

EMERGENCE, FUNCTION, AND REALIZATION

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“Realization” and “emergence” are two concepts that are sometimes used to describe same or similar phenomena in philosophy of mind and the special sciences, where such phenomena involve the synchronic dependence of some higher-level states of affairs on the lower-level ones. According to a popular line of thought, higher-level properties that are invoked in the special sciences are *realized* by, and/or *emergent* from, lower-level, broadly physical, properties. So, these two concepts are taken to refer to relations between properties from different levels where the lower-level ones somehow “bring about” the higher-level ones. However, for those who specialise in inter-level relations, there are important differences between these two concepts – especially if emergence is understood as *strong* emergence. The purpose of this chapter is to highlight these differences.

Realizing a Function

Realization, as an inter-level relation, is often thought to be tightly related to the notion of a *function*, and this is arguably due to the fact that the notion of realization was imported into the contemporary philosophy of mind literature with a defence of functionalism alongside the refutation of the view that mental properties (e.g. *being in pain*) are identical with physical properties (e.g. *having C-fibre stimulation*). It was suggested by Putnam (1967) that mental properties are multiply realizable by different physical properties in different organisms – such that it is possible for two organisms to instantiate the same mental property without having any physical properties in common – therefore, a given mental property cannot be identified with any particular physical property. After all, if it is possible to be in pain without having C-fibre stimulation, *being in pain* and *having C-fibre stimulation* cannot be identical. This argument has come to be known as “the multiple realizability argument”, and it is sometimes interpreted to support functionalism – the view that mental properties are functional properties. For those who hold this view, just as the very same functional property (e.g. *being a vending machine*) can be instantiated in different physical ways, a mental property can be instantiated in different physical ways – as long as it carries out its constitutive function, whatever that function might be.

Because of the association of the multiple realizability argument with functionalism, the idea that some higher-level property *M* is realized by physical properties is often interpreted as an endorsement of functionalism about *M* – to the extent that one occasionally sees interchangeable uses of “functionalism” and “realizationism” (e.g. Polger & Shapiro, 2016). In line with this, there is a widely held view that for some lower-level property to realize some higher-level property is for the former to play the role that the latter is associated with, where the said role is understood causally or functionally. As Polger (2004) remarks, we do not need to have a definitive account of what a function is just for the purposes of explaining what realization is. Different philosophers will have different conceptions of what a function is, and for each conception, there may be a different putative realization relation that involves how a

function of that sort can be physically realized.¹ For example, one might agree with the early functionalists about the mind that mental properties are computational properties (e.g. Putnam 1967), and thereby think that how a mental property is brought about by the instantiation of some physical properties and relations in one's brain is analogous to, or perhaps identical in type with, how the processes that are constitutive of the software of a computer are brought about by the physical processes in the computer's hardware. Or one might think that having a function is a just matter of playing some causal role (i.e. having characteristic causes and effects), where the causal role in question needn't be computational. Suppose that *being a heart* is individuated by the causal role of pumping blood in an organism's circulatory system through blood vessels. Then, for a physical system, realizing the property of *being a heart* would be a matter of having the right sort of physical properties that can play the causal roles that contribute to the pumping of blood through blood vessels.

More generally, like those who have defended the "role-playing" account of realization, one might understand functional realization along the following lines:

Functional Realization (FR): A property *P* functionally realizes a property *F* if and only if, for some causal role *R*, (i) *F* is individuated by *R*, and (ii) *P* is a property that plays *R*.²

In FR, we have three key elements: *first*, a property *F* to be realized; *second*, a causal/functional role *R* that individuates *F*; and *third*, a property that can play *R*. "Role playing" is really the right metaphor here. Let's say, in a story, we have a character (e.g. Batman), a role that is associated with that character (e.g. throwing batarangs at criminals), and someone who plays the role (e.g. whoever plays the Batman-role in that particular Batman story). Just as, in some stories, Bruce Wayne plays the Batman-role (partly) by throwing batarangs at criminals, physical properties realize functional properties in virtue of playing the causal/functional roles that characterise the latter – if functionalism is true.³ If properties in some domain *D* are individuated by causal/functional roles and, as a matter of fact, such causal/functional roles are occupied by physical properties, then properties in *D* are functionally realized by physical properties.⁴

¹ See Polger's (2004) Chapters 3 and 4 for a discussion.

² See Melnyk (2003) for an account of realization along these lines.

³ Here, I am assuming that 'Batman' is not a proper name, but refers to a vigilante via a role.

⁴ The discussion above does not cover the difference between *realizer* functionalism and *role* functionalism (about some property *P*). Roughly, the difference between these two views is that the former identifies *P* with the property that occupies *P*'s causal/functional role, whereas the latter does not. So, a realizer functionalist about mental properties may identify mental properties with physical properties because physical properties occupy the causal/functional roles that individuate mental properties (see Lewis, 1994).

Even though not all theories of realization give a central role to functions in their formulations of the realization relation (see Baysan, 2015), in nearly all accounts of realization, there is an emphasis on the causal profiles of realized and realizer properties, and moreover in these theories, it is suggested that the causal powers of a realized property are *fully accounted for* in terms of the causal powers of its realizer properties. Such claims of fully-accounting-for come in two incompatible forms. First, there are those who agree with versions of Kim’s (1992) *causal inheritance principle* that if a higher-level property Q is instantiated in virtue of some lower-level property P , then all causal powers of Q are also causal powers of P (e.g. Wilson 1999; Clapp 2001; Shoemaker 2001; Baysan 2016). Second, there are those who disagree with the causal inheritance principle but still hold that the causal powers of realized properties are conferred on their bearers in virtue of the causal powers of their realizers (e.g. Pereboom, 2002; Gillett, 2003). We will revisit the causal inheritance principle in the section ‘Realization and Causal Powers’ below.

Realization, Emergence, and Physicalism

There is a sense in which claims of emergence and claims of realization can overlap, in particular if emergence is understood as *weak* emergence. For example, an emergent property can be physically realized if it is a functional property in one sense and its function is performed by some physical property. In fact, Wilson (2015) uses the term “weak emergence” to refer to the relation that I call “realization” here. In Wilson’s use, weak emergence and strong emergence are *incompatible* relations: if a higher-level property Q is strongly emergent from a lower-level property P , then Q is *not* weakly emergent from P (and *vice versa*). The reason is that whereas weak emergence (i.e. physical realization) of Q entails non-reductive physicalism about Q , its strong emergence is incompatible with physicalism about it.⁵ (Here, non-reductive physicalism is to be understood as the conjunction of physicalism and the rejection of the identity of higher-level properties with the lower-level ones, due to multiple realizability.) So, the main difference is this: whereas realization is a relation that relates higher-level properties to physical properties only if non-reductive physicalism is true, the existence of strongly emergent higher-level properties is incompatible with non-reductive physicalism.⁶

If these observations are correct, then we can explain the differences between the relations of realization and strong emergence (henceforth simply emergence) by tracing the differences

⁵ In some usages, “weak emergence” and “strong emergence” do not refer to incompatible relations. For example, Chalmers (2006) takes strong emergence of x to be a matter of strict unexplainability of x (i.e. unexplainability, even in principle), and weak emergence of x to be a matter of non-strict unexplainability of x (i.e. unexplainability due to technical or practical difficulties). Assuming that something’s strict unexplainability entails, but is not entailed by, its unexplainability in practice, in Chalmers’s usages, the relations picked out by these two terms are not incompatible.

⁶ It is important to note that strong emergence *simpliciter* does not falsify physicalism *simpliciter*. If there are strongly emergent phenomena within physics (e.g. quantum entanglement), we should not be expected to be non-physicalists about physics! But if higher-level properties turned out to be strongly emergent, then physicalism about such higher-level properties should be falsified.

between the commitments of (non-reductive) physicalist views about higher-level properties and anti-physicalist views about them. These are:

- (1) Physicalists who put forward realization claims hold that higher-level properties are “nothing over and above” physical properties. Their (anti-physicalist) emergentist counterparts – those who put forward emergence claims – hold that some higher-level properties are “over and above” physical properties.
- (2) Physicalists take only physical properties to be fundamental, hence hold that realized properties are non-fundamental. Emergentists attribute fundamentality to some higher-level properties.
- (3) Physicalists hold that the distribution of higher-level properties (i.e. physically realized properties) supervenes on the distribution of physical properties with metaphysical necessity. Emergentists typically reject this metaphysical supervenience claim.
- (4) Physicalists typically hold that the causal powers of higher-level properties are fully accounted for in terms of the causal powers of their base properties. Emergentists reject this fully-accounting-for claim.

As we shall see, these four differences between non-reductive physicalism and emergentism will point us towards four differences between the relations of realization and emergence.

Over-and-aboveness

Physicalism about higher-level properties (e.g. mental properties) is typically understood as the view that they are “nothing over and above” physical properties (Smart, 1959). This way of formulating physicalism might have a reductive flavour, but there are reasons to think that all physicalists about the mind, reductive or non-reductive, should endorse the nothing-over-and-aboveness of the mental *vis-à-vis* the physical. The following analogy might illuminate the possibility of nothing-over-and-aboveness without identity: suppose that (mereological) composition is ontologically innocent, but that composition is not identity; under this supposition, there are instances of nothing-over-and-aboveness without identity: a whole would be nothing over and above its parts yet it would not be identical with them.

Assuming then that non-reductive physicalists will take realized properties to be nothing over and above their realizers, we can propose the following necessary condition on realization:

Realization-OA (ROA): A property P realizes a property Q only if Q is nothing over and above P .

Whatever the other features of the realization relation might be, if ROA is true, then it will never be the case that a property realizes another one whereby the latter is something over and above the former. And this is something we cannot say for the relationship between emergent properties and their bases. So, in this sense, emergent properties are not realized by their physical bases. For emergence, the following seems to be the case:

Emergence-OA (EOA): A property Q is emergent from a property P only if Q is over and above P .

Again, the analogy from composition can be illustrative. Emergence is sometimes presented as the failure of exactly the aforementioned claim about the ontological innocence of composition: an emergent whole is supposed to be more than the sum of its parts. (More precisely, a whole with emergent properties is more than the sum of its parts.) So, it is reasonable to think that the emergent properties of a whole are not merely “resultant” properties of the properties of the parts of the whole.

Admittedly the “over and above” talk is somewhat metaphorical, but some have filled in the metaphor in interesting ways, one of which we will cover in the section entitled ‘Realization and Causal Powers’ below.

Fundamentality

Let us now see how we can use the fundamentality criterion to highlight another difference between the realization and emergence relations. Non-reductive physicalists hold that mental properties are non-fundamental properties. So, a non-reductive physicalist, unlike her eliminativist counterparts, does not eliminate mental properties from her ontology; but unlike her reductive physicalist counterparts, she does not identify mental properties with broadly physical properties, which are supposed to be relatively fundamental properties.

This point about fundamentality is helpful in making a progress about a well-known problem about the formulation of physicalism. The problem is the difficulty of responding to the following dilemma: if we formulate physicalism with reference to current physics, physicalism will be false (because current physics is not complete); if we formulate physicalism with reference to an ideal future physics, we will not know what physicalism is (because we do not know what future physics will be like). One way to get around this problem is to restrict the formulation of non-reductive physicalism to certain domains of higher-level properties and then propose that physicalism about that domain of properties is the view that those properties are real but not fundamental properties, whereas physical properties – whatever they might turn out to be like – are fundamental properties.⁷ Now, in order to capture the physicalist idea that higher-level properties are dependent on physical properties, a non-reductive physicalist should also hold that these non-fundamental higher-level properties are instantiated in virtue of the instantiations of some fundamental (physical) properties. Given that realization is supposed to be the relation that relates these non-fundamental properties to their fundamental (physical) bases, we have the following observation:

Realization-F (RF): A property *P* realizes a property *Q* only if *P* is more fundamental than *Q*.⁸

⁷ Relatedly, see Wilson (2009) for a characterisation of “physical” that involves a “not fundamentally mental” clause.

⁸ See Bennett (2011) for the view that such asymmetry of fundamentality should be the case in all in-virtue-of relations. I am not committed to this stronger claim, and in fact I think the (possible) cases of emergence are counterexamples to it.

Note that RF is not committed to there being multiple degrees or levels of fundamentality. If there is only one level of fundamentality such that anything is either strictly fundamental or just non-fundamental, there can still be instances of RF: realizer properties could be strictly fundamental and realized properties could be just non-fundamental.

Now, given that emergentists hold that some higher-level entities are fundamental despite being dependent on lower-level physical entities, then the following is a plausible conditional:

Emergence-F (EF): A property Q is emergent from a property P only if Q is at least as fundamental as P .

EF entertains the controversial idea that there could be dependent-yet-fundamental entities. Could there be such entities? There are ways of thinking about such possibility. One example is the early emergentists' thought that some higher-level causal powers are fundamental (Broad, 1925; McLaughlin 1992). Surely, in suggesting that some higher-level causal powers are fundamental, early emergentists were not committed to such causal powers being ontologically independent. Also, Barnes (2012) surveys a number of metaphysical views in which some entities are both fundamental and dependent; for example, some philosophers think that *persons* are fundamental entities but are dependent on the parts of their physical bodies.

The fundamentality criterion to distinguish between realization and emergence is also helpful in resolving a problem that comes up in the realization literature: *the problem of conjunctive realizers*. RF helps us see why conjunctive properties – if there are any – are not realizers of their conjuncts (as is widely accepted).⁹ For example, the conjunctive property of *being red and spherical* is not a realizer of *being red*. Intuitively, this is because although the (conjunctive) property of *being red and spherical* necessitates *being red*, the former does not bring about the latter. The problem of conjunctive realizers is the difficulty of getting this result without stipulating from the outset that no conjunctive property realizes any conjuncts. Now, note that RF already has the resources to get this result. Conjunctive properties – if there are any – are typically less fundamental than their conjuncts, as they are constructions out of their conjuncts. So a conjunctive property and its conjuncts typically will not satisfy RF. So, although it might strike some as a truism that realization relates fundamental properties to non-fundamental properties and that emergence does not, there are interesting consequences one can discover by exploring the implications of this suggestion.

Supervenience

Many have thought that there is a difference between realization and emergence because non-reductive physicalism is committed to the metaphysical supervenience of (realized) higher-level properties on the physical ones, whereas emergentists reject this metaphysical supervenience claim and are committed to only the nomological supervenience of the higher-level on the physical. Among others, van Cleve (1990), McLaughlin (1997), Noordhof (2003)

⁹ See Yablo (1992, p. 253), Shoemaker (2007, p. 23), Wilson (2009, p. 152).

and (arguably) Chalmers (1996; 2006) are those who have endorsed this difference between non-reductive physicalism and emergentism. So, for realization, the following seems to be true:

Realization-S (RS): A property P realizes a property Q only if P metaphysically necessitates Q .

And for emergence, the following:

Emergence-S (ES): A property Q is emergent from a property P only if Q is nomologically, but not metaphysically, necessitated by P .

Let me offer two important clarifications at this point. The *first* clarification is that, in RS, realizer properties must involve background conditions in order to enable metaphysical necessitation of the realized property by the realizer (Shoemaker, 1981), where such background conditions may include even the laws of physics (but not inter-level laws, if there are any).¹⁰ If a higher-level property is not metaphysically necessitated by some physical property that includes such rich background conditions, then it cannot be realized by that physical property. Suppose that a phenomenal property M is a higher-level property of this sort. What might guarantee the instantiation of M if such an enriched physical base may not? In addition to the laws of physics, we may have to include “trans-ordinal” (Broad, 1925) or psychophysical laws (Chalmers, 1996) in the background conditions of the base property, in which case we cannot be physicalists about M . And this brings us to the *second* clarification: the reason why ES requires no more than nomological necessitation is that unless other laws of nature (including the trans-ordinal or psychophysical laws) are included in the base, the instantiation of the base does not guarantee, in the metaphysical sense, the instantiation of an emergent property. That is, P and the background conditions alone can only nomologically necessitate M . But P , the background conditions, and all the laws of nature (or a proper subset of them that include the inter-level laws), together, metaphysically necessitate M .

This criterion is controversial, however. This way of explaining the difference between realization and emergence (and likewise non-reductive physicalism and emergentism) is committed to there being a distinction between nomological and metaphysical necessity, and such a distinction is sometimes rejected for reasons that do not primarily concern us here (see Shoemaker 1998). But because of this, some may think that RS and ES are not successful in highlighting the difference between realization and emergence.¹¹

Realization and Causal Powers

So far we have covered three putative ways of explaining the difference between realization and emergence: over-and-aboveness, fundamentality, and supervenience. Now, we will revisit

¹⁰ If the laws of physics are metaphysically necessary, then they do not need to be included in the background conditions. Also, if there are inter-level laws, physicalism suggests that they are derivable from the laws of physics.

¹¹ See O’Connor (1994) and Wilson (2005) for such criticisms.

Kim's (1992) causal inheritance principle introduced above and explore whether we can use it to provide a fourth one.

Recall that the causal inheritance principle suggests that higher-level properties inherit their causal powers from the lower-level base properties they depend on. As Wilson (1999) suggests, there is a connection between the causal inheritance principle and the nothing-over-and-aboveness claims we discussed in the section titled 'Over-and-aboveness'. She argues that

[p]hysicalists [about mental properties] ... cannot ... allow that mental properties have any causal powers that are different from those of their physicalistically acceptable base properties, for this violates the physicalist thesis that mental properties are "nothing over and above" their base properties" (ibid., p. 41).

Here, the idea is that we can understand the over-and-aboveness of a higher-level property in terms of the novelty of the causal powers it confers on its bearers, and thereby understand the *failure* of over-and-aboveness as the *failure* of such causal novelty. Then, it must be the case that whereas realized properties inherit all of their causal powers from their base properties, emergent properties do not; the latter must have novel causal powers, and the former must not. So, for realization we should say the following:

Realization-CP (RCP): A property P realizes a property Q only if every causal power of Q is also a causal power of P .

And for emergence, the following:

Emergence-CP (ECP): A property Q is emergent from a property P only if some causal power of Q is not also a causal power of P .

Wilson (2015) argues that these two conditionals are true and any other putative distinction between realization and emergence is either entailed by these two conditionals or inadequate to do the job.¹² Note that even if one were to agree with Wilson that these two conditionals are true, one might still reject the further claim that other criteria are either redundant or inadequate.

There is plenty of literature to back up ECP as a conditional, as emergentists are characteristically committed to there being novel causal powers that are associated with some higher-level properties (e.g. Broad, 1925; O'Connor, 1994; Crane, 2001), unless they want to take emergent properties to be epiphenomenal. But RCP is more controversial, and that is what we shall look at more closely.

¹² I should remind the reader that, in Wilson's terminology, this distinction is between "weak emergence" and "strong emergence".

What might be the reasons to think that RCP is true? There are numerous arguments in favour of RCP, but for reasons of space, here I shall focus on only one of these arguments.¹³ Consider the following two principles:

- (A) A property *P* has a causal power *C* if and only if, as a matter of nomological necessity, all bearers of *P* have *C*.
- (B) If a property *P* realizes a property *Q*, as a matter of (at least) nomological necessity, all bearers of *P* are also bearers of *Q*.

Suppose that *having C-fibre stimulation in a suitably functioning nervous system (C-fs, for short) realizes being in pain (pain for short) and that cp₁ is a causal power of being in pain.* (Exactly what *cp₁* is does not matter for the purposes of this argument.) If (A) is true, it will be a matter of nomological necessity that all bearers of *pain* have *cp₁*. Note that this does not mean that all bearers of *pain* must manifest *cp₁*, as it is shared wisdom that causal powers may exist unmanifested. And if (B) is true, it will be a matter of (at least) nomological necessity that all bearers of *C-fs* are also bearers of *pain*. From these two observations, it follows that it is a matter of nomological necessity that all bearers of *C-fs* have *cp₁*. This last observation and (A) entail that *cp₁* is a causal power of *C-fs*. Note that what is true of *cp₁* must be true for all causal powers of *pain*. So, any causal power *pain* is a causal power of *C-fs*. More generally, any causal power that we can attribute to a realized property must also be attributed to its realizer, which suggests that RCP is true.

Is this argument persuasive? The argument makes use of two principles: (A) and (B). The second of these is not controversial, and it is entailed by RS discussed above. However, the principle stated in (A) is controversial, and admittedly the argument's success hinges on it.¹⁴ Nevertheless, the argument shows that explaining the relationship between properties and the causal powers they confer on their bearers is important for defending RCP and hence understanding the realization relation.¹⁵

RCP has received much criticism, but due to space considerations, I have handpicked three objections. The *first* one is from Noordhof (1997; 2013),¹⁶ and it suggests that a realized property may confer different causal powers on its bearers depending on how it is realized. Pains realized in human beings and pains realized in robots may cause different pain

¹³ See Wilson (1999; 2011), Clapp (2001), Shoemaker (2001; 2007), and Baysan (2016) for arguments for RCP. The one we shall look at now is from Baysan (2016).

¹⁴ This principle is defended in Baysan (2018).

¹⁵ An interesting consequence of this argument is that it appears to apply to strong emergence too, if strong emergence is to be understood simply as a same-subject nomological necessitation relation. If true, that would be bad news for emergentists as it would be impossible for emergent properties to have novel causal powers. However, emergentists have resources to deal with this problem. See Baysan & Wilson (2017) for a number of ways out of this problem.

¹⁶ Noordhof's (1997) objection is actually against Kim's causal inheritance principle, but in (2013) he presents it as an objection against Shoemaker (2007).

behaviours. So, the causal powers of a realized property outstrip the causal powers of its individual realizers. Hence, RCP is false.

The *second* objection is from Pereboom (2002) and is based on the assumption that there is a constitution relation between the causal powers of a realized property and the causal powers of its realizers. Assuming that constitution is not identity, Pereboom argues, a causal power of a realized property cannot be identical with any of the causal powers of its realizers. So, RCP must be false.

The *third* objection is from Gillett (2003), who motivates his objection by giving the following example: imagine a hard diamond which has the causal power to cut glass. In this diamond, *hardness* is realized by the properties (and relations) of the small bits that constitute the diamond. Although the causal power to cut glass is conferred on the diamond by *hardness*, no realizer property (i.e. properties of the small bits of the diamond) can confer this power on the diamond as those bits are too small to cut glass! Therefore, RCP should be rejected.

What can the proponents of RCP say in response to these objections? Regarding the first objection, they could reject Noordhof's claim that realizer-dependent causal powers are causal powers of realized properties; instead, such causal powers can be naturally said to belong to the realizer properties. Against the second objection, they could say that Pereboom is explaining a different relation: realization of causal powers by (other) causal powers, not realization of properties by (other) properties. Against the third objection, they could point out that they take realization to be a relation between properties of the very same object – not properties of a whole and the properties of its parts as Gillett does.¹⁷

Nevertheless, responding to an objection is one thing, persuading one's opponent is another; whether these responses will be persuasive remains to be seen.

Conclusion

Realization and emergence are two inter-level relations that have been invoked by some philosophers of mind and the special sciences to explain the dependence of higher-level properties on the lower-level ones. It is often suggested that higher-level properties are realized by, and/or emergent from, lower-level properties. Despite the similarity of realization and emergence claims, there are important differences between these two relations, in particular if emergence is understood as strong emergence. After briefly focusing on a functional theory of realization, I offered four different (but partially overlapping) ways of explaining the differences between these two relations. These differences are due to the fact that whereas realization claims are made as part of physicalist frameworks about higher-level properties, emergence claims are made as part of anti-physicalist frameworks.

¹⁷ I should note that Gillett foresees such a response, and thinks that a scientifically interesting realization relation should not be a same-subject necessitation relation, but should trace part-whole relations.

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