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Multiple realization and multiple "ways" of realization: A progress report

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ABSTRACT

One might have thought that if something has two or more distinct realizations, then that thing is multiply realized. Nevertheless, some philosophers have claimed that two or more distinct realizations do not amount to multiple realization, unless those distinct realizations amount to multiple "ways" of realizing the thing. Corey Maley, Gualtiero Piccinini, Thomas Polger, and Lawrence Shapiro are among these philosophers. Unfortunately, they do not explain why multiple realization requires multiple "ways" of realizing. More significantly, their efforts to articulate multiple "ways" of realizing turn out to be problematic.

In a number of individual and collaborative papers, Carl Gillett and I have championed a theory of realization that we take to characterize a many-one ontological determination relation between property instances found in the natural sciences. In addition, we have defended the view that multiple realization occurs, in essence, when two (or more) non-identical sets of property instances, $\{F_1\text{-}F_n\}$ and $\{F^*_1\text{-}F^*_m\}$, at the same level determine another property instance G at a higher level. Moreover, we have provided numerous clear scientific illustrations of this. Among these is that the property of having normal human color vision is multiply realized by individuals who differ only in the absorption spectra of their red cone opsins.

Faced with this account, many philosophers react that the account of multiple realization is overly permissive. It is not enough that the sets of realizer property instances $\{F_1\text{-}F_n\}$ and $\{F^*_1\text{-}F^*_m\}$ be non-identical; $\{F_1\text{-}F_n\}$ and $\{F^*_1\text{-}F^*_m\}$ must also constitute distinct "ways" of realizing G. So, for example, Shapiro and Polger, 2012, write, "multiple realization [of S by A and B] requires A and B to not merely be different, but … to be different in ways that are relevant to their sameness. Winged and waiters' corkscrews are different in ways that contribute to their cork removing capacities; camera and compound eyes are different in ways that are relevant to their light-sensing capacities." Unfortunately, Shapiro and Polger do not offer any reason to think that multiple realization requires multiple "ways" of realizing.[1] Moreover, they do not provide a plausible account of what multiple "ways" of realizing are.

Piccinini & Maley, 2014, seem to follow the Shapiro and Polger line. They claim "storing a '1' (as opposed to a '0') within a computer circuit is a high-level property of a memory cell that may be realized by a large number of voltages (all of which must fall within a narrow range; e.g., 4 ± 0.1 V). … That's not to say … that different voltages within the relevant range amount to multiple realizations of a '1.' On the contrary, these are cases of differences in the realizers of a property that do not amount to multiple realizations of that property" (Piccinini & Maley, 2014, p. 131). Like Shapiro and Polger, they do not say why such cases do not amount to multiple realization. They claim that "the dimensioned view makes it too easy to find cases of multiple realization. But if there are different causal mechanisms that realize a property in different ways, then this is indeed genuine MR" (ibid.). Piccinini and Maley do not explain what it means to realize a property in different "ways." Nor do they explain what it is for multiple realization to be "easy" or how easy is "too easy."

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[1] Millikan, 1999, has the following: "Sometimes different mechanisms that accomplish the same [thing] operate in accordance with different principles; other times they represent merely different embodiments of the same principles. Or we might say, sometimes looking more closely at the mechanism helps to explain how it works; sometimes it reveals only what stuff it is made of. It is only the former kind of difference that makes interesting 'multiple realizability.'" (Millikan, 1999, pp. 61–2.) This, however, does not constitute a denial that mere differences in realizers suffice for multiple realization; it is a denial that mere differences in realizers suffice for *interesting* multiple realization. For present purposes, we need not explore what exactly this means or whether it is true.

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Suppose, for the sake of argument, that we agree that we should develop a theory of multiple realization that is based on multiple "ways" of realization.[2] How does the resulting project fare? So far, not well. The theory of Dimensioned realization, as it stands, illuminates a number of scientific and philosophical issues, whereas those who have embraced multiple "ways" of realization have yet to provide a plausible formulation of the view. This is not, of course, to say that a theory of multiple "ways" of realization cannot be made to work. It might. Hence the idea of a "progress report." To make the case for the limited progress of extant works, section 1 will provide a concise review of the Dimensioned view of realization and multiple realization, showing how it describes certain scientific cases and also how it explains how multiple realization is possible. For a more elaborate description of the cases, readers are referred to Aizawa & Gillett, 2009a, 2009b, 2011, and Aizawa, 2013. Sections 2–6 then examine the progress that has been made by some of those who expect that a theory of multiple realization must be a theory of multiple "ways" of realization. More specifically, these sections will examine proposals in Shapiro, 2008, Shapiro and Polger, 2012, Polger & Shapiro, 2016, and Piccinini & Maley, 2014, pp. 125–152. The overarching point is that, whereas the current Aizawa-Gillett approach to realization and multiple realization has been fruitful in understanding certain scientific and philosophical issues, the alternative project has yet to get off the ground.

1. Dimensioned realization and multiple realization

During the 1960's and 1970's, Hilary Putnam, Jerry Fodor, and many other philosophers hypothesized that the mental and the physical did not stand in a type-identity relation, but in a relation they called "realization." They supposed that the natural sciences had implicitly embraced such a relation. Moreover, they hypothesized that many physical things can realize a single mental thing. This basic picture is the point of departure for the theory of dimensioned realization and multiple realization. Gillett and I offer what is, in various respects, a successor to what Putnam and Fodor had on offer. Putnam, Fodor, and others had a theory (or, perhaps, theories) of how the mental relates to the physical; we have a somewhat different theory. A full accounting of the differences between what Putnam, Fodor, and others had to say about the mental and the physical and what Gillett and I have to say about the mental and the physical must await another occasion. Nevertheless, a few elementary points are in order.

To begin with, where Putnam et al. proposed that science recognizes a single relation of realization, we propose that scientists implicitly postulate three sorts of non-causal, ontological determination relations. Thus, we propose that scientists postulate what we call a constitution relation between individuals, as in the case in which a water molecule is constituted by two atoms of hydrogen and an atom of oxygen. One reason to think that the relation between the atoms and the molecule is non-causal is that the bonded atoms and the molecule are contemporaneous, whereas causes are not contemporaneous with their effects. Causes precede their effects. It is not as though the atoms bond together, then the water molecule subsequently comes into existence. Moreover, once the atoms cease to be bonded, the water molecule ceases to exist. In addition, scientists postulate what we call an implementation relation between processes, as is found when the propagation of an action potential down an axon is implemented by, among other things, the openings and closings of ion channels. Again, we take the implementation relation to be non-causal, because we take the propagation of the action potential to be contemporaneous with, among other things, the openings and closings of the ion channels. By contrast, as just noted, causes are not contemporaneous with their effects. Finally, scientists postulate what we call a realization relation between properties. Corks, for example, are buoyant in water, because they have cells that are relatively impermeable to air and water. So, the theory of realization is one part of a three-part account of the relation between the mental and the physical and, indeed, between the physical, the chemical, the biological, and the psychological.

In more detail, the Dimensioned view of realization maintains that realization is a kind of compositional determination relation wherein properties at one level determine properties at a higher level (see, for example, Gillett, 2002, 2003).[3] The core idea here is simple: individuals have properties in virtue of the properties of their parts. Take a simple case. A molecule of hydrogen fluoride (HF) has an asymmetric charge distribution—a dipole moment—of 1.82 debye (D) (Nelson, Lide, & Maryott, 1967, p. 11). It has this property in virtue of properties of the hydrogen and fluoride atoms (their electronegativities) and the angle and length of the bonds between them. To illustrate multiple realization, HF has a dipole moment of 1.82 D in virtue of the electronegativities of H, F, and the angle and length of the bond between them, but chlorofluoromethane (CH_2ClF) appears to have the same dipole moment in virtue of the electronegativities of C, H, Cl, and F and the lengths and angles of the bonds between its constituent atoms (cf. Nelson et al., 1967, p. 16). This is apparently a case of multiple realization.[4]

One of the prime virtues of the Dimensioned view of realization and its companion theory of multiple realization is that, as indicated in Aizawa & Gillett, 2009a, 2009b, 2011, and Aizawa, 2013, it provides a descriptively adequate account of many compositional relations found in the natural sciences. In addition, the account bears on familiar issues in the philosophy of mind. As one example, consider the following passage from Fodor, 1997:

> Damn near everything we know about the world suggests that unimaginably complicated to-ings and fro-ings of bits and pieces at the extreme *micro*level manage somehow to converge on stable *macrolevel* properties
>
> On the other hand, the 'somehow' really is entirely mysterious, and my guess is that is what is bugging Kim. He just doesn't see why there should be (how there could be) macrolevel regularities at all in a world where, by common consent, macrolevel stabilities have to supervene on a buzzing, blooming confusion of microlevel interaction (Fodor, 1997, pp. 160–1).[5]

Through numerous scientific examples, the schema provides us cases of multiple realization that are not at all mysterious. It is rather easy to see how, at least in some cases, the microlevel can converge on stable macrolevel properties. In fact, we can distinguish three ways in which multiple realization is possible. We may call these "multiple realization by individual differences," "multiple realization by orthogonal realizers," and "multiple realization by

[2] In theory, one could add a "ways" condition to the current Aizawa-Gillett theory of multiple realization, provided we knew what "ways" are supposed to be and that there is some sound rationale for including it.

[3] This theory of realization, thus, has affinities with theories of mechanistic explanation. See, for example, (Bechtel & Richardson, 1993), (Glennan, 1996, 2002), (Machamer, Darden, & Craver, 2000), and (Craver, 2007).

[4] The qualifier "appears" is needed, since the dipole moments are experimentally determined values. Thus, it could be that HF and CH_2ClF have the exactly same dipole moment or it could be that HF and CH_2ClF have the same dipole moment *to within the limits of experimental error*. In the latter case, we would not have an example of multiple realization.

[5] For another example in this vein, see Aizawa, forthcoming.

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