

1. Why Emergence?

Make no mistake; emergence matters. 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.

There is plenty of evidence of emergence in a variety of sciences and not just medicine (Ellis et al. 2012). 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 it 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 at odds with this because it tells us that the bottom level isn't everything.

A key task is to understand exactly what is being asserted by the emergentist, and which is thus denied by the reductionist.

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?

Weak or epistemic emergence is where the emergent phenomena are said to be surprising, inexplicable or unpredictable (e.g. Bedau 1997, Chalmers 2006, Wilson 2016). We will be looking for an account of strong emergence, so that account will not concern our states of knowledge or ignorance.

Here are some of the most significant cases of alleged (strong) 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 need an account of strong emergence that would tell us what conditions have to be met in order for any of these to count as genuinely emergent.

Emergent phenomena are typically understood to be higher level than that from which they emerge. The notions of relatively higher- and lower-level phenomena can be outlined in a metaphysically innocuous way in terms of part-whole composition. If one set of phenomena jointly composes another phenomenon, then it is lower level than it.

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.
- 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?

Consequently, we aim to give an account of strong emergence that is stated in positive terms, to address i. 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).

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.

3. Emergent Causal Powers

We assume that particulars have causal powers or dispositions (Mumford & Anjum 2011) and that properties are clusters of powers (Shoemaker 1980). Because they can be parts of larger particulars, these powers sometimes compose to make resultant powers. We can say that the powers of the wholes will be higher level than the powers of the parts of which they are composed.

It will be useful first 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: that *emergent phenomena are those where wholes have powers that are not possessed by their parts*. A potential problem with this idea is articulating it in a way that makes emergence an ontologically serious notion, and avoids it becoming ubiquitous.

We start by giving some examples (van Gulick 2001) that are too weak to count as strong ontological emergence. But the cases will get progressively more significant until we arrive at our own view, which does count as strong ontological emergence.

A. Mere composition

Composition alone – what we will call mere composition – gives us only a weak form of emergence. If one added two parts together to form a whole, where the first weighed 4kg and the second weighed 6kg, then the whole would have a property/power, of weighing 10kg, that none of the parts had.

This is not emergence. A mere addition of powers (Wimsatt 1996 cases), as we have here, does not adequately satisfy the pre-theoretical requirement of novelty for emergence.

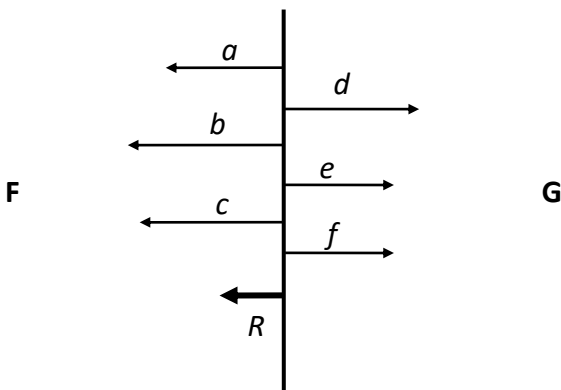


Figure 1: linear composition of powers represented as vectors

B. Nonlinear composition

There might be cases where the powers of the whole are not mere aggregates of the powers of the parts. The first sort of case is a nonlinear composition of the powers of the parts. Nonlinearity was for a time seen as a key idea in emergence (Wilson 2013).

But even if values compose in a nonlinear way, this still does not deserve the mantle of strong emergence. We do not have emergence of a new property here: the composition alters the degree of power only rather than emergence of a new power.

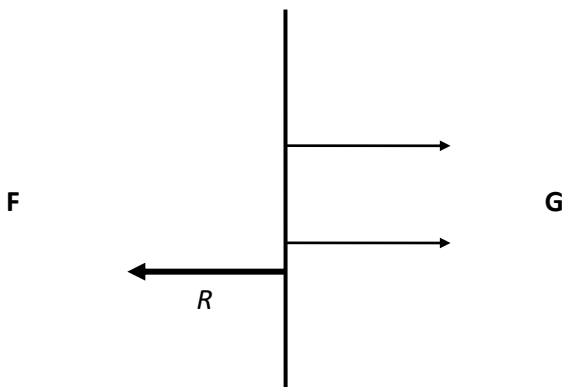


Figure 2: nonlinear composition

C. New properties

Van Gulick also discusses modest kind emergence. This is where the whole has some quality that is different in kind from the qualities of the parts. E.g. 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).

This also allows too much to count as emergent. Composition is merely aggregation along with the appropriate relatedness, which we think is still not strong enough. What the emergentist needs is that the emergent properties are of a radically different kind from those of the base properties.

D. The causal-transformative model

We advocate a 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. There must be at least a qualitative change of the parts in virtue of having entered into a whole.

E.g. 1: chemical bonding involves qualitative changes in the elements which enter into the bonding. In forming a whole, the parts have to undergo change, as in the formation of H₂O. Water has a power to put out fires, but neither of the components of water can put out fires.

E.g. 2: quantum entanglement. When two particles are entangled, they effectively form a causally connected single unit in which the numerical identity of the parts has been lost.

It is clear that 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.

Emergent powers of wholes cannot then be mere aggregates because the 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. It differs from other causal accounts (O’Connor & Wong 2005).

4. Simultaneity of cause and effect

The issues of emergence vs reductionism and top-down vs bottom-up causation traditionally have been separated.

Emergence or reduction is seen as a matter of constitution, which is a *synchronous* relation: what constitutes and what is constituted must exist at the same time.

Issues of causation are typically understood as *diachronic* as they are purported to involve a temporal asymmetry: causes occur before their effects, it is said. It is thus alleged that you cannot give a causal account of ‘horizontal’ emergence (Gillett 2002).

However, there is a weight of argument for understanding causation as a matter of synchronicity too: see Aristotle, Kant. The floor might first get wet and then, only later, does someone slip on it. Yet the causing of someone slipping only

occurs at the time that someone is in contact with the wet surface.

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 as we understand emergence as a special case of bottom-up causation in which phenomena are created that are capable of top-down causing or “demerging”.

This reconceptualises the discussion. Usually, emergence is closely allied with top-down causation. We say it creates the possibility of top-down, but it is actually a special form of bottom-up, where, through a causal transformation, the base creates radically new kinds of higher-level powers.

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. 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 holistic insofar as wholes have different powers from their parts.

What is needed is that the causal powers that have emerged then have autonomy from the parts; from their emergent base. E.g. 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 in and replacement of the parts.

6. Advantages of this account

There are advantages of our account. We 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 identifiably accessible (e.g. Cairns-Smith 1985 on the origin of life). Hence, we could know how E emerges from B by understanding how the component parts of B relate causally in order to produce E. This very clearly distinguishes strong emergence from weak. And, in focussing on lack of explanation or prediction of the emergent phenomena, 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 because they are a mere subset of them.

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. Instead, we posit some power in E that wasn't among the powers in B – the new

emergent powers – and thereby we 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. 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.

Fifth, *this is a serviceable conception of emergence*. It is neither too easy for phenomena to count as emergent nor too difficult. Not everything counts as emergent but nor does nothing. The account applies to the sorts of cases we pre-theoretically expect to be emergent and not to others.

7. Causal closure

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.

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.

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.

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

- provide a good reason why causal closure is to be rejected, or
- 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.

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. They are just higher-level, and emergent, physical things.

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. We allow 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 challenging the truth of physicalism. Our account is a threat 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.

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 Paoletti 2016).

However, emergent powers can actually affect what there is in the base, effectively making new B-level phenomena, such as when scientists intentionally synthesise new elements, like ununoctium, that do not naturally occur.

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 in turn 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. They have been altered, as we see with quantum entanglement and other cases.

We contend, therefore, that it does make sense to reject the causal closure of the basal level.

8. Conclusions

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,
- it can have a positive characterisation,
- it captures the sense of novelty that is associated with the notion of emergence,
- *prima facie* cases of emergence could be accounted for,

- 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 is no surprise from a theory of emergence.

One cannot, therefore, take wholes as aggregates of parts in that their dispositions to behave will not be the mere addition of the dispositions of their parts. Entities in our ontology must, therefore, be given an *appropriate-level* consideration.

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