

On the Notion of Diachronic Emergence*

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The notion of emergence couples the notions of *dependence* and *autonomy*, in a way primarily motivated by natural reality’s seeming to exhibit a ‘leveled’ structure, corresponding roughly to relations between goings-on (entities, features) treated by the diverse sciences. For example, people, plants, planets, and other macroscopic objects depend upon lower-level (e.g., cellular or molecular, and ultimately fundamental physical) configurations, in that (at a minimum) the existence of such macro-objects at a time (over a temporal interval) requires the existence of lower-level configurations at that time (over that interval), and the properties of macroscopic objects at a time (over an interval) are to at least some extent a function of properties of these lower-level configurations at that time (over that interval).¹ And yet notwithstanding these forms of cotemporal dependence, higher-level entities and features seem also to be autonomous from lower-level configurations and features in various respects. Perhaps most saliently, the content of and commitment to (at least the approximate truth of) distinctive special-science taxonomies and broadly causal laws naturally suggests that higher-level goings-on are autonomous both ontologically and causally—that is, are both distinct from and distinctively efficacious as compared to their dependence base goings-on. Such broadly pretheoretic appearances in turn motivate attention to a notion of distinctively *metaphysical* emergence, understood more specifically as coupling synchronic or (as I’ll usually put it, to avoid common readings of ‘synchronic’ as involving a single time) *cotemporal* dependence with *ontological and causal* autonomy.

Of course, it is a further question whether the appearances of leveled structure, and associated conception of metaphysical emergence, can be treated at realistic face value. As I’ve argued elsewhere and will briefly discuss below, there are two viable schematic conceptions of metaphysical emergence up to the task, in principle, of such realistic accommodation.² But even supposing I am right about this, one might wonder whether a conception of metaphysical emergence as synchronic or cotemporal is in an important sense incomplete. For the suggestion that metaphysical emergence is (at least sometimes) diachronic can be found in the historical literature, and the suggestion has gained traction of late, with several philosophers recently offering distinctively diachronic accounts of metaphysical emergence supposed to contrast with cotemporal accounts. As Humphreys (2008) puts it:

Approaches to emergence are often divided into two broad categories, those of diachronic and synchronic emergence. The first approach primarily, but not exclusively, emphasizes

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¹As the references to ‘lower level configurations’ indicate, the target conception of emergence here is not aimed at capturing the ubiquitous fact that composite wholes (and features of wholes) are different from individual parts (and features of individual parts). Nor—to look ahead—are target conceptions of distinctively diachronic emergence aimed at capturing the ubiquitous fact that some initially unrelated objects or features might later come to be related, one way or another. Rather, at issue in either synchronic or diachronic conceptions of emergence is the possibility of there being relations constituting leveled structure encoding the sort of dependence with autonomy associated with, e.g., special scientific goings-on *vis-à-vis* (typically massively complex) lower-level physical goings-on.

²I say ‘in principle’ since whether one or other schematic form of metaphysical emergence is properly applied to a given case will depend on further, typically empirical, details.

the emergence of novel phenomena across time; the second emphasizes the co-existence of novel ‘higher level’ objects or properties with objects or properties existing at some ‘lower level’. [...] [S]ynchronic and diachronic emergence [...] at present remain conceptually distinct. (431).

Moreover, and notwithstanding the contrast Humphreys draws here, the novel phenomena associated with purportedly diachronic emergence are, like synchronic accounts, supposed to be associated with the introduction of a new ‘level’ of existent (as on Humphreys’s own accounts of diachronic emergence, to be discussed down the line).

But is there really a need for a distinctively diachronic notion or relation of metaphysical emergence of the sort targeting leveled structure? Or—to put the question in a slightly different way—is it really the case that “there is at present no unifying account of diachronic and synchronic concepts of emergence” (Humphreys 2008, 431)? Here I argue to the contrary. In the main, my strategy will consist in considering a representative sample of accounts of purportedly diachronic metaphysical emergence, and arguing that in each case, the purportedly diachronic emergence at issue either can (and should) be subsumed under a broadly synchronic account of metaphysical emergence, or else is better seen as simply a case of causation. In addition, I will consider and argue against the suggestion that ‘in-principle unpredictability’ accounts of diachronic emergence support there being distinctively diachronic metaphysical emergence.

The more specific plan is as follows. In §1, I say more about the phenomena motivating cotemporal approaches to metaphysical emergence, and put my preferred schemas for metaphysical emergence of ‘Strong’ and ‘Weak’ varieties on the table, as setup for later arguing that certain accounts of purportedly diachronic metaphysical emergence are subsumable under one or other schema. In §2, I consider certain explicitly causal accounts of such emergence, as per J. S. Mill’s 1843/1973 account of emergence as involving a distinction between ‘heteropathic’ and ‘homopathic’ effects, and O’Connor and Wong’s 2015 account of emergents as diachronically caused. Here I argue that metaphysical emergence as a diachronic causal phenomenon can (and should be) synchronically accommodated as involving emergent powers of a composite to produce the effects in question. In §3, I consider accounts of diachronic metaphysical emergence in terms of temporally extended processes, as per Mitchell’s 2012 account of emergence as involving dynamic self-organization, and Humphrey’s (2008) ‘historical’ account of pattern emergence. In §4, I consider whether accounts of metaphysical emergence in terms of fusion or transformation, as per Humphreys 1996 and 2016, and Sartenaer and Guay 2016, support there being distinctively diachronic emergence. Here I argue that while fusion or transformation is a genuinely diachronic relation, this relation is plausibly just causation of an intralevel variety—in which case, there’s no clear relevance to emergence. In §5 I consider whether certain epistemic accounts of emergence in terms of ‘in-principle unpredictability’, as per Broad 1925, Bedau 1997, and Chalmers 2009, provide a basis for positing diachronic metaphysical emergence; in each case I argue to the contrary. I conclude, in §6, that for all that has been advanced so far, there is no need to posit an irreducible notion of diachronic metaphysical emergence.

1 Cotemporal metaphysical emergence: motivations and schemas

1.1 Motivations for cotemporal emergence

As above, the notion of synchronic or cotemporal emergence is primarily motivated by appearances suggesting that special-science entities (cells, organs, trees, birds, gases, hurricanes, humans) and their characteristic features *cotemporally depend on* yet are to some extent *autonomous from* lower-level, and ultimately physical, configurations and their features. Among the relevant considerations are ...

- *Scientific consensus*: It is standardly assumed that the only matter/substance is physical matter/substance, and that features of a given macro-entity over a temporal interval are at least in part a function of features of the base-level (ultimately fundamental physical) configuration(s) upon which the macro-entity depends, over that interval.
- *Distinctive taxonomies and laws*: Special-science entities/features are classified under types/governed by laws seemingly different from those classifying/governing base-level configurations/features.
- *Universal properties and behaviour*: Many special-science entities (e.g., thermodynamic systems near critical points) exhibit features that are functionally independent of various features of underlying micro-configurations.
- *Perceptual unity*: Macroscopic objects appear to us as comparatively stable/unified entities, even though materially constituted by complex, constantly changing micro-configurations.
- *Compositional flexibility*: The existence and persistence of many macro-entities appears to transcend that of underlying micro-configurations, in not depending on any *specific* micro-configuration(s).

Each of these considerations involves an appeal to some characteristic or feature of a seeming higher-level entity or feature *vis-à-vis* a lower-level (ultimately fundamental physical) micro-configuration which cotemporally ‘underlies’ the higher-level entity or feature. Hence while there are many different treatments of these appearances, some aiming to accommodate them in metaphysical terms, others in epistemic or representational terms, it is very common (though, looking forward, not uniformly) for these treatments to suppose that emergence is a cotemporal phenomenon.

That emergence is cotemporal is also reflected in two other very common assumptions of these accounts. First, related to the usual scientific supposition that the only substance is physical substance, accounts of emergence of whatever variety are offered as contrasting with substance dualist or pluralist accounts of the sort associated, e.g., with Cartesian dualism, which in a certain sense are compatible with the existence of ‘levels’. Given that emergents are not associated with any new substance, and if non-substantial goings-on (whether entities or features, no matter) depend for their existence at any time on the occurrence of some substantial goings-on at that time, the need for a cotemporal base entity or feature follows. (To flag the supposition of substance monism, in my 2021 I specify that the cotemporal dependence at issue in emergence is ‘material’.) Second, accounts of emergence of whatever variety very commonly assume that emergents require and are at least nomologically necessitated by (as I put: ‘minimally nomologically supervene on’) their dependence base features; moreover, many such accounts require that the necessitation hold with metaphysical necessity (such that any world where the base goings-on occur is a world where the emergent occurs). But supervenience of either variety presupposes that supervenient and base goings-on are cotemporal; for if not, then the base goings-on might occur without the supervenient goings-on occurring (if, say, the world were to end immediately after the base goings-on occurred).³

1.2 Two schemas for cotemporal metaphysical emergence

As above, in aiming to realistically accommodate the appearances of leveled structure, accounts of cotemporal metaphysical emergence characterize this phenomenon in ways ensuring that emergent

³It is also worth noting that the assumption of minimal nomological supervenience reflects that target conceptions of cotemporal emergence don’t aim to encode the uninteresting fact that wholes typically (seem to) have properties parts don’t have; rather, at issue is a (metaphysical, epistemological, or representational) relation between or involving higher-level goings-on and lower-level configurational goings-on, with the focus typically being on the emergence of higher-level features from features of lower-level configurations (pluralities or relational aggregates).

goings-on are both ontologically and causally autonomous from—that is, distinct from and distinctively efficacious as compared to—the goings-on upon which they cotemporally depend. But is such an account viable? An initial and pressing concern with taking these appearances at realistic face value is one stemming from the concern, raised by Kim and others, that taking there to be cotemporally dependent, distinct, and distinctively efficacious features gives rise to problematic causal overdetermination. And indeed, some responses to Kim’s problem undercut one or other of the supposed features of cotemporal metaphysical emergents, including a reductive physicalist response (denying the distinctness of higher-level and lower-level features), an epiphenomenalist response (denying the distinctive efficacy of the higher-level feature), and an eliminativist response (denying the existence, even as reducible, of the higher-level feature).

But there are, I have argued, two available metaphysical emergentist strategies of response. The first is that encoded in British emergentism (as per Mill 1843/1973, Alexander 1920, Morgan 1923, and Broad 1925), understood as “the doctrine that there are fundamental powers to influence motion associated with types of structures of particles” (McLaughlin 1992, 52).⁴ On this conception, some cotemporally dependent higher-level features are fundamentally novel in having of being associated with fundamentally novel powers—powers not had by the dependence base features. This strategy corresponds to the following schema:

Strong Emergence: What it is for token feature S to be Strongly metaphysically emergent from token feature P on a given occasion is for it to be the case, on that occasion, (i) that S cotemporally materially depends on P , and (ii) that S has at least one token power not identical with any token power of P .

As discussed, the first condition encodes substance monism and minimal nomological supervenience. The second condition captures a strong sense in which an emergent feature may be causally, hence ontologically, autonomous as compared to the base feature, in virtue of having a new power—one not had by base feature.⁵ Again, the base feature is a feature of a configuration (plurality or relational aggregate), and the novelty of power should be understood accordingly: the novelty is *vis-à-vis* powers of the configuration (configurational feature) upon which the emergent cotemporally materially depends, not (just) *vis-à-vis* powers of individual components or elements of said configuration. Relatedly, S ’s novel power is not just non-fundamentally novel—reflecting a merely aggregative difference between powers of (features of) a composed entity and (features of) its components), but is fundamentally novel.⁶ A Strong emergent is distinctively efficacious in having a power not had by its base feature, and the two features are thereby distinct, by Leibniz’s Law.

The second emergentist strategy offered in response to Kim’s problematic is that encoded in diverse forms of non-reductive physicalism, associated with accounts of non-reductive realization as involving (among other suggestions) functional realization (as per, e.g., Putnam 1967, Boyd 1980, Poland 1994, Antony and Levine 1997, Melnyk 2003, Yates 2012), the determinable-determinate relation (as per, e.g., MacDonald and MacDonald 1986, Yablo 1992, Ehring 1996, Wilson 2009), and constitutive mechanisms (as per, e.g., Craver 2001, Haug 2010, Gillett 2016). As I have argued, each of these forms of non-reductive realization aims to characterize higher-level features as non-fundamentally novel, and moreover arguably achieves this aim by associating realized higher-level

⁴Down the line I’ll offer reasons for thinking that this conception correctly tracks the views of Mill, Alexander, and Lloyd Morgan (§2), and Broad (§6). See also McLaughlin 1992 and discussions in Wilson 2013, 2015, and forthcoming.

⁵Or in any case, not had in the same way—if one thinks that in virtue of being a kind of necessary precondition for the strongly emergent feature and its associated fundamental power, there is a sense in which the base feature indirectly (also) has the power.

⁶It is not necessary to register in the schema that the novel power *Strong Emergence* is *fundamentally* novel, since qua feature of a configuration, P will have any non-fundamental powers attaching to the mere aggregation of lower-level components.

features with a proper subset of the powers had by base-level features. This strategy corresponds to the following schema:

Weak emergence: What it is for token feature S to be Weakly metaphysically emergent from token feature P on a given occasion is for it to be the case, on that occasion, (i) that S coteremporally materially depends on P ; and (ii) that S has a non-empty proper subset of the token powers had by P .

Here again, the first condition presupposes substance monism and minimal nomological supervenience. And the second condition captures the comparatively weak sense in which an emergent feature can be ontologically and causally autonomous, in having a proper subset of token powers of base feature. Again, the base feature is a feature of a configuration, and the overlap in powers should be understood accordingly; i.e., should not be understood as involving overlap of powers of (a feature of) a macro-entity with powers of (features of) individual entities entering into base configuration. Insofar as higher-level and base-level features are associated with different sets of powers, ontological autonomy is gained, by Leibniz's Law. But how to accommodate distinctive efficacy, given that Weak emergents do not have any new powers? The Weak emergentist answer is that the distinctive efficacy of a Weak emergent is located in the having of a distinctive power profile, reflecting difference-making considerations (if my thirst had been realized a bit differently, I would still have reached for the Fresca) or comparatively abstract systems of laws or causal grain. The key idea here is that there are two ways for a higher-level feature to be distinctively efficacious as compared to its dependence base feature: by having *more* powers⁷ than its base feature (as in Strong emergence) or by having *fewer* powers (as in Weak emergence).

I have elsewhere argued at length (see especially Wilson 2021, Chs. 2–4) that each schema for metaphysical emergence is viable: coherent, illuminating, naturalistically acceptable, and such as to avoid either problematic causal overdetermination or exclusion.⁸ Here I take these overall conclusions for granted. Correspondingly, if it can be shown that an account of purportedly diachronic

⁷That is, by having at least one different power. By 'more' here I don't mean to imply that a Strong emergent has all of the powers of its base, and then some. Indeed, whether a given Strong emergent shares *any* token powers with its base is a further issue.

⁸Importantly, the schemas above do not presuppose any heavyweight notion of powers (as, e.g., associated with irreducible dispositions, or as constitutive of or essential to the features that have them). Rather, the operative notion is as it stands highly metaphysical neutral. As I previously put it:

[T]alk of powers is simply shorthand for talk of what causal contributions possession of a given feature makes (or can make, relative to the same laws of nature) to an entity's bringing about an effect, when in certain circumstances. That features are associated with actual or potential causal contributions ('powers') reflects the uncontroversial fact that what entities do (can do, relative to the same laws of nature) depends on how they are (what features they have). So, for example, a magnet attracts nearby pins in virtue of being magnetic, not massy; a magnet falls to the ground when dropped in virtue of being massy, not magnetic. Moreover, a feature may contribute to diverse effects, given diverse circumstances of its occurrence (which circumstances may be internal or external to the entity possessing the feature). Anyone accepting that what effects a particular causes (can cause, relative to the same laws of nature) is in part a function of what features it has—effectively, all participants to the present debate—is in position to accept powers, in this shorthand, metaphysically neutral and nomologically motivated sense. (2015, 354)

Relatedly, in what follows the operative notion of causation underlying talk of powers is also metaphysically highly neutral. Again, there are many specific accounts of causation, but it may serve as an initial proof of concept (see Wilson 2021, Ch. 2, for further details) that even a contingentist categoricist Humean, who thinks that causation is a matter of regularities, that features have their powers contingently, and that all features are ultimately categoric, can accept powers and the associated notion of causation in the neutral sense(s) here: for such a Humean, to say that a (ultimately categoric) feature has a certain power would be to say that, were a token of the feature to occur in certain circumstances, a certain (contingent) regularity would be instanced. Contemporary Humeans implement more sophisticated variations on this theme; but the point remains that no 'heavyweight' notion of powers or causation need be presupposed in order to implement the schemas for Weak and Strong emergence.

metaphysical emergence can be subsumed under one or other of the above schemas, the associated motivation for there being such a distinctively diachronic conception would be undermined.

2 Emergence as causal

2.1 Mill's 'heteropathic emergence'

In the founding text of British emergentism, Mill (1843/1973) characterizes emergence via a distinction between two types of effects of joint or composite causes. First are 'homopathic' effects, which conform to 'the principle of composition of causes' in being mere sums of effects of component causes when acting in relative isolation, as when joint application of two forces brings an object to the same place it would have ended up, had the forces operated sequentially. Second are 'heteropathic' effects, which violate the principle in not being mere sums in any clear sense, and are therefore (Mill supposes) indicative of the operation of new laws. As he puts it:

This difference between the case in which the joint effect of causes is the sum of their separate effects, and the case in which it is heterogeneous to them; between laws which work together without alteration, and laws which, when called upon to work together, cease and give place to others; is one of the fundamental distinctions in nature. (408–409)

And Mill offers chemical compounds and living bodies as entities that are capable of producing heteropathic effects.

Since Mill's conception of emergence hinges on a distinction between kinds of effects, and causation is standardly supposed to be diachronic, such a conception might be seen as advancing a diachronic conception of emergence. But this line of thought can be resisted in one of two ways.

First, one can resist the assumption that causation is diachronic. Under the influence of Hume, this assumption has become nearly hegemonic, but it can be and has been denied. Among those endorsing synchronic causation are Newton (as regards, e.g., gravitational interactions), Mary Shepherd (in her 1824 *Essays upon the Relation of Cause and Effect*), Mill himself, and a plethora of contemporary philosophers, including Molnar (2003), Martin (1993), and Mumford (1998), who (like Shepherd and Mill) take causation to involve the mutual manifestation of powers or dispositions.

Second, even if causation is diachronic, a conception of emergence as involving heteropathic effects can be subsumed under a cotermporal conception of emergence as involving powers of a (feature of a) composite entity to produce such effects. As I previously put it:

[G]iven the reciprocal connection between powers and effects, it is straightforward to translate between the two approaches: to say that an effect of a feature of a composite entity is non-additive, relative to effects of features of the parts acting separately, is just to say that the higher-level feature has a power not had by the lower-level base features when in additive combination. (2015, 203)

Indeed, Mill seems to endorse such a subsumption, in moving seamlessly from talk of heteropathic effects to talk of new properties of and laws governing entities capable of causing such effects:

[W]here the principle of Composition of Causes [...] fails [...] the concurrence of causes is such as to determine a change in the properties of the body generally, and render it subject to new laws [...]. (435)

Emergence understood as involving a diachronic failure of additivity of causal influences can thus be understood in terms of the composite entity's synchronically having a new power (to produce the heteropathic effect), as per the schema for Strong emergence, above. Again, such an understanding is reflected in McLaughlin's (1992) characterization of British emergentism:

[British Emergentism is] the doctrine that there are fundamental powers to influence motion associated with types of structures of particles [...] In a framework of forces, the view implies that there are what we may call ‘configurational forces’: fundamental forces that can be exerted only by certain types of configurations of particles. (52)

So we can characterize Mill’s understanding of Strong emergence in terms of powers to produce heteropathic effects rather than in terms directly of heteropathic effects.

There is moreover good reason to characterize Strong emergence in terms of powers rather than associated effects. To see this, first note that in order for a potential cause to enter into producing an effect, appropriate conditions must be in place: for example, for a match to cause a flame, it must be appropriately struck, oxygen must be present, and so on. This crucial fact about causal relations supports characterizing ‘heteropathic’ emergence in terms of powers rather than effects, since otherwise the status as emergent of a given compound would hinge, implausibly, on whether the compound ever happens to be in whatever conditions are requisite unto its causing the effect. If the emergence of a type of compound hinges on whether it has certain powers, as opposed to whether those powers are exercised, then compounds of the same intrinsic type can be judged emergent (or non-emergent) alike—as they should (at least, relative to the same laws of nature).

The previous considerations apply as well to the views of other British emergentists, including Alexander (1920), LLOYD Morgan (1923), and Broad (1925), who similarly took causal non-additivity to be a distinctive mark of physically unacceptable emergence.

That said, one might wonder, in re certain of these philosophers—in particular, Alexander and Lloyd Morgan—whether their references to ‘emergent evolution’, whereby emergent features are a product of causal processes leading (at least locally) to increasingly complex objects and organisms, are intended to motivate a distinctively diachronic notion of metaphysical emergence. To be sure, both Alexander and Lloyd Morgan situate their discussion of emergence in broadly cosmological terms, whereby the instantiation of emergent features is associated with a historical trajectory leading to life, mind, and even, they suggest, something like divinity as a kind of emergent end-game. But here too, the operative conception of emergence is not that of a (diachronically produced) effect, but rather (following Mill) that of a non-resultant feature of a configuration. Diachronic causation is involved in these configurations or structures coming to be instantiated, but whether a given configuration has an emergent feature is a separate matter. As Lloyd Morgan says:

Additive characters, as resultants, may be—I shall accept the hypothesis that they always are—co-existent with constitutive characters, as emergents. There may often be resultants without emergence; but there are no emergents that do not involve resultant effects also. (5)

Hence despite the evocative talk of ‘emergent evolution’, the presence of emergent features would remain in place even if all the leveled structures associated with emergent features of life, mind, and Godhead had sprung fully formed into existence. Rather, consonant with Mill’s view, these British Emergentist conceptions are of a piece with that encoded in the schema for Strong emergence, according to which an emergent feature has at least one token power not had by the lower-level ‘resultant’ feature upon which it cotemporally depends.

2.2 O’Connor and Wong’s causal account

Like Mill, O’Connor and Wong (2005) characterize Strong emergence in terms of the having of non-additive powers:

[A]s a fundamentally new kind of feature, [an emergent feature] will confer causal capacities on the object that go beyond the summation of capacities directly conferred by the object’s microstructure. (665)

So far, such a conception is of a piece with the cotemporal conception in the schema for Strong emergence. Yet O'Connor and Wong explicitly claim that emergents are diachronically caused by temporally prior states of affairs. Why so? One component of their line of thought involves the need to distinguish metaphysical emergents as not just novel,⁹ but such as to contrast with specifically 'structural' properties, where

A property, *S*, is structural if and only if proper parts of particulars having *S* have properties not identical with *S* and jointly stand in relation *R*, and this state of affairs is the particular's having *S*. That is to say, there is nothing more to having the structural property than being composed by parts having certain other properties and bearing certain relations to one another—it is ontologically reducible.

They continue:

The notion of an emergent property can then be understood in part by way of contrast with structural properties. An emergent property is a property of a composite system that is wholly nonstructural. [...] The basic properties and relations of our world will be those properties whose instantiation does not even partly consist in the instantiation of distinct properties by the entity or its parts. It is the thesis of emergentism that some basic properties are had by composite individuals.

In specifying that an emergent is 'wholly nonstructural', O'Connor and Wong register their intent to characterize a strong form of emergence—one contrasting in particular with the sort of accounts of non-reductive realization that (as I argue in Wilson 1999, 2011, 2015, and 2021) rather aim to characterize a weak, physically acceptable form of emergence. As they put it:

Of central importance is to recognize that the relationship of micro-level structures and macro-level emergent properties is dynamic and causal, not static and formal (in a quasi-logical sense). Contemporary discussions of emergence by (Kim 1999), (McLaughlin 1997, though apparently not 1992), and (Shoemaker 2002) all tend, to varying degrees, to assimilate the concept of emergence to the nonreductive physicalist's picture. Insofar as this leads them to assume that the emergent property synchronically supervenes on the microphysical property which is its 'base', the assimilation generates confusion. Emergent properties are basic properties, token-distinct in character and propensity from any microphysically structured properties of their bearers. (664)

O'Connor and Wong then go on to suggest that if this contrast—between 'quasi-logical' emergence of the sort at issue in non-reductive physicalism and the metaphysically 'basic' and 'wholly non-structural' variety associated with strong, physically unacceptable emergence—is to be made out, this will require that emergents be diachronically caused by prior states:

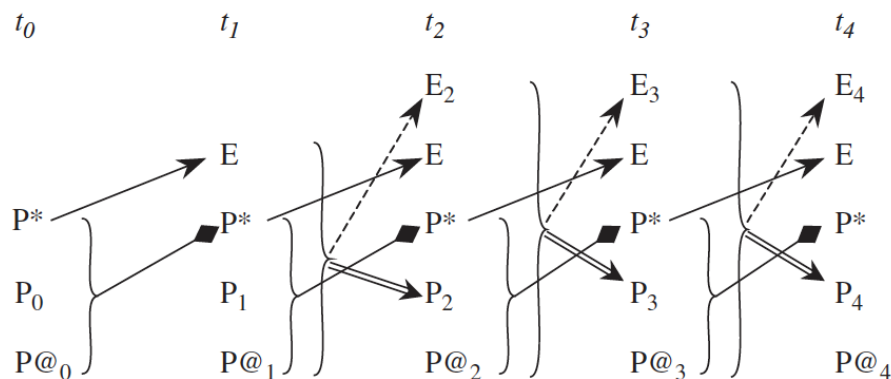
If their appearance in certain systems is to be explained at all, they must be explained in terms of a causal, not purely formal, relationship to underlying, immediately preceding structures.

⁹As they correctly observe: "Older discussions of emergence sometimes spoke of the 'novelty' of such properties in relation to more fundamental physical properties. This term is not felicitous, however. Novelty cannot simply mean "not having been instanced previously," as this has been true of ever so many non-emergent features at various junctures in the world's history (e.g., the first occasion on which a composite had determinate mass *M*, for some arbitrary, large value of *M*). Nor can it mean "not had by any of the object's proper parts," as this is true, e.g., of the mass of any composite" (662-3).

Here, what is dynamic is simply the production of the emergent feature, where the production at issue is supposed to be, one way or another, broadly nomological rather than ‘quasi’-logical. For example, “when a neurophysiological system S comes to have a certain kind of complex physical configuration P^* at time t_0 , the baseline emergent state E is the direct result at t_1 ” (665).

However, this motivation for there being diachronic metaphysical emergence doesn’t go through; for the contrast that O’Connor and Wong aim to capture doesn’t require that physically unacceptable/basic/non-structural emergence be diachronically dynamic and causal. Rather, this contrast can be captured cotemporally, in the way registered in the contrast between the schemas for Weak and Strong emergence: a Strong emergent has (in virtue, e.g., of the coming-into-play of a fundamentally novel force, power, interaction, law) at least one token power not had by (or not had in the same way as) the lower-level (ultimately physical) base upon which it cotemporally depends, whereas a Weak emergent has only a proper subset of the token powers of its cotemporal base. Nothing prevents O’Connor and Wong from cotemporally achieving the distinction that concerns them, since, as they register, “we further suppose that the continuing instantiation of the emergent property depends on the continuing presence of the structural universal that generated it” (665).

Moreover, O’Connor and Wong would do well to endorse a cotemporal characterization of the distinction that interests them. To see why, consider the following diagram, which they offer as encoding a filled-in account of the relationship(s) between emergent properties and underlying microstructural properties:



Dynamical evolution of system S over time

- upward causation of baseline emergent state E
- - - → upward causation of super-emergent states E_n
- ◆ maintenance causation of emergence-sustaining configuration P^*
- ⇒ wide horizontal causation (including downward causation)

Ignoring certain complexities at issue here,¹⁰ I want to flag to attention that in this diagram a configurational physical property is represented as directly causing a higher-level non-structural property that is (as per the Strong emergentist line) supposed not to be physically acceptable. That doesn’t make good sense, since a physical state is not in position (in virtue of being physical) to directly cause any physically unacceptable goings-on. What makes better sense is that an antecedent physical state (property, etc.) causes a later physical state which then serves as a cotemporal basis for the associated nomological posit (e.g., the coming into play of a novel fundamental interaction

¹⁰These reflect O’Connor and Wong’s aim to characterize how there might be standing emergent states (e.g., *being conscious*) associated with more specific emergent states, and how emergent states might have ‘downward’ causal influence. These further issues are irrelevant to the question at hand.

or law) in virtue of which the supervenient emergent has a fundamentally novel power—just as per the above schema for Strong emergence.

3 Emergence as involving temporally extended processes

I next turn to accounts of emergence as involving some or other temporally extended process.

3.1 Mitchell’s appeal to dynamic self-organization

Emergence has sometimes been characterized as involving ‘dynamic self-organization’, as on Mitchell’s (2012) account of the emergence of chaotic complex systems as involving “certain types of non-aggregative compositional structures” (179) (see also Kirchoff 2014). In such cases, the non-aggregativity is dynamic, Mitchell maintains, in arising in a process-like fashion from interactions of the constituents, and in involving feedback loops of the sort characteristic of self-organized systems:

Self-organized systems are ones in which feedback interactions among simple behaviors of individual components of a system produce what appears to be an organized group-level effect. (183)

The flocking of birds is a case in point:

Simple additive relations and simple linear equations [...] fail to make sense out of much of the complexity that we find in nature even though patterns and structures emerge from the simple interactions of the constituents. The vee pattern that emerges in a flock of geese or the more complex patterns of flocking starlings are not predictable by an aggregation of behaviors of individuals in solo flight, but only from the non-aggregative interaction or self-organizing that derives from the local rules of motion plus feedback among the individuals in group flight [...] Ontologically, there are just physical birds; there is no new substance, no director at a higher level choreographing the artistic patterns the flocks make. Nevertheless, this type of behavior is emergent. (179)

Does emergence as dynamic self-organization represent a distinctively diachronic form of emergence? Here again, there is failure of causal additivity. Mitchell’s account differs from the previous accounts, however, in taking the emergence at issue to be constituted by certain *manifested* causal relations. So we cannot reconceive the emergence at issue in terms of cotemporally possessed (potentially unmanifested) powers of a configuration, whether a new power (as per Strong emergence) or a proper subset of powers (as per Weak emergence) is at issue. Nonetheless, as I’ll now argue, in Mitchell’s account we still fail to have an irreducibly diachronic conception of emergence.

Crucial here is to appreciate that non-diachronic accounts of emergence do not require or suppose that emergence be instantaneous, but are rather compatible with emergent features’ manifesting over a temporal interval. The intended contrast on accounts of cotemporal emergence is with diachronic relations, where one of the relata is temporally prior to the other, as in paradigmatic cases of causation. But in that case, cases of dynamic self-organization are not diachronic in the relevant sense. For the manifestations of the patterns in cases of, e.g., flocking birds can be understood as cotemporally (broadly synchronically) dependent on temporally extended lower-level processes.

Here it is useful to compare supervenience theses, where (though supervenience is often characterized as holding at a time) it is standardly granted that base-level and supervenient goings-on may be temporally extended, as needed to accommodate spatiotemporally ‘wide’ goings-on. Hence Lepore and Loewer (1989) observe that, even if externally individuated content properties do not supervene on spatiotemporally local (i.e., neurophysiological) properties, “there may be a more global physical

property whose instantiation explains the possession of content properties” (181). And as a component of Lewis’s ‘Humean supervenience’, the laws of nature at a world supervene on the distribution of intrinsic qualities over the entire reach of spacetime (see, e.g., 1994). Similarly, characterizations of emergence in dynamic diachronic terms can be reconceived as involving the cotemporal emergence of higher-level patterns on temporally extended lower-level goings-on, without undercutting the core intended contrast with diachronic relations whose relata do not (significantly) temporally overlap.

Here again, not only *can* one conceive of dynamic self-organization in cotemporal terms, one *should* do so. For it misrepresents the situation to say that the goings-on at one time emerge from the goings-on at a previous time. What emerges is the pattern as a whole *over* a temporal interval, as a metaphysical consequence of there being certain lower-level causal processes during that same interval. To characterize the emergence of dynamic self-organization in diachronic terms would be to lose the pattern, which again occurs over time, not between times.

3.2 Humphreys’s ‘pattern emergence’

Humphreys (2008) argues that synchronic and diachronic forms of emergence are “conceptually distinct”, in that diachronic emergence often involves ‘historical development’:

[S]ynchronic and diachronic emergence [...] at present remain conceptually distinct. In particular, the current criteria for synchronic emergence are not sufficient for a state or property instance to count as emergent because the historical development of a system’s dynamics is often crucial to the system’s terminal state’s being emergent. There can be two instances of the same state, one of which is emergent and the other not, the difference being solely in the way in which they were generated. (431–2)]

The cases Humphreys has in mind reflect what he calls ‘pattern emergence’, which “involves the appearance in a system of novel structure that results from the temporal evolution of the system” (432). And he gives as examples cases of novel patterns as arising in computational models such as agent-based simulations and cellular phenomena.

There is more to be said here about why such ‘novel structure’ should be taken to involve metaphysical emergence, as opposed to just a garden variety of causation.¹¹ In any case, let us turn to Humphreys’s motivations for thinking that pattern emergence represents a form of emergence which is ‘conceptually distinct’ from synchronic emergence.

Humphreys focuses on cases of emergence that are computationally generated, as in the case of a simple cellular automaton, involving a two-dimensional grid whose cells are ‘seeded’, and to which certain iterative steps are applied. As discussed in Bedau (1997) and (2008), characteristic of certain such automata—as in, e.g., Conway’s ‘Game of Life’—is that the evolution of the system is ‘algorithmically incompressible’, such that (and notwithstanding that the operative rules are entirely deterministic) for sufficiently complex seedings of the grid there is no shortcut means of predicting the evolution of the grid after an arbitrary number of steps; the best one can do is to set up the system and let it roll. Humphreys then supposes that “the cells of the cellular automaton are either

¹¹The motivations that Humphreys cites don’t make the case, as they stand. As scientific motivation, he says that “it is widely agreed within the complexity theory literature that these patterns count as examples of emergent phenomena” (432); but this motivation doesn’t count for much, since scientific claims of emergence typically fail to distinguish between epistemological conceptions of the novelty at issue (such that any ‘surprising’ or unpredictable phenomena count as ‘emergent’). He also says that “the philosophical motivation for accepting this criterion as capturing a certain kind of emergence draws on the philosophical tradition that emphasizes the essential unpredictability of emergent phenomena. The work of C. D. Broad, for example, lies in the essential unpredictability tradition, although he, of course, did not make use of computational criteria” (434). But as we will see, Broad’s appeal to in-principle unpredictability was in service of a now-discredited criterion of Strong, not Weak emergence; and more generally, more needs to be done if an epistemic failure is to be taken to have metaphysical import. I return to this issue in §4.

black or white and after a considerable number of computational steps using the rules that define the CA [...] this pattern is displayed:

[insert bowtie figure.]

Following Bedau, Humphreys takes this pattern as generated by an algorithmically incompressible process to be emergent in a weak, physically acceptable sense. He then goes on to argue that attention to this sort of case suggests that “the historical development of a pattern is essential to its status as an emergent entity”:

It is an essential feature of emergence that the emergent entity must emerge from something else. Consider a token of the bow tie pattern that was generated by running the cellular automaton over n time steps. The process by means of which that token is generated is simply the iteration of the rules n times and it is from that process that the pattern emerges. Now suppose that I print an exact duplicate of that pattern using a bow tie shaped rubber stamp. It is another token of the same pattern, but that token is not emergent because it is generated instantaneously. In fact, there is nothing from which the token emerges, there is just the pattern itself, which was produced at a time instant. This reveals [that] Pattern emergence is an essentially historical phenomenon—whether an instance of a pattern is emergent or not depends essentially upon the process that generated it. It is therefore impossible to determine whether a pattern is emergent by looking only at synchronic relations between the pattern and the spatial array of elements that comprise the pattern. Compare this with what is claimed about synchronic relations such as supervenience or realization. In treatments of emergence that use supervenience relations, such as those of van Cleve (1990); McLaughlin (1997) one is supposed to be able to determine by examining an instantaneous state of a system whether the higher level property is emergent from the lower level. (434)

Given that there can be two instances of the same state, one emergent and the other not, and where the difference lies solely in how they were generated, Humphreys concludes that such emergence involves “an ineliminable element of historicity” (432). Humphreys also draws the moral, on the assumption that the two bowtie patterns are of the same type, that emergence is a feature of tokens, not types.

There are three initial concerns with this line of thought, which I’ll register before putting aside. First (as I’ll discuss in more detail in §5.2) one might deny that mere algorithmic incompressibility suffices for metaphysical, as opposed to mere epistemological, emergence. Second, and moving to Humphreys’s case study: one might deny that there’s any interesting sense in which the bowtie pattern as generated by the cellular automaton is of the same type as a printed bowtie pattern. Granting that the pattern in the cellular automaton case is metaphysically emergent, one might suppose that the designation as emergent attaches to the pattern understood as embedded in a cellular automaton, subject to the associated rules, not just to the superficial appearance of the pattern. Indeed, what would be more relevant for Humphreys’s purposes would be comparing a bowtie pattern as appearing in the initial seeding of the cellular automaton and comparing a bowtie pattern that later ‘emerges’ after some further iterations; for if historicity really is crucial—as Humphreys maintains, especially as motivating the supposed diachronicity of the emergence at issue—it would seem to follow that the initial bowtie pattern should not be deemed emergent (in particular, on Bedau’s conception). But third, that there would be difference in emergence status here doesn’t strike me as at all obvious, especially in light of Bedau’s focus on macro-patterns (or sequences of patterns, as in the case of a glider gun) which are comparatively stable; for a bowtie (or glider gun) found among the original seeding of the grid would go on to manifest the comparatively stable

pattern at issue. These considerations suggest that a specifically historical element is not in fact crucial to deeming a bowtie in a cellular automaton emergent; rather, it suffices for a bowtie to be emergent—in contrast to, say, a printed bowtie—that the bowtie be embedded in the relevant cellular automaton (even as part of the initial seeding). But in that case the motivation for this kind of emergence’s being irreducibly diachronic is undermined.

Even putting these concerns aside, and granting a sense of ‘emergent’ according to which it is essential to a bowtie’s being emergent that the pattern be first generated after some positive number n of iterations of a cellular automaton, Humphrey’s case doesn’t motivate an irreducibly diachronic conception of emergence. For Humphreys, like Mitchell, incorrectly confuses synchronicity with instantaneity. Again, it is no part of the various understandings of cotemporal metaphysical emergence to require that such emergence be instantaneous. Hence just as whether a given H_2O molecule is properly deemed ‘water’ (or not) may depend on spatiotemporally non-local goings-on, so may it be, at least in principle, that whether a given locally present pattern is properly deemed emergent (or part of an emergent phenomenon) may depend on spatiotemporally non-local goings-on. Relatedly, Humphreys is incorrect to assume that supervenience-based treatments of emergence build in that emergent status supervenes on instantaneous lower-level states. Rather, emergence of the physically acceptable variety associated with patterns in cellular automata can be understood as involving a temporally extended dependence base, as per the above schema for Weak metaphysical emergence.

4 Emergence as fusion or transformation

The accounts so far discussed assume that after coming to be, emergents are cotemporally materially dependent on lower-level, ultimately physical goings-on. Accounts of emergence as involving fusion or transformation relax this assumption; I address each approach in turn.

4.1 Emergence as fusion

Humphreys’s (1996) account of emergence (see also his 1997 and 2016) involves the fusion of property instances:

I adopt the property-instance approach to events [...] represented by notation such as $P_m^i(x_r^i)(t_1)$, wherein the property P_m^i is possessed by the object x_r^i at time t_1 . Here the superscript denotes the level of the property (or object) and the sub-script indexes the properties (or objects) within that level. [...] One kind of emergence [...] can then be the result of what I call the fusion of two property instances. If [...] is such a fusion operation, then if $P_n^i(x_r^i)(t_1)$ and $P_m^i(x_s^i)(t_1)$ are i -level property instances, then the fusion of these two instances, $P_n^i(x_r^i)(t_1) * P_m^i(x_s^i)(t_1)$, produces an $i+1$ -level property instance [...] the action of fusion [...] is usually a dynamic process. (60)

Here again, the powers of the emergent are taken to be non-additive:

[A fusion] is a unified whole [in that] its causal effects cannot be correctly represented in terms of the separate causal effects of $P_n^i(x_r^i)(t_1)$ and $P_m^i(x_s^i)(t_1)$. (10)

And since the components no longer exist in the fusion, fusion is genuinely diachronic:

[W]ithin the fusion [...] the original property instances [...] no longer exist [...] In the course of fusing they become the $i+1$ -level property instance. We thus have a way of describing the sense in which emergent property-instances depend upon temporally prior phenomena. (10)

Does fusion emergence represent a distinctively diachronic form of emergence? Note that the previous strategies I have offered for resisting this claim do not apply here: we cannot take this variety of purported emergence to reflect either the cotemporal emergence of novel powers of composites, or the presence of a temporally extended emergence base. Nonetheless, we are still in position to deny that fusion constitutes a distinctive relation of diachronic emergence, on grounds that fusion is simply garden variety *causation* of the sort that on the face of it has no specific relevance to accommodating leveled structure.

Indeed, Humphreys grants that fusion is sometimes causation:

An excellent way to demystify emergence is to view some emergent phenomena as arising from a ‘vertical’ analogue of the ‘horizontal’ case of causation. Certain interactions, some, although perhaps not all, of which are causal, can take things up at least one level in the fine-grained hierarchy alluded to earlier. (1996, 55)

A fusion operation [is] a real physical operation [...] * is neither a logical operation such as conjunction or disjunction nor a mathematical operation such as set formation. * need not be a causal interaction, for it can represent interactions of quite different kinds. (1997, 10)

Humphreys’s remarks also suggest, however, that fusion is not *just* causation, at least insofar as fusion might involve ‘non-causal’ interactions, and insofar as cases of fusion are seen as taking things “up at least one level”, unlike mere cases of intra-level causation. What Humphreys offers in support of these further claims is unconvincing, however.

To start, it’s unclear whether the notion of a ‘non-causal interaction’ makes sense. Humphreys offers quantum entanglement as a case-in-point of such an interaction, but one might maintain that whatever is going on in entanglement, it isn’t properly described as an ‘interaction’, causal or non-causal. Even if the notion of a non-causal interaction makes sense in principle, it’s hard to see how fusion, understood as destructively combining existences so as to create a new existent, could be seen as non-causal. On the contrary, such destructive combination seems paradigmatically causal. Humphreys says that it is “uncharacteristic” of causation that causes go out of existence upon production of their effects. But that’s not so: cases where causes no longer exist once the effect is produced are common in both science (particle pair creation/annihilation, reduction oxidation/combustion, sexual reproduction) and ordinary experience (cooking, eating, burning candles, etc.).

Might fusion rather be a distinctive subspecies of causal (or non-causal, if you like) interaction—one which is inter-level in being able to “take things up at least one level”? That would perhaps motivate the need for an irreducibly diachronic notion of emergence. But the differentium here is unclear. That entities entering into a fusion are destroyed doesn’t suffice for the interaction to be inter-level, since effects of garden-variety destructive causation—e.g., in the case of chemical reactions—are typically intra-level, and relatedly, are not considered emergent. Indeed, Humphreys’s main cases of ‘fusion’ are fundamental physical particle interactions, which on the face of it are intra-level, not inter-level. Nor will the aforementioned condition on fusions, whereby the effects/powers of a fusion cannot be correctly represented in terms of effects/powers of the entities entering into the fusion, do the trick; for intra-level effects of distinct, jointly acting entities typically have powers which can’t be represented in terms of the individual causes, as cases of chemical reactions also illustrate. So far, then, no reason has been provided to see cases of fusion as anything beyond garden variety cases of intra-level causation—in which case fusion is irrelevant to emergence, understood as accommodating leveled structure.

4.2 Emergence as transformation

In his 2016, Humphreys advances an account of ‘transmutational’ or transformational emergence, whereby “an individual that is considered to be a fundamental element of a domain D transforms into a different kind of individual [...] often as a result of interactions with other elements of D , and thereby becomes a member of a different domain D^* ”, with fundamental physical particle transformations again offering the primary case-in-point. Here again, however, it is unclear why the phenomena at issue should be seen as involving emergence of an inter-level variety; for garden-variety intra-level causation (interaction) typically produces goings-on of different types (which, according to Humphreys, “thereby” become members of different domains). To put the concern another way: reductionists could happily accept emergence, if all this comes to is that some fundamental physical goings-on bring about some other fundamental physical goings-on (which may or may not have been previously instantiated); but “It is a commonplace of both scientific and philosophical traditions that emergence and reduction are opposed” (Gibb *et al.* 2018, 5).

A similar point attaches to the account of transformational emergence developed by Guay and Sartenaer (2016, 15):

[C]onsider a natural system S a two successive times t_1 and t_2 of its evolution. [...] the given system at t_2 (S_2) transformationally emerges from the same system at t_1 (S_1) if and only if there exists a transformation [Tr] such that:

- (DEP_d) S_2 is the product of a spatiotemporally continuous process going from S_1 (for example causal, and possibly fully deterministic). In particular, the “realm” R to which S_1 and S_2 commonly belong (e.g. the physical realm) is closed, to the effect that nothing outside of R participates in S_1 bringing about S_2 . And yet:
- (NOV_d) S_2 exhibits new entities, properties or powers that do not exist in S_1 , and that are furthermore forbidden to exist in S_1 according to the laws L_1 governing S_1 . Accordingly, different laws L_2 govern S_2 .

Here the general idea is that the laws applying to S_1 and S_2 are somehow different, and that in particular are such that certain novel goings-on (entities, properties, or powers) which are exhibited in S_2 are ‘forbidden’ from being exhibited by S_1 by the laws governing S_1 . Notwithstanding that the laws governing the states are in some sense incompatible, S_1 and S_2 are supposed to be part of the same (e.g., fundamental physical) ‘realm’, in a way compatible with the causal closure of that realm. And as a case-in-point Guay and Sartenaer discuss the fractional quantum Hall effect, and the fact that a given system might be appropriately modeled by QED_4 at t_1 and QED_3 at t_2 .

Now, one might be inclined to suppose that if the realm occupied by the states S_1 and S_2 really is causally unified, and if the two states are really supposed to be states of a single system S , then the suggestion that different and incompatible laws ‘govern’ the different states of the system has to be taken with a grain of salt, as simply reflecting an artificial (e.g., pragmatic or epistemic) restriction of the full set of laws governing the one system across its various states, in ways properly taking contextual circumstances into account. Putting these issues aside, the fact remains that (in particular, given that the realm is supposed to be causally closed) nothing so far prevents us from understanding these sorts of ‘transformations’ simply as instances of intra-level causation, and hence of no clear relevance to emergence understood as accommodating leveled structure. Indeed, Guay and Sartenaer are explicit that nothing in their version of transformational ‘emergence’ involves the posit of levels:

[O]ne first advantage of [TE] is that the account doesn’t need to posit a discrete hierarchy of levels of nature, within which each system should find a proper place. Such a feature

of [TE] actually constitutes the core of the perspective shift that the account captures [...] In a word, [TE] can thus perfectly tolerate a thorough hierarchical egalitarianism. (17)

Hence by way of contrast with accounts of cotemporal aiming to capture leveled structure, schematically illustrated as follows:

Insert figure 2 (i) here

[TE] is schematically illustrated as follows:

Insert figure 2 (ii) here

Guay and Sartenaer claim that [TE] should count as a form of emergence on grounds that the most ‘classical’ conception of emergence—Lloyd Morgan’s emergent evolution—similarly took the associated diachronic conceptions of dependence and autonomy/novelty at issue to be diachronic, and also on grounds that [TE] makes sense of claims offered by scientists that certain diachronic phenomena involve emergence; they also offer by way of indirect motivation that given the lack of commitment to leveled structure, their conception of emergence is immune to Kim-style concerns about causal overdetermination. As with Humphrey’s stated motivations for a diachronic notion of emergence, these motivations don’t go through: as above, the role of diachronicity in Lloyd Morgan’s (and Alexander’s) discussions of emergent evolution is dispensable, and besides the ultimate point of the cotemporal leveled structure that was their real concern; that scientists are unreflectively inclined to describe any novel or unpredictable phenomena as ‘emergent’ doesn’t in itself count for much; and as I’ve argued (most recently in my 2021), instantiations of the schematic accounts of Weak and Strong metaphysical emergence above successfully address Kim-style concerns about causal overdetermination, and moreover do so in a way accommodating the considerations supporting there being leveled structure. At any rate, what counts for present purposes is that the phenomenon at issue in [TE] is, even by Guay and Sartenaer’s own lights, ultimately just causation of an intra-level variety, qualified as involving circumstances giving rise to some novel phenomena—again, as is anodyne in cases of causation—and so is irrelevant for purposes of characterizing metaphysical emergence understood as accommodating leveled structure.

Taking a step back: in his (2016), Humphreys also tantalizingly suggests that new fundamental interactions might underlie the transformations associated with fusion. Indeed, as I have argued, the coming-into-play of a novel fundamental interaction might well be characteristic of metaphysical emergence—of the Strong variety, in particular (see Wilson 2002, 2015, and Wilson 2021). But, two points.

First, these cases are ones where there is independent reason, as per, e.g., the existence of an associated special science (psychology, say), for taking the novel fundamental interaction to generate a distinctive level; moreover, in these cases the higher-level goings-on are again cotemporally dependent on some lower-level goings-on. In cases where the novel fundamental interaction is not associated with a distinctive special science—as in the physical particle fusions that are Humphreys’s primary case-in-point—it remains unclear that, or why, one should see the novel interaction as generating a new level, as opposed to simply constituting an additional fundamental (in Humphreys’s cases, fundamental physical) interaction. Here it’s also worth noting that on the assumption that there is no cotemporal dependence base for the product of a fusion, there is pressure *not* to characterize the product of fusion as occupying a higher ‘level’, at least if levels are understood, as per usual, as tracking the domains of the various sciences, and associated taxonomies and laws. After some lower-level goings-on fuse, nothing is left behind at the lower-level (there is no cotemporal base for the fusion); but then how can the lower-level laws continue to operate, as they presumably must do?

The lower-level laws require lower-level goings-on upon which to operate, including any products of fusions there may be. But then such products turn out to occupy the same level as the components of the fusion, after all.

Second, even granting that in some cases fusion can involve a novel fundamental interaction generating a new level, this much doesn't yet establish the need for a distinctively diachronic notion of metaphysical emergence. For even in this best-case scenario, the spectre of cotemporal assimilation re-emerges, in the form of fundamental fields serving as a cotemporal material base for such interactions. As I note in my (2021):

[I]t is common to take a given fundamental interaction to either be or be associated with a specific collection of fields. If fields are understood as objects (or some other kind of entity), then it might be natural to see them as having features and associated powers of their own [...]. (132–3)

The upshot is that cases of fusion and transformation can and should be seen just as cases of intra-level causation (or non-causal interaction, if such there be). But in that case, there's no clear relevance to emergence, understood as aiming to capture leveled structure.

5 From in-principle unpredictability to diachronic emergence?

Besides the explicitly metaphysical approaches to cotemporal emergence encoded in the schemas for Weak and Strong emergence, some epistemic accounts of emergence are intended to have metaphysical import. Moreover, some epistemic accounts are or plausibly could be cashed in diachronic terms—in particular, accounts on which at a given time it is 'in-principle unpredictable' how a given system will evolve in future. If such an epistemic feature could be seen as tracking metaphysical emergence, then that might support there being distinctively diachronic metaphysical emergence. As I'll now argue, however, epistemic accounts do not have clear metaphysical import and so notwithstanding that in-principle unpredictability is diachronic, nothing follows about the need for a diachronic account of metaphysical emergence.

5.1 Broad's 'in-principle unpredictability' account

British emergentist C. D. Broad's official formulation of his view is as follows:

The emergent theory asserts that there are certain wholes, composed (say) of constituents A, B, and C in a relation R to each other [...] 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). (1925, 64)

Though Broad's official formulation is cashed in terms of in-principle non-deducibility or unpredictability, it is clear from his surrounding discussion that his aim is to characterize a distinctively metaphysical form of emergence—in particular, one involving fundamental 'trans-ordinal' laws. As McLaughlin (1992) notes, "Emergentists often speak of emergent properties and laws as unpredictable from what they emerge from. But [...] the Emergentists do not maintain that something is an emergent because it is unpredictable. Rather, they maintain that something can be unpredictable because it is an emergent" (73). I'll shortly unpack the line of thought leading Broad to characterize his preferred conception of metaphysical emergence in epistemic terms, but let's first observe (as suggested above) that if the line of thought could be sustained, one might see it as supporting

there being distinctively *diachronic* metaphysical emergence, at least insofar as the kind of (lack of) prediction or deduction at issue in Broad’s account could be cast in diachronic terms.

Broad’s line of thought reflects the assumption, typically operative in British emergentist discussions, that non-linearity and associated failures of (additive) predictability were indicative of fundamental novelty. This line of thought was plausible enough at the time.¹² Roughly speaking, the thought was that insofar as forces compose additively, the properties and behaviour of composites not subject to any fundamentally novel forces would be predictable or deducible, at least in principle; conversely, failures of such additivity and consequently of predictability were taken to reflect the operation or obtaining of some fundamentally novel force (power, property, law), and hence emergence of a strong, physically unacceptable variety.

The underlying assumption that non-linearity is a guide to fundamental novelty has since been undermined, however, by the discovery and creation of nonlinear complex systems (e.g. turbulent fluids, populations reproducing under conditions of finite resources, the Game of Life) whose dynamics are non-linear, but which are clearly physically acceptable. Nor does the appeal to in-principle unpredictability bridge the gap to Strong emergence, since due to their sensitive dependence on initial conditions, the behaviours of physically acceptable nonlinear systems are also relevantly in-principle unpredictable (insofar as predictions even a short distance into the future would require resources going beyond those of this or any relevantly similar universe).

To be sure, such nonlinear systems are often suggested to be emergent, albeit Weakly so; hence one might wonder whether one might still maintain that unpredictability of the sort associated with non-linear systems is indicative of either Weak or Strong metaphysical emergence. But—and this is perhaps the deeper concern with epistemic approaches to emergence—it remains unclear why even in-principle unpredictability should be seen as having metaphysical import. After all, reductive physicalists are happy to allow that there may be insuperable gaps in predictability, deducibility, or explainability, while insisting on their reasons for thinking that all goings-on are identical to complex lower-level physical goings-on—e.g., parsimony considerations (as per, e.g., Heil 2003), concerns about causal overdetermination (as per, e.g., Kim 1989), and so on. The advent of a posteriori identities and the like (following Kripke 1972/80) also enters in here, to undercut the assumption that we can draw metaphysical conclusions from failures of conceptual or other forms of entailment. So what appears to be needed is independent reason for thinking that certain epistemic failures really are indicative of metaphysical emergence.

5.2 Bedau’s ‘algorithmic incompressibility’ account

Bedau’s account of physically acceptable emergence takes as its starting point that complex nonlinear systems of both chaotic and nonchaotic nonlinear varieties typically fail to admit of analytic or closed solutions. The absence of analytic or otherwise “compressible” means of predicting the evolution of such systems means that the only way to find out what this behavior will be is by going through the motions: set up the system, let it roll, and see what happens. Such algorithmic incompressibility serves as the basis for Bedau’s (1997) account of physically acceptable (‘weak’) emergence, applicable in contexts where a composed system S has ‘microstates’ (encoding intrinsic states of its parts) whose time evolution is governed by a microdynamic D , and where S ’s ‘macrostates’ are structural properties constituted wholly out of its microstates:

Macrostate P of S with microdynamic D is *weakly emergent* iff P can be derived from D and S ’s external conditions but only by simulation. (378)

¹²At least, given a suitably broad understanding of additivity as involving not just intrinsic but also certain lower-level relational features of composing entities as ‘summands’.

Derivation of a system’s macrostate “by simulation” involves iterating the system’s microdynamic, taking initial and any relevant external conditions as input. The broadly equivalent conception in Bedau’s (2002) takes physically acceptable emergence to involve “explanatory incompressibility”, where there is no short-cut explanation of certain macrostates of a composite system. In being derivable by simulation from a microphysical dynamic, such macrostates are plausibly physically acceptable, such that emergence understood as involving incompressibility “is consistent with reasonable forms of materialism” (Bedau 1997, 376).

Relevant to our present topic, Bedau describes the failure of predictability at issue as diachronic, as specifically involving an inability to antecedently predict the later evolution of a given system. And also relevant to this question is Bedau’s claim that algorithmic incompressibility, or the associated notion of ‘predictability, but only by simulation’, provides a basis for genuinely metaphysical emergence. He offers two reasons for thinking this, but neither establishes the point, at least as relevant to the question of whether there is a need for distinctively diachronic metaphysical emergence.¹³

The first is that the incompressibility of an algorithm or explanation is an objective metaphysical (if broadly formal) fact:

The modal terms in this definition are metaphysical, not epistemological. For P to be weakly emergent, what matters is that there is a derivation of P from D and S ’s external conditions and any such derivation is a simulation. [...] Underivability without simulation is a purely formal notion concerning the existence and nonexistence of certain kinds of derivations of macrostates from a system’s underlying dynamic. (1997, 379)

But as I previously observed:

[S]uch facts about explanatory incompressibility, though objective and hence in some broad sense “metaphysical”, are not suited to ground, in particular, the ontological or causal autonomy of emergent entities. What is needed for such autonomy is not just some or other metaphysical distinction between macro- and micro- goings-on, but moreover one which plausibly serves as a basis for rendering the higher-level features at issue ontologically and causally autonomous from—that is, distinct from and distinctively efficacious as compared to—the lower-level features upon which they cotemporally materially depend.

The second reason Bedau gives is more promising; namely, that the algorithmically incompressible features of complex systems typically enter into macro-level patterns and laws. As Bedau says:

[T]here is a clear sense in which the behaviors of weak emergent phenomena are autonomous with respect to the underlying processes. The sciences of complexity are discovering simple, general macro-level patterns and laws involving weak emergent phenomena. [...] In general, we can formulate and investigate the basic principles of weak emergent phenomena only by empirically observing them at the macro-level. In this sense, then, weakly emergent phenomena have an autonomous life at the macro-level. (1997, 395)

As such, Bedau maintains, “weak emergence is not just in the mind; it is real and objective in nature” (2008, 444). Attention to macro-level patterns is a move in the right direction towards gaining emergent autonomy; but in moving away from a characterization of emergence in terms of a certain (perhaps diachronic) sort of predictability, and towards a characterization of emergence in terms of the specifically metaphysical autonomy of macro-level patterns on micro-level goings-on, the promise of Bedau’s conception as motivating a distinctively diachronic conception of metaphysical emergence is undermined.

¹³The discussion to follow repurposes arguments I give in my (2015) and 2021.

Consider, for example, Bedau's preferred case-in-point of a glider in the Game of Life. Here from a given antecedent seeding of the grid (not containing a glider), one is typically not in position to predict whether the grid will later contain a glider. But that the grid didn't initially contain a glider is irrelevant to whether the associated macro-pattern is present, qua (weak) emergent. What is crucial is that the micro-dynamics are such that certain micro-configurations serve as a cotemporal base for the occurrence of the macro-pattern. Moreover, that the macro-pattern may unfold in, for example, four time steps, doesn't any more show that the emergence at issue is diachronic than it did on Mitchell's understanding of emergence as involving dynamic self-organization: here as there, the micro-base for the macro-pattern may be temporally extended. The upshot is that to the extent that Bedau's account of physically acceptable emergence is properly metaphysical, it is subsumable under the cotemporal conception encoded in the schema for Weak emergence.

5.3 Chalmers's appeal to epistemic two-dimensionalism

Like Broad, Chalmers (2006) characterizes strong emergence—emergence of the sort whose existence would falsify physicalism or materialism—in terms of in-principle lack of deducibility:

We can say that a high-level phenomenon is *strongly emergent* with respect to a low-level domain when the high-level phenomenon arises from the low-level domain, but truths concerning that phenomenon are not deducible even in principle from truths in the low-level domain.

And like Broad, Chalmers intends this broadly epistemic characterization to have metaphysical import:

If there are phenomena that are strongly emergent with respect to the domain of physics, then our conception of nature needs to be expanded to accommodate them. That is, if there are phenomena whose existence is not deducible from the facts about the exact distribution of particles and fields throughout space and time (along with the laws of physics), then this suggests that new fundamental laws of nature are needed to explain these phenomena.

Now, the notion of emergence characterized here appears to be irreducibly cotemporal, in taking the lower-level dependence base to span all space and time. But for the sake of present discussion let's assume that the latter supposition is potentially dispensible, in order to briefly register Chalmers's reasons, developed in his 1996, 2002, 2009, and elsewhere, for thinking that certain epistemic failures should be seen as having metaphysical import, in cases of Strong emergence, in particular.

The strategy Chalmers offers is based in the independent viability and attractiveness of a certain semantic framework—epistemic two-dimensionalism (E2D). On E2D, certain facts about meaning, taken to be a priori accessible, can be used to identify certain facts about modality, expressing what is genuinely metaphysically possible or impossible. Given that the a priori access to meanings proceeds by way of conceiving (as is commonly assumed), then the (suitably idealized) conceivability of certain states of affairs entails that those states of affairs are metaphysically possible. The connection to our present question can be illustrated by attention to Chalmers's primary application of the E2D framework, as motivating the conceivability, hence metaphysical possibility, of zombies: creatures which are physically and functionally like us, but which are lacking in anything resembling conscious awareness. To start, bracketing details about what would constitute relevant idealized conceiving of a scenario in which there are zombies, in any case the conceivability of zombies is enabled by the commonly accepted presence of explanatory gaps between the lower-level physical and qualitative mental goings-on. Moreover, Chalmers takes the upshot of these conceivings to support

consciousness's being strongly emergent, in the sense (consonant with the schema for Strong emergence, above) that conscious mental states would be both dependent on lower-level physical states and yet fundamentally novel as compared to those states:

I think there is exactly one clear case of a strongly emergent phenomenon, and that is the phenomenon of consciousness. [...] it seems logically coherent in principle that there could be a world physically identical to this one, but lacking consciousness entirely, or containing conscious experiences different from our own. If these claims are correct, it appears to follow that facts about consciousness are not deducible from physical facts alone. If this is so, then what follows?

I think that even if consciousness is not deducible from physical facts, states of consciousness are still systematically correlated with physical states. In particular, it remains plausible that in the actual world, the state of a person's brain determines his or her state of consciousness, in the sense that duplicating the brain state will cause the conscious state to be duplicated too. That is, consciousness still supervenes on the physical domain. But importantly, this supervenience holds only with the strength of laws of nature (in the philosophical jargon, it is natural or nomological supervenience). In our world, it seems to be a matter of law that duplicating physical states will duplicate consciousness; but in other worlds with different laws, a system physically identical to me might have no consciousness at all. This suggests that the lawful connection between physical processes and consciousness is not itself derivable from the laws of physics but is instead a further basic law or laws of its own. The laws that express the connection between physical processes and consciousness are what we might call fundamental psychophysical laws.

Now, if Chalmers were correct that attention to E2D provides independent motivation for thinking that conceivability—of the sort enabled, in particular, by certain epistemic failures—is a guide to metaphysical possibility, and in particular can motivate the strong metaphysical emergence of qualitative mental states, then—and again, bracketing that his own epistemic characterization of strong emergence builds in a strong form of cotemporality—one might naturally suppose that diachronic in-principle failures of deducibility and associated conceivings might support the need for diachronic metaphysical emergence.

As it happens, however, Chalmers is not correct that E2D supports taking (explanatory-gap-motivated) conceivability to be a guide to metaphysical possibility. Here due to considerations of space I must be very brief; for detailed exposition, see Biggs and Wilson 2017*a*, 2019, and 2021. The short story is this: E2D qua strategy for reforging the link between a priori access to meanings and metaphysical possibility is itself neutral on the operative epistemology of the intensions via which this strategy is implemented. It has been standardly assumed that this epistemology must be based in conceiving or some close cousin thereof (e.g., rational intuition). But why assume this? Why not take our judgements about the extensions of our concepts or expressions in various hypothetical scenarios to be the product of abduction, or inference to the best explanation? Plausibly, the failure to consider an abduction-based epistemology of the intensions at issue in E2D reflects the common assumption that abduction is an a posteriori mode of inference—one whose epistemic value, in particular, contingently depends on the way things are (e.g., on whether the world is ontologically parsimonious, or on whether more parsimonious theories are more likely to be true).

But as we argue in Biggs and Wilson (2017*b*), abduction is an a priori mode of inference—effectively, because the *ceteris paribus* clauses associated with abductive principles shield them from empirical disconfirmation. The view that abduction is a priori is not as unusual as it may first appear; indeed (as discussed in Biggs and Wilson 2016 and 2019) Kant and Carnap, not to mention Bonjour (1998), Hawthorne (2002), Wedgwood (2013) among other contemporary philosophers, are

plausibly seen as endorsing this view. Moreover, taking the operative epistemology of intentions in E2D to proceed by way of abduction rather than conceiving has the advantage of blocking various objections which are purportedly to E2D, according to which conceptual indeterminacy or inconsistency undermines implementation of the E2D strategy for gaining modal truth, but which are really objections to E2D implemented with a conceiving-based epistemology of intensions. Abduction, being ampliative, has resources to overcome conceptual indeterminacy and resolve conceptual inconsistency.

Again, there is far more to say about these matters than can be said here. But if we are right that E2D is best implemented using an abduction-based epistemology of intensions, then the independent attractiveness of the E2D strategy does not motivate taking explanatory gaps (of the sort enabling certain conceivings, in particular) to have metaphysical import—not in general, and not (more specifically) as regards metaphysical emergence. So no motivation for there being diachronic such emergence is to be extracted from Chalmers’s account.

6 Concluding remarks

I have examined a wide representative range of historical and contemporary accounts of metaphysical emergence which might be thought to characterize this as a diachronic phenomenon, and argued that the emergence motivated by these accounts can be subsumed under one or other cotemporal conception (in the majority of cases), or else is best seen as simply highlighting certain cases of intra-level causation having no clear import for emergence, understood as providing a metaphysical basis for leveled structure. I’ve also argued that approaches to emergence involving one or other (potentially diachronic) epistemic failure purported to have metaphysical import, do not in fact have any implications for whether there is metaphysical emergence, much less for whether there is diachronic such emergence. I conclude that as it stands, there isn’t any need for a diachronic notion of metaphysical emergence.

That said, one might wonder whether there is still a need for a conception of metaphysical emergence going beyond one on which this is a cotemporal phenomenon—namely, a conception capable of handling the metaphysical emergence of spacetime itself, or the metaphysical emergence of goings-on (certain numbers or other abstract structures, perhaps) not located in spacetime. This excellent question deserves detailed consideration, and (at least) a different paper.

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