taxonomy of fundamental properties. Each such power remains unmanifested until the right threshold degree of complexity, and so each micro-constituent cannot be observed to possess such a power when examined alone. This is the deep reason why emergence is not predictable based on the features of low-complexity systems.

[359] O’Connor and Churchill 2010
[360] See section 2.2.
[361] See section 4.3.

If Causal Powers Emergence is correct, there are two kinds of properties in the world that are quite unlike the properties of fundamental physics. One kind is the emergent properties, which are different because they are the properties of complex objects, they are fundamental but also dependent on the causal maintenance of other properties. The other kind are the emergent-producing micro-properties, which are not only invisible in the lower complexity systems observed in fundamental physics, but also have the power to produce emergent properties, a radically different propensity to the propensities of basic physics, since it is a power of causation across categories between the domains of the micro-properties and the macro-properties.[362]

Let's compare this sketch of Causal Powers Emergence with the explananda of the Problem of Reduction. To succeed, Causal Powers Emergence must explain the possibility of macro-properties. One of the explananda set out in section 3.8. was: "how can macro-properties make a causal difference?" Let's start with that.

5.1 The Problem of Causal Exclusion

We have introduced a cluster of related problems including the Causal Closure Argument, Kim's Supervenience Argument, and the problem of Causal Inheritance.[363] We have argued that a theory of emergence that assumes [Novelty] and explains [Dependence] via causal maintenance, avoids all these problems. There is another analogous argument from Kim that is aimed at diachronic theories of downward causation that in one respect seem to be like that under consideration. He concedes that a diachronic relation escapes the problem of causal circularity discussed in section 3.3, but argues that it is still subject to the problem of causal exclusion, similar to that discussed in section 3.2.[364]

Kim's argument goes like this. Assume that an emergent property M at t_1 supervenes on its emergence base P at t_1 and is a partial cause of its emergence base P* - this is described as downward causation - and the occurrence of "same-level" emergent properties M* at the subsequent time t_2.

> I earlier argued that any upward causation or same-level causation of effect M* by cause M presupposes M's causation of M*'s lower level base, P* (it is supposed that M* is a higher-level property with a lower-level base; M* may or may not be an

[362] These special micro-properties might seem analogous to panpsychism, in that they are non-physical – see below - but the micro-properties are not really the same here as they are in panpsychism, because in Causal Powers Emergence they are simply emergence-producing, not proto-conscious.
[363] Sections 3.2, 3.3., and 4.6.4.
[364] Kim 1999 pp. 26-32

> emergent property). But if this is a case of downward emergent causation, M is a higher-level property and as such it must have an emergent base, P. Now we are faced with P's threat to preempt M's status as a cause of P* (and hence of M*). For if causation is understood as nomological (law-based) sufficiency, P, as M's emergence base, is nomologically sufficient for it, and M, as P*'s cause, is nomologically sufficient for P*. Hence P is nomologically sufficient for P* and hence qualifies as its cause... Moreover, it is not possible to view the situation as involving a causal chain from P to P* with M as an intermediate causal link. The reason is that the emergence relation from P to M cannot properly be viewed as causal. This appears to make the emergent property M otiose and dispensable as a cause of P*; it seems that we can explain the occurrence of P* simply in terms of P, without invoking M at all. If M is to be retained as a cause of P*, or of M*, a positive argument has to be provided, and we have yet to see one. In my opinion, this simple argument has not so far been overcome by an effective counter-argument.[365]

The argument seems to be that the diachronic causal contribution of an emergent property will be redundant because its causal contribution is attributable to the emergence base producing it. The problem with this argument is not that Kim assumes that an emergent property doesn't make novel causal contributions: he says that an emergent property "must be capable of making novel causal contributions that go beyond the causal powers of the lower-level basal conditions from which they emerge."[366] The problem is that he assumes that the emergence base will be causally sufficient for any effect supposedly caused by the emergent property, since it was itself sufficient to produce the emergent property. This is a more general problem of the type analysed as causal inheritance in section 4.6.4: there the problem had to do with the identification of properties with the powers had by the objects in which they inhere, whereas here the problem is one of causal sufficiency and so could apply to other accounts of causation too.[367]

However, just like with the more specific causal inheritance argument, this problem is avoided by Causal Powers Emergence if the emergence relation is itself a diachronic causal relation, which not only entails the failure of supervenience, but also should indeed "properly be viewed as causal".[368] As such it enters into a chain of causal sufficiency as an intermediate link. The powers of an emergent property are indirectly attributable and

[365] Ibid p.32
[366] Ibid p.25
[367] Kim claims that "The same conclusion follows if causation is understood in terms of counterfactuals" – ibid p. 32
[368] ibid

dependent on its causal history, but they are so only in the manner of ordinary causal relations. The emergence relation is unlike other causal relations only in that the relata are in different domains as defined in section 4.6.3., but this is not relevant to a discussion of causal sufficiency.

5.2 Rejecting the Causal Closure Principle

O'Connor and Churchill develop a similar problem to the Causal Closure Argument presented in section 3.2, which they call the Causal Exclusion Argument.[369] The argument includes a premise similar to [Completeness of the physical] - Every physical event, at every time at which it has a cause, has a sufficient physical cause.[370] They assume that (at least some) emergent properties are non-physical and conclude that the premise [Completeness of the physical] should be rejected in order to maintain the causal efficacy of emergent properties.

Our analysis of both emergent properties[371] and the demarcation of the physical[372] support that conclusion. Since emergent properties are macro-properties, and so are produced only in certain composite objects of the necessary complexity, they are not discoverable by analysing the simplest interactions in fundamental physics. Since we have taken 'physical' properties to mean those properties that will be identified by a completed fundamental physics, emergence necessarily denies [Completeness of the physical].

We can also compare our characterisation of emergence in terms of the epistemic standpoint of the Laplacean demon in relation to an omniscient God. In effect, since the Laplacean demon's epistemic standpoint excludes emergent properties, and since macro-properties are emergent properties, the Laplacean demon's epistemic standpoint maps onto that of a completed fundamental physics.[373]

This neat picture now requires an amendment in light of the theory of Causal Powers Emergence. This is because, as stipulated in section 4.3., the Laplacean demon, being the perfect calculator, must, in order to not be able to predict emergence, also be limited in its epistemic standpoint to those entities that would not enable it to predict the occurrence of an emergent property. There was a potential tension here between the requirements of the explicability of the occurrence of the emergent property and its unpredictability even to the

[369] O'Connor and Churchill 2010
[370] For a discussion of the different strengths that the principle might take, see Lowe 2000a
[371] Chapter 4
[372] Briefly discussed in sections 3.4 and 4.6.2-3
[373] Which is not to say that a hypothetical completed fundamental physics would necessarily have the perfect calculating power of a Laplacean demon, just that it will have identified all the fundamental properties within its purview.

Laplacean demon. Since Causal Powers Emergence posits an emergence relation very much like the ordinary relation of causal production between any fundamental properties, this would seem to make emergent properties predictable to a Laplacean demon with knowledge of the powers necessary to produce an emergent property. It is therefore necessary to restrict the epistemic standpoint of the Laplacean demon further to exclude those emergent-producing properties. This should be a reasonable adjustment to impose. Given the background picture and some of the epistemological issues of properties as causal powers discussed in section 2.6, it seems reasonable to include the emergent-producing powers in the restrictions on the epistemic standpoint of the demon. And indeed, they are also unobservable to the methodology of fundamental physics, just because their manifestations, through which they must be observed, are the emergent properties.

Compare this conclusion to the general discussion about how to define emergence in chapter 4. In section 4.6.2., we looked at the idea of demarcating the domain of the emergent properties in terms of the physical/non-physical distinction. We can now conclude that CPE cannot avail itself of this distinction because, according to our working definitions of the physical, though emergent properties are non-physical, there are some non-emergent properties that are also non-physical. Likewise, though we note that unpredictability of a sort is still the mark of emergence,[374] demarcation between emergent and non-emergent does not map on to the epistemic standpoint of the Laplacean demon. Nor, as we have been arguing throughout and as confirmed by the identification of the emergence relation with causal production, does this unpredictability necessarily outlast the first occurrence of the emergent property. We will have much more to say about these emergent-producing mico-powers in chapters 7 and 10.

5.3 Resolving Apparent Contradictions

Macro-properties are properties of complex objects. A complex object is not fundamental or ontologically independent. Since micro-properties inhere in objects that are simple and fundamental, we should ask how it is possible for a macro-property, which inheres in a complex object, to likewise be simple and fundamental? Regarding qualitative simplicity, we ask: in virtue of what is the putative macro-property simple? Regarding fundamentality we ask: what is it about the putative macro-property that makes it fundamental?

The Problem of Reduction arises because of a lack of specificity about the nature of macro-properties. Causal Powers Emergence explains macro-properties by specifying two features:

[374] In the sense described in section 4.3.

[Novelty] – Emergent properties are ontologically additional to the emergent base.

[Dependence] – Emergent properties are dependent on the emergent base.

[Novelty] entails the emergent property's fundamentality, i.e. its ontological independence, which implies causal efficacy. Since the emergent property is ontologically independent, it is not composed, so there is no apparent contradiction to its simplicity. The emergent property is fundamental rather than derivative. Since it is not derivative, there is no contradiction to its causal efficacy.

Causal maintenance is also demonstrably independent, since it violates even the minimal definition of ontological dependence, (OD); the emergent property is merely causally dependent and not ontologically dependent. But this is still insufficiently specified to provide an explanation for all the explananda set out in chapter 3. There we argued that one of the apparent excluders to the possibility of a macro-property was the substantial complexity of the complex object in which it inheres. The rejection of ontological dependence as a candidate for the emergence relation explains how macro-properties can be fundamental. But how can Causal Powers Emergence resolve the apparent contradiction between substantial complexity and qualitative simplicity?

Part of the answer is to specify what makes a macro-property a property of a complex object, if it is not because of substantial complexity. This is partly achieved by fleshing out [Dependence] and partly achieved by describing the inherence of macro-properties.[375] Effectively [Dependence], according to Causal Powers Emergence, is merely a kind of causal maintenance. This is sufficient to satisfy [Dependence], and also to satisfy the requirement that an emergent property is "caused and sustained by the collective activity of other entities". This seems to satisfy the characterisation of macro-properties as being strongly dependent on complex objects without encountering the problems we've seen with the assumption of ontological dependence. Most importantly, since the emergent property is not ontologically dependent, there is no tension with the assumptions that it is fundamental, capable of satisfying [Novelty] and causally efficacious.

One problem with this stipulation in specifying [Dependence] is that, while the fundamentality and causal efficacy of an emergent property are necessary corollaries of the same facts that make [Novelty] true, what makes [Dependence] true involves no independent assumptions that would imply that the property that is causally maintained is a macro-property. We have simply stipulated that that is what demarcates the domains of the relata. By stipulating the

[375] See section 6.5.

continued causal maintenance of an emergent property by its base, we have turned the causal relation into one that sustains a property and provide for continued dependence, but we have not sufficiently specified how a simple property inheres in a complex object.[376]

6. The Advantages of Causal Powers Emergence

6.1 The Failure of Supervenience

In Kim's Supervenience Argument,[377] his Downward Causation Argument,[378] the Causal Drainage Argument,[379] and the problem of causal inheritance,[380] there are problems for a theory of macro-properties because of synchronic supervenience on the emergent base.

So far we have been assuming that CPE is not a supervenience theory of emergence – the emergent property does not supervene on the micro-dispositions that have produced it. This is because we have assumed that the emergence relation is diachronic, so there will be an instancing of the emergent base in the interval of time prior to the instancing of the emergent property and an instancing of the emergent property in the interval of time subsequent to the instancing of the emergent base. This suffices to solve, for example, the problem of causal inheritance.[381]

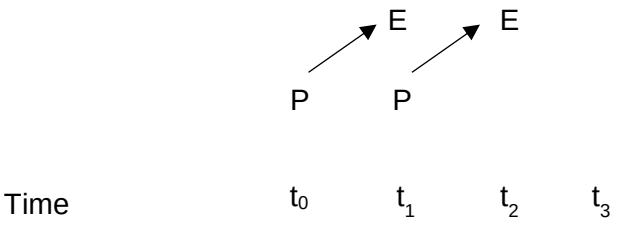
If, however, simultaneous causation is possible, then it might be possible for the emergence relation in Causal Powers Emergence to be synchronic. How then could CPE avoid these problems raised in the context of primitive supervenient emergence?

O'Connor argues that supervenience will fail in a causal account, not simply because the emergence relation is diachronic, but also because of indeterministic causation and the causal difference made by prior emergent properties.[382] Once we consider the causal contribution that other emergent properties make to the instancing of any emergent properties at a time, it seems that there could be instances where the same physical properties at *t* cause the instancing of different emergent properties. And even with the broadest notions of supervenience, indeterministic causation cannot guarantee the covariance of a supervenience relation.

[376] More on this in section 6.5 below
[377] Section 3.3.
[378] Above and section 3.4.
[379] Section 3.3.
[380] Section 4.6.4
[381] See section 4.6.4.
[382] O'Connor 2000b, pp. 11-2

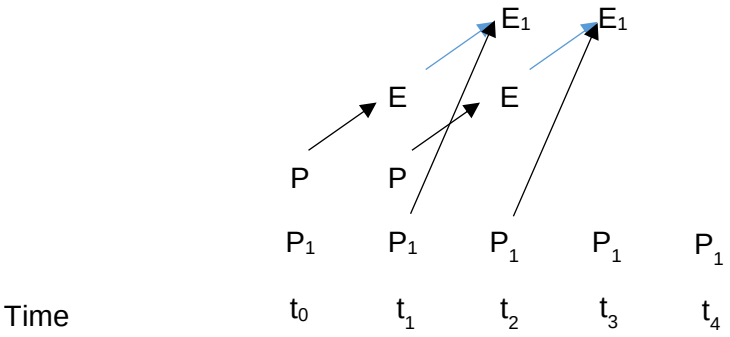
As we argued in section 4.5.3., a failure of covariance does not imply an absence of a systemic connection between an emergent property and its base, nor would mere covariance guarantee it. Kim's argument is that in the absence of covariance, the connection would be "irregular, haphazard, or coincidental, and not to be relied upon", this is no more true of a causal emergence relation as it is true of any causal relation. The causal relation answers his question "what reason could there be for saying that pain 'emerges' from that neural condition than another".[383]

Let's demonstrate the ways in which Causal Powers Emergence implies a failure of supervenience, and thereby escapes the potential problems raised above.[384] An emergent property, E, would supervene on the properties of an emergent base, P, just in case a complex object's having of E at time t implies that the object has P, and, necessarily, if it has P at t, it has E at t. In these diagrams an arrow represents a causal relation.



In this diagram there is a diachronic relation of causation. Synchronic supervenience is violated at times t_0 and t_2, since the object has P at t_0 without E, and it has E at t_2 without P. This is only a slight divergence from supervenience, restricted to the first instance of P and last instance of E. More interesting divergences occur when emergent properties are involved in the production of other emergent properties:

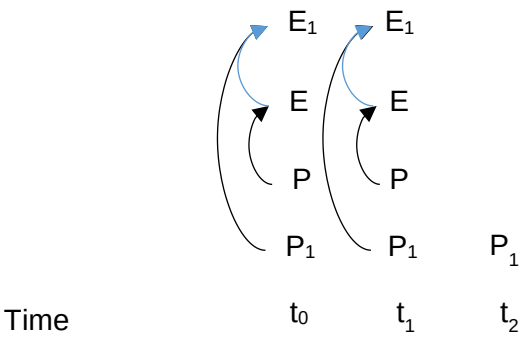
[383] Kim 2006
[384] In this we're largely following O'Connor and Wong 2005 pp. 16-9; though the presentation is streamlined and the analysis of dynamism more developed here.



In this example the emergent property E_1 has an emergence base P_1 on which it causally depends. However, its emergence base is insufficient to produce it without the causal contribution of an emergent property, E. This is what O'Connor and Wong call a dynamic account of emergence. The emergent property E is not included in the emergent base of E1 because it is a macro-property. The emergent relation between emergence base and emergent property is a cross-categorical relation between micro-properties in one domain and macro-properties in the other. Note that there is also nothing in the definition of emergence so far that rules out a dynamical account – emergent properties are dependent for causal maintenance on their emergence bases, but the instancing of an emergence base is not necessarily sufficient for the production of all emergent properties to which they causally contribute. This is the root of the dynamical account of emergence and the implied failure of supervenience.

Here we have several divergences from covariance. The first instancing of P_1 occurs at t_0, and yet E_1 is also absent in the next time interval t_1; furthermore, after a few time intervals where P fails to occur, E_1 will also not occur, like at t_4, even though P, unlike P_1, which is occurrent throughout this time, is not part of E_1's emergence base.

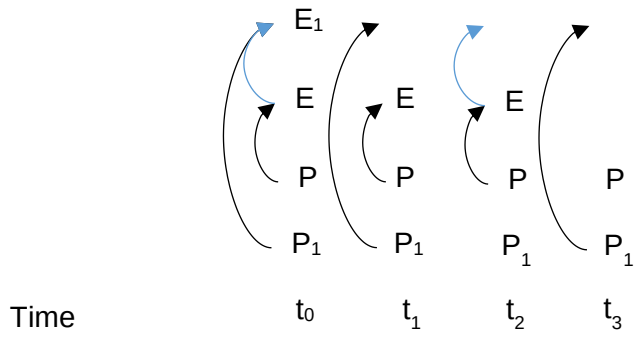
Now let's introduce the possibility of synchronic causation:



This has the effect of removing the divergences from covariance between the emergent properties and their emergent bases that occur at the first instancing of the emergent base, e.g. at t_0 in the first two diagrams, and in the proceeding time interval to their last instancing. There is, however, still a divergence between the occurrence of E_1 and its emergence base P_1 at t_2 because in this dynamic account the occurrence of P_1 is insufficient to produce its emergent property E_1.

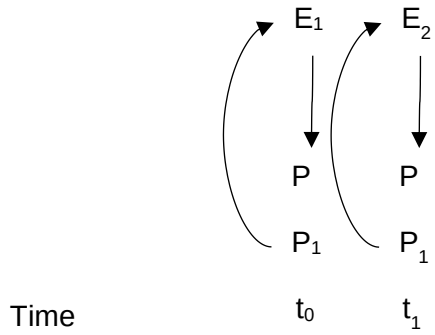
O'Connor and Wong describe another form of supervenience which does seem to hold in this scenario – global supervenience.[385] In this form of supervenience it is not only the micro-properties on which the emergent property depends for causal maintenance that are considered as the subvening base, but rather the emergent properties supervene on all of the occurrent micro-properties in the entire universe. In this example, E_1 globally supervenes on the conjunction of P and P_1 and there are no longer any divergences from covariation.

For global supervenience to fail, we must introduce the possibility of probabilistic causation. Now it is simple to generate scenarios where covariation fails even for global supervenience via synchronic causal relations, as is the case at t_1, t_2, and t_3 below, each of them time intervals where one of causal relations at t_0 has failed:



Even if we assume that emergent properties make causal contributions to the production of micro-properties and then fix the micro-properties of the universe at all times, this will not suffice to fix the distribution of emergent properties. When the production of those micro-properties is guaranteed, ex hypothesi, it would still be possible for covariance to fail wherever two different emergent properties share an emergence base (an inevitable scenario given global supervenience) and also share possible micro-properties among their effects. For instance:

[385] Ibid p.18.



There do not seem to be any relevant senses in which supervenience holds that would generate the problems referenced above. Causal Powers Emergence therefore seems to avoid whatever problems might occur for a theory of emergence that guarantees supervenience.

6.2 Dependence

So the novelty of the causal production of emergent properties is adequately specified to explain the fundamentality of emergent properties and it avoids the objections levelled at other forms of emergence. Another important feature of emergence is the maintenance of emergent properties by the base. But why bother with causal maintenance?

John Searle characterises a naive conception of emergence as the idea "that consciousness gets squirted out by the behaviour of the neurons in the brain, but once it has been squirted out, it then has a life of its own." [386] This goes beyond the notion of emergence being developed in this essay. Searle seems to suggest a notion that is not just an addition of being, but, once it is created, completely autonomous. The notion here is of an emergent whose powers are unrelated to the properties of its base. And he rightly argues that it is implausible[387]. For instance, mental properties and the physical properties of the brain are clearly causally linked. This reasoning is behind the inclusion of dependence as a key feature of emergence. Mental properties are absent when the brain is absent, for instance, and changes to the physical properties of the brain affect the mental properties. This is uncontroversial. Theories of emergence do not hold that mental properties are completely autonomous.[388]

[386] Searle 1992, p112; he calls such entities 'emergent2'.
[387] Though in his argument he seems to rely on a theory of causation that is insufficient for the general claim to causal closure, see Gibb 2010.
[388] Though in order to explain mental causation they are assumed to make a distinctive causal contribution to the world.

But what should we make of the dependence of emergent properties on their micro-constituents? What is the dependence relation? It seems to be the same as the emergence relation that produced the emergent property: which in causal powers emergence is simply the causal relation. Thus we have an ongoing causal maintenance like that which we defended in section 4.6.5: the continued occurrence of an emergent property requires a continuing cause. But of course, there isn't anything entailed by the generic causal relation that would ensure the need for continuing causes to maintain the effect, so this must be an additional stipulation of the theory.

In Persons and Causes O'Connor says: "The occurrence of an emergent property is a function of certain joint causal potentialities of underlying base properties. Consequently, the continuing instantiation of the emergent property is completely dependent on some set of properties or disjunctive range of properties in the object's microstructure."[389] The continued maintenance is just a further stipulation about emergent properties rather than something implied. They are a property that can only exist in certain circumstances and that is the end of it.

I don't think we need to make even this modest insistence without availing ourselves of an explanation in terms of the brute facts we already have. It's true that a causal powers emergentist cannot appeal to some kind of supervenience or realisation relation to ensure dependence. And at first it doesn't seem that there is anything about the core concept of emergence that would entail the need for maintenance. But in fact I think we can do so by appealing to what is essential about an emergent property.

So an emergent property is a macro-property. This makes emergent properties different to other basic properties inhering in simples because they persist if and only if the system maintains the requisite organized complexity and other structural conditions. It also seems reasonable that certain changes to that system will produce different emergent properties, and that other changes will make no difference. By its nature an emergent property is already dependent on other entities in a way that the properties of simples are not. This is in virtue not of a realiser relation, nor supervenience or causal inheritance or anything like that, but just because it belongs to a complex object and not a simple one. One might say that the

[389] O'Connor 2000a

complex must endure for there to be the proprietary substance on which the emergent property's continuing existence relies.[390]

This is a minor point, but it enhances the believability of a theory to minimise the concomitants. It's better that dependence is entailed by the brute facts already entered, than to have to add another. Imagine for instance that none of the basic properties in the universe carried a maintenance condition. There would perhaps only exist fundamental properties that once produced always exist until something causes them to go out of existence. Then the stipulation that emergence properties must be actively maintained looks to be an uneconomical further addition to the theory.

6.3 Unpredictability and Causal Indeterminacy

In section 4.3 we argued that the unpredictability by which emergence is characterised is a result of an epistemological situation that is specific to and entailed by the metaphysics of emergent properties. Emergent properties are, uniquely, macro-properties – properties of a complex whole as opposed to simples. But if the emergence relation is causal, and causation is indeterministic, would this imply that causal powers emergence is unpredictable in principle?

You can find a worry like this in Popper and Eccles' book, The Self and its Brain.[391] There we find the common refrain that ontological emergence is inherently unpredictable. But again, there is only partial truth in this and it is unproblematic. I think that it is possible that epistemological emergence is unpredictable in principle. Based on some of the discussions from the scientistic theories of epistemological emergence discussed in section 4.3 and elsewhere. And that's an incredibly interesting result.

In comparison, perhaps surprisingly, ontological emergence is not unpredictable in principle. Ontological emergence is only unpredictable *in terms of* the powers manifested at lower levels of complexity. If one were able, in some sort of holistic manner, to identify the macro-properties, the requisite circumstances for their production and the associated, otherwise-latent micro-properties, then emergence would be completely predictable. Or, rather, the emergence of a new power would not itself put the predictability at issue (because it is possible that a situation be both ontologically and epistemologically emergent and also possible that all cases that are ontologically emergent are also epistemologically emergent).

[390] See section 6.5 below.
[391] Popper and Eccles 1977, p.35

Popper and Eccles argue that physical indeterminacy would make complex systems unpredictable in principle. But this is analogous to our discussion of chaos theory in chapter 1 – it is only an epistemological consideration. In contrast it is possible that an emergent property is strictly determined by the micro-dispositions of its constituents – emergence is compatible with general causal determinism and its denial.[392] And where the emergence relation is causally indeterminate, it is only unpredictable to the extent of any other ordinary causal property – there is no special problem. Perhaps this is an unintuitive result: that ontological emergence is, in principle, predictable, while epistemological emergence might well be unpredictable.

In any case, it means that causal powers emergence per se is not mysterious in the sense that it is entirely unpredictable. Compare the discussion in section 4.3, particularly Alexander's argument that timing matters for the epistemic agent. Emergence is unknowable until it happens. The time at which it happens will appear arbitrary to an observer from before that time. The causal powers theory offers its own explanation of these remarks: unmanifested powers are invisible until they are manifested for the first time. After that time, however, there is no reason why emergence is necessarily unpredictable. It will be as reliably produced given the right circumstances as any relationship of cause and effect.

Of course, in practise, though epistemological emergence and ontological emergence are quite different, they can appear similar, and will frequently co-occur, if not always. Unfortunately, these situations may prohibit the decisive identification of a macro-power by empirical means. We will discuss this possibility in more detail in sections 7.2 and 7.6.

6.4 Ideological Economy

Causal Powers Emergence introduces a brute term into theory – i.e. emergent property. But it seems that, for the explananda we have in mind, all the emergent explanans will introduce a brute term – a really existing macro-property-entity (or at least the theories that aren't deflationary or eliminativist.) And I don't think it is immediately obvious that causal powers emergence has a significantly worse problem in this regard.

Let's compare causal powers emergence with other emergent theories in terms of their ideological economy. (Where a theory has greater ideological economy if there is a smaller number of primitive predicates in the theory.) It's clear that causal emergence has an advantage over other strong emergent theories simply because synchronic theories employ

[392] This is stated explicitly in O'Connor 1994

a metaphysical emergence relation. Whereas with causal powers emergence the emergence relation is causation, and not some new relation.

So causal powers emergence seems to be better in this respect. There is the 'is an emergent property' predicate, but other propositions in the theory are either ordinary or entailed by that first one. The causal relation is ordinary, the micro-powers are unexceptional, except that they are only manifested in circumstances that are complex in the relevant way. Dependence is entailed – see below.

Of course, metaphysical theory choice is going to involve a whole range of subtle considerations. See chapter 11 for the final comparison between emergence and inherence. But causal powers emergence at least has an advantage over other kinds of emergence when it comes to the number of primitive concepts in the theory.

6.5 Substance

Heil and Lowe offer arguments about the fundamental categories of being that substances are simple and the only category of entities in which properties inhere.[393] Among other implications, Lowe argues, if we don't stipulate that substances are particulars, then we cannot, for example, rule out the possibility that universals are substances.

Where does this leave Causal Powers Emergence as a theory of macro-properties? The emergent property must presumably belong to either a derivative complex object, or some new emergent substance.[394]

Here is the solution offered by O'Connor and Jacobs. In short, they propose that substances can form individuals, which are substantially simple.

> we wish to carefully scrutinize the view that an emergentist understanding of the mental allows for a straightforward substance monist view of human beings consistent with a property, or state, dualism. On such a view, I am a biological substance having sui generis mental states; I am at any moment simply the mereological sum of each of my fundamental parts, though these parts collectively instantiate 'simple' states that are no less fundamental, ontologically, than the energy state of a basic particle. We now try to show difficulties for such a minimalist emergentist view concerning personal identity through time.

[393] Heil 2012, sections 2.4-6, 3.1; Lowe 1998, pp.139-40
[394] For more on the possibility of substance dualism see Lowe 2006b

> The difficulties can be laid bare only in the context of a general ontology of particulars and their properties. Alas, general ontology is more controverted than the philosophy of mind. So we consider four broad ontological schemes to which we are willing to assign at least a modest degree of plausibility: transcendent ("Platonist") universals theory and one of its variants, kind-Aristotelianism; immanent universals theory (also sometimes laying claim to the 'Aristotelian' label); and trope theory, on which there are no universals, but only property instances. We argue on familiar grounds that the first two of these ontologies suffer from deep obscurities. Furthermore, the first cannot ground an emergentist picture, while the second hints at a way to do so, but only at the cost of even deeper obscurity.
>
> Accordingly, we focus on the last two ontologies for the purpose of exploring the question of personal identity, given a property emergentism. Reflection on each, we suggest, pushes the property dualist toward a stronger view, which we dub 'substance emergentism.'
>
> Now let us turn to ourselves. Our holistic mental states (or perhaps certain enduring 'baseline' states in particular) confer on us a substantial unity as thinking biological substances, requiring one to treat persons as wholes in any adequate characterization of the dynamics of the world. This functional unity does not itself constitute a particularity as an enduring thing, but it plausibly implies it. Surely our particularity is primitive, rather than deriving from the primitive particularity of our parts, as those are constantly changing. Furthermore, one who embraces this general ontology will probably want to put essentialist constraints on thisnesses—lest we permit the absurdity that the thisness of eddie the electron could have been the thisness of me—and my essential properties are not going to be any kind of function of those of my fundamental parts.[395]

Their theory is that the bearers of emergent properties are the proprietary substances of persons, the particularity of which is suggested by the substantial unity of our mental states. Must we suppose that emergence implies new macro-substances in which to inhere? Refer back to 2.5. and 2.2.2 and 4.5.2. The foundations of reality are simple, atomistic objects. Substances are ontologically independent. Ontological independence is the mark of the foundation of reality. The emergent properties must inhere in a substance. We might say that the emergent property inheres in a complex substance. But complexes are ontologically dependent on the objects that compose them. If the nature of substances is that they are

[395] O'Connor and Jacobs 2003

ontologically independent, then an ontologically dependent substance is by definition impossible.

The nature of substance is to be certain ways – to possess properties – they give existence to properties. The emergentist could hold that substances do this without themselves being ontologically independent. But this might face an objection: if this kind of ontological dependence is transitive, wouldn't we render the emergent property dependent for its existence on the simple objects composing the complex substance? To which the emergentist can reply: the ontological dependence between property and substance is not the same dependence as that between a complex substance and its component objects. In this respect they might argue for the possibility of a fundamental property inhering in a derivative object.

However, the emergentist would still need a new kind of ontological dependence: mere mereology wouldn't do the job because mere mereology results in a substantially disunified object, which cannot explain the apparent simplicity of the emergent property. This would not suffice to explain the Problem of Reduction. The emergentist seems to have to hold that there is a variety of mereology that composes a unified substance, i.e. that the macro-substance is a new kind of existence. However this is done – through a new composition relation or perhaps whatever O'Connor and Jacobs have in mind - there is a new kind of substance and a new kind of property, both representing radical additions to our fundamental ontology.

7. The Epistemological Problem

7.1 A Brief Summary of Causal Powers Emergence.

According to a causal powers account of emergent properties – at least, one like that developed by O'Connor and co-authors[396] - emergent powers are produced by emergent-producing micro-properties in certain complex arrangements.

The emergent property is a power not among the powers of fundamental physics. The emergent property is caused by the powers of the micro-constituents of the arrangement to produce the emergent property given the right circumstances. These micro-tendencies are unobservable in states of lower complexity, so they will also be properties that are unobservable by investigating the micro-physics of the situation, i.e. the powers of all of the

[396] See O'Connor 1994, 2000a, 2000b; O'Connor and Jacobs 2003; O'Connor and Wong 2005, 2012; O'Connor and Churchill 2010.

micro-constituents to produce an emergent property are also not among the powers of fundamental physics.

Both the emergent property and the emergent-producing micro-powers are hidden to experiments on systems that do not exhibit the requisite macro-complexity. Each such power remains unmanifested until the right threshold degree of complexity, and so each micro-constituent simple cannot be observed to possess such a power when examined alone. This is the deep reason why emergence is not predictable based on the features of low-complexity systems.

If causal powers emergence is correct, there are two kinds of properties in the world that are quite unlike the properties of fundamental physics. One kind is the emergent properties, which are different because they are the properties of complexes rather than simples. The other kind are the emergent-producing micro-powers, which are not only invisible in the lower complexity systems observed in fundamental physics, but also have the power to produce emergent properties, a radically different propensity to the propensities of basic physics. As O'Connor puts it: "fundamental particles or systems, [in addition to having a locally determinative influence in the manner characterized by physical science] also naturally tend (in any context) toward the generation of such an emergent state."[397]

7.2 Unpredictability and Epistemological Emergence

As we've already suggested,[398] contrary to what Popper and Eccles think[399], ontological emergence is not necessarily unpredictable. But in practice, actually testing whether a system has an emergent property may prove impossible. The epistemological problem starts with an observation we've noted previously: that both the emergent property and emergent producing powers are hidden to experiments on systems that do not exhibit the requisite complexity. This is because the emergent-producing powers are not casually operative in systems of lower complexity, and the emergent properties simply don't exist yet. Emergent producing micro-powers remain unmanifested until the right threshold degree of complexity, and so each micro-constituent cannot be observed to possess such a power when examined alone. This is the deep reason why emergence is not predictable based on the features of low-complexity systems.

We've started with a brief account of causal emergence and epistemological emergence. It is argued that, given epistemological emergence, it is practically impossible in ambiguous

[397] O'Connor 2000b p.9
[398] See sections 4.3 and 6.3
[399] Popper and Eccles 1977, p.35

cases to provide decisive empirical evidence for or against causal emergence.[400] What follows is an examination of arguments that are based on that epistemic situation and which argue against causal emergence as a desirable theory for reasons of congruence and simplicity. This chapter sets out the main problem for emergence and will also give us the template for an argument in favour of an alternative to emergence that will be tested in the final part of this thesis. It also sets out a preliminary defence by emergentists to which that alternative can be compared.

> For the emergentist, the seeds of every emergent property and the behavior it manifests are found within the world's fundamental elements, in the form of latent dispositions awaiting only the right context for manifestation.[401]

This chapter argues that invoking these latent dispositions prohibits the decisive identification of an emergent property by empirical means because even perfect knowledge of behaviour is insufficient to settle the question of the identification of a new property. If one is not sensitive to the theory of property identification involved, then one is open to the objection that no new properties are implicated by any given observed behaviour. The best way left by which to decide the truth or falsity of a theory of emergence is abstract metaphysical reasoning. We will reveal some of the emergentist's implicit reasoning here and then throughout the final three chapters I will argue that this reasoning is faulty and does not protect emergence from the epistemological problem.

7.3 The Empirical Problem: "Not a scintilla of evidence"

The title of this section includes a quote from a paper by McLaughlin[402] in which he argues that emergence is a coherent concept but implausible because of the lack scientific evidence. He goes so far as to say that emergence is incompatible with contemporary scientific knowledge.

O'Connor labels this claim as "sheer bluff".[403] In lieu of an a priori deduction eliminating the possibility of emergence, he says, the establishment of the "scientific knowledge" claim would require an insurmountable weight of evidence drawn from all across the special sciences that study complex systems.[404] While he accepts that there are no widely-accepted

[400] This argument proceeds in section 7.6
[401] O'Connor and Churchill 2010
[402] McLaughlin 1992, p91
[403] O'Connor 1994
[404] ibid

scientific theories that are necessarily committed to ontological emergence, he deems contemporary scientific knowledge to be partial enough to not rule them out.[405]

Since it is possible that decisive empirical evidence will never be available, it is not a simple matter to motivate the move from McLaughlin's first claim – the lack of scientific evidence - to his second – incompatibility with contemporary scientific knowledge. It is true as McLaughlin says that the simplistic levels-based approach by which early emergentists sought to explain biological life is incompatible with scientific knowledge. O'Connor and Wong accept that this was essentially an argument from ignorance.[406] The chemical basis of life had yet to be proven and the difficulties in reduction were overestimated and taken to be a contrapositive for emergence. Now, of course, the chemical basis for life is well documented and is generally preferred to emergence as an explanation for life.

The current epistemic situation is different in an important way – rather than the simplistic view of natural hierarchies envisaged by early emergentists, which was capable of being proved wrong by continued advancement in our understanding of the chemical basis of life, we are now faced with enormously complicated overlapping hierarchies that might preclude the possibility of the kind of theoretical reduction that took place in biochemistry. Proving this kind of emergence wrong by empirical means is much more difficult. Here is O'Connor and Wong:

> Theorists of the early twenty-first century, by contrast, are confronted with a picture of enormous, nested complexity in the biological and psychological realms. Clearly there are no sharp dynamical boundaries between such levels of organization. But for all that, we should not be astonished to discover emergent phenomena within the interconnected whole of nature -- as a subtle interplay of microphysical and holistic factors, instead of dramatic supersession.[407]

It is not the case that, if we cannot currently make a theoretic reduction, then emergence is true - this would still amount to an argument from ignorance. The new emergentists must employ other arguments to demonstrate that the analogy between current emergentism and early emergentism is weak enough in relevant ways to block McLaughlin's inductive argument.

[405] ibid
[406] 2005
[407] O'Connor and Wong 2005

There are a few putative examples of emergence within the natural sciences that might be sufficiently different to the early Emergentists to undermine the analogy.[408] In biology, Polanyi has argued that embryonic cells exhibit a macro-determinative influence on the basic physical properties of the system.[409] Also, Zylstra, among others, has argued for a special control hierarchy in biology that could be accounted for by emergence.[410] In statistical mechanics and chemistry, Prigogine has argued that the dissipative structures of thermodynamics involve principles that cannot be derived from fundamental physics and Hendry has argued that there is a molecular macro-deterministic influence.[411] In physics, the insensitivity of macro-phenomena after renormalisation to the micro-constituents of the system and the seeming irrelevancy of fundamental physics to the fractional quantum Hall effect have led many to argue that these phenomena will never be explained in terms of fundamental physics.[412]

Focusing on the last of these as an illustrative example, regarding the fractional quantum Hall effect and the Josephson quantum, Laughlin and Pines argue:

> Neither of these things can be deduced from microscopics, and both are transcendent, in that they would continue to be true and to lead to exact results even if the Theory of Everything were changed. Thus the existence of these effects is profoundly important, for it shows us that for at least some fundamental things in nature the Theory of Everything is irrelevant.[413]

And regarding renormalisation they argue:

> The belief on the part of many that the renormalizability of the universe is a constraint on an underlying microscopic Theory of Everything rather than an emergent property is nothing but an unfalsifiable article of faith.[414]

In both cases there are theoretically distinct features – what they call "higher-organising principles"[415] that as a matter of practical necessity preclude the kind of reduction that occurred with features of living organisms and biochemistry. The differences between some of these arguments and those of the vitalists is that while the vitalists posited theories of

[408] See Klee 1984
[409] Polanyi 1968, see Klee 1984 for critical examination of these and other macro-determinative views.
[410] Zylstra 1992, see also Grene 1987
[411] Prigogine and Stengers 1984 and Hendry 2006
[412] See, for example, Laughlin et al. 1999; Laughlin and Pines 2000; Lancaster and Pexton 2015
[413] Laughlin and Pines 2000, pp. 28–29
[414] Ibid p. 29
[415] ibid

emergence as an explanation for life - partly because they overestimated how difficult a Theoretical-Derivational reduction[416] would be – the new emergentists argue that a Theoretical-Derivational reduction is impossible because of the independence of the "higher-organising principles" and the practical impossibility of deriving predictions from quantum mechanics for even very small systems of particles.

If the new emergentists are correct, what does this imply? We've argued that a failure of REP-reduction does not imply ontological emergence, so in this sense what is being claimed by the new emergentists is limited.[417] But here we are examining their arguments in the context of McLaughlin's claim that there is "not a scintilla of evidence" in favour of ontological emergence; if the new emergentists are correct, does this amount to evidence for emergence? After considering some of these cases, O'Connor and Jacobs are doubtful:

> For all we know on present evidence, some perfectly respectable biological and chemical features are ontologically emergent in this way. By the same token, we do not think there is any clear positive reason to suppose so.[418]

Later in this section I will argue that decisive evidence is impossible, so in that sense McLaughlin is correct. Rather it is the metaphysical underpinnings necessary to support a theory of emergence that are decisive.

What we can say for now though is that even if there is a lack of scientific evidence, it does not follow, pace McLaughlin, that emergence is incompatible with contemporary scientific evidence. The arguments of the new emergentists are only weakly analogous with the arguments of the old emergentists. The new emergentists do not simply take the absence of a reductive proof to be evidence of the impossibility of one. They make new and positive arguments why theoretic reduction is not just impossible now, but always will be. If these arguments are correct, then future science will not be able to provide a reduction, and McLaughlin's inductive argument against emergence fails.

Perhaps the best of these arguments against the possibility of reduction pertains to one of the main candidates for emergent properties: the phenomenal properties of consciousness. There seem to be deep differences between the features of a person's experiences and their physical properties. Whatever reductive account there might be of these features it is going to be of a different kind to the account of life that was given by the discovery of, for instance, the transmission of genetic traits via DNA. As we saw in section 3.1.2, there are good

[416] See section 3.1.2
[417] Relevant sections include section 2.4., 3.1., and 3.8.
[418] O'Connor and Jacobs 2003

reasons to suppose that the existence of phenomenal properties entails the failure of REP-reduction not just in the case of Theoretical-Derivational reduction but also in the case of Teleo-Pragmatic Equivalence. We introduced this distinction to illustrate that the kind of argument made by an emergentist wishing to maintain that a failure of REP-Reduction implied a failure of ONT-Reduction differs depending on what form of REP-Reduction they are talking about. But it should also be clear that this implies that the analogy with the early emergentists is particularly weak in the case of phenomenal properties. If emergentists are questioning whether it is possible to achieve even Expressive Equivalence between representational systems invoking phenomenal properties and those invoking only physical properties, then this is an argument involving theoretic reduction of not just a different order of complexity but also of a different kind to that employed by early emergentists.[419]

Some new emergentists believe that the problem of reducing conscious mental states goes beyond finding Expressive Equivalence too. As we mentioned in sections 3.1.2. and 3.8., one of the things that a theory of macro-properties seeks to explain is the qualitative simplicity of a macro-property given that it is the property of a complex. In sections 3.1. and 6.2. we said that the emergence relation itself was unable to account for that, and the necessary explanation involved dealing with the apparent substantial complexity of the complex object and showing how this did not exclude the possibility of an emergent property's being simple.[420]

This explanation is relevant to the ability of emergence to explain phenomenal properties, since new emergentists often assume that such properties exhibit substantial unity. Here is O'Connor and Jacobs, for example:

> And the maximally direct nature of our first-person awareness of these conscious states precludes the a posteriori ascription to them of underlying physical micro-structure hidden to introspection. (By contrast, the causally-mediated awareness of a computer screen gives only coarse-grained information about its surface properties. Precisely because such information is causally transmitted, it is conceivable to each of us that we are and have been radically deceived by our sensory experiences, so that the world is quite unlike how we take it to be. But it is not conceivable, given the immediacy of our conscious awareness, that we be deceived about the intrinsic character of our experience itself.) The upshot of this familiar reflection, if it stands, is that our experiences and other conscious mental states have fundamentally

[419] Of course, if the claim is that phenomenological experiences are indubitable and transparent and represent to us real properties, then the analogy seems even weaker.
[420] An attempt at which was made in section 6.5.

> distinctive characteristics and, furthermore, lack intrinsic features that are not directly accessible to their subjects.[421]

Here, the indubitable nature of conscious experience – guaranteed because it is maximally direct and not causally mediated - is presented as an apparent excluder to any theory of phenomenal properties as merely composed complex object with substantial complexity.[422] If this is the case, then the appeal to emergence is not epistemically on a par with the contemporary science cases presented above, never mind those of C19 vitalists. In the special science cases we are motivated by empirical evidence tied to an understanding of the conditions of theoretic reduction, to argue that 1) There is always room for emergence within the dynamic nested structures of complex systems in the special sciences; and 2) there will always remain explanatory gaps between micro-theoretical accounts and macro-theoretical accounts. If these arguments are correct then emergence is one possible explanation, but there are others, see sections 7.7-9. below. As O'Connor and Wong say: "There, the question of whether other types of hypothesis might inevitably fill such explanatory gaps equally well at less ontological cost is crucial."[423] But O'Connor and Wong take the unique epistemic situation vis-à-vis phenomenal properties to uniquely provide apparent excluders to substantial complexity:

> So even if the differential behavior resulting from emergent mental features could, from a third-person standpoint, be adequately captured in formal dynamical terms by non-emergentist models of the sort described below, we have independent reasons for rejecting such models.[424]

Contemporary science cases are very different to the naïve theories of the early emergentists. As discussed, none of this is clear evidence for emergence, but these differences mean there is at least no prime facie reason why the failure of the early emergentists should be extended to theories of emergence as a whole. Nor does it seem that emergence is incompatible with contemporary scientific knowledge – emergence is possible without contravention of any scientific theories, and it seems unlikely that science will progress in ways that would conclusively contradict emergence.

[421] O'Connor and Jacobs 2003
[422] Compare with section 3.6.
[423] O'Connor and Wong 2005
[424] ibid

7.4 The Scientific Incongruence Problem: Inductive Scepticism

So there may be another way that emergence is incongruent with science. Kim has pointed out that theoretic reduction has been an "enormously success research strategy" in science.[425]

Should this concern the emergentist? On the one hand it is true that this does not give us conclusive grounds for asserting the general negative thesis that there is no emergence.[426] The appearance of an emergent property at a given level of complexity will always be unexpected given only knowledge of the powers manifested at a lower level of complexity. But the success of science depends upon the induction that what holds true at lower levels of complexity will continue to do so at higher levels.[427] A potential problem for the emergentist is that emergence seems to undermine this kind of induction – since new powers will emerge at seemingly arbitrary points as we increase the complexity of the system, why should we presume that whatever powers we observe now will continue to constitute any system above the observed complexity? We should now at least be agnostic about any generalisations we make about the powers we will find in *any* complex system that has not previously been observed.

O'Connor and Wong answer this objection by arguing that the emergentist can still allow an epistemological presumption in favour of induction for previously untested systems.[428] Only if there is special reason to suppose that they are different from the run-of-the-mill cases, will anything apart from the slightest change to our inductive expectations be appropriate for modest extensions of our theories. Scepticism about modest induction is forestalled by admitting only a small epistemic probability that such inductions will fail. They also point out that simple interpolations of linear complexity increases will presumably have an even smaller probability of failure:

> Furthermore: theories are necessarily put to the test for a finite number of case variations. Suppose we verify a theory for systems with complexity levels i and i + k, but not for systems whose complexity falls between these magnitudes. We may confidently discard emergentist hypotheses concerning systems within the interval as well, since any emergent effects for such systems is apt to be manifested at the higher i + k level.[429]

[425] Kim 1984, p.176
[426] O'Connor 1994
[427] Otherwise the predictive capability is limited.
[428] O'Connor and Wong 2005 pp. 27-8
[429] Ibid p. 28

O'Connor and Wong go on to argue that, if anything, the emergentist will exhibit the kind of measured scepticism about extrapolation that is complimentary to scientific practice, that, if anything, it is the sweeping judgements of McLaughlin, based only on very partial contemporary scientific knowledge, that fall foul of scientific practice.[430] While allowing that it is reasonable to suppose theories have a broader application than the specific scenarios actually tested. They suggest that we should be less confident that a scientific theory will hold "the further removed a scenario is from the well-confirmed range along a scale of increased structured complexity."[431]

7.5 Congruence: The Problem of Natural Unity

There's one more explanatory criticism of emergence that I'd like to mention, and that's the notion that emergence is disunifying in a way that threatens natural unity. This is a distinct concern from causal closure. The unity of nature is not necessarily a theoretical virtue[432] but in any case, as we'll see, emergence is compatible with a pervasive and uniform causal continuity anyway – a unity of dispositional structure, not behaviour:

> But unity does not require the reductionist vision of the world as merely a vast network binding together local microphysical facts, with a pervasive and uniform causal continuity underlying all complex systems. It is enough that at every juncture introducing some new kind of causally discontinuous behavior, there is a causal source for that discontinuity in the network of dispositions that underlie it. In short: unity in the order of the unfolding natural world need not involve causal continuity of behavior, only continuity of dispositional structure.[433]

Causal emergence retains a unity of dispositional structure because the emergent properties it postulates make a difference to, but fit in with, the normal unfolding of the universe. Macro-level phenomena arise through entirely natural microphysical processes and their existence continues to causally depend on processes of this kind. In order to claim that emergence violates natural unity it would be necessary to argue for some sort of Constitution Thesis.[434] That is, a rule that all macro-level phenomena are not only causally dependent on, but also *constituted* by microphysical processes. And while that rule would preclude emergence, it's a thesis that would require independent argumentation, because it does not follow from the understandable desire for casual unity.

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[430] ibid
[431] ibid
[432] See Cartwright 1999 for example.
[433] O'Connor and Churchill 2010
[434] See O'Connor 2000a, pp. 108-25 for argumentation along these lines

To sum up, the current empirical situation regarding emergence is that there is a lack of decisive evidence either way, and it has been argued that decisive evidence will never be available; furthermore, theories of emergence in their current form do not seem to be threatened by an inductive argument based on past scientific progression, nor do they pose a threat to the appropriate application of scientific induction. The existence of emergence is empirically open. Next we will look at some other 'epistemological' objections to emergence. These are arguments based on the existence of alternative explanations for macro-phenomena, specifically inherent explanations.

7.6 The Epistemological Problem is Not an Empirical Problem

O'Connor and Wong:

> Even so, absent a fully worked out picture of microbiology and a reasonably good set of mappings from complex physical structures to basic microbiological features, emergence cannot be entirely ruled out, either.[435]

I will argue that this is not true. Both emergence and its denial face a deeper problem. This is an epistemological difficulty that is specific to and entailed by the metaphysics of emergent properties.

For a start, emergent properties are, uniquely, macro-properties – properties of a complex as opposed to properties of simples. Experimental methodology seeks to understand a situation by breaking it down and examining the constituent objects in isolation. This presents a problem when conducting experiments on emergent properties because, once the whole is broken down, the emergent property is no longer produced. For the same reason experimental analysis of the constituent simples will fail to discover the basic powers that will produce the emergent property. Unfortunately, this prohibits the decisive identification of an emergent power by experimental means.

Imagine employing a brute-force method to analyse an emergent system. Let's assume we can achieve precise knowledge of the state of the system and the ability to precisely predict how the behaviour of each of the constituents will evolve in combination with the behaviour of the other constituents. For some complex systems this might be currently impossible: the compounding errors of approximation techniques used to measure fundamental physical features may always leave room for ambiguity in identifying a potential emergent power's distinctive causal contribution.[436] In general, with increasing system size comes the

[435] O'Connor and Wong 2005
[436] See Laughlin, et al 1999

increased potential for epistemologically emergent features that are empirically indistinguishable from ontological ones.

With less certainty we might settle on giving a theoretical-deductive account of system behaviour in terms of the powers of the constituents, and should anything else be required to explain behaviour we could take this to be good evidence that there are additional entities present; however, we saw in sections 2.4.4 and 3.1 that not only are such reductions vexingly difficult, they are also not good evidence of the existence of additional entities. Furthermore, following the discussion in sections 3.6-8, the methodology employed here does not rely on semantic analyses of these theories to determine what exists and in general does not assume that theoretical necessity reifies properties.

In addition, even if it were not practically impossible to employ the brute-force method to empirically test for emergence, the discussions in sections 2.4., 3.1.2. and 4.2-3 illustrate that, even if one had perfect knowledge and perfect deductive powers like the Laplacean demon, determining when it is necessary to invoke an emergent property is impossible in principle. This is because the epistemic standpoint of the demon is either restricted to only micro-properties, in which case the production of an emergent properties is utterly predictable, or the epistemic standpoint of the demon is restricted to exclude the emergent-producing powers too. In the first case the reasoning becomes circular: we have to assume knowledge about which powers are micro- and which are macro- in order for an agent to be able to discover which properties are micro- and which are macro-. In the second case, even though it has perfect empirical knowledge of all micro-powers apart from those that produce emergent properties, the Laplacean demon is in no better position than we are to decide which of the remaining observed powers are micro- and macro-. Even a perfect calculator with perfect knowledge could not, in principle, use a brute-force empirical method to decisively identify which powers are which. This illustrates that the epistemological problem is a metaphysical one: it is entailed by the metaphysics of emergence and can only be solved by a (metaphysical) theory of property identification.

This contradicts O'Connor and Churchill:

> Suffice it to say that if, for example, a particular protein molecule were to have emergent properties, then the unfolding dynamics of that molecule at a microscopic level would diverge in specifiable ways from what an ideal particle physicist (lacking computational and precision limitations) would expect by extrapolating from a complete understanding of the dynamics of small-scale particle systems. The nature

> and degree of divergence would provide a basis for capturing the distinctive contribution of the emergent features of the molecule.[437]

The ideal particle physicist would not have a basis for capturing the distinctive contributions of emergent features. This is entailed by the presence of emergent-producing micro-powers, which would not be observed by the ideal particle physicist in the dynamics of small-scale particle systems.

The significance of this is that, even with precise knowledge, one is still open to the objection that any observed behaviour does not in fact implicate the emergent entities. It could, for instance, merely imply that the properties we already know about produce very different behaviour in different circumstances.[438] When Shoemaker made this objection he said that this behaviour merely implies a complication of the micro-powers.[439] Or there might be micro-properties we have not observed before, or some other better alternative. The crux of the argument is O'Connor and Wong's claim that: "given the right sort of evidence, better alternatives [to emergence] would not in principle be available."[440] Which relies on arguments beyond the empirical evidence.

Timothy O'Connor[441] and O'Connor and Wong[442] argue that in the face of uncertainty, it is preferable, on the basis of abstract metaphysical grounds, (i.e. the principles by which powers are individuated and a preference for ontological simplicity), to posit emergent properties wherever there is discontinuous systemic behaviour (discontinuous in the sense that the behaviour changes radically and suddenly as the complexity of the system increases)[443]. When a macro-power has been "precisely specified" in such circumstances, it is preferable to posit the existence of an emergent power than to posit that the behaviour is produced by the interactions of micro-powers alone.

Their arguments variously involve the following premises:

1. "Properties are posited… to explain differences among various general patterns of events"[444]. Precisely specifiable causal features are the mark of a new power.[445]

[437] O'Connor and Churchill 2010
[438] This is similar to the 'collapse' objection, compare Taylor 2015.
[439] Shoemaker 2002
[440] O'Connor and Wong 2005
[441] 1994, 2000a
[442] 2005
[443] O'Connor and Wong 2005, p.682
[444] O'Connor 2000a p.113
[445] O'Connor 1994, 2000a; O'Connor and Wong 2005, p.682

2. When the causal behaviour of a system meets the same individuation conditions as the behaviour of a simple, it is appropriate to posit a new power.[446]
3. The behaviour of a non-emergent complex system cannot be somehow additional to the powers of its components.[447]
4. Accounting for discontinuous system behaviour of a complex system using micro-powers would require complicated disjunct micro-powers.[448]
5. Accounting for a complex system that shows responsiveness to macro-circumstances using basic powers would require basic powers that are responsive to macro-circumstances.[449]

Premise 1 is a general principle about how powers are individuated by behaviour. Premise 2 assumes that this principle generalises to the macro. Premises 3, 4, and 5 are proposals about how the powers of the components of a non-emergent complex system can combine to produce the behaviour of the system. They also have implications for how we might impute the essence of powers from their combined effects. They propose the following: the combination of basic powers cannot produce powers additional to the basic powers (premise 3); the combination of non-disjunct basic powers cannot produce system-wide discontinuous behaviour (premise 4); and the combination of locally-acting basic powers cannot produce system-wide responsive behaviour (premise 5).

Let's assume that a complex system exists that has a precisely specifiable causal profile featuring discontinuous macro-behaviour and responsiveness to macro-circumstances – there seem to be plenty of examples. We should note that these premises do not alone imply the existence of an emergent property; however, when combined with the entirely reasonable premise that it is undesirable for powers to be complicated and disjunct, or to produce effects at a distance, it is possible to construct an argument that positing an emergent property is the preferable option.

In the next section I will argue that premises 3-5 are false. It is the case that powers in combination can produce effects that are discontinuous, responsive to macro-circumstances, and somehow additional to the powers of the components. I will show how this is possible and in what senses powers in combination can be additional to the same powers in isolation. In order to do this we will have to discuss how powers produce effects. Once we have illuminated the way that powers produce effects we will also be better placed to refine the

[446] O'Connor and Wong 2005, p.682
[447] O'Connor 2000a p113
[448] E.g O'Connor 1994, pp. 17-8; O'Connor and Wong 2005, p.682-3
[449] O'Connor 1994, p. 18; O'Connor and Wong 2005, p.683

principle by which we individuate basic powers (premise 1). We will than see that this principle does not generalise to macro-behaviour (premise 2).

First let's have a look at some of the previous arguments that rely on the epistemological problem and see where the above premises come from.

7.7 Pepper's Objection: Complicating our Micro-Powers

O'Connor:

> If an emergent property is a necessary consequence of certain base-level properties, then its instantiation is one of the potentialities of that set of properties. Thus, are not the additional potentialities of this emergent property also a subset of the total set of potentialities of the base properties, in virtue of the necessary connection between the base properties and it? They are simply potentialities of the base properties at one remove. One is now led to wonder why we might ever think to postulate an emergent property at all, as it provides no explanatory gain over an account that excises the mediating link by taking the "additional" potentialities as directly tied to the base properties.
>
> Before addressing this objection, I want to remark briefly on the importance of its challenge to the whole gambit of appealing to emergent properties. I have emphasized the importance of a causal grounding condition to render emergent phenomena naturalistically explainable. Yet this must be consistent with the core emergentist intuition that certain higher level properties are radically new features… The objection just noted in effect claims that one cannot have both of these features; they are in conflict.[450]

The first such argument comes originally from Pepper.[451] He argued that novel macroscopic phenomena can be represented by complicating the laws that quantify over the constituents - but not the macro-properties - such that there is a dynamical evolution in response to the apparently emergent situation. These comprehensive physical laws would have nonlinear functionality above and below the threshold level of complexity and could thereby quantify over the macroscopic phenomena and the microscopic. The emergent laws quantifying over just the macroscopic phenomena are therefore assumed to be epiphenomenal.

Taken as is, this argument doesn't make sense in a causal powers ontology. First of all, if an emergent property exists, and therefore makes a causal contribution, it makes no difference

[450] O'Connor 2000a
[451] 1926

whether or not it is possible to give a different representation of macroscopic phenomena by complicating the causal profile of the constituents' properties: the mere ability to give an alternative theory does not change reality. Pepper's objection rests on the error, familiar to us by now, of assuming that possibilities of description imply metaphysical facts.

The causal powers theorist can instead interpret the suggestion as this: when faced with potentially emergent phenomena we should always choose the theory that complicates the micro-powers before we choose the theory that posits new ones. That is, we invoke a principle whereby we should prefer to change our theory of the micro-properties and make those powers more complicated. The thought here might be that we should only posit a new property when it is necessary. The more complicated powers theory sacrifices one kind of simplicity, but it has the same explanatory power as a theory of emergence and it compares favourably in terms of ontological economy, i.e. there are fewer entities – the same small number of properties as before, but made complex and disjunct.

However, finding a motivation for this principle is difficult for a causal powers theorist. A property's causal role is essential and powers are individuated by their causal profiles. This is the presumption behind premise 1, above. When there are precisely specifiable causal features among the micro-constituents one should posit new properties to account for them rather than complicating existing ones. If this is the case for the micro-powers, why is it not the case for the macro-powers?[452]

The discontinuous behaviour at the macroscopic level would require complicated disjunct micro-powers. It is usual to identify new properties with these disjunctions – for instance, we wouldn't, for the sake of ontological economy, consider the mass and charge of a fundamental particle to be a single complex property. The objector would require some principled reason why the same is not true in the case of macro-phenomena. O'Connor and Wong argue that such cases 'demand explanation' in causal/dispositional terms.[453] And O'Connor says that it is 'always appropriate' to account for fundamental, systematic discontinuity with new properties.[454] One option for the objector could be to rule out complexes as things to which these principles of property individuation apply, but this stipulation would require independent metaphysical reasoning.

The counter-argument goes like this then: when we are in the situation of identifying a set of powers {m, n, p} with a property M, where {m, n, p} is a 'precisely specifiable' causal profile,

[452] See chapter 10 for an answer to this question.
[453] O'Connor Wong 2005
[454] O'Connor 2000a

we would not complicate this profile - like {m, n, p, q}, say - in a way that is not precisely specifiable. And, likewise, when we are in the situation of deriving a set of powers {x, y, z} of a complex object (E1, M, E2, R, G, E3), where {x, y, z} is a 'precisely specifiable' causal profile, we would not complicate this profile - like {x, y, z, a, b, c}, say - in a way that is not precisely specifiable. In the case of M, we would rather postulate the instantiation of a further property, N, than postulate that M is identified with {m, n, p, q} instead of {m, n, p}. Likewise for the complex object (E1, M, E2, R, G, E3): we would rather postulate the instantiation of a further property, Ɛ, than postulate that {x, y, z, a, b, c} is derived from (E1, M, E2, R, G, E3).

What is meant by 'precisely specifiable' in these circumstances? Does the discontinuous behaviour at the macroscopic level really require complicated disjunct micro-powers? One option for the objector could be to point to the difference between the identification of particular properties with their powers and the derivation of powers from a complex object. In the model, the derived powers x, y, and z are not necessarily identified with any of the particulars in the sequence (E1, M, E2, R, G, E3). Perhaps the powers of a complex system are quite unlike the powers of the particulars. This derivation is not as straightforward as the identification of powers with properties, so it is not obvious that an analogous rule should apply when it comes to the postulation of new powers. The derivation of causal powers is relevantly dissimilar to the identification of causal powers with properties. More on these issues in chapters 8-10.

7.8 New Latent Micro-Powers

The next option is to appeal to latent micro-powers. O'Connor attributes this objection to Shoemaker.[455] Just as the emergentist posits latent micro-powers that are manifested in circumstances of the requisite complexity to produce an emergent, the objector can also posit new micro-powers to account for systemic discontinuities. These latent micro-powers are also invisible in the lower complexity systems observed in fundamental physics, but instead of the tendency to produce emergent properties, they have the power to directly produce the macroscale effects. This power still seems to be radically different to the powers of fundamental physics because it is triggered by complex macroscopic circumstances and is directed to complex macroscopic effects.

These latent micro-powers must be able to give a full account of the macroscale phenomena in order to have the same explanatory power and gain preference over the emergent theory. However, it seems that in order to do this, the micro-powers would have to have different characteristic effects in response to macroscale situations, different micro-effects that would

[455] For instance in O'Connor 1994 Shoemaker is quoted in person; Shoemaker also uses the argument in Shoemaker 2002

aggregate with the other micro-effects to produce the discontinuities. Compared with the emergent property, which, being the property of a complex, has a macroscale causal profile, the micro-powers would require either a complicated causal profile, or some sort of responsiveness at a distance. O'Connor finds the second option mysterious.[456]

The first option suffers from the same objection about disjunct causal profiles as before. It doesn't matter whether micro-powers are latent or not, the systemic discontinuities require immense complexity at the micro-level:

> Consider the complexity of the effects that will be directly ascribed to the microphysical particles (acting in tandem): in quantum-mechanical terms, a large-scale distribution of qualities unevenly distributed across the region in question (and perhaps not at all in some sub-regions). We are thus required to suppose that each of the basic particles is disposed towards a highly complex result.[457]

For this reason, O'Connor considers the latent micro-powers approach to be implausible.

The latent micro-powers theory has the advantage of greater ontological economy than emergentism: the only additional entities are some latent micro-powers, rather than latent emergent-producing micro-powers plus an emergent property. The theory also benefits from an economy of kinds of entity – its properties are had only by simples, rather than there being a kind of property had by simples and a kind of property had by complexes. The set of properties would be richer, and no longer just those properties observed in fundamental physics, but all of what happens would share the feature that it is produced by micro-properties.

There are also drawbacks to the theory. It would require one of two options, both of which are potentially incongruent with other metaphysical tenets. First of all the latent micro-powers seem to be responsive to non-local situations. This is mysterious and would require a metaphysically plausible account, or else weigh heavily in considerations of theory choice.[458] Secondly, the micro-powers seem to be directed towards non-local effects, which would require a compex, disjunct causal profile operating in aggregate. This second option is not compatible with common theories of property identity and would also sacrifice one kind of theoretical simplicity in order to gain another.

[456] O'Connor 1994
[457] O'Connor and Wong 2005
[458] A response is given in section 7.9.1, below.

7.9 Structured Latent Micro-Powers

There is a variation on the above proposal, whereby the structure of the complex has some influence on which powers a property manifests. Here is what O'Connor has to say about such a proposition:

> As an alternative to the claim that there are further micro-properties, one might maintain that the micro-properties there are have causal features that don't come into play until the particles having the micro-properties become parts of systems having certain structures and degrees of complexity.
>
> But, if I am understanding this idea properly, it seems to involve a micro-particle's having different effects in the same sort of local situation, depending on the broader context in which that local situation is itself imbedded. But here we avoid the sort of 'downward' causal influence that the emergentist hypothesis envisages only at the cost of a causally inexplicable 'responsiveness' of micro-level behavior to macro-level circumstances.[459]

And here is O'Connor and Wong:

> A variation on the latent-micro-dispositions proposal will suppose instead subtle differences in the specific dispositions being exercised by the different particles, depending on their location within the appropriate type of complex. Since the particles are of the same type, each has all of these dispositions, but they exercise only those that their different circumstances permit. While perhaps more realistic than the original idea, the variation needs to posit a wide range of hidden dispositions (the number depending on the empirical details) for each specifiable dynamical discontinuity. Our view is simpler and so to be preferred: for each discontinuity, just one basic disposition -- to give rise to an emergent property under suitable circumstances -- that is had by every fundamental constituent.[460]

This response, and the premises above, rest on assumptions about what simple properties can do in a complex system that are simply incorrect. Remember the examples of statistical physics, chaotic systems and self-reinforcing systems in chapter 1, and even systems with so-called 'classical' structure. All illustrate that this assumption is an error. It also leads us to some more nuanced metaphysical considerations about the identification of causal powers.

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[459] O'Connor 1994
[460] O'Connor and Wong 2005

7.9.1 Responsiveness to Macro-Contexts and 'action at a distance'?

If the thought is that powers acting together at the micro scale could never have a combined effect at the macro scale, then this is obviously wrong. System-level effects are not 'spooky action at a distance'. If the thought is that some property of the whole must be a property of the parts – this is a famous mistake about complex objects. To ask, why does the system respond this way when I push this button? Does not require that every part of the system has a power that corresponds to that counterfactual. The counterfactual is made true by the system without the parts of the system being responsive. Perhaps the thought is that some sort of counterfactual about the whole system implies that there is some sort of power of the whole system that could not be derived from facts about parts of the system. But this example requires that powers are implied by true counterfactuals, and we will see in chapter 8 that this is also a mistake.

7.10 Conclusion

There is no deep reason that would prevent a metaphysical identification of the profile of macro-powers with micro-properties. O'Connor's and other's objections do not necessarily require complicated micro-properties. We have several options to explain how discontinuous system behaviour is caused by the actions of relatively simple powers. Firstly, mere aggregation of the simple nodes involved in a connectionist system like a neural net suffices to generate discontinuities and macro-responsiveness – this might be true for any self-regulating aggregate utilising feedback. Secondly, chaotic systems suffice to generate discontinuities and macro-responsiveness with simple constituents. Thirdly, and more decisively, any structured system can easily generate discontinuities of behaviour and macro-responsiveness from simple elements.

The first two of these options, feedback-reinforced aggregation and chaotic systems, might – even if ubiquitous – be considered special cases that do not generalise to all of the cases of putative emergence. The third however, is much more general, as can be seen by the analogy of the debate between connectionism and classical structure in cognitive science: while special self-reinforcing elements of a system – like connectoplasm - can generate some systematicity on their own, classically structured systems can guarantee pervasive systematicity, which is the basis of the objections we raised on behalf of O'Connor and others above. Pervasive discontinuities and systematicity at the macro-level is insufficient motivation for reifying apparent macro-properties. At the very least these possibilities illustrate that there are many exceptions to the general rules for identifying emergent properties proposed by O'Connor and others.

The emergentist can counter that these principles still apply to systems that do not demonstrate either chaotic features, self-reinforcing behaviour, or classical structure. One problem for the emergentist is that many of the systems identified as possessing potential emergent properties are organised: sometimes enormously complex nested hierarchies. Given that the epistemological problem is compounded by the difficulty of studying such systems – which give rise to the examples of epistemological emergence we have seen – this raises doubts about the emergentist's conditions for property identification.

The problem of decisively identifying when a new emergent property has occurred is kicked down the line. We have already shown that the application of the brute force method could not make such an identification by isolating the influence of all of the constituents of a system. We then examined the suggestion that, in the absence of the brute force method, there are principles of property identification that would preference emergentism because discontinuous system behaviour necessarily involves disjunct constituent properties. This claim is not true. The requirements for identifying new emergent properties have now shifted so that making a decisive determination now requires that the system in question lacks any of the specific macro-structural features that are capable of influencing the combination of the constituent properties in such a way that could produce any putatively emergent macro-properties. In the face of the enormous, dynamic, massively nested hierarchical systems, it seems difficult for the presence of such structural influences – especially when it's possible that they operate in combination with previously unobserved latent micro-powers - to be entirely ruled out for a given system. In any case, the abstract metaphysical principles thus far advanced by the emergentists are insufficient for resolving the epistemological problem. And as we shall see in the next three chapters, the problem is only compounded when one properly analyses the causal power properties involved in this theory of emergence. I will argue that an alternative, inherent explanation would make a viable alternative to emergence within a causal powers ontology.

8. Causal Powers Theories of Properties

8.1 Properties, Causal Powers, and Manifestations

Sydney Shoemaker says “For something to have a power... is for it to be such that its presence in circumstances of a particular sort will have certain effects”.[461] The powers of an object are conceptually distinct from the properties of an object, and in virtue of which it has those powers. The properties of an object determine what causal powers that object has and the causal powers of an object in turn determine the object’s behaviour, i.e. which effects occur in which circumstances. There are a number of different positions regarding the nature of the relationship between powers and properties. Shoemaker for example says that the having of properties ‘determines’ or ‘contributes to’ the object’s causal powers.[462] Whereas others say that causal powers are ‘bestowed’ on their objects by the properties they have.[463]

In this chapter I examine what causal powers are and how one might individuate properties based on effects. Making the relationship between properties, powers and effects clear, and having a firm understanding of what the manifestations of powers are, and in what circumstances they occur, is necessary for deciding what can be inferred about properties from the behaviour of objects.

One role played by properties is their role in explanation. It is to properties that we appeal when we are trying to explain what an object does or what it would do. If it is the object’s properties that explain its behaviour, then this suggests some sort of connection between an object’s properties and its powers. A tomato has the properties of sphericalness and redness, in virtue of which the tomato has, respectively, the power to roll and the power to look red to normal observers in normal conditions. It also has the powers to cause a round impression in soft surfaces or to stand out against a green background, etc.

For our purposes, following on from the arguments in our introduction to causal powers in section 2.6., what matters is that properties are individuated by causal powers. This is the causal theory of properties. Here is Shoemaker again:

[461] 1980
[462] Ibid
[463] E.g. Clapp 2001

> [W]hat makes a property the property that it is, what determines its identity, is its potential for contributing to the causal powers of the things that have it. This means, among other things, that if under all possible circumstances properties X and Y make the same contribution to the causal powers of the things that have them, X and Y are the same property.[464]

O'Connor and Churchill explicitly assume the causal theory of properties.[465]

In turn, it is an essential feature of powers that they are directed towards the effects that they produce. This is one of the five basic features of powers identified by Molnar:

> I. Directedness. A power has directionality, in the sense that it must be a power for, or to, some outcome.[466]

Despite being essentially directed to these outcomes, the effects produced by powers are distinct from the powers themselves. The other four basic features of powers in Molnar rule out the possibility of identifying powers with the effects they produce, or otherwise reductively analysing powers:

> II. Independence. Powers are ontologically independent of [the effects they produce]. They can exist even when they are not being exercised and will not be exercised.
> III. Actuality. A particular strand of anti-realism holds that a power is nothing over and above the possibility of [the effects they produce. Powers are fully actual and not reducible to analysis of conditionals or counterfactuals.]
> IV. Intrinsicality. Powers are intrinsic [to objects. They cannot be reduced to relations or analysed relationally.]
> V. Objectivity. [Powers are features of the world and not] … generated by the psychological structure of human observers.[467]

Since powers are not the effects they produce nor the possibility of such effects, they will not have the same individuation conditions as the effects nor as the mere possibility of such effects. Since powers are, assumed here, not extrinsic to their objects, they will not have the same individuation conditions as relations that hold between objects. Since they are objective, they cannot be individuated in terms that are mind-dependent. Since they are,

[464] 1980
[465] 2010
[466] 2003, p.57
[467] 2003, pp.57-8

however, essentially directed to certain effects, they will, at least in part, be individuated by the effects that they tend to produce.

If powers are not individuated by their effects, then how else can they be individuated? There is no other obvious candidate. And there are also other reasons to suppose that powers are individuated by their effects, other than it being the only criteria revealed by looking at this list of the essential features of powers. The first is that it makes sense of the language we use to talk about powers that they be individuated by the effects they produce. Powers are often defined as "the power to *x*" or "the power for *y*". Though, of course, since powers are independent of their effects and not reduced to the possibility of their effects, the distinctness of *x* and *y* does not in itself entail distinct powers. This will depend on the principles we adopt for the individuation of powers. More on this in a bit.

There is a strong epistemic rationale behind the individuation of powers by their effects. Effects seem to be the only way that we can perceive the operations of powers – I see the glass shattering, but I cannot directly perceive the fragility of the glass. Shoemaker again: "We know and recognize properties by their effects, or, more precisely by the effects of the events which are the activations of the causal powers which things have in virtue of having the properties."[468] Effects are the only epistemic access we have to the existence and nature of powers. If two distinct types of causal power meant the production of exactly the same effects in the same circumstances, then there would be no perceivable difference between the two distinct powers.

8.2 Conditional Analysis

While powers are not reducible to conditional statements[469], we might try to appeal to conditional statements to individuate powers. Disjunctive conditionals have the advantage that they include a consequent describing the power's effect and an antecedent that describes the circumstances in which a powers will produce that effect. This can provide a route to criteria for individuation. For instance, one might claim that a power can be individuated by the conditional statements the truth of which that power entails. There do seem to be readily available subjunctive conditionals that are entailed by the presence of certain paradigmatic powers, for instance, it is true that, for a fragile vase:

> If the vase is hit by a hammer, then it will shatter.

[468] 1980
[469] See Molnar 2003 ch. 3-7 for defence of the points above.

Perhaps the entailment of conditionals like this can be used to individuate powers. The simplest version of a general conditional analysis of powers is what Molnar calls the 'Naïve Conditional Analysis':[470]

> NCA Something x is disposed at time t to give response r to stimulus s iff if x were to undergo stimulus s at time t, then x would give response r.

In order for statements of this form to provide individuation conditions for powers, the presence of a power must entail the truth of some conditional of this form. That is: that the entailment of the truth of this sort of conditional must be a necessary condition for the individuation of powers. It also needs to be shown that two different powers cannot entail the truth of the same set of conditionals, otherwise the criteria would be insufficient for the individuation of powers. Simple conditionals like NCA face problems on both counts.

Most of the problems for using statements like NCA result from them being "clumsy and inexact linguistic gestures"[471] towards powers that fail to represent the essence of powers as outlined above. The first problem is no exception. Statements of the form of NCA say nothing about what it is about the object that makes the statement true; how is the effect produced in these circumstances? This relates to the intrinsicality of powers. By missing out this feature, room is left for counterexamples where the entailment of NCA proves insufficient for individuating powers. Molnar uses the example of Malebranche-style occasionalism.[472] Suppose that every time stimulus s occurs, God intervenes to cause the object x to give response r. NCA is true, but the truth of NCA is entailed by any set of powers of x whatsoever. So the entailing of NCA is insufficient for the individuation of powers.

A more general problem is the problem of unconditional manifestations. These are powers that, while still being independent of their effects, produce those effects without being triggered by any stimuli. While most everyday cases of the exercise of powers involve the action of some stimulus or trigger, it is not necessarily the case that all powers do. And if a power exists for which this is not the case, then the entailment of NCA-form statements is not a necessary condition for the individuation of powers.

Such a power could exist if it produced its effects spontaneously. Such a power would be a counterexample to the proposed conditional criteria for power individuation. And in fact, we do have good examples of powers that are exercised spontaneously. Particle decay, for example. The muon has the power to decay into an electron, a neutrino, and an antineutrino.

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[470] 1999
[471] Martin 1994, p.8
[472] 2003, pp.84-5

Its properties produce decay at some point in the life of the muon without any external stimulus. Attempts to account for this by invoking an internal trigger are bound to fall into a regress because any internal trigger looks to be a spontaneous effect too.[473]

A power would also provide a counterexample to the conditional criteria if it continuously produced its manifestations. This would be a power that, for as long as it exists, is always exercised. It too would have no stimulus and would fail to entail a NCA-form statement. Resting mass is an example that has been suggested for this sort of power – objects are continuously exercising this power in interaction with space-time.

Then there are what Martin call 'finks'. The general form of a finkish case is for the stimulus to cause the object to acquire or to lose powers at time t. This can work both ways. The object x could be lacking a power D at time t, but, if the stimulus s were to occur, ex hypothesi, x would gain D, which would at the same time mean the production of response r. Thus the conditional is satisfied without x having D at time t. In this example the object x entails the truth of NCA, but this entailment is insufficient for individuating the powers of x.

Conversely, x could have D at time t, but if it were to undergo s, ex hypothesi, x would lose D, and would not produce r. Thus the conditional is not satisfied even though x does in fact have D at time t. In this example the object x does not entail the truth of NCA, but entailment is not a necessary condition for individuating the powers of x.

8.3 Identifying Powers I

The force of the epistemological objection to causal powers emergence depends on how causal powers are individuated. If powers are individuated in such a way that the novel behaviour of a complex object would imply the existence of new powers – like if there was an isomorphism between effects and powers, i.e. a one-to-one mapping – then the causal theory of properties implies that new properties are involved. Likewise, if the relationship is not isomorphic, but something like the principles of property identity set out by O'Connor and others in section 7.6., then the causal theory of properties implies that new properties are involved.[474] Let's examine some of the other candidate principles for the individuation of powers, illustrating the difference between the manifestation of causal powers and observed behaviour.

[473] Ibid, pp. 85-6
[474] See sections 7.6-10 for a preliminary rebuttal of these principles.

As we mentioned above: powers are essentially directed towards their manifestations. Next we will look at two theories of powers that differ in their definition of this essence. According to these theories, manifestations are either:

- the events caused by objects bestowed with those powers; (Martin)
- or, the contributions to caused events made by objects bestowed with those powers. (Molnar/Mumford)

Either way, powers are distinct from, but necessarily linked to their manifestations. We will assume therefore that powers are identified by their manifestations.[475] Despite being essentially directed to these outcomes, the caused events produced in virtue of powers are distinct from the powers themselves. Effects are the only epistemic access we have to the existence and nature of powers - if two distinct types of causal power meant the production of exactly the same effects in the same circumstances, then there would be no perceivable difference between the two distinct powers - but only one of these theories posits a direct link between observable effects and powers. The important difference is that on Martin's account we retain the epistemological loading of the term 'manifestations', i.e. they are manifest. Whereas on the Molnar/Mumford account manifestations are hidden and we recognise them only indirectly through caused events.

8.4 Martin's Mutual Manifestation

Here's one theory in that regard.[476] The term mutual manifestation refers to the caused event and powers combine as reciprocal partners for their mutual manifestation. The observed caused event is produced by a holistic power net that acts in concert where whatever is causally operative for that caused event is part of that net. For any individual power, the caused events produced by different nets containing that power will differ wildly depending on the other manifestation partners for each event.

In Martin's words a single power is directed towards an "infinity of reciprocal disposition partners for, against, or neutral with regard to an infinity of manifestations, with an infinity of different disposition lines, are actual in the quark itself."[477] If this looks complicated when you are trying to define the essence of any individual power then Martin doesn't consider that a problem: "Of course, all of God's children have identity conditions." But giving 'specific and

[475] It might not be quite so simple, for example, Bird is open to the idea that powers are partially individuated by stimulus conditions, and Shoemaker has previously introduced the idea of properties having backwards-looking causal profiles as well as the forward-looking ones. Let's just put that to the side.
[476] See Martin 2008 for example.
[477] Ibid, p. 30

full' identity conditions for anything but abstract entities would be 'endless'. "The demand for them is the ploy of the mad logician."[478]

There doesn't seem to be any real theoretic cost to additional disjunctions in the essences of powers on this account. Disposition lines in the power net are a direct connection between manifestation partners and caused events. And the combining of powers is all in the power net. When every power is directly connected by dispositional lines to an infinite number of caused events towards which it can contribute, there's no need for the additional step of composing those powers.[479]

Under Martin's theory of property identity we see the repudiation of two implicit premises in the argument to CPE set out in 7.6:

1. powers are not complicated or disjunct, and

2. micro-properties are not responsive to macro-circumstances.

This is because the direct connection between powers and caused events makes powers very complicated anyway, the additional complexity, even disjunctions, would not be troubling. Regarding the second implicit premise, micro-powers are responsive to macro-circumstances on the theory of mutual manifestation because these power nets are going to be thrown pretty wide for every caused event.

Given that the arguments to CPE presented don't work in Martin's ontology, it's not surprising to find out that O'Connor and his co-authors are explicitly committed to a different theory, which we will now introduce.

8.5 Manifestations as Causal Contribution

One key difference between Martin's theory and the theory of powers set out in the work of, for example, Molnar and Mumford,[480] is the definition of the manifestation of a power. In the latter theories, the manifestation is the causal contribution of that power to different potential effects. In the former the manifestations of a power were the caused events themselves. Both the theory of mutual manifestation and the theory of causal contribution posit that any given power is disposed to multiple caused events, but whereas the theory of mutual

[478] Ibid, p. 47. For more on the potential problem of infinities in the universe, compare Heil 2013 ch. 3 and 4; and Schaffer 2010a.
[479] Ibid, p. 30
[480] Molnar 2003; and e.g. Mumford and Anjum 2011b

manifestation posits multiple (indeed, infinite) potential manifestations of a power, the theory of causal contribution posits only one manifestation per power.

According to this theory, a power is continuously manifesting and the manifestation of a power is the same in all circumstances. There is no longer the direct connection between the powers and the caused event. Causal contributions combine in the production of caused events rather than being connected by disposition lines in a power net. Crucially, the compositional principles at work in causation will determine how the presence of powers from observed behaviour can be traced.

8.6 Conclusions

Multi-tracking or mutual manifestations cast doubt on O'Connor and co-authors' objections regarding 'disjunct' properties. However, O'Connor is committed to a theory of powers where the manifestations of powers are unitary causal contributions.[481] However, this theory of powers does not imply that changes in the observed behaviour in a complex object are the result of changes in the properties had by that object. Properties are not strictly identified by the events they cause. This is because these events are not, according to this theory of powers, the manifestations to which powers are essentially directed.[482] The theory adopted by O'Connor requires a mediation between caused events and powers – there is not a direct connection between the two. This has the potential to undermine O'Connor's claim that a change in observed behaviour implies a change in properties.

O'Connor assumes a theory of properties. What we're pointing out here is not a problem for that theory, but it is a theoretical cost. The weakness is just that it depends on a theory of property identification with extra commitments beyond those of the underlying theory of powers. One might choose to defend those commitments, and in sections 7.6-10. we raised some preliminary problems that would have to be accommodated in such a theory. Or, we can say that, while a discontinuity in observed behaviour does not "demand" an explanation in terms of new properties, it should be taken as evidence of a change in properties present.

This second option does not require the commitments discussed in sections 7.6-10, all that is required is for it to be bad for powers to be overly complicated on a single-track theory of powers like unitary causal contribution, and that some discontinuities in observed behaviour do imply complications in the underlying powers, a possibility we left open at the end of chapter 7. However, in addition to the cases raised in that section, this complexity can come from somewhere else once the manifestation of a power is distinct from its causal effects.

[481] Explicitly in O'Connor and Churchill 2010, p. 4
[482] Compare the definition of causal powers in section 8.1.

This is complexity through the combination of powers. In an analogous fashion to the example of complexity through structure, it is possible for there to be a combination of powers beyond aggregation. We will examine this possibility in the next section.

Unitary causal contribution (that is, the single-track, mutual manifestation theory) suggests that simple powers (with a single manifestation) can contribute to various complicated effects. This is the theory assumed by O'Connor, but without his supplementary premises it is congruent with the examples given in chapter 1 (and sections 7.9-10) of systems that violate those premises. We shall also see that the theory of unitary causal contribution also enables a metaphysical form of combinatorial complexity through compositional pluralism – the ability of powers to compose non-linearly. Conclusion: from the perspective of the individuation of powers, there is no principled reason to prefer emergence over inherence.

9. Powers-Based Causation

Coming up with principled identity conditions in terms of observed behaviour is made even more difficult because many different powers are typically involved in the production of any macroscopic behaviour, and the same power can be involved in the production of many different behaviours depending on its combination with other powers. In other words, I'm taking this from Molnar here, who took it from somebody else: events are polygenic and powers are pleiotropic.[483] There's an analogy here with the genotype/phenotype distinction in biology, where the expression of any individual gene is dependent on the rest of the genome and any observed behaviour results from the whole genotype in combination with environmental and developmental factors.

This is to say that we cannot 'read off' the nature of powers from caused events. Power identification will depend on how powers combine in the production of caused events – how we move from genotype to phenotype. The identification of properties is going to depend on how this combination of powers works.

9.1 Getting from Powers to Causation

A theory of causation based on an ontology of powers proposes that caused events are produced by one or more powers manifesting. The solution to the epistemological problem in chapter 7 depends on how one individuates basic powers from the salient macro-behaviour. If we are to individuate powers based on caused events then we need to know specifics about how powers work. We have already discussed the debate about the nature of powers

[483] Molnar 2003

in relation to their manifestations and the effects to which they contribute: we concluded in the previous chapter that a single property may contribute to a wide array of effects but this does not imply that the property has, or confers, a wide array of powers.

Properties are individuated by the powers they have, but this relation is not isomorphic, there can be more than one power per property.[484] There is no separate entity that is a power. Each power is in turn individuated by its causal contribution, and this relation *is* isomorphic. In fact, the manifestation of a power just is its causal contribution. In the sense of manifestation, the power is always manifesting, always making that contribution.[485] In practice, we can only individuate powers when that causal contribution is in a context that produces an effect. The language around the term 'manifestation' can be a bit slippery, since 'manifestation' is often and ordinarily used to mean the salient effects of the operation of powers and not a power's essential and constant contribution toward those effects.

When a power's contribution is in a context in which it does not produce an effect, it is latent. When it is producing an effect, it is salient. What makes individuation difficult is that the same power can contribute to many different effects, depending on its context. The salient effects are but a clue to the nature of the powers behind them. Furthermore, for each of those effects, in each of those contexts, the causal influence of the power remains the same. Powers have a unitary causal influence, but this influence is pleiotropic – it contributes to a variety of effects that each involve various other partners. This is what we established in the last section and it also seems that O'Connor and Churchill have the same theory of powers in mind.[486]

The effects are a clue to, but not identical with, the contribution of the power. In order to identify the contribution in these circumstances – and thereby individuate the power – we need to know more about how the effects relate to powers. In the previous section we looked at arguments about the difficulty of individuating powers and what this might tell us about the nature of powers. And the pleiotropic nature of powers is compounded by complexity, which makes the epistemological difficulty for a theory of emergent powers, mentioned above, drastically worse.

9.2 Modelling Powers-Based Causation

"[T]he way in which we choose to represent some phenomenon can shape the way in which we think about that phenomenon"[487]. While we're investigating a theory of causation and its

[484] See e.g. Molnar 2003
[485] ibid
[486] O'Connor and Churchill 2010, p. 4
[487] Hitchcock 2006, 69

implications for property identification, our choice of model matters. Stephen Mumford and Rani Lill Anjum object to the reliance on neuron diagrams[488] to represent causation on the basis that they are not metaphysically neutral representations. These commitments are likely to be more acceptable to a Humean or Lewisian than to an upholder of powers.[489] Neuron diagrams misrepresent two key features of the powers view thus far explicated, which is impressive considering neuron diagrams only feature two basic elements, see figure 1 below.

A neuron diagram represents causation as a stimulatory connection that holds between events. Neurons can fire, corresponding to the occurrence of an event, and when they do so they send a stimulatory signal to the next neuron causing it to also fire, and so on.[490]

In general, however, this is not a good model for powers-based causation, and this is because it is not a good representation of the nature of powers. The model depicts events as discrete and independent of their causal connections. The events themselves are self-contained neurons, distinct from the causal connections that they bear. If they are read this way, the implication is that the individuation conditions for these events are independent of their stimulatory connections to other events. The result of the diagram apparently depicting the event and its stimulatory connection as separate (separable) entities is to suggest that they are two entities when in fact they are not. This is not conducive to a powers-based approach because events that involve powers are essentially directed towards certain manifestations: powers are individuated by their causal contribution, so the stimulatory connection here is at least partly constitutive of the event bearing them. In the diagram, event *a* would still be event *a* without the arrow. For a powers theorist, the arrow is either essential to what *a* is (its causal contribution), or follows from the nature of *a*.

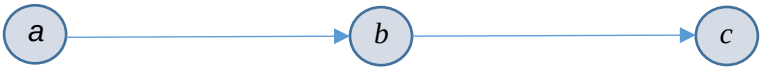

Figure 1: A neuron diagram

As well as suggesting that a power's causal contribution is contingent to the nature of that power, the neuron diagram also suggests that the stimulatory connection between events is a necessary connection. This too reduces its suitability as a way of thinking about how

[488] Popularised by, for instance, Lewis 1973
[489] Mumford and Anjum 2011a, p.55
[490] The similarities that exist here with the stimulus-manifestation view of powers are perhaps telling.

powers work.[491] The firing of *a* in figure 1 guarantees the firing of *b*, so *a* seems to be an entirely sufficient cause for *b*. This will be true if the power instantiated in *a* just so happens to be a sufficient cause of the power instantiated in *b* and this is a fine representation in those circumstances; but often this will not be the case. As was suggested in the previous section, the causal contribution a power makes is not alone sufficient for most effects to which it contributes.[492] Stimulatory connections in neuron diagrams are bad representations of this causal contribution because stimulatory connections are entirely sufficient stimuli for the proceeding manifestation. In the absence of inhibitors, stimulatory connections necessitate the effect rather than merely contributing to it.

We cannot read the nature of our powers off of a neuron diagram. Considered this way, not only would the neuron diagram suggest that a power's essence is not constituted at least partly by that to which it is directed, it would also suggests that the power's directedness is stronger than it is. Is this really a problem for neuron diagrams as models of causation? Well, it depends what you are interested in. We are interested in the relationship between the nature of powers and causation. As a model of powers-based causation these diagrams are unhelpful because they do not properly represent the nature of powers. At best it can show us is that there is a connection between certain powers and certain effects, but it offers no further illumination about how we might individuate powers based on effects.

9.3 Practical Problems

Aside from being a bad representation of the entities involved, neuron diagrams also have problems modelling the complexities of causation. There are certain everyday features of causal situations that are problematic. Firstly, neurons are a binary model of causation; a given cause or effect either occurs or it doesn't. But what of the possibility of an effect that has degrees (say, degrees Celsius)? Or the fact that many different things seemed to be directed towards the same effect, but to different degrees.[493] Maybe we can model this by being precise about the events that feature in the neuron diagram, but in general it seems a poor representation of causes and effects that *can* form a continuum to insist on discreteness.

The main problem with neuron diagrams is their inability to model complexity. The causes of effects can involve many different powers operating together. Since we are particularly

[491] See Schrenk 2010 for argument on this point.
[492] At least, this is a corollary of both Martin's theory of mutual manifestation and the theory of manifestations as causal contribution.
[493] Mumford and Anjum use the example of sunlight and a kettle being both disposed to heat water, but the kettle does so to a higher degree than the sunlight. (2011a p.57)

interested in the essences of powers in complex systems, it is best that we look to another model for insight.

9.4 Vector Addition

Vector diagrams represent one or more properties on a quality space, with each dimension representing one property. We then plot powers as vectors according to how they act on the quality spaces, the direction of the vector representing what a power is directed towards on that quality space, and the length of the vector representing the magnitude of the power – how much it contributes to the change in property.

Resultant powers are identified with the causal profile of a system with several component powers. These component powers come together and produce something that none of the component powers could produce alone. The question of how powers can be composed and the ontological status of the resultant powers is central to the theoretical attractiveness of emergence.

Vector diagrams represents one or more properties on a quality space, with each dimension representing one property.

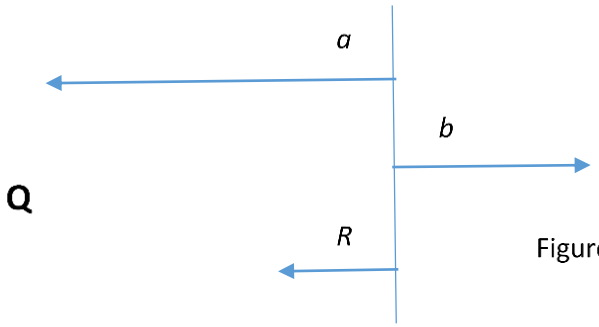

Figure 2: A vector diagram

The resultant power, *R*, is composed of the component powers of the system, *a* and *b.* There is no longer a direct connection between caused events and the component powers because the manifestation of those powers is the causal contribution they make to the resultant power *R*. Indeed, the caused event is now one more step removed, because not only are the component powers not essentially linked to that event by their manifestations, they also contribute only to the composition of a resultant power, itself only essentially directed to the contribution it makes and not necessarily to any particular caused event.

We can begin to see why, even if you knew which powers were implicated in any given event, one cannot simply read off the essences of those powers from the observed

behaviour. In this theory it is necessary to also consider how the causal contributions combine to produce the caused events.

9.5 Resultant Powers

Resultant powers are identified with the causal profile of a system with several component powers. These component powers come together and produce something that none of the component powers could produce alone. The question of how powers can be composed and the ontological status of the resultant powers is central to the theoretical attractiveness of emergence. If resultant powers are not distinct entities – if for instance they are identical to their component powers and the relations between them - then resultant powers are not emergent.

This is not necessarily a problem for the emergentist, who is likely to hold that there are resultant powers and emergent powers and that the relation between them and their components is in each case different (for instance, that the relation between component powers and resultant powers is a relation of composition and the relation between component powers and emergent powers is a relation of causation). My intention here is to show that the relation between component powers and resultant powers can be non-linear and pluralistic. And if component powers can produce resultant powers in non-linear, pluralistic ways, then emergence loses one of its main explanatory advantages. The non-linearity of the putatively emergent properties in relation to their components is frequently appealed to in order to motivate the identification of those putative properties as distinct entities.[494] Of course, if resultant powers themselves are distinct entities, then it is open to the emergentist to suggest that the resultant powers just are emergent entities, so the ontological status of resultant powers is an important part of the case too. We will examine the two issues in turn.

9.6 Nonlinearity

When discussing how powers might combine a good place to start is the notion of vector addition. O'Connor appeals to vector addition several times to flesh out the idea that a certain level of complexity is required for an emergent to be produced.[495] (Though O'Connor explicitly remains uncommitted to this model.)[496] We have already suggested one reason why vector addition might be a bad model for the systems that are generally thought to be emergent, like the brain and certain chaotic systems.[497] This is because the simple addition

[494] There are plenty of good examples in Wilson 2013
[495] O'Connor and Wong 2005, p. 670
[496] ibid
[497] See section 7.9.

of powers considered separately and independently of one another fails to capture the additional complexity created by the structure of a system. We'll raise this problem again in support of a compositional pluralism, but for the current purpose what is required is just to show that powers can be composed in non-linear ways. This result will be more secure if it does not rely on the additional thesis of compositional pluralism. If powers can combine non-linearly using only vector addition, then our case will be stronger.

I will now make that case using a famous example: simple molecular symmetry breaking of the sort invoked by P.W. Anderson in support of emergence.[498] He used the example of the ammonia molecule, which has the power to undergo rapid nitrogen inversion at room temperature because the nitrogen atom exhibits quantum tunnelling between the two low energy states of the system. The power to invert is not a power had by the nitrogen atom or any other components, nor is it the result of any of their powers being somehow "added" together in a straightforward way. If we make a list of the powers of the nitrogen atom and three hydrogen atoms that compose an ammonia molecule, and we were to list only those powers that each atom has in isolation, we might include the power to form molecular bonds and the power to exhibit quantum tunnelling behaviour; however, it is not at all clear that these powers, considered in isolation, could add up to or feature as vectors in a quality space for rapid nitrogen inversion. Indeed, it barely makes sense to talk about vector addition in a quality space for rapid nitrogen inversion where those vectors are not powers of the molecule as a whole, rather than its component atoms, because rapid nitrogen inversion is a power that can only be had by the molecule. In so far as the component powers produce a vector in that space, they do so obliquely; while the power of each atom to make molecular bonds obviously contributes to the ammonia's power to invert, this contribution is necessary but not sufficient.

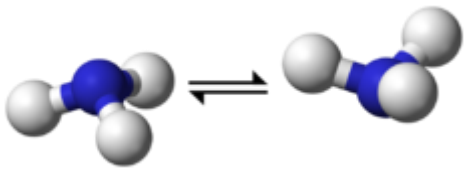

Figure 3: Nitrogen inversion in an Ammonia molecule

The difference between the powers of the component atoms and the power of the ammonia molecule to invert is the manner in which they are composed – the structure of the system. This is a necessary component in the nitrogen-inversion quality space. The atoms are

[498] Anderson 1972

composed in a bonded structure in a pyramidal shape that produces two potential low-energy states for the system. Without that structure there wouldn't be the two low-energy states, the system wouldn't have a dipole moment and the symmetry of the system wouldn't be broken - and the nitrogen atom would not rapidly tunnel from one position to the other. Perhaps then we should include the energy barrier as a power vector in our quality space?

To recap, when adding vectors in the nitrogen-inversion quality space, the powers of the atoms to form bonds is necessary, so should be included as a vector; however, bond-forming powers alone are insufficient for nitrogen inversion: the energy barrier is also necessary. What is odd about the situation is that, of course, the power to form molecular bonds is what produces the energy barrier in the first place. It is through that structure and only through that structure that the basic component powers of the atoms compose the resultant nitrogen inversion power. In a neuron diagram this causal chain is easily modelled: one power produces another power which produces a third. Modelling the same using vectors addition is more difficult.

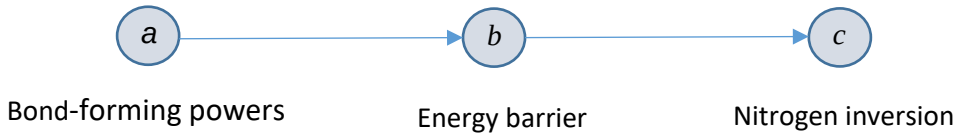

Figure 4: Neuron diagram of nitrogen inversion

Here is how it might be done. We would include among the range of powers of the components the power to form bonds up to the threshold set by their outer electron shells. If we wanted to finesse the resultant vectors we could also include among the powers involved the power for lone electron pairs to repel more strongly than electron bond pairs. If we were to add these together as two oppositely-directed vectors of differing magnitude, then the resultant vector would determine the bond angle between the central nitrogen atom and each of the hydrogen atoms. Here vector addition has produced the angle of the pyramid structure. The magnitude of the resultant vector would also determine the energy barrier.

Incorporating such magnitudes is vexing in a neuron diagram, so this demonstrates an advantage of the vector model. Only one more power has to be included to produce the inversion effect: the tendency of atoms to exhibit quantum tunnelling. This tending becomes less likely the higher the energy barrier, so the inversion rate of the ammonia molecule can still be modelled as vector addition. The power of the nitrogen atom to exhibit quantum tunnelling is one vector, the energy barrier of the ammonia molecule – a resultant vector of

the power of different electron bonds to repulse – is another, opposed, vector. When these two vectors are added together the resultant vector is the power of the ammonia molecule to invert, which produces, in combination with other vectors like temperature, the manifestation rate of nitrogen inversion.

What the above example shows, apart from the fact that P.W. Anderson-type cases can be regarded as resultant powers, is that simple vector addition can successfully model the production of some putatively "different" powers of composed systems; "different", that is, than the powers of the components. The success of vector addition is perhaps surprising because of two features of the account given above. These are possible drawbacks of the vector model over neuron diagrams. Firstly, vector diagrams model only one quality space at one moment, so in order to get from the more basic powers to nitrogen inversion we had to add vectors in multiple quality spaces. Secondly, resultant vectors in one quality space become component vectors in another. The account goes like this:

Electron pair bonds, *a*, have a smaller power to repel than lone electron pairs, *b*.

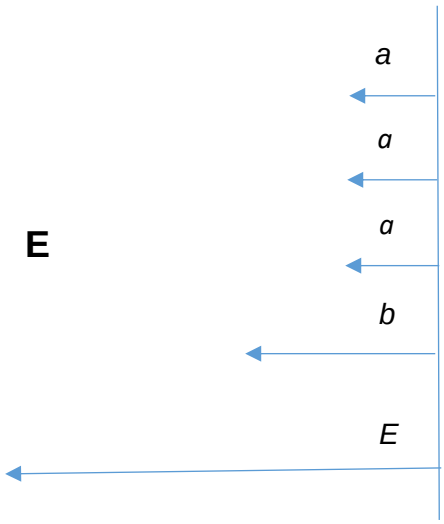

Figure 5: Repulsion powers composing an energy barrier

In the energy-barrier quality space, **E**, the electron-bond repulsion power vectors (*a*, *b*) together produce the resultant vector of the energy barrier of the molecule to the nitrogen's position, *E*.

Nitrogen atoms have the power to exhibit quantum tunnelling.

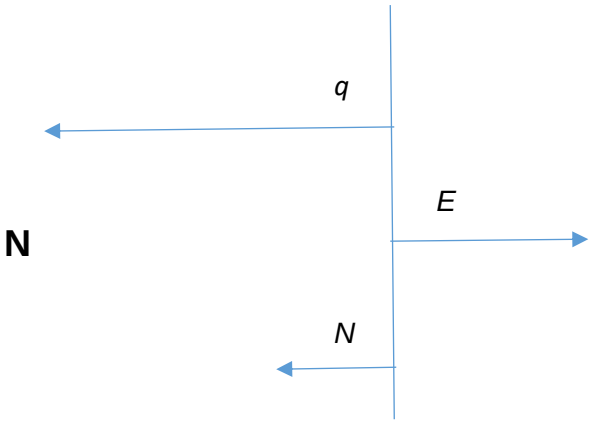

Figure 6: The energy barrier as a power vector in a different quality space

In the nitrogen-inversion quality space, **N**, the power of the molecules' energy barrier to the nitrogen's position, *E*, and the nitrogen's power to exhibit quantum tunnelling, *q*, together produce the resultant vector of the nitrogen-inversion quality space.

While the presentation is verbose, this model seems like a natural way of characterising the way that component powers have come together to produce the power of the ammonia molecule to invert. Notice how the resultant vector in one quality space is a component vector in a different quality space. The basic powers of the atoms compose powers of the system in which they are components – molecular powers - and those powers of the system are the ones it makes most sense to use in quality spaces concerning that system.

Here there are only two stages, but imagine a more complex system where powers are combined to produce resultants in many stages of quality space. Basic powers would combine to produce resultants that combine with other resultants which combine with other resultants to compose powers in a myriad of different quality spaces in differently composed, overlapping systems. If one were then simply to look at the final quality space, featuring resultant powers many times removed from the basic ones of which they are composed, it would not appear that the final powers were the results of simple addition of the basic ones.

In complex systems, the multiple stages through which vector additions must be run will often produce non-linear functions when the most basic component powers and the most complicated resultant powers are compared. If the only explanatory role of emergence was to account for these non-linear functions, then it would not be necessary. The existence of many levels of quality space means that non-linearity is to be expected in complex systems, even when powers are only ever composed linearly in any single quality space.

9.7 How Vector Addition Can Generate Nonlinearities: Part 2

Let's look at the example of diminishing marginal utility. I've included this as an example because you can account for it on a simple set of successive vector diagrams using only additive composition, and while not as iconic or perhaps as radical as the example of symmetry breaking, it is still a classic of systemic nonlinearity. Using the first vector diagram from above:

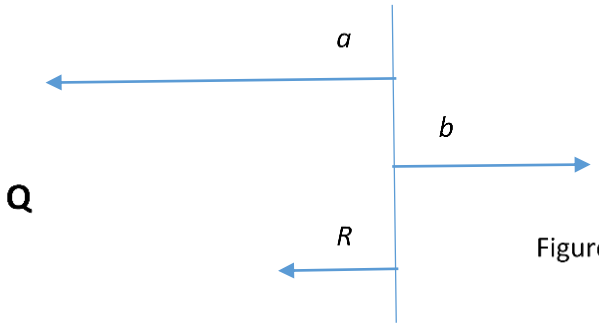

Figure 2: A vector diagram

Let's make the component vector *a* represent the sum of the intrinsic power of some good to create utility – like the intrinsic deliciousness of an ice-cream. The quality space **Q** is utility and the resultant vector *R* is the resultant power of the good to produce utility. The countervailing vector, *b*, would be some composite of the physiology of the person consuming the good. In each successive vector composition the good would contribute the same vector, because the good is the same. But the countervailing vector would increase in magnitude with each successive vector diagram as the person became more satiated. This would continue until we are so sick of ice-cream that each additional ice-cream actually has negative utility, see below. Again, the nonlinearity is only apparent because we are producing resultant powers in multiple quality spaces. Here it is successive iterations of the same quality space and the same two inputs. Only the inputs are not the same. The changing magnitude of the component power *b* is itself a resultant power produced on a quality space of the various physiological components that compose a person's satedness when it comes to, say, ice-cream. The result of this composition changes over time as more ice-cream is consumed because the property with the power pf component vector *a* does not only compose a resultant power *R* in a utility quality space **Q**, but also has a power that contributes to a resultant power in the quality space that itself partially composes the physiological resultant power *b*. The composition of powers takes place over multiple quality spaces just because the power to produce utility is not the same as the power to produce satedness. It is only when we look at a single quality space over time, and assume that all of the component powers are unchanging, that there appears to be a surprising nonlinearity.

This is an example of a dynamic composition; it is also an example of negative feedback. The effect of consumption – utility – is diminished in the future because what is consumed has the power both to produce utility and to produce satedness, which inhibits the good's power to produce utility. The good has the power to produce utility, *R*, and also the power to inhibit the composition of *R* in the future. But is this because the good has two powers that are at work here, one in each quality space, or a single power at work in both?

9.8 How Vector Addition Can Generate Nonlinearities: Part 3

Linear vector addition across multiple quality spaces is going to work for some apparently nonlinear observations, but it is not clear that all cases of nonlinear behaviour can be modelled this way. The use of equilibria, threshold effects and successive vector diagrams can model nonlinear causal contributions using only one dimensional quality spaces and additive composition in each of the following cases, for example.[499] These are all cases in which the nonlinearity is shown to be only apparent: the output only seems to be more than the input because of the choice of quality spaces.

- Overdose cases – diminishing contributions, going out of equilibrium, e.g. too much ice-cream or watering a plant too much.

- Escalatory cases – output seems to be more than input – tipping points are successive, or thresholds exist. This can account for some chaotic effects like the flapping of a butterfly's wings – cases where the contribution surpasses a tipping point or reaches a threshold.

- Antipathetic cases – composition reverses contribution. Here we might model an allergy as a strong component vector within a very specific quality space concerning the antipathetic power, and composing a resultant that can override the contribution of the power to which there is an allergy in all of the normal quality spaces to which it contributes.[500]

In each of these cases, the contention is that models representing the full richness of the situation are available and they explain resultant powers through addition alone. The use of a threshold is somewhat different – it introduces a discontinuity into the quality space itself. There is no switching between powers operating in different quality spaces, so this is an

[499] These examples are from Mumford and Anjum 2011b pp.89-96
[500] This contradicts Mumford and Anjum in e.g. 2011a p.75-6, where antipathetic cases are introduced as an example of nonlinear composition that cannot be accounted for on the linear vector model.

entirely different example of how additive composition can produce nonlinearity without the component vectors being complicated.

9.9 Multi-Dimensional Powers and Quality Spaces

When objects that have otherwise simple characteristics come together in systems of some complexity, the resultant behaviour often does not follow in any straightforward manner from the characteristics of the components. Sometimes linear transformations can succeed in modelling these difficult cases with the right choice of quality space, but it is doubtful that such a solution will always be available. There are nonlinearities everywhere in complex systems, including some examples with which we are already familiar: phase transitions, turbulence, chaotic systems in general, strange attractors, Renormalization, degrees of freedom.

Here the vector model of causation can still be instructive: "even if there were irreducibly complex causal processes, which cannot be reduced to conjunctions of causes within one quality dimension, they could still be accommodated within a vector model."[501] Mumford and Anjum argue that considering multi-dimensional powers acting in multiple quality spaces simultaneously can lead to more non-additive composition: "We may have two powers relating to different quality spaces but such that, when they act together, they interact in a nonlinear way that does not decompose into the individual actions of those powers had they acted alone."[502]

How to interpret this statement? The addition of vectors is still the only function at work in composition here. But once we are used to thinking about vectors operating in multiple quality spaces at once, and the quality space being whatever it is that we are interested in, we do have a way to explain situations where there is apparently nonlinear composition.

The first is to point out that the selection of quality spaces matter. It is an abstraction. We might identify a power with its contribution in one quality space, but not recognise that this power makes contributions in other quality spaces. Then when two or more powers compose on the quality space of our choice it would be surprising to see other effects on other quality spaces despite nothing but those two powers being involved.

If we combine this observation with the others from above we can also get to a situation where two multi-dimensional powers combine in a radically nonlinear way too. Think about the negative feedback in the overdose case. Let's assume that the ice-cream has a power

[501] Mumford and Anjum 2011b p.44
[502] Mumford and Anjum 2011a pp.77-8

that is individuated by contributions on two quality spaces – it is a multi-dimensional power. The two quality spaces were utility and satedness. Now, in that example there were successive quality spaces for each iteration of the consumption of ice-cream, separated into different time slices. But these interactions need not be diachronic.[503] And if they are synchronic, it could be possible for multi-dimensional powers to interact in a way that simultaneously composes a resultant power on a second quality space that itself affects the composition on the first quality space. From the point of view of the first quality space, if that was all that we were interested in, there would not only be the potential for surprise caused by the unexpected contributions of those powers on a different quality space, there would also be the potential for two multi-dimensional powers to compose in a nonlinear way on one quality space, through their interactions on another quality space. If compositions are simultaneous, and resultant powers can be multi-dimensional (as they must be in the case of satedness and utility, since utility is a partially a function of satedness), then even restricting the composition of powers to linear additive functions implies the possibility that, on any given quality space, two powers could compose in any number of ways that would be unpredictable based on their vectors in that space alone.

9.10 Compositional Pluralism

We started with a simple model of causation as vector addition in a quality space. We've outlined several different ways in which this simple model can generate complexity. We can go further. So far we have merely stipulated that the vectors representing the manifestation of powers are 'added' together to compose resultant powers. This stipulation reflects the choice of model. Vectors are defined as magnitude and direction, so when two vectors are put together in a one dimensional space, the only directions available are represented by a positive or negative magnitude, and the combination is a simple sum.

Even in multiple dimensions, it is possible to abstract away all but the dimension that interests us by considering only the magnitudes of each vector in that dimension. Without the dynamic influence of multiple quality spaces – which can create apparent nonlinearity in various ways as described above – the composition is still straight forwardly additive.

There are, however, potential cases of causal nonlinearity that are simpler and/or do not seem to involve a complex situation with powers acting in multiple quality spaces. One basic example might be the production of gravitational force. Here the influence of distance reduces the magnitude of gravitational attraction in a non-linear way: it is an inverse square function that is applied to the mass of the objects undergoing gravitational pull, not mere

[503] Mumford and Anjum themselves talk about simultaneity in causation in 2011b.

addition.[504] And by nonlinearity I mean something quite general, not just the use of a nonlinear function. Let's just say that nonlinearity is the failure of the single-quality-space vector model. These are examples where the same power composes in different ways. The contribution of each power is changed as part of composition; and not just apparently or effectively through their influence on other quality spaces. That can't happen with simple aggregation.[505]

This is potentially a problem for the vector model of causation as presented above. If just some of these cases cannot be explained by vector addition, then the principle of additive composition fails to adequately model how individual powers come together in causation. Empirical evidence suggests that there are a variety of ways in which powers compose.

This may be true, but we are not committed to aggregation as the only kind of composition at work in causation, only that vector addition is a useful model to shape our thinking. It might be that relying on this model causes our thinking to be led astray. The necessary modification to the vector diagram model would be to allow for other principles of composition apart from the simple, linear, additive one. These principles do not have to reflect the methodology of the model, and so leave us unconstrained when considering how causation works in real life. The model is instructive in that it demonstrates a way that relatively simple powers can produce behaviour that is radically different to the components, with little supporting theoretical apparatus. Once these lessons are learned, the additive principle can be taken for what it is – a metaphor for how powers come together – and the model of vector addition discarded. Does this suggest a failure of reduction? Here is Mumford and Anjum:

> "It would be nice and easy if all composition were additive, for then we could just use vector addition to predict an outcome. But we know we cannot. Powers can still nevertheless be a basis for prediction, if they and their interactions are understood. To understand certain nonlinear causal interactions, therefore, it is not enough that we know and understand the individual powers that are involved. That would be too simplistic and suggest a reductionist view of the physical world."[506]

[504] This and another example is given in Mumford and Anjum 2011b pp. 96-7 in support of compositional pluralism; the other example there, sensitivity to initial conditions in some chaotic systems, is less obviously a problem for the vector model insofar as they could be dealt with using thresholds.
[505] Mumford and Anjum 2011b refer to this feature of their theory of causation as emergence. I disagree.
[506] Mumford and Anjum 2011a p78

There may be many different kinds of function that can describe the composition of powers – addition is just one kind of composition. Mass and distance produce a gravitational force in a non-linear way: not by mere addition but by the inverse-square relationship described by the law of gravitational attraction. There are many examples in chaos theory of the output of a system not being proportional to its input. There may be many such functions that compose powers, not just mathematically simple functions, but perhaps functions that are far more complex.

Furthermore, it's not only that there is a problem with nonlinear causation that would be solved by an expansion to other sorts of general functions. The general form of the problem for us is where the caused event does not seem to follow in a straightforward manner from everything we know about the powers contributing to the causing of that event in the other circumstances in which we find them. This is obviously relevant to emergence in general. Mumford and Anjum again:

> "Composition is, then, a coming together of powers to do work jointly. The effect that is produced, *H* in our case, is not just the conjunction of *F* and *G*. Indeed, there might be nothing that is recognizably *F* or *G* once they have jointly produced their effect. Causation often involves change or transformation so there is no reason why the cause should survive in the effect."[507]

They then argue that the nonlinear composition of causes introduces a kind of emergentism. The resultant power is not just a derivative of the components, but something new, something 'over and above' the powers composing it.

Contrary to what Mumford and Anjum claim I argue that this is not ontological emergence as we first defined, it is not an addition of being. The resultant powers that are composed according to these functions are not entities in their own right – the properties that bestow the powers are the basic entities. The resultant power is still derived from these fundamentals. The novelty of the position of non-reductive inherence is that it takes compositional pluralism seriously and puts it at the core of powers-based causation, rather than treating it as an afterthought.

9.11 The Ontological Status of Resultant Powers

Resultant powers are identified with the causal profile of a system with several component powers. These component powers come together and produce something that none of the component powers could produce alone. This is true regardless of whether the composition

[507] Mumford and Anjum 2011b p100

is linear or nonlinear. When two powers work together in ordinary causation, they are often producing an effect for which neither was individually sufficient; likewise when they compose a resultant power. Let's now answer the question: are resultant powers real?[508] And is the answer to that question different when a resultant power is composed nonlinearly?

One problem with assuming that resultant powers are real and do causal work is that they then seem to compete with the component powers, if they are indeed supposed to be doing the same work. This is the problem of causal overdetermination – if both the resultant and component powers are supposed to have caused the same effect, then the effect is overdetermined.[509]

Why would it make a difference that the resultant is composed nonlinearly? The important part is that they are composed, and we have already accepted that they are composed according to a plurality of principles, including some complex principles. The claim by Mumford and Anjum that nonlinear composition of resultants is a kind of emergence is incorrect. In saying that it is more than the mere aggregation of the component powers we are saying only that it is a different kind of composition and not merely an additive one. Since they accept that the composition of resultant powers implies that they do not have a distinct existence – I would say that the resultant power does not, in fact, exist – then, by our definition of emergence at least, resultant powers are not emergent entities.

All power compositions result in a transformation of the component powers. If the idea is that some transformations result in distinct entities and others do not, then why privilege nonlinear resultant properties? In order to argue that nonlinear composition implies emergence, it seems that one would have to implicitly assume that only aggregation - or composition by an additive principle – is really 'composition' in the sense of being a transformation into a non-distinct entity. I think this implicit assumption is revealed in Mumford and Anjum's argument for emergence. If one takes the commitment to compositional pluralism seriously, then one has to accept that sometimes composition transforms the contributions of the component powers without producing a new entity.

9.12 Conclusion

Mumford and Anjum's emergence is not really emergence. The appearance of non-linearity when comparing basic powers with resultants is not an indication of emergence. Even if we insisted that basic powers must be individuated to minimise their complexity and rule out discontinuities and nonlinearities, our theory of causation involves an additional step by

[508] Molnar 2003 argues that they are not; Compare Mumford and Anjum 2011b, pp. 42-4, 98
[509] See Wilson 2009 for more argument along these lines.

which those powers ae transformed. It is this step that implies that the individuation conditions for resultant powers are not the same as the individuation conditions for basic powers. Nonlinearity in the behaviour of resultant powers in relation to their components is therefore insufficient to reify those new powers. The lesson for the emergentist is that you don't just consider the basic powers acting alone when you are comparing with a putative macro-power, you also have to consider how the basic powers compose.

Also, there is a problem familiar from ordinary cases of composition: composition is not identity. The statue and the clay that makes it are not identical, in the sense that one could persist while the other ceases to exist. This is true even though the statue and the clay are not distinct existences. For any causation that the statue and clay enter into, the caused event is produced by both. But such an event is also not overdetermined because the two properties are not distinct entities. Composition is not identity, in the sense that the statue and the clay have different modal properties. And neither is the relation between the two a part-whole relation. If it were then that would be amenable to the argument that only the additive principle ensures the resultant power and the component powers have non-distinct existences.

A part-whole relation fails to capture the different ways in which a resultant power changes – or doesn't - when its component powers are changed. Sometimes a resultant is changed when a component is removed, or when a component is swapped out. Sometimes different component powers are fungible in a given composition. Any given set of components only ever compose one resultant, but for any single resultant, the set of components that could compose it is potentially infinite. As we noted above, the individuation conditions of resultant and component powers are often such that they cannot be related as a whole is to its parts. The resultant power is not made of 'parts'.[510]

There is also a deeper problem, because there is more than one kind of compositional principle: aggregation/addition of the basic powers is not the only one. Yet often the only epistemic access we have to either the true natures of the component powers, or the composition principles by which they produce causation, is through our experience of the behaviour of the resultant powers. We will examine some of the epistemic issues with powers theories of causation - and this view of powers in particular - in the next section.

Before that, let's deal with some potential objections to the claim that nonlinearities are everywhere in causation. First off, it might be pointed out that the only nonlinearity we see in

[510] See Wilson 2009, Cartwright 1983; Mumford and Anjum also agree, see 2011b p.42-3.

some of these examples is because of our choices of quality space. Is it possible that all nonlinearities in causation are caused by the imposition of a quality space – by choosing what we are interested in we create an infinity of different quality spaces. If we restricted the selection of quality spaces to only those that feature in the essences of the basic powers, we could build a model where nonlinearity was impossible except through emergence.

We'll say a little bit more about the relationship between the individuation conditions for powers and the quality spaces they enter into in the next section. Here it is just worth noting that, even if we constructed a model of causation where basic powers were simple and composed in merely additive or linear ways, there would still be examples like the law of gravitational attraction that seem to require nonlinear principles of composition, and examples of fairly simple systems that exhibit behaviour - like, for instance, symmetry breaking and molecular behaviour – that is very different to anything seen among the basic powers and would seem to justify a new quality space. The objector is left with two unpalatable options, either emergence is everywhere, when even just two basic powers come together, or basic powers would have to be complicated and disjunct for their essences to enable linear transformations of even well understood compositions.[511]

Another objection that might be made on behalf of the emergentist is that the transformative relation that exists between component powers and resultant powers is not composition, it is causation. It is with the causal relation that one expects there to be radical differences between the relata, and for it to be possible for there to be nothing of the cause that survives in the effect. Compositions, in contrast, derive their features entirely from its components and their arrangements. These nonlinear results are either occurring in an evolving dynamic process of linear compositions, or they are produced by a causal relation. Since the emergent relation is a causal one, this picture is the same as the proposed theory of powers based emergence.

Again, the problem with this objection is that, if we restrict the composition of powers to some putative macro-powers but not others, we need principled reasons why the composition of powers is so limited. And if the composition of powers is restricted to linear principles, while the nonlinear resultant powers are reified by the relation of emergent production, then we run into the same dilemma: either emergence is ubiquitous or basic powers are complicated and disjunct. The second option in this case being particularly

[511] These options are unpalatable because they are both uneconomical compared with a theory of causation that allows nonlinear transformations in potentially infinite quality spaces. This claim is defended in the final chapter and conclusion of this thesis.

unattractive because avoiding complicated powers was one of the advantages proffered in support of a theory of emergence.

In order to avoid this dilemma, an emergentist might accept that sometimes powers are composed according to established alternative principles and not merely the additive principle. These alternatives might include the inverse square law, or the regularities found in chaotic systems; wherever there is enough empirical evidence to support these principles. But we do not need to accept any other compositional principles. These alternatives are limited in their application, so power composition would remain modestly simple and emergence won't be ubiquitous. This seems to be a good way forward for the emergentist: to come up with principled empirical reasons why the range of composition functions is limited. Unfortunately for this empirical project, there is another version of the epistemological problem one encounters when individuating powers, as we shall see in the next chapter.

10. The Composition Principle Difficulty

The conclusion of this chapter is that a more sophisticated theory of powers-based causation gives rise to a different formulation of the epistemological problem for emergence, in the face of which previous arguments are inadequate. We will incorporate the findings of the previous chapters and end by identifying some of the most promising positions in the debate. The aim is to set out and defend a new position, one with which emergence has not properly been compared.

10.1 Responding to Metaphysical Arguments for Emergence

We start from the observation that resultant powers can be radically different to the powers that compose them. The previous chapters have detailed a variety of ways that this can happen. The problem for emergentists becomes most acute if compositional pluralism is admitted without limits. In that case, it seems that composition and emergence would look precisely the same in terms of macro-behaviour. Emergence therefore faces a new version of the epistemological problem: for any observed novel behaviour of a system, unless we can give a principled reason to limit the set of compositional principles, then the behaviour could just be the same set of entities composing new powers.

Let's look back at the premises employed by the defenders of CPE earlier:

1. "Properties are posited… to explain differences among various general patterns of events"[512]. Precisely specifiable causal features are the mark of a new power.[513]
2. When the causal behaviour of a system meets the same individuation conditions as the behaviour of a simple, it is appropriate to posit a new power.[514]
3. The behaviour of a non-emergent complex system cannot be somehow additional to the powers of its components.[515]
4. Accounting for discontinuous system behaviour of a complex system using micro-powers would require complicated disjunct micro-powers.[516]
5. Accounting for a complex system that shows responsiveness to macro-circumstances using basic powers would require basic powers that are responsive to macro-circumstances.[517]

The problem for these premises is that they are making incorrect assumptions about how the composition of powers works. Indeed, there is an implicit assumption of an additive principle of composition.[518]

The nonlinear possibilities for the composition of powers furnish us with replies to a couple of the metaphysical premises set out above in favour of emergence. In response to premise 4, it seems that the apparent nonlinearity produced by equilibria, successive dynamical complexity and threshold effects would be a way of accounting for discontinuous macro-behaviour using basic powers that were simple and linear. So according to our theory of causation, this premise is false.

Premise 5 also doesn't make much sense with composed powers in general, linear or not. If a group of basic properties constitute a complex object and those basic properties compose a resultant power then that object is going to be responsive to macro-circumstances and engage in macro-causal interactions. There doesn't seem to be any benefit in positing an emergent property when it comes to the question of responsiveness.

In response to premise 3 compositional pluralism implies that, when powers come together, they can be "somehow additional" to when they are apart. The very contribution of the

[512] O'Connor 2000a p.113
[513] O'Connor 1994, 2000a; O'Connor and Wong 2005, p.682
[514] O'Connor and Wong 2005, p.682
[515] O'Connor 2000a p113
[516] E.g O'Connor 1994, pp. 17-8; O'Connor and Wong 2005, p.682-3
[517] O'Connor 1994, p. 18; O'Connor and Wong 2005, p.683
[518] There are other implicit assumptions about the individuation of powers too. We have assumed a theory of powers as unitary causal contributions, which is the same theory of powers assumed by the emergentists making these claims.

powers is altered by composition. It is the compositional principle that gives us something more than the manifestation.

Premise 1 is going to depend a lot on how you unpack the idea of 'precisely specifiable'. But since premise 2 is false - as illustrated by the falsity of the other three premises - we cannot use the individuation conditions of micro-properties to unpack the meaning of premise 1. There are differences between the individuation conditions of micro-properties and putative macro-properties. Since resultant powers have the extra step of the composition principle, their causal behaviour does not relate to their individuation conditions in the same way as uncomposed basic powers.

At least four of these premises then no longer function in a sound argument for emergence. They are false for our theory of causation. The real epistemological problem for CPE isn't that for any observed novel behaviour of a system we will always have the option of complicating the constituent properties in a disjunctive way instead of postulating a new emergent property, like with Martin's infinitely multi-track theory of properties,[519] the problem is that, for any observed novel behaviour of a system, unless we can give a principled reason to limit the set of compositional principles, then the behaviour could just be the same entities we already know about working in new and unexpected ways.

That's the form of the epistemological problem that engages with the theory of properties within which CPE is developed. The abstract metaphysical arguments presented by O'Connor and his co-authors don't work within that theory of properties.

10.2 What are Composition Principles?

In response to both premise 3 and 4, it at first seems that multi-dimensional powers and compositional pluralism show that, when powers come together, they can be "somehow additional" to when they are apart. Importantly, this 'something more' isn't just the coming together of powers to produce an effect that they each couldn't produce individually – that's true in the most straightforward cases of linear causation – rather, it is instead the coming together of powers to compose new powers over and above the composing powers. This would also usually imply that behaviour was discontinuous as complexity increased.

I say 'at first it seems' because the extent to which these observations challenge the premises depends on what these nonlinear compositional functions actually are. How are they physically realized? If there are a plurality of compositional rules that add something

[519] Because, to be clear, my position assumes that powers make a single-track contribution that are internally governed by composition principles.

extra when powers come together, then these compositional principles look something like natural laws: traditionally it was natural laws that were thought to govern what occurred when one property interacted with another. But if it is a natural law that determines these nonlinear outcomes, we are left with the question: what are those laws and how do they do the work that they do?

The metaphysics of powers provides alternatives to this nomological account. What look like natural laws are just descriptions of how powers behave and interact and there is no need for the additional entities in our ontology. So the power to compose nonlinearly is part of the nature of the powers involved.[520]

A defence of these premises then occurs to us: for, if we recognise a discontinuity in behaviour, or powers that seem beyond the powers of the components involved, we should, if we are not availing ourselves of emergent explanations, say that nonlinear composition is a power and the power to compose nonlinearly rests with the basic components. This imputation to the component powers certainly seems to support premise 3. But for it to also support premise 4 would require that complicating the essences of our basic powers was the only way to incorporate nonlinear compositional principles.

Our discussion of the individuation of powers in chapter 8 alighted on the fact that, when the manifestations of powers are causal contributions and not caused events, powers are not individuated by their effects nor the set of their possible effects. One supposed advantage of this theory of powers over the radically multi-track theory is that we postulate simple essences for our basic powers, and it is desirable that their essences be simple. This is also an implicit premise in the argument from premise 4 to the conclusion that emergence is preferable to the alternative. Whatever the range of possible effects that can be produced by a power, it is up to the theory of causation to explain how that power works to produce effects.

It is difficult to see the motivation for insisting that simple powers should not be complicated just because they can lead to a range of possible effects, but they should be complicated when they can lead to them by a nonlinear function. This overlooks the complexity that is already implied by in the composition of powers. It is as if we are taking the vector diagram too seriously, and assuming that the additive principle is the only compositional principle allowed for translating the essence of a power into an effect, without that effect having to be incorporated into the essence of the power.

[520] For more argument on the explanatory usefulness of appeals to laws, see Mumford 2004.

To illustrate what I mean by this, assume that we do not allow any compositional principle that is not already essential to the powers involved. Then, assume that there are two one-dimensional powers, *F* and *G*, that compose one-dimensional power *H* in a linear fashion. It would not be enough to say that the essence of *F* and *G* is a directedness towards that to which *H* is directed, with a magnitude that is jointly equal to the magnitude of *H*. We cannot avail ourselves of the compositional principle of addition, so we must say that it is in the essence of *F* that it compose *H* in combination with *G*, or something to that effect. If we have to insist that compositional principles are essential to powers, then it would seem that powers just are very complicated and disjunct by nature, and it is of no great advantage to an advocate of emergence that a theory of emergence avoids adding disjuncts in a few of the cases. Alternatively, if we allow that compositional principles are in the nature of powers because that is how powers work – how they relate, interact, and combine - without being imputed to the basic directedness of powers by which one might individuate them,[521] then it is to be expected that the behaviour of a complex system is 'somehow additional' to the essences of the basic powers involved. All composition and causation is as well.

Premise 3 is difficult. In one sense it seems that compositional effects are additional – they do not individuate powers. But in another, compositional effects can only follow from the powers at work and their natures. It seems that powers are essentially simple, but it is also in their nature to combine in ways that result in something new. The reference to 'somehow additional' in premise 3 is ambiguous as to what part of this picture it is denying. I want to say that the compositional principles are essential but non-individuating, e.g. it is of the essence of Socrates that he is a man, but being a man doesn't individuate him (because other people are also men).

This dilemma could of course be avoided if we could find principled reasons why additive composition was the only compositional principle that came for free. Relying too much on the vector model is not a principled reason. I don't see any a priori reason why linear functions should be the only way that powers compose, and there is plenty of empirical evidence that nonlinear outcomes are ubiquitous in causation.

It is acceptable on this metaphysical view for the resultant powers to bear little or no resemblance to the component powers of its parts. Returning to the quote from Mumford and Anjum:

[521] In contrast to Martin's view.

> Composition is, then, a coming together of powers to do work jointly. The effect that is produced, *H* in our case, is not just the conjunction of *F* and *G*. Indeed, there might be nothing that is recognizably *F* or *G* once they have jointly produced their effect. Causation often involves change or transformation so there is no reason why the cause should survive in the effect.[522]

Powers in combination act very differently to powers in isolation. More generally, one should not expect to always be able to predict the causal profile of a power in one set of circumstances based on the causal profile of that same power in other circumstances. In similar fashion to the epistemological situation with emergent causal powers, the only sure way to find out about the powers of a complex object is to observe how powers interact with each other. Experiments conducted on systems below the requisite level of complexity will fail to tell us about how a power works in combination with other powers. Here is Mumford and Anjum again:

> It would be nice and easy if all composition were additive, for then we could just use vector addition to predict an outcome. But we know we cannot. Powers can still nevertheless be a basis for prediction, if they and their interactions are understood. To understand certain nonlinear causal interactions, therefore, it is not enough that we know and understand the individual powers that are involved. That would be too simplistic and suggest a reductionist view of the physical world.[523]

The composition principles are to be found in the individual component powers. This leaves two options: either the composition principles are essential to that power, which complicates the essences of power – though in any case it seems that they would at least have to be complicated by the additive principle, which itself is a composition principle – or composition principles do not feature in the individuation conditions for a power. Either way, it is not the case that any potential resultant power or effect must figure in the individuation conditions of component powers. This is because the power is individuated merely by its single-track manifestation, which can contribute to a diverse range of effects.

10.3 The Ontological Status of Component Powers

The individual powers make the causal truths. But it is only resultant powers and their effects that we can observe. This epistemic situation might make some doubtful of the theory of causation being presented here. Cartwright presents the following argument:

[522] Mumford and Anjum 2011b p100
[523] Mumford and Anjum 2011a p78

> The vector addition story is, I admit, a nice one. But it is just a metaphor. *We* add forces (or the numbers that represent forces) when we do calculations. Nature does not 'add' forces. For the 'component' forces are not there, in any but a metaphorical sense, to be added; and the laws that say they are there must also be given a metaphorical reading.[524]

With one-dimensional, linear vector addition, the magnitude and direction of the resultant vector represents a direction that would also have been achieved if all of the component vectors had achieved their full effect, one after another. Cartwright argues that, even though the destination in this case is the same, whether the resultant vector has its effect or each of the components individually have their effects, it is not true that the two component vectors actually had their full effects. In fact, only the resultant vector had its effect. If one thinks of the vectors as representing movement in a direction, there was not multiple stages on the journey, heading first one way then another according to magnitudes and directions of the component vectors. In fact, only one movement occurred: the one matching the direction and magnitude of the resultant vector.[525]

This complements the arguments above because it illustrates that even linear, one-dimensional compositions involve a transformation. In fact, a transformation from a complex of constituent powers to the substantial unity of a resultant power. And that transformation does not come for free: a composition, even a simple one, is not the same as letting each of the components have their full effects.

Where Cartwright differs is that she also argues that addition is something that we do, not something that is in the world. In reality, she argues, causation does not have a step analogous to the calculations we make upon the vectors in our models. This is part of her wider argument denying the reality of the component powers in favour of 'resultant' powers.[526] Afterall, it is the behaviour of the resultant powers that we observe.[527]

We have already provided reasons during our discussion of derivative properties that would lead us to make the opposite assumption. Where we have competing putative causes for the same effect, the fundamentalist is likely to reify the component properties instead of the derivative properties. The appeal to our better knowledge of the derivative properties also doesn't carry much weight for the causal powers theorist. As we saw in our discussion of causal powers, individuating powers is a vexed business. We can take some clues from

[524] Cartwright 1983 p.59
[525] Ibid p.60-3
[526] ibid
[527] See Wilson 2009 for another argument along these lines

conditional analysis, but we do not individuate powers that way. Martin's arguments about allegedly finkish dispositions are instructive on this point.[528] As Mumford and Anjum put it: powers "are often epistemically problematic or even verification transcendent."[529] Nevertheless there are ways that we can learn about these natures: by making interventions and conducting experiments on these systems, we can detect component powers and observe the changes in resultant powers to which they contribute in a variety of circumstances. The only way to discover the nature and capabilities of the fundamental properties is to see what they can do. The mistake of emergence is to presume to know.

Cartwright elsewhere argues for causal pluralism – the view that there are many different types of causation. Indeed, according to her and some other causal pluralists, there is nothing that the different kinds of causation have in common. This seems to imply that all-encompassing theories of causation are bound to fail. Here is part of her argument:

> There are untold numbers of causal laws, all most directly represented using thick causal concepts, each with its own truth makers; and there is no single interesting truth maker that they all share by virtue of which they are labelled 'causal' laws.[530]

The 'thick causal concepts' here are something like causal verbs. Each of which she says is more precise and content rich than the causal words used in philosophy. Perhaps each of them represents a different way that one thing causes another:

> The pistons *compress* the air in the carburettor chamber, the sun *attracts* the planets, the loss of skill among long-term unemployed workers *discourages* firms from opening new jobs.[531]

We might apply something like this line of thought to the notion of composition in our theory of causation too. Powers don't really 'compose', they are 'summed', 'multiplied', 'catalysed', subject to inverse square functions, etc. Causal and compositional pluralism are both supported by the heterogeneity of our causal observations. But these observations do not threaten our theory of causation or make the existence of causal and compositional relations less likely. There are lots of different powers that do lots of different things. What all causation and composition have in common is that they occur when powers are doing their work.

[528] Martin 1994
[529] Mumford and Anjum 2011b p43
[530] Cartwright 2007 p. 22
[531] Ibid pp. 19-20

10.4 Individuating Component Powers

The individuation conditions for basic powers are not the same as the individuation conditions for resultant powers. We do not individuate basic powers by reading off the effects of resultant powers because the essence of a power is the causal contribution it makes – either to the events to which it directly contributes or the resultant powers which it helps compose. But since caused events are the only epistemic access we have to a power's essential nature, they are all we have to go on when determining the individuation conditions.

How exactly one goes about doing this is a difficult question with no simple answer. We can observe the events caused by the contributions of multiple resultant powers, and we must then break down those contributions by analysing how the same resultants perform in different combinations, while bearing in mind that resultants themselves may compose in various ways. Then, once we have identified the manifestations of the resultant power, we must break down the contributions made by all of its component powers to the composition of that resultant. Again, it seems that interventions and experiments are necessary to break down those contributions and we have to bear in mind that the component powers may compose in various ways.

Just like with basic powers, the resultant powers must come with composition principles in order to do causal work.[532] If the lack of epistemic access didn't make the individuation of a new power difficult enough, the difficulty is further compounded by the possibility that resultant powers might themselves compose other powers. The implication of this is not just that there is an extra stage in the detection process for new powers (now that we have to run through two or more layers of composition), but also that, whatever resultant powers we are able to individuate in a complex object, those powers could be essential directed to manifestations that bear nothing but the most attenuated relationship to the basic powers of the components of that object. We might not be able to determine that an additional basic power is present until we have run through an exhaustive series of nested hierarchical compositions. This illustrates the folly of presuming that basic powers must be directed towards macro-causal outcomes. The failure of reduction that would be required to prove the existence of a new basic power – never mind individuating an emergent power – is very different to the kind of reduction that looks at either end of the nested hierarchy of composed

[532] Whether those principles are essential to the individuation of powers or not, they must be grounded in the natures of the basic powers, given that the resultant powers are not distinct entities in their own right.

powers and concludes that reduction has failed because the most basic micro-power is not the sort of entity that is capable of composing the most complex resultant power.

Might not there be some version of this comparison that would prove the impossibility of the basic powers composing the 'final' resultants? Perhaps sufficiently radical differences between the basic powers and the final resultant powers would demonstrate a relevant failure of reduction and thereby form an individuation condition for an emergent power.

It seems, however, that the only principled way to make such a condition is to know what the powers can do. And by this I don't just mean what the basic powers can do. We would need to know what every composed power at every stage in the hierarchy can do. This is because once the basic power has composed a resultant, it has then, with respect to the final resultant, fully discharged its duty. Whatever the power of the resultant and the composition principles it has – whatever the resultant power can do in combination with other powers – it does not enter into the individuation conditions of the basic power. This is true whether the composition principles feature in the individuation conditions for powers or not.

For emergence, the Composition Principle Difficulty is much worse than the Epistemological Problem. The latter can be overcome by stipulating individuation conditions for powers, like those we have been testing above. And, though in our case they have been found lacking, these conditions can be supported by independent reasoning, which, if successful, can decisively prove that complicating the essences of basic powers or positing new ones to account for a phenomenon is at least undesirable. In comparison, it does not seem that the Composition Principle Difficulty can be overcome this way. To form individuation conditions that would be effective in an argument to emergence requires assumptions about what composition principles exist. But that is the very question at issue. Once the theory of powers is adopted, it seems that observing how powers actually work in a given circumstance is the only way to discover what composition principles exist. To argue that existing powers alone cannot account for observed behaviour one would need to already know what existing powers can do. This begs the question against causal powers inherence.

Bottom line: we do not need to alter our basic powers in order to account for macro-powers. There could always be unknown resultants while still having exactly the same basic powers. This is possible because the essence of basic powers can stay the same – nothing about them is straightforwardly entailed by what we observe to be putative macro-properties (it could be an extremely complex process). We therefore reject the following premise:

> Further, newness of property, in this sense, entails new primitive causal powers, reflected in laws which connect complex physical structures to the emergent features. (Broad's trans-ordinal laws are laws of this sort.)[533]

We have to use the macro-behaviour as a guide for the individuation of our basic powers, but unexpected resultants will often occur in complex systems – especially ones with intricate structure. That is the Composition Principle Difficult. And in that situation, O'Connor and Wong's arguments must assume a premise that we reject: the direct individuation of basic powers by the effects of their resultants. And without this premise, it is hard to find an alternative argument about power individuation that does not just assume that the putative macro-powers could not be resultants just because they are so different to micro-powers, which is of course to beg the question in favour of emergence.

10.5 What is a Quality Space?

A quality space is a pragmatic construction looking at what concerns us in any situation. These pragmatic constructions rarely map directly onto the essences of the component powers acting on that quality space because our concerns are rarely just the nature of those interactions. As such we inevitably observe nonlinearities when we switch from one quality space to another. We know that these nonlinear results are everywhere in composition – whether a system is random or organised. In a structured system the most basic mechanism produces nonlinear results in relation to the properties of the components. We've already discussed one way that the vector model can illuminate the source of surprising nonlinearities: the unfounded assumption that all powers aggregate – and only aggregate - and that this aggregation comes for free. The notion of quality space is another source of surprising nonlinearity.

We've already discussed how the multi-dimensionality of powers and the switching between quality spaces can generate apparent nonlinearities. The notion of a quality space represents how we change the manner in which we look at system-wide characteristics relative to components. This means that even when compositions are essentially linear, our observations are not.

I illustrated this possibility in chapter 9. And I mention it again in relation to the epistemological difficulty of compositional pluralism because it suggests a question: is it perhaps, whenever we see nonlinearity, merely a matter of quality spaces? Are we just

[533] O'Connor and Wong 2012

imposing a different quality space, or asking different questions about the behaviour of the system?

When we looked at some purportedly nonlinear examples of the composition of powers in chapter 9[534], I argued that, when one considered the situation in full, only linear compositions were required.[535] The objection occurs to us that perhaps all purported cases are like this, but with the apparent non-linearity massively compounded by the multiple stages of the composition of powers and obscuring the real situation. If this were the case, then is it necessary to advance a theory of causation involving many principles of composition? In effect, the suggestion is that we can select our quality spaces and thereby 'iron out' compositional pluralism and turn it into aggregation – we can ignore the essence of the composing powers except for the one aspect that contributes to this space.

I don't think this is a threat to the line of argument we've developed. It might be true that quality spaces are merely pragmatic constructions representing what concerns us in the world, and that there are potentially an infinite number of such quality spaces.[536] But it is not true that the ability to come up with gerrymandered quality spaces that abstract away nonlinear compositions tells us anything about the individuating essences of fundamental powers or the principles by which they combine. That sort of gerrymandering would have to define quality spaces in terms of the composition principles they seek to eliminate. In so doing, they would be defining away unwanted compositions by implicating a new power, one caused by the outcome of the powers acting on the gerrymandered space.

Indeed, this is exactly how an emergent power would appear on the composition model. The emergentist supposes that, instead of component powers composing a resultant nonlinearly, they are acting linearly on an alternative quality space for the occurrence of an emergent power in that same situation. The emergent power will then be the one to act on the initial quality space with its own magnitude.

Far from being a problem for the line of argument here, the pragmatic nature and potentially infinite possibilities of quality spaces only illustrate the epistemological difficulty. Without already knowing the essences of powers, how does one choose between these two

[534] Sections 9.6-9
[535] Mumford and Anjum briefly raise this possibility when they introduce multi-dimensional powers, but I think that applying this strategy more broadly can eliminate the nonlinearities in some of the cases they advance in favour of compositional pluralism.
[536] This is analogus to Williams' arguments about the pragmatic choices we make when individuating powers in general. See Williams 2011

competing theories? In the final concluding chapter of this thesis we will consider some relevant factors in making that choice.

10.6 Conclusion

My conclusion is that, given a theory of powers as unitary causal contributions (like that of Molnar, Mumford and Anjum, or O'Connor and Churchill, etc.) combined with the widespread nonlinear outcomes of complex systems, arguments for a theory of emergence are under-motivated by considerations like the existence of powers at the macro-level that are radically different to powers at the micro-level. It is to be expected that resultant powers in a complex system will bear little resemblance to basic powers.

The solution to the Problem of Reduction is a not a choice between the emergence of a new property and the inherence of a new property. I have been arguing that a third option within the inherence position is possible where no changes to the properties inhering in the objects are implicated, only a difference in their resultant powers as the complexity of the system increases. For any given observation about the behaviour of a complex object, the inherentist has a range of possible explanations: these include, resultant powers composed by previously latent properties;[537] resultant powers composed by previously active powers that have individuating essences not fully known before;[538] and resultant powers composed by previously active powers but in new combinations.[539]

In the following and final chapter we will consider some general theoretical considerations that might help us to choose between emergentism, the latent powers view, and my compositional view. For now I've shown that, in order for an emergentist to make a conclusive argument to emergence using abstract metaphysical principles about the individuation of powers, they would have to overcome both the Epistemological Problem and the Composition Principle Difficulty.

[537] As in sections 7.8-9
[538] As in section 7.7
[539] As I've been arguing in chapters 9 and 10.

Conclusion

This section will alight on some future work that can be done in this area. We will sketch out some of the theoretical considerations that might help to settle the debate between emergentism, latent powers, and my compositional view. The three positions all offer sufficient explanations for the Problem of Reduction but each follows a broadly different strategy: emergence invokes a new macro-property; what I will call reductive inherence invokes new or previously unknown micro-properties; and non-reductive inherence, or the compositional view, invokes new or previously unknown principles of composition.

In this chapter we will briefly describe some of the advantages of each position over the alternatives. These will be described in relation to a few criteria for theory choice, specifically ontological economy, ideological economy, and explanatory power. Their relative advantages and disadvantages are summarised and it is concluded that, if powers are complex (wherever that complexity consists in), then emergence is unnecessary. My aim has not been to settle the debate, but merely to show that there is a strong competitor to emergence that is underexplored and worthy of further consideration.[540] By outlining some of the theoretical advantages of the view, I'm also providing reasons for some people to accept it (depending on which theoretical virtues they think trump others).

11.1 The Power of Compositional Pluralism

The lesson of the previous two chapters is that radical discontinuities in system level behaviour do not imply new fundamental properties, nor do they imply that the essences of properties are radically disjunct (in the way that they are in, say, Martin's theory of powers.) There is some additional complexity among the fundamental entities and this suffices to generate a nested structure of resultant powers belonging to complex objects. These resultant powers are not, however, really existing entities: they are merely derivative entities, so no new properties are implicated in their generation.

There is a question in the metaphysics of powers as to whether properties bestow their powers or whether properties *are* powers. Shoemaker, for example, seems to have shifted position on the point: moving from the latter to the former sometime between 1980 and 1999.[541] Mumford believes the latter.[542] I don't want to assert pandispositionalism here or

[540] To come to a settled conclusion would require, among other things, addressing meta-philosophical questions about the relative weighting of different theoretical virtues.
[541] See Shoemaker 1980 and 1999
[542] 1998

rule out the grounding of powers in categorical properties, because I'm not sure what, if anything, in this argument would turn on this point. The natural characterisation of non-reductive inherence would be that composed powers are not the powers of fundamental properties and neither are they directly bestowed by fundamental properties. I think this is an open option whether fundamental properties bestow powers or if they just are powers. If fundamental properties just are powers, it doesn't mean that the resultant powers of derivative or structural properties have to be a fundamental property: that would be to confuse necessity and sufficiency.[543]

What we're seeing here with the compositional view is a failure of resultant powers to reduce to individual basic powers (while still being reductive in the sense of admitting no addition of being). The composition of powers starts to look a little more like causation rather than metaphysical dependence – we're used to seeing one kind of caused event following from a completely different kind of caused event – we don't expect to find the effect in the cause. Or as Martin puts it, "The medieval doctrine (or a twist on it) that all of the perfections (intrinsic properties) in the effect must be present in the cause is not self-evidently true."[544] That was why it was reasonable for the causal powers emergentist to postulate that emergent properties would be produced in a relatively straightforwardly causal fashion by the micro-properties of a system.[545]

Compositional pluralism can explain new types of causation in new types of quality space that no powers contributed to before. This removes the need to go to fundamental ontology to explain them. Here is Molnar hinting at this possibility: "While ontologically there is nothing over and above individuals and their properties… *causally* there is."[546] In emergentism these new types are not reduced to the powers producing them, because causal production is not a relation of reduction. In non-reductive inherence these new causal possibilities are not the causal products of powers, but the composed products of basic powers in millions of nested quality spaces – and the composition of powers looks more like causation than metaphysical dependence. It is true that, since there are no new entities in the fundamental ontology, there is a sense in which these causal possibilities reduce to the basic powers. It is also true that they do not reduce in the sense that we would expect to find these causal possibilities among the basic powers individually.

[543] That all properties are powers doesn't imply that all powers are properties.
[544] Martin 2008, p.130
[545] See chapter 5.
[546] Molnar 2003, p.198

Here is an extract from O'Connor about how causal powers, of nomological necessity, are capable of producing a property of a radically different kind – in this case to explain agent causation:

> Can we make sense of agent causation as an emergent capacity of a fundamentally biological system? Note that such a theorist is committed to the emergence of a very different sort of property altogether. Instead of producing certain effects in the appropriate circumstances itself, of necessity, this property enables the individual that has it in a certain range of circumstances to freely and directly bring about (or not bring about) any of a range of effects. It might be thought that because of this distinctive character, it isn't possible that it could naturally emerge from other properties. Such a property could be instantiated only in a very different kind of substance from material substances, as on the problematic Cartesian view.
>
> This thought does not bear well under scrutiny, however. Given that there is nothing inconsistent about the emergence of an "ordinary" causal property, able to causally influence the environments in which it is instantiated, it is hard to see just why there could not be a variety of emergent property whose novelty consists in enabling its possessor directly to effect changes at will (within a narrowly limited range, and in appropriate circumstances). If properties are able, as a matter of nomological necessity, to produce an entirely novel type of property, what reason do we have to assert that, when it comes to the property-kind distinction just noted, properties can spawn others of their own kind alone? At least, this would seem to be an empirical, not philosophical or conceptual, matter.[547]

One factor that will affect the explanatory power of the compositional view is the extent to which powers can compose "entirely novel types of property", or, rather, resultant powers. The closer this ability comes to the capabilities of the causation relation, the more that composition will be able to explain, including, perhaps, agent causation. I agree with O'Connor's implication that, if properties are able, as a matter of nomological necessity, to compose an entirely novel type of power, I do not see why we should assert that, when it comes to the property-kind distinction, properties can only spawn others of their "kind". At least, for the argument I have been making, it suffices that this is an empirical rather than a philosophical or conceptual matter. If the only way to determine what compositional

[547] 2000a pp. 14-5

principles exist is to observe what powers can do in combination, then the compositional view seems to always be a viable alternative to emergence.

11.2 Theory Choice

Let's defend three methodological principles that can help us to decide between viable metaphysical theories. The Principle of Quantitative Ontological Economy, The Principle of Qualitative Ontological Economy, and The Principle of Avoidance of Ad Hoc Ontology.

11.2.1 Quantitative Ontological Economy

If C and E are theories competing in the explanation of phenomenon M, and C has greater quantitative ontological economy, then this is a reason (though a defeasible one) to prefer C over E.

A theory is ontologically economical quantitatively if it postulates relatively few entities of any kinds. This is a theoretic virtue that might be supported by a standard result in statistical theory: that if the conjuncts of a theory have a probability of being true, then a smaller number of independent conjuncts would make the theory more likely to be true.[548] Non-reductive inherence seems to have the obvious advantage in terms of quantitative ontological economy because the compositional principles are not further entities in their own right. Reductive inherence, depending on how the theory is fleshed out, potentially posits a great many micro-properties. Emergence, since it implicates latent micro-properties of its own – the emergent-producing ones – posits perhaps as many or more micro-properties as reductive inherence; but in addition, emergence also posits additional emergent entities.

11.2.2 Qualitative Ontological Economy

If C and E are theories competing in the explanation of phenomenon M, and C has greater qualitative ontological economy, then this is a reason (though a defeasible one) to prefer C over E.

A theory is ontologically economical qualitatively if it postulates relatively few *kinds* of entities. The same probability improvement can be seen as with quantitative economy: if the universe consists in a conjunction of different kinds of entity, then a list of postulated kinds of entity will each have an associated probability that any entities of that kind do, in fact, exist. An ontological theory with a smaller list would therefore, as a matter of basic statistics, have a higher probability of being true. Again non-reductive inherence has an advantage – it posits only simples – as does reductive inherence. And the composition principles and

[548] See also Nolan 1997

resultant powers should not be considered distinct kinds of things. Emergence is disadvantaged – it postulates both micro- and macro- properties.

11.2.3 Avoidance of Ad Hoc Ontology

If C and E are theories competing in the explanation of phenomenon M, and C postulates fewer ad hoc entities for that purpose, then this is a reason (though a defeasible one) to prefer C over E.

Ad hoc entities are those entities postulated for the main reason that they play a certain theoretical role. Avoiding these entities is a theoretic virtue because an ontology without these entities has an independent credibility whereas an ontology with them has credibility only to the extent that the theory has credibility. This is related to Russell's "supreme maxim of scientific philosophising": that wherever possible, logical constructions are to be substituted for inferred entities[549] and "in dealing with any subject-matter, find out what entities are undeniably involved, and state everything in terms of these entities."[550]

The theories here offer explanations of the Problem of Reduction. For non-reductive inherence there is no question of ad hoc ontology because there are no new inferred entities. Everything rests with those entities we already know about and that are undeniably involved. The entities that are invoked to explain the Problem of Reduction are not postulated for the main reason that they play a certain theoretic role. Are the additional properties posited by reductive inherence ad hoc? I think the answer is yes. These micro-latent entities are only theorised because it is thought that the existing micro-properties that we believe exist could not solve the Problem of Reduction. But emergence is worst of all – while the emergentist does not think it's ad hoc because they do not think anything else could play the same theoretical roles as emergent properties, I've blocked that response by introducing an alternative picture. If the alternative is viable, then emergence has ad hoc emergent properties and ad hoc emergence-producing latent properties.

11.3 The Complexity of Compositional Pluralism

All of these theoretic virtues are debatable, and of course the brief justifications we've given are far from conclusive. Furthermore, each criterion is in any case only a defeasible reason to prefer one theory over another. The work in this conclusion is only a quick sketch of the work that must be done in order to make a choice between the theories we have been describing.

[549] Russell 1917
[550] Russell 1926 p. 109

There is also at least one criterion by which the compositional view seems to fare relatively badly, and that is ideological economy. In this case we might consider it to be a drawback to the theoretical attractiveness of non-reductive inherence that it involves complicating the essences of our basic powers. Let's make a few observations about the relative complexity of the entities involved in this view.

According to our theory of powers, powers are single-track but can make causal contributions to many different effects.[551] This is because they combine with other powers and they act in many different quality spaces. Because a single-track power on this view manifests in multiple dimensions of quality space at once, this allows single-track powers to do some of the things that a multi-track power appears to do.

Combination increases the number of dimensions that single-track powers operate in. Since the number of potential combinations and quality spaces are infinite, this allows single-track powers to do everything that a multi-track theory can do. Combination in complex systems radically changes the dimensions that single-track powers operate in, in ways that are not always predictable based on the individuating essences of the basic powers in that system. This allows basic powers to do some of the things that an emergentist says they are needed for.

Combination in complex, structured systems radically changes the dimensions that single-track powers operate in, in ways that are seemingly unrelated to the individual basic powers in that system. This is not to say that the resultant powers are actually unrelated to the essence of the basic powers, it is just that a massive multitude of powers are possible using the same basic powers, so one cannot read off the resultant powers' causal profile from the basic one, or impute anything about the basic powers based simply on the resultant causal profile. The epistemological problem is even more vexed than the problem of the individuation of powers based on effects that must be tackled in multi-tracking powers theory.

The essences of powers are difficult to know. And on both the single-track and multi-track theories of powers they must be exceptionally complicated. The main difference between the two is that, because the manifestation of the single-track powers is a causal contribution

[551] As we've already mentioned, there are other single-track theories of powers. For ease of reference assume that 'single-track' here refers only to the theory of powers as unitary causal contributions. Ellis 2001 or Bird 2007 both have theories of powers that are single-track, and neither encounters the same issues being discussed here because both theories have a closer connection to dispositional characterisations of powers. Likewise, all references to multi-track powers should be assumed to refer to a view like Martin's theory.

rather than the caused events, the multi-track powers have direct connections between observable behaviour and their individuating essences. Powers are individuated by their manifestations, so the multi-tracker individuates their powers by their effects. All these multi-track powers are mutually manifesting, so individual powers are both infinitely complex and combinatorial. The manifestations of single-track powers are just their contributions, not the compositional principles that transform those contributions in combination. So their individuating essences are less accessible because they must be abstracted,[552] but they are also ideologically simpler.

Whereas in Martin's account one might need a new disjunction for the new event that might be caused by a new combination of objects, with compositional pluralism you would have the resultants for multiple complex objects and then their combination, rather than the combination of all of the individual entities that compose those complex objects. The simplification is that compositional principles are general and not like disposition lines draw between disposition partners.

What is at issue with single-track powers is that, though they do seem to be individually simpler in this way, they must also have some connection to potentially infinite quality spaces, and they must have compositional principles in their non-individuating essences. But is this a problem for the relative theoretical attractiveness of non-reductive inherence? Only if there is an alternative that does away with this complexity; but it's not at all clear that emergentism or reductive inherence would, assuming the same theory of powers, make much of an improvement. Bear in mind that the ontological emergentist must allow quite a lot of nonlinear composition, they can't limit composition only to addition. If nonlinearity is ubiquitous then the ontological reductionist must be able to help themselves to these principles or else you have eliminated the possibility of that reduction. I will concede, however, that whichever compositional principles emergence replaces, those complications at least will be removed from the essences of micro-properties.

11.4 Different Epistemic Values

Perhaps there are examples of epistemic values that favour emergence when making this choice. We've already seen some examples of supposed differences between the epistemic stances of emergentists and reductionists.

There was Alexander's notion of 'natural piety':

[552] This in itself might be considered a theoretical cost.

> The existence of emergent qualities thus described is something to be noted, as some would say, under the compulsion of brute empirical fact or, as I should prefer to say in less harsh terms, to be accepted with the "natural piety" of the investigator. It admits no explanation.[553]

Tim Crane concludes his essay on emergence by arguing that the distinguishing feature of emergentism in relation to non-reductive physicalism is also 'natural piety', an attitude which recommends the former position over the latter:

> It is here that we encounter the deep difference between emergentism and nonreductive physicalism. It is not a metaphysical difference, but a difference in the reactions of the two theories to limitations in our knowledge. Both emergentism and nonreductionism agree that we do not currently understand how the nonmental properties of the brain are related to its mental properties. But they react to this in different ways: the nonreductionists react by claiming that there must nonetheless be an account of *why* "we experience qualitative character of the sort we do," an account that does not just state the complex correlations between the nonmental and the mental. The emergentists deny that this *must* be so. If it turns out that the relation between consciousness and the brain is inexplicable, this ends up being one of the facts that must be accepted with natural piety.[554]

Firstly, non-reductive inherence has clear metaphysical differences with emergence, so our case is disanalogous with the kind of nonreductionism Crane is arguing against. But secondly, in both of these cases the supposed epistemic virtue of 'natural piety' is tied to the supposed inexplicability of emergence. I've argued in this essay that theories of emergence can and should offer sufficient specificity to explain the problems for which they are invoked. And insofar as these explanations are sui generis with respect to known 'nonmental properties' of the brain, positing new composition principles to do the same work is perhaps just as sui generis. When the only way to discover what our basic powers can do is to observe the resultant powers in different systems, I would say, adopting the "more authentic position for a genuine naturalist",[555] that these facts of composition must also be accepted with the natural piety.

Lastly here is O'Connor and Wong on the superior epistemic stance of emergence compared with reduction:

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[553] Alexander 1920 pp. 46-7
[554] Crane 2001, p. 221
[555] Ibid, p. 222

> We contend, to the contrary, that it is sweeping judgments such as McLaughlin's, based on partial evidence, that fall afoul of sober scientific practice -- practice that includes measured scepticism regarding broad extrapolation of confirmed results. We allowed above that we reasonably suppose theories to have broader application than to just those types of cases actually tested. However, the further removed a scenario is from the well-confirmed range along a scale of increased structured complexity, the less confident one should be that the theory is fully adequate to the situation.[556]

I contend, of course, that non-reductive inherence possesses a similar virtue of reasonable inductive scepticism. This is a sensible stance when there are potentially unknown emergent properties or composition principles both.

But there is of course one way in which emergence assumes less natural piety than non-reductive inherence, and that is in the tacit assumptions it must make about the limitations of principles by which powers combine, and the amazingly varied effects to which basic properties can contribute. I contend that it is the emergentist that makes sweeping judgements and falls “afoul of sober scientific practice” when they presume to know a priori about the essential nature of basic powers and the limits of their capacities. Emergentists merely shift the emphasis of their scepticism away from additions to the fundamental ontology onto the complexities of causation. This is no more pious than supposing that causation is more complex than we previously thought.

The stance of the emergentist would seem to indicate a preference for making additions to our fundamental ontology over complicating our theory of causation. But choosing to read off features of the world as new additions in your fundamental ontology is ad hoc ontology, the avoidance of which is an important epistemic value for fundamentalists. For a fundamentalist emergentist it is insufficient motivation that we don’t have a reductive story: we do not make new additions to fundamental ontology whenever we don’t understand how a macro-phenomenon is produced by our current ontology.

11.5 Further Work

In conclusion, there is nothing about the nature of powers and how they compose that supports an emergent explanation over one that employs only inherent principles of production and composition. The latter has no special problems dealing with macro-phenomena unless one assumes a restricted principle of the composition of powers.

[556] O’Connor and Wong 2005, p. 686

Emergence is still of course a coherent theory, while it doesn't have the supposed advantages set out in chapter 3, it may have others. For instance, the preceding sketches notwithstanding, it may have greater simplicity, or greater explanatory power. Productive further work can be done in this area by analysing the uses to which emergence has been put to see if the causal relation is really necessary for those purposes.[557] Closer analysis of potential compositional principles could also help to decide the issue – if abstract reasoning leads us to a principled limitation on the principles that could exist, then that could potentially be a boon for the emergentist.

There are, of course, excellent arguments in philosophy of mind why mental properties are very different form the physical properties we know, but do any of these arguments also rule out that mental properties could be the result of compositional pluralism in combination with those basic latent properties? I don't think this is often addressed. One can point out the differences between mental and physical properties, but metaphysics must decide whether it could be composition or not.

An emergent theory of properties has costs. There are trade-offs in the causal theory of properties that make carving out a theoretically attractive space for emergence more difficult than is generally supposed. The argument is that even if causal novelty, holistic effects and "top-down" causation are apparent in a system, a properly developed causal powers ontology can account for them without positing new fundamental properties. Crucially, issues in the fundamental ontology of properties determine the viable positions one can hold within this emergence/inherence debate. Developing these options allows for a more fruitful analysis of the metaphysics of emergence.

[557] A powers-compositional approach to the combination problem would be one example.

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