

Emergence and Demergence

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1. *Why Emergence?*

Make no mistake; emergence matters. It matters in medicine, for instance, where it could support the idea of an intervention at a relatively high level in order to improve a health problem at a lower-level. One might reasonably make a lifestyle adjustment, then, aiming to alleviate digestive difficulties or high blood pressure.

Because metaphysics is often understood as lacking empirical content, it could be thought that it is irrelevant for science. However, this is certainly not the case with the question of whether there are emergent phenomena. If there are higher-level emergent properties, capable of downward causal influence, then it matters for how we relate to the world. It justifies the thought that you could intervene on factors such as stress in order to produce, through downward causal influence, desired changes at lower levels. Thus, the possibility of emergence is relevant to the question of whether a chemical imbalance causes depression or depression causes the chemical imbalance.

There is plenty of evidence of emergence in a variety of sciences and not just medicine (Ellis et al. 2012). Indeed, one could argue that it is assumed in almost every action we perform as agents. We go to lift a chair, for example, rather than its molecules. Molecules are not the sort of thing we can intervene upon, except in special laboratory conditions, but it seems that we can interact with macro-level phenomena and thereby change the position of an assemblage of molecules. That is just the practice, however. The problem has always been how emergence works in theory, and how it does so without wreaking havoc upon a fairly successful way of understanding the world. There is an idea that all other sciences rest on, and are ultimately explained in terms of, fundamental physics. Emergentism is often seen as at odds with this because it tells us that the bottom level isn't everything that matters.

Until we can provide a philosophical vindication of emergence, there will always be some scepticism about the idea of distinctly higher-level phenomena. A key task is to understand exactly what is being asserted by the emergentist, and which is thus denied by the reductionist. Our aim in this paper is to provide a good answer to that question. We also accept that some account is owed of how emergent phenomena arise; that is, we accept the objection from bruteness (e.g. Strawson 2008: 65). There has to be some intelligible sense in which emergent phenomenon, *E*, emerges from its base-level phenomenon, *B*, rather than from anything else; or that *E* is just free floating (as in forms of substance dualism). The emergence of *E* cannot be just a brute fact.

2. *Weak and strong emergence*

In particular, we need to understand strong emergence, where something genuinely novel emerges in nature. What does that mean? What is novelty and how is it generated? This makes so-called strong emergence metaphysically problematic, and also interesting, at least compared to weak or epistemic emergence in which the emergent phenomena are said to be merely surprising, inexplicable or unpredictable (e.g. Bedau 1997, Chalmers 2006, Wilson 2016). We will be looking for an account of strong emergence, as opposed to the merely epistemic variety. So nothing we advance in our account will concern our states of knowledge or belief.

It will help to provide examples of the sort of thing we are talking about. Here are some of the most significant cases of alleged emergence for philosophy:

- Life emerging from lifeless components
- Mind emerging from mindless components
- Meaning emerging from meaningless components
- Free agency emerging from nomologically constrained components
- Social phenomena emerging from individual components

These all seem *prima facie* like cases of strong emergence; but that may be mere illusion. We will not be offering any proof that settles the question of whether or not these are genuine cases of strong emergence. That matter would depend very much on the specific details, which we cannot give here. What we will do, however, is provide an account of strong emergence that would tell us what conditions would have to be met in order for any of these to count as genuinely emergent. And while we may have such ‘philosophers cases’ in mind, it is clearly not just philosophers who take emergence seriously. Physicists do so too, for example with the Quantum Hall effect (Sarma and Pinczuk 2004). Our account should also apply to the scientific cases, allowing physicists to judge whether they really have strong emergence.

Among other things, emergent phenomena are typically understood in philosophy to be higher level than that from which they emerge. If we are to make use of the notion of a level of nature then we also owe an account of what we mean. We accept that the idea of levels is problematic to a degree. Are planets really of a higher-level nature than, say, electrons; and, if so, on what basis? Would we really want to say that nature is stratified into discrete and discontinuous domains, hierarchically ordered (Dupré 1993: 97, Schaffer 2003: 512-13)? Isn’t the division of sciences into physics, chemistry, biology, psychology, meteorology, and so on, instead a human artefact? If nature is more of a continuum, perhaps we could divide it up in another way, which might not even be hierarchical.

But we don’t think one has to accept a strict hierarchy in nature or pyramid of the sciences in order to argue for emergence, or to state it in terms of levels of phenomena. The notions of relatively higher- and lower-level phenomena can be outlined in a metaphysically innocuous way in terms of part-whole composition. On this use of the term, if one set of phenomena jointly composes another

phenomenon, then it is lower level than it. Sub-atomic particles can compose in a specific way so as to constitute a planet, for example, whereas particles are not composed of planets. This part-whole relationship is all that we mean, therefore, when we say that a planet is a higher-level phenomenon than an electron. Similarly, organisms are higher level than genes, brains are higher level than neurons and societies are higher level than individual people.

The giving of such an ontologically innocuous definition of levels in nature is not all that is needed for an account of strong emergence, however. There are other challenges, such as the two set by Kim (2006):

- i. Emergence is defined in terms of what it is not (*E is not reducible to B*). Consequently, being emergent is not a unitary or homogeneous relation. Compare being not-reducible with being not-red. Things that are not-red might have little if anything in common. How, then, can emergence be defined in positive terms that are potentially unitary?
- ii. Can we show that emergent phenomena are not epiphenomenal? Specifically, how can we explain their downward action without violating the principle of the causal closure of the physical? Some say that if mental phenomena are emergent and capable of ‘top-down’ causation, it amounts to the falsehood of physicalism, or at least shows the incompleteness of physics.

Consequently, we aim to give an account of strong emergence that is stated in positive terms, in order to address Kim’s first challenge. It concerns what must (positively) happen in order for a phenomenon to count as emergent, instead of what must not be the case (absence of reduction). This is a considerable and significant task: to say what conditions must be met in order for something to count as emergent. And such a task is prior to the empirical question of whether anything in nature meets those conditions. Of course, there is already a plethora of theories of strong emergence (surveyed by Wilson 2016, for instance). We would be reluctant to add to them just for the sake of it. But we do believe we can offer something genuinely new and which answers some remaining concerns. Ultimately, we hope that the lack of consensus over what should count as strong emergence could be dispelled if we can offer a more persuasive account than those already available.

Once we have given our positive account, we will address Kim’s second challenge and explain why, in our view, strong emergence need not automatically violate a principle of the causal closure of the physical. We argue, instead, however, that it does violate the causal closure of the micro-physical or, you could say, causal closure of the basal level. But that, as we will show, is a different matter entirely.

3. Emergent causal powers

Like Wilson (2016), and others, we think it most clear and helpful to articulate claims of emergence in terms of causal powers. Unlike Wilson, we are prepared to adopt an accompanying robust realism

about causal powers (Mumford and Anjum 2011). However, we don't think that anything we say here depends upon that as a premise. Cash powers claims out in other terms, if you must. We think that leaves you with a weaker metaphysics generally but you should still be able to understand what we say about emergence.

We are assuming that particulars have causal powers. Because particulars can be parts of larger particulars, these powers sometimes compose to make resultant powers; for example, when component forces are added, such as when a group of people pull on the same rope. Given our account of higher and lower levels, in terms of wholes and parts, this provides a basis on which we can say that the powers of the wholes will be higher level than the powers of the parts of which they are composed. This follows once we accept that a higher-level power is one that is had by a higher-level particular, and a lower-level power is one had by a lower-level particular.

The idea of there being higher-level powers is a starting point from which we will come to offer our account of emergence. But it will be useful, before we get to that, to understand cases of the composition of powers that fall short of emergence. Not all higher-level powers will be emergent, by our lights, because they might fail to provide any genuine novelty.

There is a simple idea that we want to exploit in understanding what is meant by emergent, namely that emergent phenomena are those where wholes have powers that are not possessed by their parts. It is tempting to say that, for emergent cases, wholes have more power than the (sum of) the parts, but we will see that this would not be quite right. It is, rather, about the wholes having *different* powers, where we mean not merely the sum of the powers of the parts, and nor a mere subset of powers thereof. Another potential problem with this idea is articulating it in a way that makes emergence an ontologically serious notion, which includes avoiding it becoming ubiquitous. For, under some interpretations of the basic account, emergence would come far too easily and would have relatively little metaphysical significance.

We will start, therefore, by giving some examples that are too weak to count as strong ontological emergence. But the types of case will get progressively more significant until we arrive at our own view, which we think does deserve to count as strong ontological emergence.

A. *Mere composition*

Composition alone – what we will call mere composition – gives us only a weak form of emergence, such as Van Gulick's (2001) specific value emergence. These are also known as Wimsatt (1996) cases. For example, assume that having a particular weight is the same as having a causal power, which pandispositionalists would accept because they think that all properties are causal powers (Shoemaker 1980). One could then say that if one added two parts together to form a whole, where the first part weighed 4kg and the second part weighed 6kg, then the whole would have a property/power, of weighing 10kg, that none of the parts had.

We do not think that such powers deserve the name emergent. A mere addition of powers, as we have in this case, does not adequately satisfy the pre-theoretical requirement of emergence that it involves novelty in the higher-level phenomena. There is perhaps novelty in some sense – the whole

does have something that the parts lack – but this comes from the aggregation of powers alone. Confirmation that this is insufficient novelty is that it would make emergence far too cheap and easy and virtually ubiquitous. Every complex whole – that is, every whole that is made out of parts – would have emergent powers, which were just the addition of the powers of the parts.

We say ‘virtually’ ubiquitous, however, because we will be arguing that there are genuinely emergent wholes that do not have simply a sum of the powers of the parts. Indeed, we think that one way to deny emergence is to claim precisely that the powers of wholes are never more than sums of the powers of their parts; though we will argue that such a view is entirely implausible empirically.

Emergence, therefore, must be more than mere composition.

B. Nonlinear composition

However, there might be cases where the powers of the whole are not mere aggregates of the powers of the parts. We know empirically that there are such cases but they come in significantly different kinds. The first sort of case is where there is a nonlinear composition of the powers of the parts. The idea of nonlinearity is simple to illustrate. Candy bars cause pleasure when eaten but in a nonlinear way. 10 candy bars do not produce 10x the pleasure of one (Mumford and Anjum 2011: 89). It is probable that consumption of 10 candy bars in short order actually produces negative pleasure.

Nonlinearity was for a time seen as a key idea in emergence (Wilson 2013). But even if values compose in a nonlinear way, we still do not think that this deserves the mantle of strong emergence. Again, we can question the nature of the alleged novelty that is introduced in nonlinear composition. Does it really matter if, for instance, the individual parts of a possible whole have a joint sum value of 10 units, on some measurement scale, but the whole they compose has a value of 30 units? We think not. We do not have emergence of a new property here, as such, other than there being a change in the quantity of an existing quality. What interests us about emergence is the appearance of new qualities, at the higher level. What we have with nonlinearity is no doubt of some metaphysical interest – and we can certainly consider the metaphysical question of how certain magnitudes can compose according to a nonlinear function. But this concerns, by our account, only the degree of power rather than emergence of a new power. Counting nonlinear composition as emergent would, again, make the phenomenon too commonplace. So we will continue to look for strong ontological emergence worthy of the name.

C. New properties

Van Gulick (2001) also discusses modest kind emergence. This is where the whole has some quality that is different in kind from the qualities of the parts. Adding this requirement may seem to address the concern we have just expressed with nonlinearity. For example, modest kind emergence could

include cases where something is coloured even though its parts are not, or a table top is square though its parts are two triangles (Martin 2008: 51).

Let us consider the latter example. We still claim that this also allows too much to count as emergent. We have two triangular pieces of wood and see that if we arrange them in a certain way, they form a square. But, here, this occurs simply in virtue of the parts being duly arranged by entering into a certain spatial relation. To that extent, composition is merely aggregation along with the appropriate relatedness, which we think is still not strong enough.

What the emergentist needs is some form of radical kind emergence, where the emergent properties are of a radically different kind from those of the base properties. And since we do believe that there are such phenomena in nature, where radically different kinds of property are generated, they deserve a theory that separates them from all the preceding cases (with a possible exception of colour, which might indeed be strongly emergent).

D. The causal-transformative model

We advocate what we call the causal-transformative model of emergence in which some powers emerge only from the powers of the components interacting, and being changed by their causal participation in the whole.

A simple example shows what we have in mind. Chemical bonding involves qualitative changes in the elements which enter into the bonding. In forming a whole, the parts have to undergo change. Consider the formation of H_2O , which *prima facie* looks entirely a matter of additive composition. A hydrogen atom has a vacant space on its outer shell of electrons and an oxygen atom has two vacant spaces. When they have bonded, they can be understood as sharing electrons, thereby completing the outer shells of all the atoms – two of them being hydrogen – which thereby forms a stable molecule. The three ‘parts’ have thus each changed in order to form the whole. This change can be at least a part of the explanation why their powers have not simply aggregated. Water, for example, has a power to put out fires, but neither of the components of water can put out fires; indeed, they would fuel them.

It is because of such change that scholastics denied that the parts existed in the whole other than ‘virtually’ (Feser 2014: 177-84). The parts made the whole and could be recovered from it but they were not there while forming the whole. This may be too strong as a general claim. If the essential feature of an atom is its nucleus, then we could say that the parts of an emergent whole can retain their numerical identity even if they lose their qualitative identity. Other cases could be more drastic, however. Consider quantum entanglement. When two particles are entangled, they effectively form a causally connected single unit in which, arguably, the numerical identity of the parts has been lost. If we had two electrons, e_1 and e_2 , then once they have become entangled, there might be no fact of the matter which is e_1 and which is e_2 .

To accommodate both types of case, we therefore say that for an instance of emergence, there must be at least a qualitative change of the parts in virtue of having entered into a whole.

It is clear that the aforementioned modest kind emergence does not meet this standard. The two triangular parts do not change in virtue of forming a square. Indeed, they might not make a square if they did undergo change. Whereas, in the case of strong emergence, it is such change in the parts that explains why the powers of the whole are not simply aggregates of the powers of its parts. To take another example, chlorine is a poisonous gas; sodium ignites spontaneously on water. But sodium chloride has neither of these causal powers. And it tastes salty, which none of its components do.

This, we say, is where we can find radical kind emergence: the coming together of the parts to form a whole involves a transformation of the parts through their interaction. Emergent powers of wholes cannot then be mere aggregates because those parts themselves change, losing at least their qualitative identity, in order to enter into that whole. And it is thus by a power entering into a relation with another that a new, holistic power emerges.

The causal transformative account gives us strong ontological emergence in a perfectly naturalistic way, without resorting to any *deus ex machina* 'magical' or 'spooky' device, as we will now explain.

4. Causal composition and supervenience failure

Ours is a causal account of emergence. We are not the first to offer a causal account of what emergent dependence consists in (for instance, O'Connor and Wong 2005). However, because we reject certain orthodoxies concerning the nature of causation, we are able to avoid some of the problems of explaining emergence in causal terms. We can understand why some emergentists (e.g. Gillett 2002) are thus suspicious of causal accounts of emergence but we think that our dispositionalist theory of causation bypasses the problems. Distinctive of our account is that we reject the temporal priority of causes over effects (Mumford and Anjum 2011, ch. 5) and this makes our causal theory apt for a 'vertical' account of emergence and not just a 'horizontal' one of causes having later effects at the same level. This requires more explanation.

The issues of emergence versus reductionism and top-down versus bottom-up causation have traditionally been separated. Emergence versus reduction is usually seen as a matter of constitution, and this is a synchronous relation that explains 'verticality': how the lower-level phenomena constitute higher-level phenomena. In constitution accounts, that which constitutes and that which is constituted must exist at the same time, hence constitution being a matter of synchronicity.

There is resistance to explaining such verticality in terms of causation because it is standard to understand causation as a diachronic matter. Following a Humean tradition, causes and effects are purported to involve a temporal asymmetry: if A causes B, then A occurs before B. Hence, one way to decide whether stress caused the bodily disturbance, or the bodily disturbance caused the stress, would on this account be to determine which came first.

With a temporal priority account, causation may look fit only for the explanation of 'horizontal' change, such as when a particular undergoes a routine alteration and, in that respect, a new properties 'emerges' at a later time out of earlier ones. But this alone clearly does not deserve to be

called strong emergence. Indeed, causation cannot tell us anything about how higher-level phenomena emerge if that is a synchronous matter and causation isn't.

However, although we cannot offer a full demonstration here, there is a weight of argument for understanding causation as a matter of synchronicity too. This view can be found in Kant (1791: A203) but goes back to the Aristotelian point that a cause can only affect a change in something if it exists at the same time as that thing (Aristotle *Physics*: VII, 2). So, for example, we are accustomed, through orthodox thinking, to saying that the floor first gets wet and then only later does someone slip on it. Yet, such a representation of the case is misleading. The causing of someone slipping only occurs at the time that someone is walking upon the wet surface. The slipping must, then, be simultaneous with the wetness. An earlier incident in which the floor became wet is only the explanation of how it did so: it is not the cause of the slipping.

Suppose the simultaneity of cause and effect is accepted. Do we then have two different inter-level relations that can hold synchronously: constitution and causation? Or do they amount to the same? We will see that they are closely connected. We advance an account of emergence as a special case of bottom-up causation in which phenomena are created that are capable of top-down causing or 'demerging'. But we will be arguing that the causal-transformative account of emergence should replace accounts in terms of mere constitution, for the latter could be no more than aggregation of parts, duly arranged.

Also distinctive of our causal theory is a notion of mutual manifestation (Anjum and Mumford, forthcoming). In order for the components to begin a causal and transformative interaction, they must enter into a mutual manifestation partnership; and this requires that, in addition to the components existing, they must also be suitably related (Paolini Paoletti 2016). Which relations, it may be asked, are needed for powers to form a mutual manifestation partnership? Must the powerful partners be spatially contiguous, for instance? We say that the requisite spatial relations can vary according to the case. A match and the rough edge of its box form a mutual manifestation partnership with respect to the match lighting, and clearly this requires the partners to be in contact. But two radiators at opposite sides of a room needn't be in contact in order to form a partnership with respect to the warming of the room. And people in different countries can be mutual manifestation partners with respect to a telephone conversation. So causation as a mutual manifestation of multiple partners or components is more than simply a matter of spatial arrangement. Of course, the partners have to exist at the same time in order to compose a mutual manifestation partnership.

This framework reconceptualises the discussion. Usually, emergence is closely allied with top-down causation. We say instead that it creates the possibility of top-down, as we will explain shortly, but it is actually a special form of bottom-up causation where, through a causal transformation, the base phenomena create new higher-level powers. What might also be considered radical in our account is that this requires a dynamic view of emergence rather than the static view of constitution and classical mereological composition. Contrary to any initial inclinations, there is no tension between dynamicity and simultaneity. That causes and effect are simultaneous does not entail that they are instantaneous, consistent with transformation taking time. Hence, we say that causation is a *broadly* synchronous matter. Once a mutual manifestation partnership is in place, it can produce its effect.

The effect does not complete itself instantly: it takes time to do so. In that time, there is a process of on-going change that is completed when the cause has eventually exhausted itself and ceased to act. Cause and effect are both temporally extended, therefore, but their extensions are simultaneous.

The dynamic view isn't just about the original formation of emergent properties. The idea is that emergent properties are sustained through the on-going activity; that is, through the causal process of interaction of the parts. A static instantaneous constitution view wouldn't provide this.

It is also distinctive of our account that, being causal, it allows us to deny the strict supervenience of emergent phenomenon *E* on *B*. We have two reasons for denying the supervenience of the emergent.

First, because this is a causal account of emergence, and all cases of causation are subject to the possibility of interference and prevention, they are to be understood as operating with what we call the dispositional modality (Mumford and Anjum 2011: ch. 8). This means that we could have the same type of components, appropriately arranged, and while they may tend to form a certain higher-level emergent property, there is no guarantee that they will do so. We cannot say simply that if we have the same components within *B*, we will have the emergent phenomenon *E*. That depends on the causation working out successfully, and many causes don't succeed in manifesting their effects. Wilson (2016: 378) suggests that all emergentists allow that *E* at least depends on *B* with nomological necessity, but we again deny this. Once *B* is in place, it will dispose towards the formation of *E*, but as this requires the completion of a natural causal process, which is subject to prevention and failure, there is no necessity that we will get *E*.

The second reason for denying the supervenience of *E* on *B* is that once composed into a whole, the parts no longer exist as they did prior to that composition; so you cannot say that the whole depends on those original parts, or that same parts = same whole, when the parts are not the same as before. The parts have been transformed in the process of forming the whole, and thus lose their qualitative identity.

Now someone resistant to our view may say that, while they accept that the parts undergo change, on a causal-transformative view, the claim is that *E* supervenes on the *changed* parts that comprise *B*: so supervenience still holds. But this is confused. We can no longer equate *B* after the causal transformation with the sum of unchanged parts prior to that transformation. On our account, the transformed *B* should instead be *identified* with the whole, along with its emergent properties, that *B* has made. If so, there may be supervenience trivially – because everything supervenes on itself – but what we do not have is *E* supervening on the pre-transformed parts that form the base-level mutual manifestation partnership.

5. Top-Down Causation: Demergence

If there are higher-level and emergent phenomena of the sort we have described, it creates the possibility of top-down or downward causation. This is where a change or intervention at a higher level produces a change at a lower level, such as when a person experiences stress leading to physiological changes. Reductionists who accept that nature is stratified into levels will think that all

causation is bottom-up, for instance that biochemistry is directly responsible for feelings of stress. It is clear that our account is anti-reductionist: it is holist insofar as wholes have different powers from their parts.

It is hard to see how one could accept downward causation unless one also allowed emergence. But an emergentist is not strictly committed to top-down causation. The emergent phenomena could be merely epiphenomenal, though this is an unattractive position. Or an emergentist could claim that emergent phenomena have effects only at the same, high level. This view doesn't avoid all problems, as we will see when we consider the matter of causal closure. To recognise the logical possibility of emergent phenomena with downward causal influence is important, nevertheless, because it shows us that we have to say something more to justify the idea that emergent phenomena can be top-down causes. How, then, would downward causation work?

First we must accept, as we have already argued, that emergence involves the creation of new causal powers possessed by wholes that are not possessed by their parts. The parts have undergone a bottom-up, causal transformation in order to constitute a whole with emergent powers. And note that not all causally interacting aggregates thereby possess emergent causal powers so our account applies only when they do.

What is crucial to acknowledge is that the causal powers that have emerged then have autonomy from the parts; from their emergent base. If we consider some of the examples with which we began – mind, meaning, life – we can start to see how this might be so. A living organism has a power to self-sustain, for instance, involving the regeneration of living cells when old ones die, fuelled by the high-level behaviour of taking in nutrition. A desire to eat is the emergent power that crucially is exercised in the case: for it is a power, the exercise of which is able to ensure the continued functioning of the whole through changes and replacement in the parts.

So what this tells us is that emergent powers can then act on their parts, and this is what we mean by downward causal influence. It might be useful to think of this as, to coin a phrase, demergence. Emergence is where there are new powers of wholes in virtue of causal interactions among their parts; demergence is where there are subsequent new powers of the parts in virtue of the causal action of the whole upon them. This might be better explained by a further example.

6. Example of social phenomena

Another instance we listed of prima facie emergence was social phenomena, which seem able to emerge from component individuals that make up the society. Thus, social science can provide a source of examples (Elder Vass 2012), which we will use to illustrate the causal-transformative view.

First, there is emergence. To see this, we should accept that while societies are constituted by a plurality of individuals, it is also vital that those individuals stand in a certain relation. Specifically, to be a society, the plurality must as a bare minimum be an interacting plurality. We constitute a society because we interact with each other: what we do affects others and what others do affects us.

Our account could be applied to other social phenomena such as shared norms and values, cultural heritage, political structures and duties, shared sense of identity, and so on. But let us focus on language use. A reasonable interpretation of Wittgenstein's (1953: secs 269-75) private language argument is that a solitary individual could not create, sustain or use a language because doing so requires following a set of norms of meaning that can only be supported by an interacting plurality of users. Other language users can correct our usage if we misuse a word, and if they did not do so we would never know that we were using it correctly. We mutually enforce the norms of meaning of the language. Language can then be understood as a higher-level social phenomenon, having normative emergent powers that are more than the mere aggregation of the powers of the individuals who have jointly created the language. To put the point in a blunt form: no single individual had the power to use language. But if a group of individuals form a society, they each then change through their continuing interactions. Their society has the power to create and sustain a language, and doing so involves the transformation of those constituent individuals who then become language users. The causal-transformative model seems to fit the case well and validates the prima facie judgement that social phenomena are emergent.

But there is also demergence. Significantly, the existence of these higher-level normative powers causally affects the behaviour of the individual users. They speak the language, which enables conceptual thinking, literature, philosophical reflection and political ideologies. We see that these linguistic powers thus have autonomy from the prior powers of individuals, illustrated in behaviours we are able to adopt only because we are parts of a language-using community. This includes very simple behaviour, such as when someone uses the word 'internet', but also more sophisticated behaviours such as making lifestyle changes after having read about, or heard about, the health benefits. Language, in these cases, has 'demerged' in the sense that it has gone back 'down' to affect the behaviour of the individual users.

Thus, a demergent property or power is one that something has only in virtue of i) participating in a whole greater than itself, where ii) that has led to the creation of emergent causal powers, which iii) have then in turn produced a further alteration in the constituent parts. Note how these lower-level demerged changes could not have occurred without the action of the higher-level phenomena, as we have shown. But we can see that there is also a two-stage transformation possible for the constituent parts of wholes. They undergo a causal transformation in composing an emergent power. But that emergent – hence higher-level – power is then capable of subsequent downward causal influence, producing further change in the parts.

7. Advantages of this account

There are a number of advantages of our account and here we will mention five.

First, it does not contain any epistemic element. Indeed, the causal-transformative account is consistent with the facts of emergence, in its particular cases, being entirely scientifically accessible. Hence, we could know how *E* emerges from *B* by understanding how the component parts of *B* relate causally in order to produce *E*. In principle, it should be explicable how life emerges from lifeless components, for example (Cairns-Smith 1985). Although it obviously is difficult, requiring

calculations and accuracy, previously unknown emergent phenomena could even be predictable. This very clearly distinguishes strong emergence from weak, which emphasises the role of epistemic states. And in focussing on lack of explanation or prediction of the emergent phenomena, we think weak emergentists get it wrong.

Second, unlike the subset view (Wilson 1999, 2016), we provide an ontological account of the alleged novelty of emergence. The emergent feature has different powers from the base. With the subset view, the emergent feature has fewer powers than the base. With the causal-transformative account, emergent powers will not be a mere subset of the base powers. Until the causal transformation, those emergent powers do not exist in the base phenomena at all. So emergence involves a different set of powers; and once the causal transformation has occurred, the emergent powers exist only in the whole, rather than in the parts, contrary to the subset view.

Third, a more credible account of the causal autonomy of the emergent is provided. Claims of the autonomy of *E* within the subset view can be questioned, for example. Although a proper subset of powers is strictly distinct from the powers of the whole, it is not entirely distinct from it either, so in what sense, it can be wondered, is that subset autonomous? Wilson (2016: 360) has offered a defence of autonomy within a subset view, but we think it is not enough. While, granted, a subset of *B* will technically have a different causal profile from *B*, there is nothing within *E*'s causal profile that is not also in *B*'s. Instead, we posit something in *E* that wasn't in *B* – the new emergent powers – and thereby provide a stronger account of autonomy and holism.

Fourth, our characterisation of emergence is a positive one, in answer to Kim's first challenge. In Kim's account, a property *E* is emergent when it depends upon but is not reducible to *B*. But this, he says, is a negative characterisation, like when we say that something is not-red, which has no unificatory or explanatory power. Our account does not take such a route. Rather, we provide positive conditions for what must happen to *E* in order for it to count as emergent: through their interaction the parts undergo a change from which the whole they compose has a new power. This is as positive a characterisation as any can be.

Fifth, we have provided a serviceable conception of emergence. It is neither too easy for phenomena to count as emergent and nor too hard. We saw that it was a problem if we had such a weak conception of emergence that every whole would count as emergent. What we want is that some phenomena come out as emergent and some don't. What's more, the account applies to the sorts of cases that we think pre-theoretically should qualify as emergent, such as where life emerges from lifeless parts and social phenomena emerge from individual parts. This fifth argument is a very powerful one. The concept of emergence is largely a philosophical artifice. Unlike some other concepts, such as that of causation, there is not much common usage, outside of philosophy, that the philosophical notion must respect. Further, the notion of strong ontological emergence has only been in philosophy for a century or two, with relatively little consensus. It is therefore a strong positive consideration if we can offer a conception of emergence that would be useful to put into service, along the lines we indicate. Adopting this account would give us a principled way in which to distinguish the special nature of some wholes from others.

8. Causal closure

We move now to the second challenge that Kim raised against emergence. It is widely acknowledged that any theory that allows strong emergence has to respond to this problem, which concerns the alleged causal closure of the physical. Perhaps the causal-transformative account we have offered sounds plausible, as it stands; but, unless we can give a credible response to this issue, then it may yet be rejected.

The problem is well-known so we will give only a very short summary, cutting technical corners, including some that arise from our preferred account of causation. According to a standard way of thinking, everything at the base-level is causally closed. Thus, a base-level state or event, B^* , must be caused completely by another base-level state or states, B (whatever we take the relation of causal relations to be). Emergent phenomena seemingly threaten this view. Suppose E is emergently dependent on B . If E is supposed to be able, through downward action, to cause B^* , then the base level cannot be causally closed. Just as bad, if E causes E^* , another high-level phenomenon, but E^* is supposedly emergently dependent on B^* , then the causal closure of the base level is still threatened.

The issue seems especially urgent when it is mental states that are alleged to emerge from physical states. For here, it is said, the causal closure of the physical is under attack, if mental states are capable of downward causal action. And surely they must be. An agent's decision to walk out of the room carries the molecules of her body out of the door. Accepting that a decision is an emergent, causally autonomous power seems to undermine the claim that from complete knowledge of where all the particles of a body are, plus the laws of nature, you should be able to calculate where those particles will be at a later time.

Given this problem, it seems that the emergentist must either:

- a) provide a good reason why causal closure is to be rejected, or
- b) show that her account of emergence does not violate causal closure.

Option a) is sometimes depicted as a rejection of physicalism, thus a non-starter. It is partly so as to avoid this that Wilson (2016) offers the subset view, which is a form of response b). The powers of E are a subset of those of B , hence there is a sense in which both E and B can be causes of B^* . This allows that an effect is systematically overdetermined by E and B but without violating the principle of causal closure. She calls this non-reductive physicalism and acknowledges that it is short of strong emergence. However, we have given a positive account that we say deserves the name strong emergence, and we also explained why we prefer it to Wilson's account. Do we, though, have a plausible response to the causal closure problem?

9. Response to Kim

We are going to say that physicalism is not the problem, here, even though we offer a type-a) response: that causal closure should be rejected.

In the first place, we insist that emergence is not a threat to physicalism, nor vice versa. There is no reason why the emergent phenomena, in our account, are not also physical. We offered the example of life emerging from lifeless parts, but that in no way suggests that organisms are not physical, at least according to most understandings of what it is to be physical. They are just higher-level, and emergent, physical things. Similarly, many physicists think that there are emergent, higher-level phenomena in physics. But that does not disprove the completeness of physics; it just tells us that a full physical account of the world needs to accept higher-level phenomena as well as lowest-level phenomena.

The causal closure of the physical looks to be at risk, however, when we concentrate overly on the mind-body problem, and assume a sharp division between the mental and the physical: a division perhaps supported by the acceptance of the mental as emergent. But the case skews the debate, in our view. We have allowed that it could be perfectly explicable how *E* emerges from its base. And in other cases, there need be no automatic assumption that the existence of *E* threatens physicalism.

What really seems to be the issue, then, is the causal closure of the basal level. One can contest that without disputing the truth of physicalism. Perhaps our account is a challenge to micro-physicalism, if that is the view that the only significant causation occurs within a micro-physical level. We do indeed deny the causal closure of the basal, but we have explained why and shown in what way we do so.

Only a committed reductionist has to defend the causal closure of the basal, and putting it in these terms allows us to question what good evidence there would be for such a reductionism. If it only amounts to a denial of the view that powers of wholes can be more than sums of powers of parts, then we have already had that discussion. Hence, if we decide in favour of emergentism, it makes no sense to raise the issue of causal closure as if it is a subsequent objection to that view. The reasons for allowing higher-level phenomena will have already been considered.

It should also be noted that our emergentism still gives a special place to the base level. It is from the base properties that higher-level properties emerge – they are causally dependent on them – as long as they enter into the ‘right’ causal relations with each other. So it is consistent with the idea that everything is ontologically dependent in some sense on micro-physical entities (see Paolini Paoletti 2016). However, emergent powers can actually affect what there is in the base, effectively making new *B*-level phenomena, such as when scientists synthesise new elements, like ununoctium, that do not naturally occur. So demergence can lead not only to new properties/powers at the lower-level, but in special cases the creation of new entities too.

Because we have a causal-dispositional-transformative account of emergence, *E*-phenomena are not solely dependent on micro-physical entities since *E* also depends on them being appropriately related such that they become a successful mutual manifestation partnership. In our account, this means that the basal level is changed. When the base elements enter into those causal relations, they transform such that sometimes they can no longer be treated as the underlying elements or units. The higher-level whole now has to be understood as the unit because it makes no sense to

disaggregate it into its components. The components have been altered, as we see with quantum entanglement and a host of other cases. We contend, therefore, that it does make sense to reject the causal closure of the basal level.

10. Conclusion

Our aim was to provide a credible account of what strong emergence could be. We believe we have succeeded in that aim, including by showing that the account of emergence does not depend on our epistemic states, how it can have a positive characterisation, how it captures the sense of novelty that is associated with the notion of emergence, how some prima facie cases of emergence could be accounted for, and how there is no automatic threat to physicalism from our causal transformative emergence. What emergence does threaten is the causal closure of the basal level, but that really should be no surprise from a theory of emergence.¹

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