

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 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 to some extent autonomous from lower-level configurations and features. Perhaps most saliently, the content of and commitment to (at least the approximate truth of) distinctive special-science taxonomies and broadly causal laws naturally suggest that higher-level goings-on are both ontologically and causally autonomous from—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:

*Forthcoming in *Rethinking Emergence* (David Yates and Amanda Bryant, eds.), Oxford University Press. I dedicate this paper to the memory of Paul Humphreys, a brilliant philosopher and generous, insightful interlocutor, whose original, scientifically informed, and metaphysically astute investigations into emergence kickstarted and laid the groundwork for the current renaissance of philosophical attention to this important notion. Those who knew him will miss him greatly, and his work will live on to inspire future generations of philosophers.

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¹See Baysan (this volume) for discussion of the operative notion of levels. As 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.

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

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 such conceptions can (and should) be cotemporally 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. Here I argue that such conceptions can be cotemporally accommodated as involving Weak emergence from a spatiotemporally extended base. In §4, I consider accounts of metaphysical emergence in terms of fusion or transformation, as per Humphreys 1996, 2016, and this volume, and Sartenaer and Guay 2016. Here I argue that while fusion or transformation are genuinely diachronic relations, they may be plausibly seen simply as involving causation of an intra-level variety, in which case they fail to motivate the need for a distinctively diachronic conception of metaphysical emergence, whether or not aimed at capturing leveled structure. In §5, I consider accounts falling under the rubric of ‘contextual emergence’, as per Bishop *et al.* 2022, Silberstein (this volume), Drossel (this volume), and Seifert (this volume). Here I argue that the considerations canvassed in favour of ‘contextual’ emergence may be accommodated as involving causation, where (as per usual) causes (or associated powers or dispositions) enter into producing effects only given the obtaining of relevant background conditions. 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 sense are compatible with the existence of ‘levels’. Given that emergents are not associated with any new substance, and given that 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. (In my 2021 I flag the supposition of substance monism by specifying 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

³The assumption of minimal nomological supervenience additionally supports the previous observation (see note 1) 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).

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 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 are such accounts viable? An initial and pressing concern with taking the appearances of metaphysical emergence at realistic face value is one stemming from the worry, 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 reject 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 or 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 . (Wilson 2021, §2.2.2)

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,

⁴See also McLaughlin 1992 and Wilson 2013 and 2015.

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 at issue in *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.

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 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 coterporally materially depends on P ; and (ii) that S has a non-empty proper subset of the token powers had by P . (Wilson 2021, §2.3.2)

Here too the first condition encodes substance monism and minimal nomological supervenience. 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 conclu-

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

sions for granted. Correspondingly, if it can be shown that an account of purportedly diachronic 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 cotemporal 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)

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.

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. 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 whether references by certain of these philosophers (Alexander and Lloyd Morgan) 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)

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).

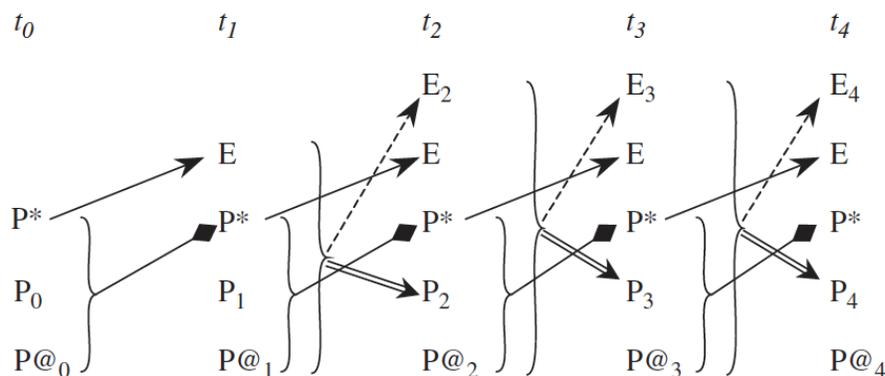
O'Connor and Wong then go on to suggest that if this contrast—between ‘quasi-logical’ emergence of the sort at issue in non-reductive physicalism and the metaphysically ‘basic’ and ‘wholly non-structural’ variety associated with strong, physically unacceptable emergence—is to be made out, this will require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

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 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 modeling the relationship(s) between emergent mental 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)

More specifically, O’Connor and Wong here aim to model how a given ‘neurophysiological system S ’ might have a certain ‘standing’ emergent mental state (e.g., *being conscious*), which in turn is

associated with more specific emergent mental states having ‘downward’ causal influence::

Suppose [...] that E is a very general state of being disposed to visual awareness. At t_0 , P^* obtains, giving rise to the disposition to visual awareness at t_1 . This dispositional state, in conjunction with the total physical state of S at t_1 , and in the presence of certain physical stimuli, causes the visual awareness of a red apple in front of S , E_2 , and an aspect (P_2) of the subsequent physical state. (The physical state of S and its environment at t_1 suffice, apart from E , to maintain the critical structural feature, P^* .) As, let us suppose, the apple is moved and this information is encoded in S ’s physical state, E_2 accordingly gives way to E_3 as well as influencing the perceptual information encoded in P_3 . (666–7)

For present purposes what is most crucial to register is that O’Connor and Wong here suppose that a configurational physical property (P^*) may directly cause a higher-level non-structural property (E) that is (as per the Strong emergentist line) not physically acceptable. That doesn’t make good sense, since a physical state is not in position (in virtue of being physical, at any rate) 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 whatever nomological posit (e.g., a fundamental interaction, force, 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 Kirchhoff 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. As such, 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.

A related point is familiar from discussions of supervenience, 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., Lewis 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 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)]

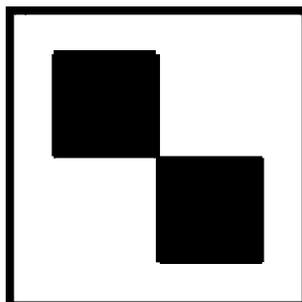
The cases Humphreys has in mind reflect what he calls 'pattern emergence', which "involves the appearance in a system of novel structure that results from the temporal evolution of the system" (432). And he gives as examples cases of novel patterns as arising in computational models such as agent-based 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.¹⁰ In any case, let us turn

¹⁰The motivations that Humphreys cites for his cases' involving emergence don't seal the deal, as they stand. As

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 black or white and after a considerable number of computational steps using the rules that define the CA” the following bow tie pattern:



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 [...] 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

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: “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 I discuss in Wilson 2007, 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.

(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’ve discussed elsewhere (see, e.g., Wilson 2013) 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 this status 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 (on Bedau’s conception, in particular). But third, that there would be difference in emergence status here isn’t obvious, 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, Humphreys’s case doesn’t motivate an irreducibly diachronic conception of emergence. For Humphreys, like Mitchell, incorrectly conflates synchronicity and instantaneity. Again, it is no part of the various understandings of cotermporal 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 nonlocal goings-on, so it may 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 nonlocal 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 the above schema for Weak metaphysical emergence allows.

4 Emergence as fusion or transformation

The accounts of purportedly diachronic emergence so far discussed assume that after coming to be, emergents are cotermporally materially dependent on lower-level, ultimately physical goings-on. Accounts of diachronic 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 subscript 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 *causation* of the sort that, pace Humphreys, 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 in any case 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 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^* " (60). More recently (this volume), Humphreys dispenses with talk of different 'domains', instead simply noting that the transformation relation connects different types of entity:

[W]hat accounts of transformational emergence [...] have in common is that they all allow elements of the fundamental ontology to change over time [...] either the fundamental objects, the fundamental properties, or the fundamental laws can alter. In diachronically producing an emergent entity, at least some of the earlier entities are transformed into distinctively new types of entity in the transition to the emergent entity. This opens the possibility of [...] ontologically novel fundamental phenomena, where the novelty, although not the fundamentality, is a necessary step on the way to emergence.

Humphreys's focus here is on cases where the relata of the fusion relation are all occupants of a single (more specifically, physical) fundamental level, though he allows (following Ganeri (2011) and Santos (2015), that transformational emergence might connect entities at different levels.

As in his work on fusion emergence, Humphreys (this volume) offers certain empirically confirmed cases of fundamental physical particle transformation (muon decay, tau decay) as illustrative of transformation emergence. Hence:

Under the influence of the weak force a tau transforms into other particles, such as a tau neutrino, an electron and an electron antineutrino [...]. Each decay product has at

least one different essential property [namely, quantity of mass] compared to the tau, and none of the product particles possess the disposition to transform in the same way that the tau particle does. We therefore have a case of transformation and genuinely novel entities [...].

Transformational emergence claims that these decay particles are emergent objects on the basis of four features: they develop from the tau particle, they depend for their appearance on the tau particle, they are autonomous from the tau particle, and they have novel properties with respect to that predecessor.

As with the case of fusion emergence, however, and even bracketing the concern that emergence of an intra-level variety isn't to the point of accommodating leveled structure, it is unclear why decay interactions of this sort should be seen as motivating any conception of emergence, since the features Humphreys highlights are again compatible with such interactions' simply being cases of intra-level causation. To wit: effects typically 'develop from' and 'depend for their appearance' on causes (features one and two). Since effects are typically of different types than their causes, they typically have different 'essential properties' and to this extent are both 'autonomous' from (feature three), and such as to have 'novel properties' with respect to (feature four), their causes. To press the concern here another way: reductionists could happily accept emergence, if all this comes to is that some fundamental physical goings-on cause 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 at 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 in 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 different versions of quantum electro-dynamics at different times. Finally, like Humphreys, 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)

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 this issue 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 aiming to accommodate leveled structure.

Now, Guay and Sartenaer claim that [TE] should nonetheless count as a form of emergence on grounds that the most ‘classical’ conception of emergence—Lloyd Morgan’s emergent evolution, as per his 1923—similarly took the 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, however, these motivations don’t go through: as above, the role of diachronicity in Lloyd Morgan’s (and also Alexander’s) discussions of emergent evolution is dispensable and ultimately besides the point of the cotemporal leveled structure that is 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. The upshot is that no good reason has been provided to see the phenomena at issue in [TE] as involving anything more than causation of an intra-level variety, qualified as involving circumstances giving rise to some novel phenomena—again, as is anodyne in cases of causation.

One last gambit remains—namely, to maintain that transformational emergence might suffice to accommodate leveled structure, after all. In his (2016), Humphreys tantalizingly suggests that new fundamental interactions might underlie the transformations associated with fusion. Indeed, as I have argued, an attractive implementation of the schema for Strong metaphysical emergence is one involving the coming-into-play of a novel fundamental interaction (see Wilson 2002, 2015, and Wilson 2021). Hence if fusion/transformation involves new fundamental interactions, and new fundamental interactions “take things up at least one level”, then perhaps transformations involving such interactions might be seen as a diachronic form of emergence, after all. But, two points.

First, the (hypothetical) novel fundamental interactions¹¹ associated with Strong emergence in my previous work are ones where there is independent reason, as per, e.g., the existence of an associated special science (psychology, say), for taking the fundamental interaction to be associated with a distinctive level; moreover, in such cases, the associated higher-level goings-on would again be 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 cases-in-point—it remains unclear that, or why, one should see the novel interaction(s) as generating a new level, as opposed to simply constituting an additional fundamental (in Humphreys’s cases, fundamental physical) interaction.

Second, 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

¹¹Should they be posited; I take no stand on which fundamental interactions exist here.

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.

Even granting that in some cases the fundamental interactions associated with fusions ‘can take things up a level’, this 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 the usually proffered cases of fusion and transformation are plausibly just cases of intra-level causation (or non-causal interaction, if such there be); and even the speculative suggestion that some other such cases might involve a novel fundamental interaction ‘taking things up a level’ is likely assimilable to one or other cotemporal schema for emergence, whereby the fundamental interaction (and associated entities and features) at issue cotemporally depend on one or more fundamental fields. Hence attention to cases of fusion and transformation fail to motivate the need for a distinctively diachronic conception of metaphysical emergence, whether or not aimed at capturing leveled structure.

5 Contextual emergence

Finally, I consider accounts falling under the rubric of ‘contextual emergence’.

I start with Silberstein’s recent characterization (this volume), following on work in Bishop *et al.* 2022 and elsewhere. Silberstein first notes that Weak and Strong conceptions of metaphysical emergence agree in supposing that natural reality is, first, ‘foundationalist’, in that the physical goings-on are both fundamental and compositionally basic, and second, ‘hierarchical’, in that there exist goings-on at higher ‘levels’ of natural reality which cotemporally depend on lower-level, ultimately physical goings-on. Where these conceptions disagree is over whether any seemingly higher-level goings-on are best understood as involving, in addition to whatever fundamental physical power/forces/interactions there may be, fundamental non-physical fundamental powers/forces/interactions: Weak emergentists say no; Strong emergentists say yes.¹²

Contextual emergence differs from these previous approaches in rejecting that natural reality is either foundationalist or hierarchical. Rather, “the emergence of everything at all [e.g., length]

¹²A complication in Silberstein’s discussion is that he takes weak emergence to be a merely epistemic notion. This supposition is common among contextualists, as in Bishop’s (2022) characterization of the ‘false dilemma’ according to which one must choose between weak emergence (which qua merely epistemic is compatible with reductionism and moreover is “banal because it’s ubiquitous”) or strong emergence (which in involving fundamental higher-level novelty is “radical” and “mysterious”). Bishop *et al.* (2022, 33) do discuss my degrees-of-freedom-based (DOF-based) implementation of a subset-of-powers-based account of weak metaphysical emergence, and offer some objections. These include that the DOF-based account may not cover all cases (I respond: the account is offered as a sufficient, not necessary condition, on weak metaphysical emergence), that the DOF-based account supposes that the constraints giving rise to eliminations in DOF are physical, so that the account is really ontologically reductive (I respond: in my paper, I argue that theoretical deducibility is compatible with ontological irreducibility), and that the account takes emergence ‘to be a function of the configuration of the micro-constituents’, but emergence depends on more than just the configurations of micro-constituents (I respond: a powers-based account of weak emergence is neutral on whether the constraints or other determinants of a system or associated feature’s having a distinctive set of powers are extrinsic or intrinsic; and similarly for the conditions requisite for exercising the power).

scales is a function of multiscale interactions’, which are “top-down and bottom-up, and everything in between”. On such a view:

[N]ew relations/interactions at multiple scales in differing contexts naturally lead to the emergence of novel entities, properties, and laws. [...] instead of being as foundationalism describes it, reality is more like multiscale complex networks or structured graphs of extrinsic dispositions.

The ‘context’ in contextual emergence reflects that which dispositions are manifested (which multiscale relations/interactions occur) is typically a matter of broadly extrinsic features or constraints:

Contextual emergence focuses on contexts, but what does this mean? There is a wide variety of contexts, such as a system providing a context for its components, an environment providing a context for a system. [...] Such multiscale features (such as various constraints) can range from the purely physical/mechanical to more mathematical such as purely topological constraints, and everything in between. Such multiscale features can be more or less mechanistic/dynamical or more or less acausal/adynamical as in global or systemic conditions such as being a small-world network (a topological constraint).

Yet more generally, the conditions serving as contexts for multiscale interactions may be “global or systemic, dynamical or adynamical, topological, dimensional, network or graphical, conservation laws, free energy principles, least action principles, symmetry breaking, and order parameters, among other possibilities”. Such conditions are sometimes associated with what Silberstein calls ‘stability conditions’, and may include “global organizing principles such as plasticity, robustness, and autonomy” in biological or other systems.

In Bishop *et al.* 2022, a number of case studies of the multi-scale interactions characteristic of contextual emergence are offered, including, as an evocative start, the synchronous flashing of fireflies:

Even in this relatively simple case, explaining synchronous behavior requires environmental conditions involving temperature, humidity, moisture, darkness, terrain, vegetation, anthropogenic behavior (e.g., low light levels and the absence of other forms of pollution), and so on. Also required are the “biopsychosocial” mating and communicating factors that the fireflies only bring to the table given appropriate contexts that prohibit some firefly behaviors while promoting others to produce synchrony. This is contextual emergence *par excellence*, and we will argue that it is the alternative to strong and weak emergence that some people have been seeking.

Drossel (this volume) also offers several case studies of what she sees as contextual emergence in physics, with a special focus on cases in which the contexts at issue involve “additional information external” to the goings-on treated by the physical theory at issue, which additional information may cite phenomena at either larger or smaller scales. For example, in quantum physics, a measurement of a system as being in a comparatively determinate state requires information about the macro-experimental context (e.g., what orientation a given Stern-Gerlach apparatus is set to measure), such that “a measurement outcome is a clear example of contextual emergence” (see also Bishop *et al.* 2022, Chs. 4–5); in condensed matter physics, the properties of solids (electrical conductivity, heat capacity, and so on) are functions of “the composition, lattice structure, and other properties of the solid”, such that “the phenomena in a solid are contextually emergent”; in thermodynamics, the universal behaviour of thermodynamic systems near critical points can be seen as generated by (e.g., renormalization group) constraints of a ‘mathematical nature’, which should be included “in the set of influences from outside the microphysical level, which are responsible for emergent features”; and in

cosmology, many phenomena are dependent upon “overall properties of the universe”, such that “the expansion of the universe, its energy content, its symmetries and degrees of freedom, the spacetime structure as described by the theory of general relativity, and the second law of thermodynamics are the contextual properties that determine what happens in the universe”. And for a final case-in-point, Siefert (this volume) offers the case of molecular structure, as “not only determined by the interactions of its constituents, but also by the interactions of the system with its environment”, which dependence in turn (per Franklin and Seifert forthcoming) is seen as reflecting that in isolation, the ground state of many molecules corresponds to a superposition of structures—which brings us back to Drosser’s case of quantum measurement.

The general metaphysical view underlying contextual emergence, of a world which is fundamentally interactive and relational, is fascinating; and the proffered case studies of how diverse phenomena depend on a wide range of contextual considerations seem plausible enough. But—to return to the question at hand—does any of this motivate the need for a distinctively diachronic notion of emergence?

Silberstein thinks so. He starts by observing that “there is no logical reason why one couldn’t adopt a diachronic view that also emphasizes contexts beyond the synchronic. This is exactly the position of contextual emergence”. Moreover, he suggests that case studies of seemingly synchronic emergence more fundamentally involve “dynamical multiscale interactions”, so that from that perspective all emergence is dynamic and diachronic. In support, he cites Ladyman (2017) as observing that “Composition is a real feature of the world and is in general diachronic, dynamical, and domain-specific”, and that (pace those offering broadly synchronic accounts of emergence) “the answers that science gives to the special composition question make reference to causal processes, not to instantaneous facts about, for example, how close things are to each other” (3491–2). Silberstein concludes that “with regard to Wilson’s claim (this volume) that there isn’t any need for a diachronic notion of metaphysical emergence, scientifically motivated contextual emergence could not disagree more”.

Silberstein’s line of thought can be resisted, however. To see how, it’s useful to return to the sort of cases which proponents of contextual emergence take to involve this notion—e.g., the synchronization of firefly flashes, the taking on a determinate value upon measurement, the decaying or emitting de-excitation products, the fusing with another celestial body, the vibrating in a certain fashion, the undergoing a phase transition and manifesting associated universal behaviour near critical points, the expanding at a certain rate—given a certain ‘context’.

The first thing to note is that as characterized, these cases are each plausibly just cases of causation, where the obtaining of the causal relation, and the associated production of the effect at issue, is one which depends on the holding of some or other ‘background’ or (if dispositions are at issue) ‘stimulus’ conditions.

That such conditions are requisite to most (all?) cases of causation is a truism, of course. Hence the striking of the match causes the flame—but only against the background conditions that oxygen is present, the match and the striking surface are dry, enough force is applied, and so on. That entities or features enter into producing effects only when in appropriate circumstances is even more salient when thinking of causation as involving powers or dispositions (as Silberstein seems inclined to do, given his view that reality consists in ‘extrinsic dispositions’); for any understanding of dispositions will make reference, one way or another, to these being manifested only under certain (‘stimulus’) conditions. For example, the fragility of a vase encodes that if dropped (among other conditions, including that it is not ensconced in bubble wrap, and so on), it will break. Of course, it may never be dropped; but in any case conditions need to be right for the vase’s disposition to break to be manifested. Similarly, *mutatis mutatis*, for (any understanding of) powers. The same structure—of causes as typically operative in specific circumstances serving as background or stimulus conditions—is true across effectively every account of causation—Humean or non-Humean, productive or counterfactual or transference-based: causes (or potential causes) typically enter into

producing effects only when in certain circumstances. Moreover, these circumstances needn't be merely local, but may include global states of affairs—including, most saliently, the operative laws of nature. Nor need they be merely 'causal-dynamical', but may more generally include any and all relevant environmental, situational, compositional, global, topological or more generally mathematical, symmetry- or conservation-law-involving or more generally nomological, etc., states of affairs. But what are these relevant (circumstantial, background, stimulus) conditions if not the contexts at issue in purported contextual emergence?

Indeed, proponents of contextual emergence agree that contextual factors can be understood in this way, though they think that doing so 'underestimates the importance' of the relationality at issue:

These external, environmental conditions—part of the context shaping firefly behavior—might easily be relegated to nothing but background conditions or boundary conditions, but the view of ontological emergence we advocate in this book—contextual emergence—indicates that this move underestimates the importance of contexts and relationality. (Bishop *et al.* 2022, xxii)

From a metaphysical point of view, however, the question of 'importance' is moot. The bottom line is that cases of purportedly diachronic contextual emergence are plausibly just cases of causation, notwithstanding that (as proponents of contextual emergence nicely point out) a diverse range of background or boundary conditions is in fact operative in such cases.¹³

The second thing to note is that nothing prevents reductive physicalists (or other ontological reductionists) from accommodating cases where what causes what depends on 'context'—that is, on background or boundary conditions which may be nomological, compositional, mathematical, or what-have-you. The reductive physicalist can happily accept that there are 'multiscale' interactions, so long as the entities and features at any given scale are identical to some or other (typically massively complex) lower-level physical goings-on. Of course, whether this is or is not the case is the main source of dispute between reductionists and emergentists of any variety. But the present point is that merely calling attention to the fact that causal relations are often multiscale and highly extrinsically conditioned doesn't in itself go any distance towards establishing the falsity of ontological reductionism. This point bears also on the fact (highlighted by both Drossel and Siefert), that scientific treatments of macrophenomena typically fail to proceed by derivation from first (physical) principles, but rather need to appeal to assumptions or constraints about environmental or other contextual features. Contextual emergentists acknowledge that ontological reductionists will maintain that such appeals reflect merely pragmatic limitations,¹⁴ but they aim, as Siefert (this volume) does, to make a case that such an epistemic understanding of scientific practice is ultimately infeasible. Upon examination, however, these attempts (as in, e.g., Hendry's 2010 argument that properties of molecular isomers require appeal to a 'configurational' Hamiltonian encoding assumptions about the molecules' nuclear geometry) rely on the supposition that derivations cannot appeal to such comparatively 'global' features—a supposition that the reductionist can deny, whether or not current microphysical theory explicitly takes such features into account. As I put it in my (2021):

The considerations Hendry offers in his (2010) appear to presuppose that it suffices for molecular structure to be Strongly emergent that the structure (or associated features) is not determined solely by the locally interacting parts. In particular, he says "the explanation of why molecules exhibit the lower symmetries they do would appear to be

¹³This observation also suggests that contextual emergence is subject to the objection that Bishop (note 11, above) raised to weak epistemic emergence—namely, that it is "banal because ubiquitous".

¹⁴As Bishop (2022) observes: "As a matter of scientific practice and necessity we are often forced to use higher-level descriptions for chemical, biological and social phenomena [...] Nevertheless, this [...] is consistent with a reductively structured world" (245).

holistic, explaining the molecule’s broken symmetry on the basis of its being a subsystem of a supersystem (molecule plus environment). This supersystem has the power to break the symmetry of the states of its subsystems without acquiring that power from its subsystems in any obvious way. That looks like downwards causation” (215–16). However, as I observed in Ch. 3 (§3.3.3) when considering the bearing of spatiotemporally non-local higher-level features on satisfaction of the conditions in Weak Emergence, such non-locality might be seen as indicating just that the dependence base feature must be appropriately spatiotemporally extended. (123–4)

Similar remarks apply, e.g., to Siefert’s case of molecular structure: even if molecular structure cannot be seen as intrinsic, nothing prevents the ontological reductionist from embracing a relational view of such structure. The reductive physicalist, in particular, claims that all seemingly higher-level goings-on are identical to some or other (typically massively complex) lower-level physical goings-on; they don’t claim that all seemingly higher-level goings-on are identical to intrinsic or otherwise circumscribed) lower-level goings-on. Hence even if (to return to Hendry’s case) distinguishing isomers sharing the same Schrödinger equation requires “putting in by hand the parameters that specify an important difference between the two cases: the nuclear positions” (153–4), it doesn’t follow that any Strong emergence is at issue. As I previously put it:

Representational underdetermination aside, presumably the nuclear positions are completely determined by lower-level physical goings-on; but in that case, why think that the need to appeal to such structural details indicates that molecular structure has new powers? (2021, 139)

More generally, it doesn’t follow that ontological reductionism is false. But again—as proponents of contextual emergence seem willing to agree, since they present their view as an alternative to reductionism—“emergence and reduction are opposed” (Gibb *et al.* 2018, 5).

The third thing to note is that even if it can be established on independent grounds that at least some multiscale interactions, or associated dispositions, cannot be treated in ontologically reductive terms, on the face of it nothing prevents the associated emergence from being given a cotemporal treatment, either via the strategy offered above for cases of explicitly causal emergence (à la Mill or O’Connor and Hong) or via the strategy offered above for cases of spatiotemporally extended broadly causal processes (à la Humphreys or Mitchell). In re the latter strategy, it is worth observing that the kind of consideration offered by Ladyman and endorsed by Silberstein, according to which the scientific understanding of composition involves diachronic causal processes as opposed to ‘instantaneous’ states, doesn’t go any distance toward undercutting the viability of a cotemporal treatment, since it involves conflating emergence’s being broadly synchronic or cotemporal with emergence’s being instantaneous. In particular, the varieties of cotemporal emergence at issue in my schemas for Weak and Strong emergence can accommodate dependence bases which are spatiotemporally as broad as need be.

I conclude, then, that the considerations canvassed in favour of ‘contextual’ emergence may be accommodated as involving causation, where (as per usual) causes (or associated powers or dispositions) enter into producing effects only given the obtaining of relevant background conditions, and that (at least for all proponents of contextual emergence have thus far established), such considerations in themselves fail to motivate any notion of emergence, much less one which is distinctively diachronic.

6 Concluding remarks

I have examined a wide representative range of historical and contemporary accounts of metaphysical emergence which might be thought to characterize such emergence as a diachronic phenomenon, and

argued that in each case, the purported emergence can be subsumed under one or other cotemporal conception (in the majority of cases), or else is (for all proponents have established) really just a form of causation. I conclude that as it stands, there isn't any need for a distinctively 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.¹⁵

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¹⁵See Mariani and Wilson in progress.

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