Mechanistic Emergence: Different Properties, Different Levels, Same Thing!

A Commentary on Carl F. Craver

Denis C. Martin

In this commentary I will briefly sketch the notion of "levels of mechanisms" as presented by Carl Craver and propose that we extend it to a more general notion of "level" that ensures wider applicability. The account of levels I develop is essentially based on an account of "properties", claiming dependence of instantiation on a certain epistemic context. The main goal is then to reconcile Craver's notion of "mechanisms" with "emergence" resulting in a contemporary account of "mechanistic emergence" implementing the developed concept of a level. Such an account could provide explanatory potential for and elucidate on seemingly mysterious higher-level properties and their ontology.

Keywords
Causation | Descriptive pluralism | Dispositional essentialism | Dualism | Emergence | Epistemic context | Level | Mechanisms | Mechanistic emergence | Mechanistic explanation | New essentialism | Novelty | Ontological novelty | Part–whole relationship | Properties | Property instantiation | Realization | Unexplainability | Unpredictability

Commentator

Denis C. Martin
denis.martin@hu-berlin.de
Humboldt Universität zu Berlin
Berlin, Germany

Target Author

Carl F. Craver
ccraver@artsci.wustl.edu
Washington University
St. Louis, MO, U.S.A.

1 Introduction

Are mind and brain on the same level? Mental properties and biological properties are so different that some kind of dualism is still an attractive position for many people. Intuitively, mental phenomena are often assumed to be on some kind of higher level than physical phenomena. For example, in order to accurately describe what it means to have compassion for another living being, most people would probably agree with the popular expression that this simply *cannot amount to nothing but* the description of the underlying neurophysiological activity or behaviour *related* to that compassion —that presenting the neurophysiological activity alone does not fully capture all properties of being in a state of compassion. Instead, especially in everyday life, we might rather refer to the phenomenological properties of compassion,

the properties we draw on to identify that we are in a state of compassion at a given time. These properties seem to have a special value for us. In a way, they seem to be much richer than those of "cold" science. But what, exactly, does it mean to say that mental and physical phenomena are not on the same level? If I were to ask what compassion is, most people would probably agree that it is somehow realized by their body, just as an elaboration of this fact does not suffice for a complete description of compassion, implying that there must be something *more* than that, on a *higher* level. This, at least for a philosopher, inevitably leads to the question of what those levels actually *are*. What does "level" refer to? To what extent do levels *exist* in the world at all? These questions become even more pressing when we make ourselves aware of the extent to which the sciences use the concept of "level". Whole disciplines, such as psychology and neuroscience, are distinguished as operating on different levels with different theories aiming at specific target phenomena. Levels also play a role within disciplines. In neuroscience, for example, it is quite common to distinguish between lower-level brain functions as realized in the brain stem or primary sensory areas as opposed to higher-level functions like decision-making or emotion regulation that are attributed primarily to the frontal lobe. Likewise, the distinction of processes and functions as operating "bottom-up" or "top-down" is quite prevalent.

There is a general strategy in science that has proven to be effective for explaining a certain phenomenon: decomposition. The reason for that is as follows: to fully explain a phenomenon, it does not suffice for us to be able to elaborately describe it or list certain correlations with singular components or other phenomena. Rather, we need to know in detail how the phenomenon comes into existence, based on how exactly it is realized: which components underlying the phenomenon are doing what, where, when, and how in order to make the phenomenon emerge. These requirements are captured excellently by Carl Craver's (2007; Craver & Darden 2013, p. 15) famous definition of a mechanistic explanation:

> mechadef/mechanistic explanation $=_{\mathrm{Df}}$ [m]echanisms are entities and activities organized such that they are productive of regular changes from start or set-up to finish or termination conditions. (Craver & Darden 2013, p. 15)

But in what sense are the mechanistic components of a phenomenon on a lower level than the whole phenomenon? This is the question Craver answers in his article "Levels", in this collection.

In what follows, I shall first point out I find most important about Craver's account of levels of mechanisms and where I see some difficulties in his account. I shall then propose an alternative way of defining levels by emphasizing the notion of "properties". The idea here is that levels are a direct result of property instantiations and thereby constitute "property-dependent epistemic dimensions". By focusing on properties in general, and not only on properties of mechanisms, I hope to show that an account of levels does not have to be as restricted as Craver proposes. I shall also argue that levels of mechanisms and levels of emergence do not have to be conceived as necessarily distinct, but can rather be combined quite well into a productive account of mechanistic emergence. Expanding Craver's account of levels this way provides not only a notion of levels with wider applicability but also builds on his account of mechanisms as operating on different levels, which instils explanatory potential into a contemporary account of emergence. This still secures the application of "levels" in science, but at the same time makes transparent how the epistemic contexts of science are property- and level-generative. The ultimate goal of this approach is, of course, to elucidate how one and the same material system may show significantly different properties to an extent that elicits serious confusions about matters of identity.

2 Levels of mechanisms

First of all, the approach Craver takes for defining levels is notable in many ways. What I find especially important, however, is that he develops his definition in an interdisciplinary frame-

work, paying close attention to compatibility with or even application in neuroscience. So what are levels as used in such a scientific context? In his article of this volume, Craver extends his original definition of mechanisms a little to accommodate for the existence of lower-level mechanisms that take part in the realization of higher-level mechanisms.

> I use the term 'mechanism' permissively to describe non-aggregative compositional systems in which the parts interact and collectively realize the behavior or property of the whole. Mechanisms are by definition more than the sums of their parts: they have properties their parts do not have, and they engage in activities that their parts cannot accomplish on their own. (Craver this collection, p. 16)

Mechanisms as construed here are entities and activities organized in non-aggregative compositional systems, such that they are productive of regular changes from start or set-up to finish or termination conditions, and the properties of the whole mechanism are produced collectively through the interaction of its component mechanisms. This establishes the basis for Craver's introduction of levels of mechanisms.

Craver's three defining questions—namely about the relata, the relations, and their placement—constitute a valuable contribution to the conceptual clarification of the term "level" helping to capture the criteria for the correct usage of the term. This already hints at the descriptive pluralism Craver promotes, meaning that there is a set of equally correct ways to use the term depending on the respective answers to these three key questions. In the case of mechanisms, levels are best individuated, according to Craver, in terms of a part–whole relationship between the property "ψ-ing" of S, given that S is a mechanism as a whole, and the property "ϕ-ing" of X, given that X is a mechanism component that is a constitutively relevant spatiotemporal part of S.

Summing up Craver's position on levels and levels of mechanisms as I understand it, they:

- are *metaphors* with multiple distinct conditions of correct usage dependent on the relata, relations, and their placement and
- refer to *part–whole relationships*.
- Levels of mechanisms have *properties* of mechanisms and properties of their parts *as their relata* (as opposed to levels of size, which have objects as their relata),
- are always *non-aggregative* (though aggregative levels do also exist),
- are *not monolithic*, but constitute a *local organizational part–whole hierarchy*, while
- the part–whole relationship must satisfy the *constitutive relevance condition*;[1] **while**
- there is *no causal relation* between them,
- they bear *explanatory potential*,
- and, finally, the *placement* of entities on levels of mechanisms *is weak* in the sense that for all entities that are not related as part and whole it can be said that they are on the same level.

What might the difficulties with this account of levels be? As a minor point, first, there might be some implications of using the concept "metaphor" in connection with levels. By definition, a "metaphor" identifies two things—a primary and secondary subject—with one another, such that one of the two can be captured in description more powerfully (Hills 2010). What could the primary and secondary subject in a level-metaphor be? The primary subject would probably be a level in the sense of a level of mechanisms, the secondary subject could maybe be a plane, a stage, or a degree. But how would that help elucidate what the primary subject levels actually are? As far as I can see, using "level" as a metaphor would more effectively *describe* what a level is, but not actually *define* it and, thereby, simply capture what our intuition about levels is in the first place—namely that it is somewhat analogous to a level in the secondary subject sense. Also, it seems that conceiving of "levels" as a metaphor would

1 "Constitutive relevance": "[…] all the lower-level properties, activities, and organizational features of the parts are relevant to—contribute to—the property or activity of the whole" (Craver this collection, p. 15).

already somewhat negatively answer the question of what levels actually are, as solely existent as a figure of speech—an analogy that could be eliminated without any ramifications. Craver's descriptive pluralist approach is formulated specifically to counteract elimination of levels and thereby to sustain their application in science. However, descriptive pluralism obviously does still act on the assumption that levels are metaphors, and only describes conditions that fit their application better than others. Therefore, this approach does not seem to be particularly helpful for our intended and certainly desirable goal.

Another issue I would like to raise is that in Craver's account of levels as presented here, the key defining feature of levels seems to be a relation condition[2] between certain entities. This already becomes apparent with the three questions mentioned above, which aim to help us adequately describe specific instances of levels. Levels of mechanisms in particular are specified as a part–whole relationship between properties of mechanisms that are located on different levels. But does this really capture what *levels* actually are? Or does it rather render the relation condition *between* levels more precise, instead? While helpful to set the criteria for conditions under which the term "level" is correctly employed, and highlighting distinguishing features of different levels, saying that levels are essentially relations between sets of entities is at best an indirect or descriptive definition of levels and does not seem sufficient for a complete definition. It leaves open how levels come into existence, what their ontological status is, and why we posit certain entities on the same level in the first place, that is, what the commonalities of entities are that lead them to be on the same level.

From the key aspect of a part–whole relationship in Craver's account stems the notion that levels are local and non-monolithic. This means that only those entities that are involved in such part–whole relationships can intelligibly be said to be on different levels. What are our theoretical options for conceptually covering all other entities? Since they don't fulfil the part–whole criterion they cannot be on distinct levels and, therefore, in a sense they are all on the same level. However, according to the definition of levels at hand, to be on any level means that there are other levels, which are distinguished from the first level by the part–whole relationship of the entities involved. Since the entities under consideration do not exhibit this kind of relationship, they are on no level at all. In general, this seems like a reasonable option. But let's consider the case that entities that are not in such a part–whole relationship do, nevertheless, share some features—for example a hedge and a fence both one meter high. In accordance with levels not being monolithic and the previous considerations, these would not be on the same level, but on no level at all. What exactly is wrong, however, with saying that two entities sharing the feature of being one meter high but which are not related as part and whole are on the same level? One could, of course, simply invoke the account of levels of mechanisms and argue that it is designed such as not to warrant such a level. But does this limitation really procure us a better understanding of "level", or could it rather be too restrictive for that purpose? Its consequence, at any rate, is a very strong focus on the vertical dimension, namely the relation between levels, whereas the horizontal dimension, that is, entities related qua being on the same level, is somewhat neglected. So, let us ask, what are the criteria for two entities being on the same level? It is exactly this relation between entities on the *same* level that the concept is primarily supposed to capture, and yet which seems to be underspecified by the definition provided. And how similar do two part–whole relationship units have to be in order for it to be correct to say that their respective wholes and parts are on the same level? Or does it even follow that two things that are not part of one and the same part–whole relationship cannot even be on the same level at all?

As a third point, finally, there remains the issue of the extent to which levels of mechanisms are similar or distinct from levels of realization and emergence, respectively. All three kinds of levels share that an application of the

2 "Relation condition": "the componency relationship between things at higher and lower levels" (Craver this collection, p. 19).

concept of inter-level causation is not feasible in their case, since they do not fit classical assumptions about causation such as non-synchronicity of cause and effect—a very substantial point Craver emphasizes in the target article. But what are the differences between these kinds of levels?

According to Craver, levels of mechanisms and levels of realization seem to differ in that the former exhibit a relationship between wholes and parts, whereas the latter exhibit a relationship between wholes and sets of realizers. But this distinction seems rather frail. How are the parts involved in levels of mechanisms different from the set of realizers involved in levels of realization, such as to warrant this distinction? At least in levels of mechanisms, as Craver envisages them, the parts are several mechanisms that together form the whole, which is comprised of all the particular "part-mechanisms". If mechanisms in general realize certain phenomena, this suggests that all "part-mechanisms" are also realizers in the same way. Now, if the "part-mechanisms" on the "part-levels" are all realizers, it is reasonable to say that the "whole-mechanism" on the "whole-level" is realized by the organized coaction of its parts and that the "part-levels" are the realizers of the "whole-level". Thus, the distinction between levels of mechanisms and levels of realizers conflates.

The difference between levels of mechanisms and levels of emergence, on the other hand, is based on the unpredictability, unexplainability, and metaphysical novelty of higher-level properties, as opposed to lower-level ones. Craver's point here is that levels of mechanisms, while they can be unpredictable, do not have to be so necessarily, that they are always explanatory, and the novelty of higher-level properties is a trivial fact. But why think that the opposite must hold in the case of emergence? Of course, "spooky emergence", "[…] the existence of higher-level properties that have no explanation in terms of the parts, activities, and organizational features of the system in the relevant conditions" (Craver this collection, p. 21), is spooky by definition—that much is clear. Also, admittedly, the way emergence was construed historically by the British Emergentists perfectly fits this view and deliberately opposes mechanisms as it can be found, for example, as per Broad (1925). However, why should we prematurely accept this view of emergence as given and eliminate any possibility of further development towards a notion of emergence that is perfectly commensurable with modern science? In fact, I think the formidable way in which Craver develops his account of levels of mechanisms is perfectly suited to facilitate development in this direction. So what could a definition of emergence be, and how can it be united with mechanisms? The following definition of emergence by Evan Thompson (2007) already seems compatible with Craver's framing of the way properties of higher-level mechanisms are constituted by properties of lower-level ones.

> A network, N, of interrelated components exhibits an emergent process, E, with emergent properties, P, if and only if:
>
> (1) E is a global process that instantiates P, and arises from the coupling of N's components and the nonlinear dynamics, D, of their local interactions.
>
> (2) E and P have a global-to-local ("downward") determinative influence on the dynamics D of the components of N.
>
> And possibly:
>
> (3) E and P are not exhaustively determined by the intrinsic properties of the components of N, that is, they exhibit "relational holism." (p. 418)

This definition is compatible with Craver's characterization of levels of mechanisms in the following respects: properties of higher-level mechanisms, global emergent properties, are realized by properties of lower level mechanisms; and there is a part–whole relationship between those relata, as well as a non-causal influence between the levels. What Thompson's definition additionally contributes is a point about predictability. For many phenomena in

nature, the interactions of lower-level components are so complex that they can only be described by non-linear dynamics. A precise predictability of the higher-level phenomena might not always be possible at present due to there being too many factors involved in the underlying processes—it simply exceeds current computational tractability. Craver acknowledges this point—so it can also be said to be consistent with his account—but worries that this might have ontological ramifications: "[i]f that explanatory relationship is severed, then the sense in which emergent properties are at a 'higher-level' must be altogether different than the compositional notion of levels in levels of mechanisms" (Craver this collection, p. 21). More precisely, he suspects that in emergence ontological novelty arises through the epistemological limitations just mentioned; otherwise ontological novelty would simply be a banal fact already expressed by his account.

There are, however, several problems with this view: first, one can make a distinction between the epistemological (e.g., "predictability") and ontological (e.g., "novelty") dimension of emergence (O'Conner & Wong 2009). There is, in principle, no reason to assume that the ontological dimension is dependent on the epistemological; rather, they seem to be fully dissociable.

Second, his criticism backfires with regard to the banality of the properties that higher-level mechanisms exhibit in his own account of levels. For there to be "higher" levels of mechanisms, these mechanisms must show *new properties*, that is, in order for them to qualifiedly be on that level. Hence, his account cannot go without ontological novelty of some kind. To now say that this ontological novelty would be only a banal fact undermines his very own striving for mechanistic explanation, which certainly is not banal. In fact, it is still interesting how "higher-level" properties come into existence, what it means to say that they are *new*, and how the concept "level" might be connected to this. A successful reconciliation of mechanisms and emergence in the form of mechanistic emergence could provide a solution to this problem.

Third, the dissociability of the epistemological and ontological dimension of emergence does not contradict the possibility of their mere coexistence. Once we dismiss the idea that ontological novelty follows from epistemological intractability, overcoming the restraints of historical accounts of emergence, the fact that the coming into existence of new properties on a higher level is not tractable at the moment does not mean that it is not so *in principle*. The reason why we call this coming-into-existence "emergence", as might be conceived by a revised account, is not based on the fact that it *is* epistemically intractable *in principle*, but rather that it shows novel properties on a higher level that *appear* to be epistemically intractable *in principle*, while they might at some point be very well explained in a mechanistic framework combined with a proper theory of property instantiation.

Thompson's definition leaves room for local components to be part of a mechanism. A mechanistic explanation of the emergent phenomenon, it seems, would not be incompatible with an account of emergence, but rather contribute to its explanation by elaborating on how the organization of the parts is essential for emergent properties to arise. As for the ontological novelty of higher-level phenomena, this is certainly a crucial point in emergence: there are new properties coming into existence on the higher levels that are somehow realized by processes of components on the lower level, which in isolation do not show the same properties as the whole. For this to happen, however, contrary to what Thompson's definition implies, the underlying interactions of the components or the emergent properties themselves must not necessarily be unpredictable in principle. But I anticipate an objection: this form of emergence would again only be very weak or banal, but not ontologically new. As already mentioned above, unpredictability does not have a bearing on ontological novelty and is therefore not crucial for emergence. What levels of mechanisms and emergent levels share is that on higher levels there are *new properties*, which means that there is a notable ontological difference. How extensive such an ontological difference

must be in order not to be banal remains a matter of debate. Still, in the case of mechanisms, as well as in the case of emergence, it is very likely that there is a significant phenomenon making up the higher level—otherwise it probably would not be of such interest for enquiry as it clearly is.

As a result of these thoughts, in what follows I will try to reconcile levels of mechanisms and levels of emergence as two interconnected forms of realization. This alone, of course, does not solve the problem of what the levels involved actually *are*. So in fact there are two problems to be solved for an account of mechanistic emergence: (a.) what it means exactly for a higher-level phenomenon to exhibit *new* properties, and (b.) what exactly constitutes a *level*. As a route to a possible solution, in the next section I will sketch a definition of properties that can be implemented in a definition of mechanistic emergence and that at the same time provides a positive account of levels.

3 Level-carving properties in mechanistic emergence

In this section, I propose an alternative account of levels that is fully compatible with the mechanistic framework and the way in which levels of mechanisms are construed by Craver, but which at the same time has a wider scope of application. Since this account will rely on properties as the crucial defining criterion, I shall first sketch a working definition of the concept of "properties". In a second step, this definition of "property" will conceptually ground the alternative account of levels. Finally, I will implement both the definition of properties and that of levels into a formulation of mechanistic emergence.

What might be a working definition for the term "properties"? Inspired by Brian Ellis' (2002) "new essentialism"[3] and Alexander Bird's (2007) "dispositional essentialism",[4] I propose the following view: what exist in the world are entities with individual dispositional profiles. An example that Ellis (2002) gives is the dispositions of particles to attract or repel each other. These essential dispositions, individuating the particles as that which they are, make it possible for us to formulate laws of nature. Many of these dispositions are the result of structural and organizational combinations of matter with different dispositions, e.g., ions have the disposition to form ionic crystals, which by means of the resulting structural characteristics in turn have other specific physico-chemical dispositions. Those essential dispositions alone, however, are not properties yet. That is because dispositions exist outside of an epistemic context. The property of being one meter high, for example, is dependent on the disposition of an object to exactly fit the measurement revealing it to be the height of one meter. Without the measurement, however, the property is not instantiated—only the disposition of its instantiation exists inherently in the structure of the object. Thus, according to my theory, properties are instantiated through the interaction of the essential dispositions of matter and an epistemic system. Of course, now you will ask what this epistemic system could possibly be. Admittedly, this aspect of the definition is in a particularly embryonic stage and requires further research. As a general characterization, epistemic systems are structured such that they feature sensors or gauges that capture specific dispositions of entities and provide characteristic values as an output. Human and non-human animals, as well as physical devices of measurement, are epistemic systems in this sense. Let us note the following as a working definition of "epistemic system":

> Epistemic system $=_{\mathrm{Df}}$ (ES) Epistemic systems are organized (a.) such as they feature sensors or gauges that pick up a specific disposition exhibited by an entity and (b.) such as there is a transformation of that signal into a particular value characteristic of the system's organization.

3 "[...] things must behave in the sorts of ways they do not because the laws of nature require them to, but rather because this is how they are intrinsically disposed to behave" (Ellis 2002, pp. 3–4).

4 "[...] the claim that fundamental natural properties are essentially dispositional. [...] x is disposed to manifest M in response to stimulus S iff were x to undergo S x would yield manifestation M" (Bird 2007, p. 24).

With this definition at hand we are able to formulate a working definition of properties:

> Properties $=_{\mathrm{Df}}$ (P) Properties are instantiated through epistemic processes, which are constituted by interactions between epistemic systems and complementary dispositional profiles of entities.

Let us now turn to how levels depend on properties. The idea here is that levels are established by the epistemic systems in use that instantiate the properties which belong to the respective level. Measuring ion conductance at an axon with electrodes, for example, establishes properties on a cytological level; whereas measuring reaction times of participants in a behavioural experiment establishes properties on a psychological level. The way in which different epistemic systems — e.g., a functional magnetic resonance imaging (f) scanner and a blood test — applied on the same entity — a human — establish different properties — a local decrease in de-oxygenated heamoglobin versus, for instance, cortisol levels in the bloodstream — on different levels — the level of brain activation versus the level of endocrine activation — shows that levels and properties are intimately connected. Coming back to our example from the beginning, different properties of the mental state compassion are instantiated in several ways: (a.) through a person as an epistemic system directed towards a myriad of dispositional interactions of her own body, which can then (b.) be picked up as values of standardized questionnaires probing those experiences while, finally, (c.) some properties of the underlying mechanism of compassion are instantiated by means of fMRI (cf. Klimecki et al. 2014). What becomes strikingly apparent in this example is that each of these different ways of property instantiation yields properties we would intuitively base on very different levels. Experience of compassion seems to have a very different quality and complexity to the more abstract numerical values of questionnaires or activation patterns visualized by fMRI. Thus, we can say that the specific way a certain property is instantiated already establishes a corresponding level. This way of defining levels offers a broader range of application than the levels of mechanisms account, since it is not restricted to properties of mechanisms but rather bears on properties in general. After these considerations, we are now in a position to put down the following as a working definition of levels:

> Levels $=_{\mathrm{Df}}$ (L) Levels are sets of properties established with respect to their instantiation through the same or a similar kind of epistemic system, which targets the same or a similar dispositional profile as compared to different epistemic systems targeting different dispositional profiles.

Considering the identity criteria of epistemic systems, an epistemic system identical to itself might be involved in the instantiation of two properties, that are on the same level qua being picked up by the said epistemic system—for example, a ruler instantiating the length of 1 meter and 20 centimetres. Two epistemic systems are similar if they pick up exactly the same kind of dispositions and exhibit a similar dimension of output value. For example, two rulers picking up the dispositions of a set of tables to instantiate the height of 1 meter and 59.1 inches (1.5 m) or two humans seeing the color blue. Note that the properties might be different in these cases but they are still on the same level, since they are instantiated by the same or similar epistemic system. A ruler and an infrared detector, for instance, are neither identical nor similar epistemic systems, since they differ in the kind of dispositions they pick up and have different dimensions of output values.

Having provided the two missing definitions for an account of emergence, let us now consider how these can be connected to mechanisms and implemented into a new account of mechanistic emergence. What could properties of mechanisms be? According to the definition of mechanisms given in the introduction, we have to identify entities and activities belonging to the mechanism, as well as starting and termination conditions. These might all be established by property-instantiating epistemic sys-

tems. We decompose, measure, and intervene with the phenomena or their realizing components to establish temporal, functional, or organizational properties. Properties of mechanisms on higher levels are instantiated differently to properties of mechanisms on lower levels. We can use one epistemic system to track particular sequences within a mechanism on a specific level in order to be able to recognize stepwise changes as they unfold in temporal order. For properties on higher levels, however, we have to change the kind of epistemic systems involved. We are dealing with different properties on a different level, and we cannot capture the same causal chain as in the single lower-level mechanism. Instead, we capture a synchronously emergent property on a higher level. A formulation of such an account of mechanistic emergence that incorporates the above definitions of "properties" and "levels" could be constructed as follows:

> Mechanistic emergence $=_{\mathrm{Df}}$ (ME) Mechanistic emergence is a special form of property instantiation, in which the novelty of the properties is established by a change in epistemic systems involved in their instantiation and through which they span a higher level compared to the level of the components, which realize the higher-level properties by means of their mechanistic organization and process dynamics, thereby changing the overall dispositional profile of the whole while, at the same time, being constrained with respect to their individual dispositions in virtue of the synchronous, non-causal constituency relation.

What is new in this account of emergence is that it acknowledges how even emergent properties ultimately arise out of perfectly explainable mechanistic processes. Unpredictability or unexplainability are no longer the defining characteristics of emergent properties themselves, but only characteristics of the *epistemic context* involved in their instantiation. However, these emergent properties are still *novel* in the sense that they are non-causal, non-aggregative products of mechanisms that come into existence only on a higher level, established through the kind of property instantiation that none of the components show in isolation.

4 Conclusion

In this commentary my aim has been to point out (i.) that defining levels as crucially dependent on properties has a wider and more flexible range of application than using part–whole relationships as the defining criterion; and to put forward (ii.) that levels of mechanisms and levels of emergence can be reconciled into an account of mechanistic emergence in which the property-dependent definition of levels finds application.

My argument was (a.) that descriptive pluralism, by conceiving of levels essentially as metaphors, cannot yield sufficient conceptual clarification concerning the term "level"—namely, what levels actually are and how they exist and, even undermines the goal of preserving the use of the concept in science. Further, I highlighted (b.) that in "levels of mechanisms", as presented by Carl Craver, the core criterion for a definition of "level" is a part–whole relationship in conjunction with a constitutive relevance constraint, and that this focuses solely on the vertical dimension existing between levels, and completely omits the more important horizontal dimension of the conditions that must apply for a set of entities to be on the same level. As such, the concept is only very weakly and indirectly characterized, offering little toward its clarification and broader application. Finally, I showed (c.) that ontological novelty is not dependent on epistemic intractability, and that the ontological novelty of properties on higher levels of mechanisms is not a banal fact either in levels of mechanisms or in levels of emergence. What emergence expresses at its core is that new properties are coming into existence and that they are so strikingly novel that they might not be predictable at the moment—or seem to not be so, even in principle. They are novel to such a degree that their instantiation coinstantaneously establishes a wholly new level.

As positive proposals for an alternative view, I defined (d.) "properties" as instantiated by epistemic systems capturing specific dispositional profiles of entities, and (e.) "levels" as sets of such properties instantiated by the same or a similar epistemic system, as compared to those properties instantiated by another epistemic system. Furthermore, I (f.) provided a definition of "mechanistic emergence" implementing the core idea of emergence as aforementioned, together with the proposed definitions of "levels" and "properties".

Concerning future directions for research, it seems most pressing to further develop the notion of an "epistemic system". Moreover, the notion of "levels" needs to be further refined with regard to how much epistemic systems can or must differ in order for there to be a new level. Ultimately, of course, it will be intriguing to see whether the developed definitions hold in the light of practical implementations in scientific contexts.

To finish, let us come back to the initial question of whether mind and brain, or more precisely mental processes and neurobiological processes, are on the same level, which we are now in a better position to answer. So far as we acknowledge that mental properties and properties of the brain are different properties, and if we also consider how I defined levels above, we can conclude that mind and brain are in fact on different levels in this sense. But are we thus slipping back into dualism? Absolutely not, since the definition of properties developed above makes clear how it comes about that there can be different properties of one and the same thing: it is dependent on the kind of epistemic system in use to capture specific dispositions or, in short, on the *epistemic context*. Taking up our example of compassion once again, it is now obvious why the phenomenon did not seem to be fully captured only by reference to, for instance, physiological properties. Of course it makes sense to investigate the physiological realization of compassion, to measure autonomic parameters, conduct blood tests, or undertake fMRI scans, but it is equally important to conduct behavioural experiments or even interviews with participants to target the phenomenological experience that encompasses compassion (cf. Singer & Bolz 2013). This only means that we are doing research on all the different properties of the phenomenon of compassion. We are doing research in different disciplines with different methods, on different levels, and we are capturing different properties of one and the same thing—so let's work together to incrementally integrate those epistemic contexts and get the complete picture.

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