

Collapsing Emergence

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Abstract

The thesis that nature is composed of metaphysical levels is commonly understood in terms of *emergence*. In this paper I uncover a problem for accounts of emergence, the *collapse problem*. The collapse problem suggests that emergence merely tracks relations between arbitrary groups of properties and so cannot be used in service of the levels view. I reject several failed attempts to solve the collapse problem and argue for an alternative solution according to which emergence is not a distinction between metaphysical levels, but instead tracks the unavailability of scientific explanations.

Section 1: Introduction

Emergence is a crucial concept for those who hold that there are metaphysical levels in nature, because, it is often claimed, emergence accounts for distinctions between such levels. For example, emergence has been presented as the relationship that obtains between properties of qualitative experience and physical properties¹, and some have argued that a successful account of emergence can substantiate the apparent causal autonomy of certain higher-level entities, particularly the entities of the special sciences².

In this paper, however, I will reveal a problem that afflicts accounts of emergence. The problem is this: cases of emergence presuppose a distinction between micro-level and macro-level properties.

For any purported case of emergence, there are properties that *prima facie* belong to the micro-level,

¹Chalmers, D. (2006); Chalmers, D. (1996)

²Wilson, J. (forthcoming)

but if they are included in the micro-level then the purported emergent fails to meet a necessary condition for emergent autonomy. I call these problematic properties *collapse-inducing properties* because when they are included in the micro-level, the purported emergent effectively “collapses”, and yet it seems arbitrary to exclude them. Furthermore, this problem does not depend on the details of any particular account of emergence and so applies quite generally. This is *the problem of collapsing emergence* (or, for short, *the collapse problem*) and I give an account of it in Section 2. The collapse problem suggests that emergence tracks relationships between arbitrary groups of properties, rather than distinctions between levels of properties in nature.

A seemingly attractive response to the collapse problem is to restrict the micro-level properties in cases of emergence in line with some or another metaphysical distinction, such as the distinction between intrinsic and extrinsic properties, or between dispositional and non-dispositional properties. I argue (in Section 3) that such strategies fail, and instead I offer (in Section 4) a solution appealing to the connection between emergence and scientific explanation. I argue that my proposal not only solves the collapse problem, but captures what is truly interesting about emergence: the availability and unavailability of scientific explanations.

Section 2: The Collapse Problem

In this section, I will present a problem for accounts of emergence (the collapse problem), which will show that a purportedly emergent property fails to meet a necessary condition for emergent autonomy.³ This problem is generated by following a recipe, which I will illustrate first by formulating a simple, toy case of a collapse problem and then by formulating collapse problems for

³ The claims I aim to establish are about emergent properties, but a simple transformation would allow this objection to apply to claims about emergent entities or substances instead.

three accounts of emergence from different backgrounds: a historical account from C.D. Broad, an account grounded in scientific practice from Mark Bedau, and a contemporary metaphysical account from David Chalmers. The proponent of the position that there are emergent properties faces the challenge of showing that the recipe for generating collapse problems is illegitimate, a challenge which proves surprisingly hard to meet.

2. 1 *A Simple Case*

Consider one hundred apples arranged in a circle with a circumference of forty feet. Consider also a person with complete knowledge of the intrinsic properties of each of those one hundred apples.⁴ It is not possible for this person to deduce the circle's circumference from the intrinsic properties of its constituent apples.

Suppose that a philosopher (call her Em) observes that this is the case and claims that the circle has properties that emerge from the properties of its constituent apples. Em claims that the micro-level properties are the properties of each of the apples, the macro-level properties are properties of the circle, and the emergent macro-level properties are dependent on the micro-level properties in so far as the circle is constituted by the apples, but nevertheless autonomous in so far as they cannot be deduced from complete knowledge of the micro-level properties. Em presents the failure of deducibility as a necessary condition for emergent autonomy, and she takes *having a circumference of forty feet* to be an emergent property of the circle.

⁴ I understand 'intrinsic' in the Lewisian sense to mean 'invariant over duplicates'. Lewis, D. (1986)

However, Em appears to be confused, because whether the circumference of the circle meets the necessary condition for emergence obviously depends on which properties are included in the micro-level. If the micro-level properties include only the intrinsic properties of the apples, then it is impossible to deduce the circumference of the circle from the micro-level properties, and *having a circumference of forty feet* meets the necessary criterion for emergence. If, on the other hand, the micro-level properties include the extrinsic properties of the apples, particularly their relative positions, then there is no failure of deducibility. It seems as if Em has made a mistake in claiming that *having a circumference of forty feet* is an emergent property of the circle, because the moment we broaden the micro-level properties to include extrinsic properties, this property is plainly not emergent. One might argue that Em has not made a mistake because what counts as the micro-level properties in cases of emergence is a matter of stipulation. However, if we do not think that Em has made a mistake, then we take emergence to be an arbitrary, fragile phenomenon that disappears when a wider, and seemingly equally legitimate, group of micro-level properties is taken into consideration.

This is an example of a collapse objection, and it follows a very simple recipe. Starting with the micro-macro distinction used by the proponent of the account of emergence, we find a micro-level property that crosses the barrier that marks emergent autonomy but is also, according to the original micro-macro distinction, a micro-level property. Following this recipe, the collapse objection generalizes to existing accounts of emergence. In the rest of this section, I will present collapse objections to three different accounts of emergence. I will show that, if we think that Em is wrong to believe that *having a circumference of forty feet* is an emergent property of the circle, then we are

committed to thinking that most mainstream philosophical treatments of emergence are wrong for similar reasons.⁵

2.2 Broad's Emergent Wholes

In the following famous passage, C.D. Broad laid out the commitments of his “*emergent theory*”:

Put in abstract terms the emergent theory asserts that there are certain wholes, composed (say) of constituents A, B, and C in a relation R to each other; that all wholes composed of constituents of the same kind as A, B and C in relations of the same kind as R have certain characteristic properties; that A, B and C are capable of occurring in other kinds of complex where the relation is not of the same kind as R; and that the characteristic properties of the whole R(A, B, C) cannot, even in theory, be deduced from the most complete knowledge of the properties of A, B, and C in isolation or in other wholes which are not of the form R(A, B, C).⁶

For Broad, the micro-level properties are the properties of the parts A, B and C in isolation, while the macro-level properties are the properties of the whole R(A, B, C). Broad claims that in cases of emergence we cannot, even in principle, deduce the properties of the whole R(A, B, C) from complete knowledge of the properties of the parts A, B and C in isolation or in wholes other than R(A, B, C). That is to say, if we knew about the parts, and furthermore knew that they were arranged

⁵ Other philosophers have considered versions of the same problem. Kurt Grelling considered one version of this problem for Hempel & Oppenheim’s epistemic account of emergence, and he recommended that emergence be understood as relative to a class of attributes. See Hempel, C. & Oppenheim, P. (1948) pg 148. As we will see in Section 3, however, it is very difficult to specify a metaphysically non-arbitrary, non ad-hoc class of attributes. C.D. Broad also considered a version of this problem, which he attempted to avoid by distinguishing between properties of the components in isolation and in wholes. I discuss that attempt in footnote 9. See Broad, C.D. (1925) pg 61-63. More recently, Robert Howell considered a specific, law-based version of the problem for certain forms of emergentism as part of his defence of supervenience physicalism in Howell, R. (2009). Some different versions of the collapse problem have been discussed, but in this paper I will show that the extent and implications of the collapse problem for emergentism have not been fully recognized or explored.

⁶ Broad, C.D. (1925), pg 61.

in whole $R(A, B, C)$ ⁷, then we would not be able to deduce the features of the whole. This is presented as a necessary condition for emergence.

There is a lot packed into the claim that the micro-level properties are the properties of A, B and C *in isolation*, and the case of sodium chloride provides an illuminating example. Broad thought that sodium chloride has emergent properties, such as solubility in water, and that its possession of these properties cannot be deduced from full knowledge of the properties of sodium *in isolation* and of chlorine *in isolation*, nor from the properties of other wholes of which they may form parts. From our complete knowledge of the properties of sodium and chlorine *as elements* or in any compound other than sodium chloride, and our knowledge that they are combined together into a compound, we cannot deduce the features of sodium chloride.

To generate a collapse objection to Broad's view, I will focus on part A of the whole $R(A, B, C)$ and let **X**, **Y** and **Z** be the characteristic, and purportedly emergent, features of whole $R(A, B, C)$. Part A has the following dispositional property: *to form a whole with characteristic features X, Y and Z when combined in relation R with parts B and C*. Parts B and C have similar properties.⁸ The emergent features of the whole $R(A, B, C)$ can obviously be deduced from complete knowledge of the features of the parts A, B and C and the knowledge that they are arranged as a whole $R(A, B, C)$, so long as the features of the parts include these dispositional properties. This case of emergence "collapses" when these dispositional properties are included among the micro-level properties.⁹

⁷ Broad does not make this element explicit, but a reconstruction of his view suggests that it is necessary because without it Broad's account permits many trivial cases of emergence. For instance, any case in which some parts may be arranged in different ways to form different wholes will generate a case of emergence, and Broad's account of emergence was not intended to cover such cases.

⁸ For the purposes of this discussion, I will assume that A's disposition manifests itself of natural necessity in response to the stimulus condition of A's being joined in relation R with parts B and C.

⁹ Broad argued that when forming predictions about the behavior of any whole you need information about the components, and about whatever general laws govern their interaction in complex wholes. To form predictions about

Returning to the case of sodium chloride, we can see that these dispositional properties are, by Broad's own standard, micro-level properties. For example, one of the characteristic properties of sodium chloride is its solubility in water. Accordingly, sodium has the following dispositional property: to generate a compound that is soluble in water when combined with chlorine into sodium chloride. In Broad's terms, this property is a property of sodium "*in isolation*". This claim may be counterintuitive, but by Broad's own lights, the dispositional property is a property of sodium and so a micro-level property.

According to Broad, the failure of deducibility is a necessary condition for emergence. Yet this case shows that whether a macro-level property meets the necessary condition for emergence depends on what counts as a micro-level property.

2.3 Bedau's *Weak Emergents*.

Mark Bedau has developed an account of "weak emergence" based on cases from Artificial Life, and his approach is typical of proposals rooted in scientific applications of the concept of emergence.¹⁰ Bedau's account of emergence was developed in a philosophical context very different from Broad's, but I will show that Bedau's view is also subject to the collapse objection.

emergents, however, Broad noted that we need information about the components *and* observations of *this specific compound*, rather than more general laws. See Broad, C.D. (1925) pg 61-65. Accordingly, Broad would probably have argued that the collapse-inducing property is not a genuine property of the components in isolation, but my point here is that this distinction between genuine and non-genuine properties of the components in isolation is extremely fragile. Section 3 is devoted to a discussion of this general claim, and in Section 3 I demonstrate the failure of various attempts to distinguish between genuine and other properties of components in a non-arbitrary way.

¹⁰ Bedau, M. (2003)

Artificial Life worlds are computer worlds consisting of cells that can be ‘dead’ (empty) or ‘alive’ (filled). Filled cells form configurations that change in accordance with simple update rules that specify, given the current configuration of alive and dead cells, what the configuration will be after the next tick of the clock. The state of any given configuration after any interval of time can be derived by simulation; we can simply apply the update rules, over and over again, to determine how the configuration changes with each successive time step. For some configurations, computational shortcuts allow us to find out about the state of the configuration at a given stage without our having to carry out this step-by-step simulation. Other configurations, however, resist such treatment. If we want to find out about the state of *those* configurations after a certain number of generations, we *have* to simulate their development. According to Bedau, such configurations have “*weakly emergent*” properties, and underivability except by simulation is necessary for weak emergence.

One example of a weakly emergent property is possessed by the “R-Pentomino” configuration, which appears in Conway’s Game of Life, an Artificial Life world. This configuration starts off very simply and develops into increasingly flamboyant shapes before settling into a stable state at 1103 generations (the R-Pentomino’s “halting point”). Armed with our knowledge of the states of the cells in the first stage of the configuration and our knowledge of the Game of Life’s update rule, we can derive the halting point *only* by walking the configuration through each stage in its development. Bedau claims that *having a halting point of 1103 generations* is an emergent property of the R-Pentomino configuration, but Bedau’s position is subject to a collapse objection. A filled cell in the Game of Life has the property of *forming a configuration whose development halts at 1103 generations when combined with*

*other cells into an R-Pentomino.*¹¹ This disposition is a property of the individual filled cell, and by that standard is a micro-level property. But if we include this property among the micro-level properties, then we can obviously derive the halting point of the R-Pentomino by means other than simulation.

Of course, any given observer faced with the R-Pentomino for the first time would be unlikely to know that the configuration halts at 1103 generations, and that accordingly any filled cell has the property of *forming a configuration whose development halts at 1103 generations when combined with other cells into an R-Pentomino*. But whether a given observer *knows* that a filled cell has this property is irrelevant to whether it in fact has the property, and having the property is all we need to establish the collapse objection to Bedau.

2.4 Chalmers on emergence as failure of logical necessitation.

According to David Chalmers, almost all of the facts about the world are logically necessitated by the fundamental physical facts, with one very important exception: the case of consciousness.¹² The facts about consciousness are not *logically* necessitated by the fundamental physical facts, but only *nomologically* necessitated. In worlds with laws like ours, the same micro-states will give rise to conscious experience, but there are logically possible worlds in which the same micro-states will not give rise to conscious experience. According to Chalmers the relationship between the fundamental physical facts and qualitative experience is governed by psychophysical laws.

¹¹ As in the case of Broad, I will assume that this disposition manifests itself of natural necessity in response to the stimulus condition.

¹² Chalmers, D. (2006) and (1996)

Chalmers presents failure of logical necessitation by the fundamental physical facts as a necessary condition for emergence, but his view is also subject to a collapse objection. Take a particular individual's conscious experience to have characteristic (and purportedly emergent) features x , y and z , and along with Chalmers take the micro-level properties in question to be the fundamental physical properties of that individual. Let the "Psycho-Law" be the psychophysical law that governs the relationship between the fundamental physical facts and the relevant features of qualitative experience. Now consider the property of *being governed by the Psycho-Law*. If this is included among the micro-level properties, then the micro-level properties logically, rather than just nomologically, necessitate the macro-level properties. With the inclusion of this micro-level property, the purported case of emergence has collapsed.

An immediate response to the collapse objection is to think that it involves some kind of cheating. You might suspect that in formulating the collapse problem I have willfully misinterpreted the authors in question by attributing a broader group of properties to the micro-level than they themselves would recognize. In Section 3, I will cut off several attempts to flesh out this criticism by attempting to restrict the relevant group of micro-level properties in cases of emergence. Then, in Section 4 I will offer a solution to the collapse problem that will also explain the intuition that the collapse objection involves some kind of cheating.

2.5 The Impact of the Collapse Problem

In philosophy, emergence has been used to capture the idea that the universe is composed of metaphysical levels, or layers.¹³ On this kind of picture, there are distinctions between levels of properties in the universe and emergence is the relation that tracks those distinctions. The collapse problem, however, suggests that emergence does no such thing. The collapse problem indicates that, rather than tracking distinctions between levels of properties in nature, emergence tracks distinctions between metaphysically arbitrary, gerrymandered groups of properties.

One seemingly attractive response to the collapse problem is to rule out any micro-level properties that in some sense “involve” a property that can only be possessed by the macro-level. If we adopt this restriction, then a collapse-inducing property will not count as a micro-level property. Obviously this strategy requires a carefully specified notion of “involve”, and the exact details of that notion will determine just how general this solution will be. However, even a general version of this response will not solve the collapse problem for the simple reason that it permits too much emergence. For example, consider a group of pieces of wood, which are arranged into a whole that happens to be a table. These pieces of wood could have been gathered into wholes with any number of different properties, such as boats, piles of sticks of different shapes and sizes, or even art installations. If I cannot include in the micro-level any properties that in some general sense “involve” the macro-level, then proponents of emergentism like Broad and Chalmers would have to admit that many properties of the table, such as having four legs and a flat top, are emergent because they are not deducible from the properties of the parts. These are *not* recognized as cases of emergence by Broad, Chalmers, or indeed by most emergentists, indicating that this attempt to avoid the collapse problem on their behalf fails because it permits too many cases of emergence.

¹³ Wilson, J. (forthcoming), Chalmers, D. (1996), McLaughlin, B. (1992). See Barnes, E. (2012) for critique of the emergentist focus on levels.

We are faced once again with the threat that emergence is merely a relation between metaphysically arbitrary groups of properties. But there is a sensible way to resist this conclusion. If we can restrict the micro-level properties in line with an antecedently recognized metaphysical distinction, then we can show that the recipe for generating collapse objections is illegitimate. If this strategy works, we can avoid collapse objections by showing that they involve *the wrong* micro-level properties. In Section 3 I will explore some attempts to solve the collapse problem by restricting the micro-level properties in cases of emergence.

Section 3: Distinctions to Hitch To

Here are my standards for the success or failure of an attempt to solve the collapse problem by imposing a restriction on the micro-level properties. If a proposed restriction lets in collapse-inducing micro-level properties for many mainstream accounts of emergence, and accordingly permits collapses, then it will not help. If a proposed restriction requires us to rule out many of the properties that one could sensibly wish to include in the micro-level base of an emergent, then it also will not help, because were we to preclude such properties, we would depart too far from philosophical and scientific practice.

3.1 Intrinsic/Extrinsic

It is tempting to respond to the collapse problem by thinking that collapse-inducing properties are somehow illegitimate; they are not genuine, proper properties. One way to respect this intuition is to restrict the micro-level properties in cases of emergence to only *intrinsic* properties. The distinction between intrinsic and extrinsic properties is the subject of some controversy, but the basic idea is

that a property-bearer has intrinsic properties in virtue of features independent of its environment, and accordingly that intrinsic properties, unlike extrinsic properties, hold across duplicates.¹⁴ A canonical example is the difference between mass and weight; the mass of an object is among its intrinsic properties while its weight, which it has in virtue of the force of gravity exerted upon it, is extrinsic.¹⁵ For the purposes of making the appeal to intrinsic properties as attractive as possible, I will assume that there is a distinction between intrinsic and extrinsic properties, that this is a metaphysical distinction, and that we can wield this distinction to some level of accuracy.

In appealing to the distinction between intrinsic and extrinsic properties, the emergentist would claim that emergence is relative to a micro-level composed entirely of intrinsic properties. This appears to be a sensible strategy. Indeed, in the simple case involving apples from Section 2, the collapse-inducing micro-level properties (such as the apples' relative positions) were extrinsic properties, so it might appear that by ruling out extrinsic properties, an emergentist would be able to avoid collapse objections. There are, however, serious problems with this strategy: it is both too restrictive and too permissive.

The appeal to intrinsic properties is too restrictive in so far as there are many examples of extrinsic properties that an emergentist may very reasonably wish to include among the micro-level properties in purported cases of emergence. In many contemporary treatments of emergence, philosophers concentrate on the relationship between neuroscientific (or physical) properties and the properties of qualitative experience. These facts about the literature suggest that two paradigm micro-level bases for purported cases of emergence are physical properties and neuroscientific properties. Both

¹⁴ For discussion of the distinction between intrinsic and extrinsic properties, see Lewis, D. (1983); Langton, R. and Lewis, D. (1998); Kim, J. (1982); Weatherson, B. (2001)

¹⁵ Though even this apparently paradigm case is controversial. See Bauer, W. (2011)

physics and neuroscience are, however, full of extrinsic properties. Take *voltage* for example. The property of *being 5 volts* is relative to a ground and accordingly extrinsic, but *being 5 volts* is also a paradigm case of a physical property. *Relative speed* is another example. One particle *having speed of 5 m/s* relative to another is an extrinsic property and another paradigmatic physical property. Turning to neuroscience, the property of *being a synaptic cleft* is extrinsic; a synaptic cleft is simply a gap across which neurotransmitter molecules are passed from neuron to neuron.¹⁶ The region of space is a synaptic cleft in virtue of the use that it made of it by the neurotransmitters, which makes being a synaptic cleft an extrinsic property of that region of space. There are many extrinsic properties that an emergentist may reasonably wish to include in the micro-level base of a purported case of emergence, and in most cases these are not collapse-inducing properties.

As well as being too restrictive, the strategy of restricting micro-level properties to just the intrinsic properties is also too permissive. For example, the property that generated the collapse objection to Broad (*having the disposition to form a whole with characteristic features X, Y and Z when combined in relation R with parts B and C*) is plausibly intrinsic¹⁷ and so wouldn't be ruled out by the restriction to intrinsic micro-level properties. Accordingly, I will move on to consider a different restriction, to non-dispositional properties.

3.2 Dispositional/Non-Dispositional

As we just saw, the distinction between dispositional and non-dispositional properties appears to be a promising candidate. The basic idea behind this distinction is that what it is to possess a given

¹⁶ Purves, D. et al (2008) pg 96.

¹⁷ The position that all dispositions are intrinsic is popular, but we need not endorse it to take this as a plausibly intrinsic property. See McKittrick, J. (2003) for discussion.

dispositional property is to have the power to produce certain manifestations in response to certain stimuli. This power exhausts the property and is associated with it as a matter of necessity, while non-dispositional properties lack a stimulus-manifestation essence. Classic examples of dispositional properties include solubility and fragility. The emergentist could stipulate that the micro-level properties in cases of emergence are exclusively non-dispositional properties, and thereby hope to avoid the collapse problem.

This response assumes a clear distinction between dispositional and non-dispositional properties, and this distinction is a matter of significant controversy, but for the purposes of this discussion I will adopt the most charitable view possible.¹⁸ I will assume that there is a distinction between dispositional and non-dispositional properties, that we can successfully wield that distinction, and that the distinction is metaphysical rather than, say, conceptual.

This strategy shows promise because dispositional properties often are the properties that generate collapses. In the last section, I mentioned the property that generated the collapse for Broad's case of emergence: *the disposition to form a whole with characteristic features X, Y and Z when combined in relation R with parts B and C*. Once again, however, the restriction to non-dispositional properties is both too restrictive and too permissive. For instance, if we turn to the cases of physics and neuroscience, we can see that both are full of dispositional properties. Consider, for instance, the property of *being a working neurotransmitter receptor* (that is, a molecule that is primed to bind a neurotransmitter). This property has the stimulus-response essence of a dispositional property and is a central neuroscientific property. Or, turning to physics, consider the property of *having a mass of 5g*. Some have suggested that this property is the susceptibility to be accelerated by $n \text{ cm/s/s}$ by a net force of

¹⁸ The literature on these questions is vast. See e.g. Blackburn, S. (1990); Molnar, G. (1999); Mumford, S. (1998); Langton, R. (1998); Lewis, D. (2004); Bird, A. (2007); Prior, E. Pargeter, R. & Jackson, F. (1982)

5n dynes, for any n.¹⁹ This is again a central physical property that some have argued is dispositional.²⁰ These cases indicate that the restriction to non-dispositional properties is too strong, because, in appealing to this distinction, an emergentist will very seriously restrict the properties they can take to be included in the micro-level. Furthermore, these dispositional properties aren't typically collapse-inducing, which indicates that the dispositional/non-dispositional distinction doesn't track the distinction between collapse-inducing and non-collapse-inducing properties.

The restriction to non-dispositional properties is also too permissive, for there are some non-dispositional properties that generate collapse objections. Consider, for example, the problematic property that generated the collapse objection to Chalmers: *being governed by the Psycho-Law*.

Dispositional properties have a stimulus-response essence, but there is no stimulus in the case of the property that generated the collapse objection to Chalmers. Hence, this is not a dispositional property even though it generates a collapse. Therefore, the restriction to non-dispositional properties will not rule out all of the problem cases.

3.3 Natural/Non-Natural

According to many philosophers, some properties are privileged in so far as they account for similarity, play a role in causation and the laws of nature and ground other kinds of properties.²¹

These "natural properties" are the categories that really divide up the world, and typically those who

¹⁹According to classical physics.

²⁰ This claim is somewhat controversial, as endorsing it appears to involve endorsing baseless dispositions. Such controversy depends on the precise conception of the dispositional/categorical distinction in play, however, and so I will leave this question to one side.

²¹ See Lewis, D. (1983); Armstrong, D. (1978); Sider, T. (2012)

endorse the idea that there are such properties follow Lewis²² in endorsing the idea that there is a spectrum from perfectly natural to non-natural properties, rather than a binary distinction between natural and non-natural. Some philosophers have appealed to natural properties in response to skeptical problems very similar to the collapse objection²³. It might seem that by restricting the micro-level properties to natural properties, the emergentist can avoid the collapse objection.

There is significant controversy about what naturalness actually amounts to - whether, for example, the natural properties are given to us by *all* of the sciences, or whether they are simply the most fundamental properties.²⁴ The answer to this question will determine just how useful the appeal to naturalness will be for an emergentist, but I will again adopt the most charitable interpretation. I will assume that metaphysically natural properties are given by all of the sciences, and examine the strategy of restricting the micro-level properties to the natural properties.

Even given these concessions, however, there are some problems with the appeal to naturalness as a way to solve the collapse problem. First of all, naturalness comes in degrees, so we would have to find some point on that spectrum of naturalness at which properties are excluded from the micro-level. If we resort to the idea that properties are non-natural enough to be ruled out of the micro-level only when they generate collapse objections, then this would, of course, be ad hoc. An easy response would be to rule out all but the perfectly natural properties. This move does, however, lead to a very restrictive result. For the perfectly natural properties, even if they are given to us by all of the sciences, presumably form a small group.

²² Lewis, D. (1983)

²³ Lewis, D. (1983)

²⁴ Schaffer claims that Lewis and Armstrong vacillate between the two in Schaffer, J. (2004)

The appeal to natural properties also appears not to track the distinction between collapse-inducing and non-collapse-inducing sets of micro-level properties. Consider, for example, the Artificial Life case discussed in Section 3. *Being alive in the Game of Life* and *being dead in the Game of Life* are clearly very important properties of the Game of Life, but they do not have that status outside of the Game of Life, which suggests that naturalness (being context-independent) does not account for the inclusion of such properties among the micro-level properties in a case of emergence.

As well as being too restrictive, the appeal to natural properties is also too permissive. Some of the properties that one would need to exclude to avoid collapse objections look fairly natural. Consider, for example, the property of *being the firing C-fiber of a person in great pain*. This property is not perfectly natural, but is not completely gerrymandered either and would certainly have to be excluded from the set of micro-level properties to avoid collapse objections to the claim that properties of qualitative experience emerge from neural properties. Furthermore, consider the position that there are irreducible psychophysical laws that link facts about the physical world to facts about qualitative experience. Perfectly natural properties are widely thought to be those that appear in the laws of nature, but if this is correct, then the view that there are such laws implies that properties such as *being the firing C-fiber of a person in great pain* will be perfectly natural. Restricting the micro-level properties to only the natural properties still lets in too much.

3.4 Where do these failures leave us?

So far I have examined three different metaphysical distinctions between kinds of properties, with the aim of establishing whether or not someone who thinks that emergence tracks levels of properties in nature could hitch claims about emergence to one of these distinctions and thereby

avoid the collapse objection. None of these distinctions tracks the distinction between collapse-inducing and non-collapse-inducing properties. Considering three distinctions will have brought a host of others to mind - the distinction between physical and non-physical properties, perhaps, or between determinates and determinables.²⁵ Surveying every potentially viable distinction in the hope of solving the collapse problem is not, however, a sensible strategy. Adopting another distinction requires an independent argument for the position that this particular one is privileged, such that cases of emergence are relative to a micro-level base containing *only* properties of that kind. In the absence of an independent argument for the position that some other distinction is *the* privileged metaphysical distinction when it comes to emergence, it is clear that merely restricting micro-level properties in cases of emergence will not solve this problem.

One might be tempted to think that embracing this result involves embracing the idea that emergence is an uninteresting and arbitrary relation, but in the next section I will argue that this is not the case. According to the solution I will now offer to the collapse problem, emergence tracks the availability or otherwise of certain scientific explanations.

Section 4: An Appeal to Explanation

²⁵ For example, Shoemaker adopts a distinction between two different kinds of powers had by components of wholes, in Shoemaker, S. (2002). There are micro-latent powers, which only manifest when the components are combined in emergence-engendering ways, and micro-manifest powers, which may manifest when the components are isolated and/or combined in non-emergence-engendering ways. Shoemaker uses this distinction to respond to some problems associated with downward causation. It may appear that we could use this to address the collapse problem, but this strategy fails too. Specifying the acceptable micro-level powers in terms of what does and does not give rise to emergence is ad hoc. Instead, to solve the collapse problem in this way we needed an independently motivated metaphysical distinction between properties. Shoemaker himself does not face this concern because he does not use this distinction to respond to the collapse problem.

In this section, I will formulate a condition for emergence that ties emergence to explanation and I will argue that this condition, combined with a minimal condition for explanation, solves the collapse problem. A collapse-inducing property appears to make a purportedly emergent macro-level property non-emergent. I will show that the presence of a collapse-inducing property is not enough to render some property non-emergent. Of course, the property in question may still turn out to be emergent, or non-emergent. I aim simply to show that a collapse objection does not settle the matter either way.

4.1 Emergence and Explanation

Emergence is one way in which properties of different levels may be related. For example, in debates in philosophy of mind that focus on the relationship between neuroscientific properties and properties of qualitative experience, emergence is an *option*, a way in which the levels may turn out to be related. This *option*, I will now argue, specifically tracks the availability and unavailability of certain kinds of scientific explanation.²⁶

A simple survey of the philosophical literature on emergence shows that most authors are committed to the idea that emergence is associated with the unavailability of explanations. For example, Hempel and Oppenheim explicitly associated emergence with the absence of scientific explanations.²⁷ According to Jackson and Chalmers the facts about emergent phenomena are not a priori entailed by the facts about their micro-level bases, and this just is the unavailability of a certain kind of explanation, a priori reductive explanation.²⁸ Kim also describes the conceptual connection

²⁶ See Taylor, E. (2015) for discussion of this conceptual connection between emergence and explanation.

²⁷ Hempel, C. & Oppenheim, P. (1948) pg 151

²⁸ Jackson, F. and Chalmers, D. (2001)

between emergence and explanation when he says, “*the concept of explanation is invoked in the claim that emergent phenomena or properties, unlike those that are merely “resultant”, are not explainable, or reductively explainable, on the basis of their “basal conditions”, the lower-level conditions out of which they emerge.*”²⁹

Furthermore, even on those accounts of emergence according to which emergence is not primarily explanatory, emergence is associated with the unavailability of certain kinds of explanation. For example, Barnes defends an account of emergent entities as fundamental but not independent, and points out that on one characterization of fundamentality, derivative entities are explained by fundamental entities but fundamental entities are not explained by derivatives.³⁰ Alternatively, Wilson defends an account of emergence according to which an entity E is emergent from its components when one of the degrees of freedom needed to describe a characteristic state of the components is eliminated from the description of the same state of E, in virtue of some constraint being imposed on the components.³¹ Even if it is deducible from the fact that the components stand in a particular relation that there will be some constraint, it is not deducible that the constraint will be associated with weak emergence, because the appearance of the weak emergence is partly determined by the laws of nature. So again, even though this is not an explicitly explanatory conception of emergence, emergence is associated with a certain kind of explanatory failure.

These facts about the literature provide evidence for the claim that emergence is conceptually tied to the absence of (at least certain kinds of) explanations. In the rest of this section, I will codify this connection into a condition for emergence, “the explanation condition”. I will argue that, in addition

²⁹ Kim, J. (1999) pg 6

³⁰ Barnes, E. (2012) pg 877

³¹ Wilson, J. (2010) pg 292

to capturing the conceptual connection between emergence and explanation, the explanation condition will provide resources for a solution to the collapse problem.

I propose a condition for emergence (“the explanation condition”) that codifies the connection between emergence and explanation:

A macro-level property p is emergent iff there is no available explanation of the fact that the following regularity obtains of natural necessity: *Whenever components $A, B, C \dots n$ are combined in relation r , the resulting whole instantiates property p .*³²

“Components” could be parts of a whole, micro-physical entities, people, brains, cells in A-Life worlds, chemical elements - whatever bears the micro-level properties in the case at hand. The resulting whole is whatever bears the macro-level properties in the case at hand, where, as before, the micro-macro distinction varies across different cases of and accounts of emergence. To explicate this proposal, I will now specify 1) Why this explanandum? 2) What is meant by “explanation”? 3) What is meant by “available”?

In response to the question of why we should take this to be the schema for the explanandum, note that the concept of emergence picks out one way in which some micro-level properties and one particular macro-level property may be related. The question we are asking when we are investigating whether or not some property is emergent is *why* it is that when a group of micro-level entities are combined into a macro-level entity, that macro-level entity instantiates a certain property. This feature is captured in the general form of the explanandum I have offered.

³² I use Broad’s simple notation here to describe a situation in which a multitude of components arranged in a certain way give rise to a particular property. Despite this notation, and as will be made clear in the coming sections, this account is very different from Broad’s.

It is important that this regularity obtains of natural necessity because natural necessities are counterfactually stable, non-accidental and therefore more explanatorily potent than other generalizations about relationships between levels in nature. When investigating relations between levels in nature, we are interested in the question of why, *given the laws of nature*, a certain macro-level property is instantiated when a group of micro-level entities are gathered together. This is reflected in the fact that many authors take supervenience to be necessary for emergence.³³

I will now move on to address the question of what is meant by “explanation” in “explanation condition”. There are many different sorts of scientific explanation associated with emergence. For instance, Stephan associates emergence with the failure of mechanistic explanation³⁴, Bonabeau and Therelautz associate emergence with the need for a new model of the relevant phenomenon³⁵, Chalmers and Jackson argue that emergence involves the unavailability of a priori reductive explanation³⁶ and Bedau takes underivability except by simulation to be associated with the unavailability of what he calls “micro-level explanation”³⁷. A reasonable way to take this variation into account is to acknowledge that the relevant kind of scientific explanation may vary depending on who is conducting such investigation. For instance, one investigator may be interested in an explanation that involves a particular kind of model, which another may be interested in an explanation that involves decomposing a mechanism. On this approach, emergence is relative to a particular form of scientific explanation.

³³ See e.g. Crane (2001).

³⁴ Stephan, A. (2006)

³⁵ in Langton, C. (1995)

³⁶ Chalmers, D. and Jackson, F. (2001)

³⁷ Bedau, M. (2003)

One could alternatively adopt a position according to which emergence is associated with one form of explanation, and still embrace the explanation condition. I do not intend to settle this question here, but there are a few reasons for adopting the more open approach according to which emergence is relative to a form of explanation. One motivation is that different sciences, and different ways of practicing those sciences, are associated with different kinds of explanation. The collapse problem affects many accounts of emergence, and yet those accounts involve very different notions of scientific explanation. To adopt a connection between emergence and explanation based on only *one* kind of scientific explanation would not offer a general solution to the collapse problem, whereas the solution that permits variation across perspectives does. Furthermore, understanding emergence as relative to only one kind of explanation presupposes not just a clear definition of scientific explanation, but also an argument for one particular form being privileged. Neither of these is a desirable requirement on an account of emergence, whereas the appeal to variation across perspectives offers a simple, universal solution to the collapse problem, making only minimal assumptions about the nature of scientific explanation.

Having proposed that when a given macro-level property is emergent, a certain scientific explanation is unavailable, we now face the question of what it is for an explanation to be “unavailable”. I propose that what counts as availability may also vary across different cases, depending on factors such as, for example, the number of people involved in an investigation and their interests. However, my solution to the collapse problem does not depend on this detail and someone who wishes to adopt a particular standard for unavailability could do so and still endorse the explanation condition.³⁸

³⁸ For further discussion of the explanation condition and of the metaphysical status of emergence, see Taylor, E. (2015)

Earlier in this section, I argued that a good reason to endorse the explanation condition for emergence is that we *already do* endorse a conceptual connection between emergence and the unavailability of explanations. I will now offer a further argument for the position that we should endorse the explanation condition, because doing so not only respects the practice of using the concept of emergence to track the availability of certain kinds of explanation, but also offers a solution to the collapse problem.

4.2 A Minimal Condition for Explanation

In this section I will present a minimal condition for scientific explanation that applies to almost all accounts of scientific explanation, and is intended to capture the very basic idea that facts cannot explain themselves. In this section, I use the intuition that facts cannot explain themselves to motivate a restriction on whether or not any two sentences can stand in the relationship of explanans to explanandum.³⁹ This minimal condition for explanation, combined with the explanation condition for emergence, will enable me to offer a solution to the collapse problem.

As an introduction to the idea that facts cannot explain themselves, consider the fact that bare repetitions of an explanandum statement are universally recognized as failing to explain. Let's take as an example the situation of a cat, Lucy, who has fleas. Lucy's owner wants an explanation of the fact that Lucy has fleas, and so he takes Lucy to the vet. Obviously, if the vet offers "*Lucy has fleas*" as an *explanation* of the fact that Lucy has fleas, then something has gone wrong. Something has gone similarly wrong if the vet offers "*Lucy has the property of having fleas*" as an explanation of the fact that Lucy has fleas. In the second case the vet's attempt at explanation is not quite identical to the

³⁹ For the sake of convenience I will assume that one sentence can explain another, but little hangs on this locution. These claims could be translated into talk of facts or propositions instead.

explanandum, but still doesn't offer enough to be a contender for an explanation. What Lucy's owner is looking for from the vet is something like "*the brand of flea treatment you have been using is inferior*" or "*Lucy has had contact with a flea-ridden cat and fleas spread*".

I will now propose a necessary condition for explanation that captures the fact that sometimes two sentences are factually "too close" for one to explain the other. Let us say that two sentences are "factually equivalent" iff there is no metaphysically possible world in which either sentence is true and the other false.⁴⁰ So, for instance, "*all ravens are black*" and "*all non-black things are non-ravens*" are factually equivalent. "*Lucy has fleas*" and "*Lucy has the property of having fleas*" are factually equivalent, as are "*Lucy has fleas*" and "*Lucy has fleas and $2+2=4$* ", but "*Lucy has fleas*" and "*Lucy's owner has been using inferior flea powder*" are *not* factually equivalent. I propose that no explanandum can be explained by a sentence to which it is factually equivalent. This "*factual non-equivalence*" condition is a minimal constraint on explanation, as obviously it takes far more for one sentence to explain an explanandum than for that sentence to be factually non-equivalent to that explanandum. But the factual non-equivalence condition successfully captures the intuition that facts cannot explain themselves.⁴¹

Although the factual non-equivalence condition applies across almost all accounts of scientific explanation, there is an important class of exceptions, which I will take a moment to identify before setting aside. In any case in which the explanandum is metaphysically necessary, no attempt at

⁴⁰ I say "metaphysically possible" rather than "logically possible" because the latter criterion would fail to rule out many cases in which the purported explanans and explanandum are too close for one to explain the other. For example, "water is able to put out fires" and "H₂O is able to put out fires" are not far enough apart for either to explain the other, and yet a restriction based on logical possibility would not rule this case out.

⁴¹ Two sentences are factually equivalent iff there is no metaphysically possible world in which either sentence is true while the other is false. If the criteria for factual non-equivalence were only that there be no metaphysically possible world in which *one* sentence were true while the other false, deductive explanation would not meet the condition and so would not count as scientific explanation.

explanation will meet the factual non-equivalence condition. If we wish to permit explanations of metaphysical necessities, as we should, then we must acknowledge that this class of cases is an exception to the factual non-equivalence condition. Examples of such cases include explanations in mathematics. For the purposes of this discussion, however, I will put such cases to one side.

4.3 A solution to the collapse problem

So far we have established “the explanation condition” for emergence:

A macro-level property p is emergent iff there is no available explanation of the fact that the following regularity obtains of natural necessity: *Whenever components $A, B, C \dots n$ are combined in relation r , the resulting whole instantiates property p .*

We have also established the “factual non-equivalence” condition for explanation: that one sentence cannot explain another factually equivalent to it. We are now in a position to return to the collapse objection and assess the resources that these findings offer for solving the collapse problem.

A collapse objection is a challenge to the position that some macro-level property is emergent. The presence of a collapse-inducing property supposedly makes the purported emergent no longer meet a necessary condition for emergent autonomy. If a collapse-inducing property is enough to make the relevant macro-level property non-emergent, then according to the explanation condition for emergence, a collapse-inducing property must provide resources for an explanation of the relevant regularity. I will call a “collapse account” any attempt at explanation based on a collapse-inducing property. In this section I will show that any collapse account fails to meet the factual non-equivalence condition for explanation, and so a collapse-inducing property is not enough to make the relevant macro-level property non-emergent.

I will begin by examining a familiar case before stating this claim in a general form. In the case of Broad, the explanandum is the fact that the following regularity obtains of natural necessity: *Whenever sodium and chlorine are combined into sodium chloride, the resulting compound is soluble in water.* The collapse objection to the claim that solubility is an emergent property invokes the fact that sodium has the property of *generating a compound that is soluble in water when combined with chlorine into sodium chloride.*⁴²

This property provides resources for the following collapse account: *Sodium has (of natural necessity) the property of generating a compound that is soluble in water when combined with chlorine into sodium chloride, and that is why it is naturally necessary that whenever sodium and chlorine are combined into sodium chloride, the resulting compound is soluble in water.* As we can immediately see, the collapse account fails because the explanans is factually equivalent to the explanandum.⁴³

This should not be surprising when we consider that the general form of the explanandum is that the following regularity obtains of natural necessity: *Whenever components A, B and C are combined in relation r, the resulting whole instantiates property p.* The general form of the collapse account is *Component A has the property of forming a whole that instantiates property p when combined in relation r with parts B and C.*

⁴² Where, as in the original collapse objection, this disposition manifests itself of natural necessity in response to stimulus conditions.

⁴³ The same holds for Bedau and for Chalmers. For Bedau, the explanandum is the fact that the following regularity obtains of natural necessity: *Whenever five filled cells are combined into an R-Pentomino, the resulting configuration halts at 1103 generations.* The property invoked in the collapse objection to Bedau is each individual filled cell's property of *forming a configuration whose development halts at 1103 generations when combined with other cells into an R-Pentomino.* This property provides resources for the following collapse account: *Each filled cell has the property of generating a configuration that halts at 1103 generations when combined with four other filled cells into an R-Pentomino, and that is why it is naturally necessary that whenever five filled cells are combined into an R-Pentomino, the resulting configuration halts at 1103 generations.* The explanans is factually equivalent to the explanandum, and so the collapse account fails. For Chalmers, again taking Jim as our example, the explanandum is the fact that the following regularity obtains of natural necessity: *Whenever micro-physical entities are combined together into P, Jim experiences red.* In Chalmers' case, the fundamental physical entities have the property of *being governed by the Psycho-Law,* where the Psycho-law is the psychophysical law that governs the relationship between the fundamental physical facts about Jim and Jim's qualitative experience. This property provides resources for the following collapse account: *Each micro-physical entity has the property of generating a whole that experiences redness when combined with other micro-physical entities into configuration P, in virtue of being governed by the Psycho-law, and that is why it is naturally necessary that whenever micro-physical entities are combined together into P, Jim experiences red.* Again, the explanans is factually equivalent to the explanandum, and so the collapse account fails.

The presence of a collapse-inducing property doesn't provide resources for an explanation, but merely for a sentence that is factually equivalent to the relevant explanandum. A collapse account is rather like the vet's statement that "*Lucy has the property of having fleas*". It fails as an explanation in virtue of being factually too close to the explanandum.

On reflection, we can see that this result accords with a common, intuitive response to collapse objections, which is something along the lines of "*that's cheating*" or "*that's clearly not what the author meant*". The collapse objections generate dissatisfaction, and the connection between emergence and explanation reveals why this is the case. We use the concept of emergence to track the availability and unavailability of explanations, and collapse objections simply bypass that explanatory work. A collapse objection is an attempt to establish 'on the cheap' that some property is non-emergent, and so it makes perfect sense to regard collapse objections as illegitimate.

4.4 Taking Stock

I have now argued for a condition for emergence and a condition for explanation, and have shown that collapse accounts (attempts at explanation based on collapse-inducing properties) do not meet the necessary condition for explanation. Given the explanation condition for emergence, I conclude that a collapse-inducing property is not enough to make a given macro-level property non-emergent. Of course, the failure of the collapse objection does not show that the relevant property *is* emergent. Rather, it shows that a collapse-inducing property cannot decide the matter either way.

The results of this section, in addition to providing a solution to the collapse problem, also provide some insight into the failure of the strategies attempted in earlier sections. In Section 3 I examined

various attempts to restrict the micro-level properties in purported cases of emergence (to intrinsic, or non-dispositional, or natural properties). None of these attempts worked, and now we can see why. These metaphysical distinctions failed to pick out what is really important about emergence: the availability or otherwise of scientific explanations.⁴⁴

In Conclusion

I have presented a problem for accounts of emergence, the collapse problem, which indicates that emergence does not track distinctions between levels in nature, but instead tracks distinctions between arbitrary groups of properties. However, this does not mean that emergence is an *entirely* arbitrary relation. According to my solution to the collapse problem, emergence tracks the availability and unavailability of scientific explanations.⁴⁵

⁴⁴ If explanations are a good guide to ontology, and in some cases of emergence the explanation is absent for all forms of explanation and standards of availability, then does this not show that those properties are metaphysically emergent? I address this question in Taylor, E. (2015), where I discuss the ramifications of this account of emergence in detail. I acknowledge that some cases of emergence *may* obtain for metaphysical reasons, but hold that emergence itself is an explanatory phenomenon, not a metaphysical one.

⁴⁵ Thanks are particularly due to Marc Lange, William Lycan, Karen Neander, Ram Neta, Laurie Paul, John Roberts, Jessica Wilson, participants of the UNC dissertation research seminar and two anonymous referees. I gave this paper at numerous venues in the US between 2011 and 2012, and greatly benefited from those discussions.

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