

Flat Versus Dimensioned: The What and The How of Functional Realization

Ronald P. Endicott

Department of Philosophy & Religious Studies

North Carolina State University

Campus Box 8103, Raleigh, NC 27695

ron_endicott@ncsu.edu

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ABSTRACT: I resolve an argument over “flat” versus “dimensioned” theories of realization. The theories concern, in part, whether realized and realizing properties are instantiated by the same individual (the flat theory) or different individuals in a part-whole relationship (the dimensioned theory). Carl Gillett has argued that the two views conflict, and that flat theories should be rejected on grounds that they fail to capture scientific cases involving a dimensioned relation between individuals and their constituent parts. I argue on the contrary that the two types of theory complement one another, even on the same range of scientific cases. I illustrate the point with two popular functionalist versions of flat and dimensioned positions – causal-role functionalism and a functional analysis by decomposition – that combine into a larger picture I call “comprehensive functional realization.” I also respond to some possible objections to this synthesis of functionalist views.

I resolve an argument over “flat” versus “dimensioned” theories of realization. The theories concern, in part, whether realized and realizing properties are instantiated by the same individual (the flat theory) or different individuals in a part-whole relationship (the dimensioned theory). Carl Gillett has argued that the two views conflict, and that flat theories should be rejected on grounds that they fail to capture scientific cases involving a dimensioned relation between individuals and their constituent parts. I argue on the contrary that the two types of theory complement one another, even on the same range of scientific cases. I illustrate the point with two popular functionalist versions of flat and dimensioned positions – causal-role functionalism and a functional analysis by decomposition – that combine into a larger picture I call “comprehensive functional realization.” On this picture, flat causal-role functionalism addresses *what* is realized, meaning the functional nature of a system’s realized properties, while a dimensioned functional analysis addresses *how* realization occurs, meaning the connections to subsystem physical mechanisms that underlie realized properties. This picture also comports well with the views of philosophers such as Jerry Fodor and William Lycan who have expressed commitment to both types of functional theory, as well as the work of Robert Cummins who suggests a similar complementary role for causal transition theories and property instantiation theories. I also respond to some possible objections to this particular synthesis of functionalist views.

I. Flat and Dimensioned Positions

According to a flat view, (I) the realized and realizing properties are possessed by the same individual (a token identity condition), and (II) the causal powers that individuate the realized property are a subset of or otherwise contributed by the causal powers bestowed upon an individual by the realizing property (a matching causal powers condition).¹ Several theories fall under this category. Gillett (2003: 593) cites the work of Jaegwon Kim and Sydney Shoemaker. For example, Shoemaker once promoted and Kim now promotes a functional-role view of realization.² Under its popular second-order interpretation:

(FRR) a property G realizes a property F if and only if some object x instantiates F and G , F is the property of having some property that occupies a causal-role R , and G occupies role R .

The position is flat, since the same object instantiates both causal-role and occupant properties, as expressed by condition (I). Moreover, the idea of the realizing property occupying the role of the realized property implies the requisite match in causal powers, as expressed by condition (II). As Gillett explains: “Under the flat view one property instance contributes all the powers individuating of the realized property – the realizer property instance thus literally plays the very causal role that individuates the realized property” (2003: 593). Parenthetically, one might wonder how a second-order functionalist theory could be metaphysically “flat,” as Gillett describes, given that philosophers have understood it to imply a hierarchy of distinct ontological levels in nature (e.g., Lycan 1987: 37-38). Yet one must distinguish “property orders” from the “causal levels” implicated by the powers that a property can bestow upon an individual. Kim makes this distinction by pointing out that while first-order and second-order properties are possessed by the same individual, the causal powers that make a difference in levels are bestowed upon different individuals in the macro/micro hierarchy, illustrated by the set of causal powers associated with a table having a mass of ten kilograms versus the sets of powers associated with the table’s individual micro-constituents having lesser masses (Kim, 1998: 82). As a result, one may say that the second-order functionalist position is ontologically ordered but causally flat.³

Now the contrasting dimensioned view of realization affirms that (I*) the realized and realizing properties are possessed by an individual and its constituent parts, respectively (a mereological condition), and (II*) the realized and realizing properties bestow upon their individuals distinct causal powers suited to the different albeit compositionally-related individuals that possess them (a compositional powers condition).⁴ Gillett (2003: 598-599) says that Ned Block’s and Jerry Fodor’s discussions of multiple realizability imply a dimensioned view of realization. Indeed many were explicit. For example, Cummins subsumed realization under a general theory that explains the instantiation of a property in a kind of system S by “the properties of S ’s

components and their mode of organization” (1983: 15). That is the mereology of a dimensioned perspective.

In fact, this mereology is central to the more publicized species of a property instantiation theory introduced to the philosophical community by Fodor (1968) and developed by Cummins (1975), namely, a functional analysis according to which higher-level functional properties or associated capacities possessed by a system decompose into lower-level sub-capacities and ultimately simple mechanistic-level processes (the more basic realizing parts and their properties). Functional decomposition is composition is reverse. Therefore as long as the functional properties in question are associated with causal capacities, and hence plausibly tied to causal powers, the resulting functional analysis counts as a dimensioned theory of realization. I present this species of the dimensioned perspective, which I call functional part-whole realization, more formally as follows:

(FPR) properties P_1, \dots, P_n realize a property F if and only if there is an object x that instantiates a functional property F , there are objects y_1, \dots, y_n that instantiate P_1, \dots, P_n , y_1, \dots, y_n are the proper parts of x , and, necessarily, for any x and any y_1, \dots, y_n , if y_1, \dots, y_n are the proper parts of x , then if y_1, \dots, y_n have P_1, \dots, P_n then x has F .

This is a “core idea” of functional part-whole realization because it contains no reference to familiar metaphysical supplements, such as a complex aggregate of the parts that is coincident with x , or a complex structural property G that could be identified as a role-player for the functional property F .

II. The Alleged Conflict

Gillett believes that the flat and dimensioned theories conflict with one another. Specifically, he refers to a conflict with Lycan’s own version of a dimensioned theory in which the capacities of homunculi decompose into the lesser capacities of sub-system homunculi. Gillett says of the standard flat view:

This view thus conflicts with some previous accounts of realization, such as Lycan 1987, that have taken chains of realization relations to hold between properties instantiated in distinct individuals. The standard account obviously makes no room for any such possibility (2002: 318).

It appears that Gillett envisions the conflict to be quite strong inasmuch as the flat view “makes no room for any such possibility.” In other words, if the flat view is true, then the dimensioned view *cannot* be true.⁵ Indeed, one might reason that if realization involves just one object as the flat theory requires, the same x having realized and realizing properties, then it cannot involve multiple objects as the dimensioned theory requires, with an object x and its proper parts y_1, \dots, y_n . This reasoning might appear especially plausible if one believes that there is but one relation that is relevant to the kinds of cases under consideration, or that the preferred relation cannot be complex and inclusive with regard to flat and dimensioned positions. In any case, Gillett then argues against the flat view on grounds that it fails to capture the dimensioned aspects of paradigm scientific cases. To use his favorite case, the hardness of a diamond is not a property of the individual constituent atoms, but it is realized by the properties of those individual atoms in accordance with the dimensioned position (2002: 318-19).⁶

Gillett provides other arguments against the flat position. In another paper he says that flat and dimensioned theories are “opposing accounts,” which he explains by saying that they lead to different judgments on cases of multiple realization (2003: 594 ff.).⁷ He then favors the dimensioned judgments. Illustrating with Putnam’s case of the mammalian versus the octopus eye, Gillett says that the flat view counts them as the same realization of the property of *being an eye* while the dimensioned view counts them as different realizations of the same property. But this is a weaker claim about the kind of conflict between the two theories. That the flat and dimensioned theories lead to different judgments on certain cases does not imply that they always do, meaning that it does not imply that if the flat view is true then the dimensioned view *cannot* be true. Moreover, the claim is complicated by the fact that judgments of *multiple* realization involve additional issues beyond the two accounts of realization, chiefly but not limited to additional criteria for counting something as the “same” or “different.”⁸ But I put this

issue to one side. My focus is on the previous claim that the flat and dimensioned theories are contrary to one another or whether they can be joined into a coherent picture.

Finally, in still another place Gillett (2007) argues against the *plausibility* of certain flat theories rather than their *compatibility* with his favored dimensioned theory, maintaining that such flat theories violate principles of simplicity. I will consider that argument later. But, to be clear, I agree that flat theories fail to capture important dimensioned aspects of paradigm scientific cases. Nevertheless, I do not think that flat theories should be faulted on that account. On the contrary, flat and dimensioned theories are compatible views that serve quite different but complementary purposes even over cases of dimensioned part-whole realization.

III. A Compatibilist Resolution of Flat & Dimensioned Functional Positions

I put my thesis in terms of the two different functionalist theories already discussed, functional-role realization (FRR) and functional part-whole realization (FPR): the main purpose of a flat functional theory is to express *what* is realized by supplying information about flat, intra-level causal roles that individuate a system's functional properties; the main purpose of a dimensioned functional theory is then to indicate *how* functional properties are realized, supplying important and otherwise missing information about the determination of a system's flatly individuated functional properties by the properties of the subsystem physical mechanisms.

To better understand the larger picture according to which both flat and dimensioned functional theories are true, consider again Gillett's paradigm scientific case of the diamond. Speaking flatly, the diamond is token identical with a complex instance COMBO of carbon atoms that possesses the role-playing lattice-structure property G that realizes the diamond's macro-hardness property F .⁹ The type of lattice structure that results from the bonding of individual atoms is a broad structural property possessed by the diamond/COMBO, not the individual carbon atoms. But this is not the whole story, or rather it is just a flat story about the whole object. There is also a complementary dimensioned account that addresses how that object is determined by its parts and how its causal powers are built up from those of its component parts. Indeed, the flat functionalist story says only that a second-order property F is associated with a causal role and that a first-order physical property G plays that role. Yet, as I have argued elsewhere (Endicott,

2007: 230), this does not indicate how the first-order role-player property G is *able* to occupy the causal role associated with the second-order functional property F . In order to understand that, one would need a deeper story about how the role-player G and its instances are themselves determined *via* the mereology of a dimensioned theory. Thus COMBO'S role-playing lattice-structure property G is explained by the accumulative powers of more basic properties P_1-P_n of the constituent atoms a_1-a_n .

Compare a familiar scientific paradigm in the philosophy of mind. There is a particular computer SYSTEM of engineering components that is token identical with a mind and which displays a role-playing property G , say, having a structure of electronic logic gates. This role-playing property serves to realize a mental property F , say, processing a disjunctive argument. The computer SYSTEM is the object within the domain computer engineering that possesses the complex structural property of logic gates, not the individual component circuits, but it possesses that complex property by virtue of the capacities of the several individual circuits. So the SYSTEM'S role-playing structure of logic gates G is explained by the accumulative powers of the more basic properties P_1-P_n of the engineering components a_1-a_n in a mereologically dimensioned way. I call this larger picture "comprehensive functional realization," which is a mix of flat causal-role realization and dimensioned functional realization. It can be illustrated as follows:

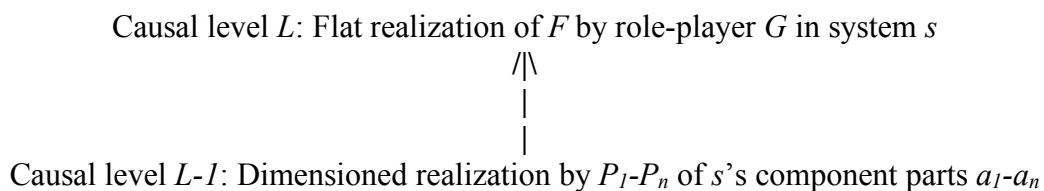


Figure 1. Comprehensive Functional Realization

The causal level L represents a pattern of relations of the kind causal-role functionalists use to define their target properties, in the philosophy of mind, the intra-level causal transitions between types of inputs, internal computations, and behavioral outputs. This causal-level also includes structural properties like G , since they play the causal role of functional properties like F (this level therefore includes the complex role-

playing tokens that are identical with s , like COMBO). Causal level $L-I$ then represents a pattern of relations of the kind that exist between the mereological parts of the instances of F and G , the individual subsystems or molecules or atoms that compose the system s and determine its powers by the contributions of the several properties P_1-P_n .

Parenthetically, one could dispense with the flat theory's token identities and tell the same compatibilist story in terms of a weaker relation of material constitution with regard to a coincident object, for the relation between objects like the diamond and coincident objects like COMBO is still distinct from the dimensioned relation between those wholes/aggregates and their individual carbon atoms. In other words, there are still two stories that one can combine in the way suggested for comprehensive functional realization. Hence a coincident-friendly version would remain what is depicted in *Figure 1*, save that the causal level L would now involve the “instantiation of F by role-player G in system s and its coincident aggregate s' respectively.”¹⁰

In any event, since two concepts of realization are in play, the flat and dimensioned, and since both the role-player G and the more basic properties P_1-P_n have been called “realizations” with respect to the realized property F , it might be helpful to call the structural property G the “realizing role-playing” property and the more basic properties P_1-P_n the “realizing part” properties. But however they are labeled, on the larger compatibilist picture of comprehensive functional realization, the part properties jointly determine the role-playing property which in turn determines the functional property. In other words, on this picture realization is a three-place relation ‘... realizes ... in virtue of ...’:

(CFR) a role-playing property G realizes a functional property F in a system s in virtue of more basic realizing part properties P_1-P_n possessed by s 's subsystem parts a_1-a_n .

I will have more to say about comprehensive functional realization when I consider some possible objections. But first I want to highlight some areas of agreement within the philosophical literature.

IV. Common Ground for Agreement

Many philosophers accept the two aspects of comprehensive functional realization: the idea of flat functional roles and occupants *as well as* the idea of a dimensioned functional metaphysics. For example, as noted already, Fodor famously supports a dimensioned functional analysis that proceeds by a decomposition of functional capacities. But he also defends the flat causal-role account of mental states. As he says:

The intuition that underlies functionalism is that what determines which kind a mental particular belongs to is its causal role in the mental life of the organism. Functional individuation is individuation in respect of aspects of causal role; for purposes of psychological theory construction, only its causes and effects are to count in determining which kind a mental particular belongs to (1981: 11).

So causal-role functionalism concerns matters of individuation and thus it addresses the kind of thing in question – *what* is being realized. But functional decomposition addresses the connection between the functional property that has a role-player and the underlying subsystem types and physical mechanisms – *how* the functional property and its role-player are realized by the more basic part properties of the subsystems. Of course Fodor does not say that the two functional theories are theories of *realization*. Like many others in decades past, he was content to leave the idiom of realization largely as an undefined primitive (save any constraints imposed by its usage, for example, to express some kind of determination or dependency between special and general science properties). Commitment to a functionalist theory is not *ipso facto* commitment to a functionalist theory of *realization*, since one could be a functionalist about items in a particular domain and believe that their realization is by virtue of something else, say, a mapping relation, or some form of supervenience, or subsets of causal powers, and so on. This is how Block views early nonreductive functionalists, for he articulates their position as a second-order functionalist theory but maintains that they held a mapping view of realization (1996: 207). But whatever their view, functionalists like Fodor are certainly free to describe realization in the comprehensive functionalist

way, given their acceptance of its two components and barring the adoption of some other view of realization.

Similarly, Lycan accepts the two components of comprehensive functional realization. He accepts a dimensioned functional analysis that explains the abilities of postulated homunculi in terms of many lesser homunculi (1987: 37-38), and he also believes that the functional role/occupant distinction is absolutely fundamental to mind and metaphysics quite generally (Ibid.: 39-41). Of course, like Fodor, Lycan does not say that the functional theories are theories of *realization*. On the contrary, Lycan defines realization in a different way in terms of a traditional one-to-one mapping that is constrained by a teleo-functional account of the realized property (Ibid.: 30-33). However, since he is committed to the same two functional components, Lycan's view is indistinguishable from comprehensive functional realization if one assumes that the mapping relation is satisfied (which many believe to be trivial) and as long as the designated functions are given a teleological reading.

I also note that my compatibilist sketch of comprehensive functional realization comports well with what Cummins says about the integration of transition theories and property instantiation theories when the latter involve causal capacities or dispositions. As Cummins observes: "property theories and transition theories fit together in an important way when target properties are dispositional. For when a system manifests a disposition, we have cause and effect (precipitating event causing manifestation), hence state transition" (1983: 21; see also 2000). So there is an item in a flat causal transition theory, for example, a dispositional property or capacity picked out by a psychological theory that describes the state transitions between a mind's input or triggering conditions for that mental disposition, the mental state or disposition itself, and the output or manifestation of that disposition. But the dispositional property also decomposes into simpler part properties and subcapacities *via* a dimensioned property instantiation theory.

Granted, causal transition theories are not equivalent to functional theories of causal *roles* and *occupation*. Statements of causal transitions are typically silent about whether a causal capacity is associated with a functional-role property that has a distinct role-playing or occupier property. Consequently, causal transition theories are not equivalent to causal-role theories of *realization* either. Indeed, for Cummins, realization

is only tied to the dimensioned functional analysis, which is to say, the property instantiation theory and not the causal transition theory. And there are other points of difference. For example, Cummins believes that the primary data to be explained in psychology are capacities that are *not* typically specified as laws (2000: 123). Scientific causal-role functionalists, on the contrary, assume that psychological laws are widespread, which is why they present their theory in terms of laws, or rather conjunctions of laws as captured in a Ramsey postulate (Block 1980). Even so, the complementary work of flat and dimensioned functionalist theories of realization is very much like the complementary work of causal transition theories and property instantiation theories. For both accounts, the dimensioned mereology serves to explain the realization of a target functional property.

Finally, turning from the substance of theories to a point about methodology, the comprehensive functionalist picture of realization also coalesces nicely with Robert Wilson and Carl Craver's view that there are two sources for contemporary thought and talk about realization: one they label the "Metaphysician of Mind" and the other the "Cognitive Scientist" (2007: 83). The goals of the former are to elucidate such things as the relationship between functionalism, physicalism, and reductionism, as well as issues like mental causation and multiple realization. The goals of the latter are to identify neural structures that are relevant to the operation of psychological capacities across populations and provide step-by-step accounts of how those capacities are realized by the neural structures in the pertinent populations. Seen in this light, a flat theory of causal-role functionalism is very much the product of philosophers wearing the hat of a metaphysician of mind, addressing matters of individuation and essence that indicate what the nature of mind happens to be, while a dimensioned theory of functional decomposition is very much the product of philosophers wearing the hat of a cognitive scientist, basing their analyses on work in psychology, neuroscience, and artificial engineering areas of cognitive science that indicate how the mind is realized step-by-step through various subsystem structures.

Moreover, like myself, Wilson and Craver believe the two methodologies should yield compatible results. After noting that the desiderata for the Metaphysician of Mind and the Cognitive Scientist are different, they say:

More pessimistically (and even more speculatively), it is possible that the concept of realization satisfying one of these sets of desiderata must be different from the concept of realization that satisfies the other. While a certain kind of peaceful coexistence could persist were the preceding scenario to eventuate, to find that there was some kind of deep incompatibility between the desiderata of the Metaphysician of Mind and of the Cognitive Scientist would be a sort of intellectual disaster. So much so, we think, that one of the desiderata on the list of each should be that their view of realization should be at least consistent with (ideally, well-integrated with) that of their counterpart (2007: 84).

My explanation of the complementary work of flat and dimensioned theories thus serves to confirm their view and avert the disaster of having the Metaphysician of Mind and the Cognitive Scientists talk past each other, as well as avert the disaster of having theories that describe the mind's causal transactions and theories that describe the mind's mereologically dimensioned relations pull apart, thus disunifying science at the very place where mental causal laws meet realizing mechanisms.

V. Objections, Responses, and Rationales

I think that the synthesis of causal-role functionalism and the dimensioned functional analysis presents a viable theory of realization. But it raises some questions. I start with objections to the flat elements of the theory. Gillett discusses the complex instance COMBO of carbon atoms that is token identical with the diamond as well as a complex structural COMBO property whose powers enable it to play the role of the hardness of the diamond (note again the qualification mentioned in note 9). But he rejects such COMBO postulates on grounds that his dimensioned analysis can be reiterated at a more basic level: "Once again, it appears that COMBO is not identical to any of these specific microphysical properties/relations of fundamental particles," since fundamental properties and relations are "instantiated in particular microphysical individuals such as quarks, whilst COMBO is instantiated in the diamond" (2002: 320).

Defenders of the flat view could respond in kind by reiterating their constructivist methods at this more basic level. In particular, they could postulate another complex of quarks, say, QUARKO, that is token identical with the diamond and which possesses a structural QUARKO property that contributes its powers to the hardness of the diamond. However, I think

Gillett is correct to see that such complexes must be explained by a deeper story about determination between proper parts and wholes. Still, the problem with Gillett's argument is that reiterating a dimensioned analysis at a more basic level only provides a reason for thinking that the *dimensioned parts* have a place in the world (and hence a place in a theory of realization). That does not provide a reason for thinking that flat entities like *COMBO* have *no* place in the world (and hence no place in a theory of realization). So Gillett's point does not show that there is a problem with my compatibilist proposal that gives place to both flat and dimensioned theories.

Yet Gillett has more recently objected to the *plausibility* of flat causal-role theories rather than their *compatibility* with the dimensioned account. Specifically, he has argued against postulating entities like the role-playing COMBO-style structural property on the basis of a principle of *simplicity*:

Unfortunately, although structural properties may be an ideal fit for the demands of the Standard Picture [flat causal-role functionalism] there is a grave concern that arises when structural properties, or similar entities, are used to understand scientific cases. For there are good reasons to think that we should not accept the existence of COMBO, and other structural properties, given the strong ontological parsimony arguments against positing such properties (2007: 33).

In support, Gillett focuses on the neuroscientific case of ion channels and their dimensioned realization by protein sub-units. The opening of a neuron's ion channel is explained by the fact that its component parts swivel in response to a change in the charge of the surrounding cells, thus resulting in a different spatial organization that constitutes the open ion channel of the neuron. There is no mention of any role-playing property, which leads Gillett to say: "the introduction for the ion channel of a further *property of being made up by* the sub-units and their properties and relations, i.e., a structural property like COMBO, looks almost perversely profligate" (2007: 33-34).

In response, I think Gillett is correct that looking solely at the relation between a neuron's ion channel and the properties of its component parts does not justify postulating any role-playing COMBO-style entities. But defenders of the flat functionalist view, as well as any who support comprehensive functional realization, should say that considerations about scientific

unification count in favor of a COMBO-style postulate *if one looks slightly higher and beyond the perspective of the theory about the neurochemical mechanism for ion channel functioning*. Viewing the matter *inter-theoretically* is the key. In particular, suppose one is also interested in a more general theory about voltage-sensitive gates and how they carry information, a broader perspective that includes voltage gates in electrical engineering as well as other fields outside neuroscience.¹¹ One might then find that the role-occupant distinction is very useful in forging a connection between the ontology of a theory about voltage-sensitive gates and the ontology of the neuroscientific theory about ion channels.

Specifically, expressing this broader perspective in terms of comprehensive functional realization (CFR): signaling through a voltage-sensitive gate F is realized by a role-playing open ion channel property G in a neuron s in virtue of more basic realizing part properties P_1-P_n of the neural components a_1-a_n . This is very much like saying that macro-hardness F is realized by the lattice-structure property G in the diamond object s in virtue of the more basic properties P_1-P_n of the constituent carbon atoms a_1-a_n , and very much like saying that processing a disjunctive argument F is realized by a structural property of logic gates G in a computer system s in virtue of the more basic properties P_1-P_n of the engineering component circuits a_1-a_n .

So while the postulation of role-playing entities may appear ontologically profligate, they actually play a central role in the broader practice of inter-theoretic unification by indicating what, within the domain of a lower-level theory, corresponds to the entities in a higher-level theory that have been targeted for explanation. There is no ‘diamond’ in the concepts and vocabulary of micro-chemistry, only in the macro theory. But there are carbon atoms and most importantly a complex lattice-structure COMBO of them that can be identified with or at least correlated with the diamond and thus explain its macro hardness by the lattice-structure property. Likewise, there is no ‘mind’ in the concepts and vocabulary of electrical and computer engineering, only in psychology and computational psychology. But there are electrical and engineering components and most importantly a SYSTEM of engineering components that can be identified with or at least correlate with a mind and thus explain its ability to perform cognitive processes like formulating a disjunctive argument by a structural property of its logic gates.

Now for one final objection to the flat elements of comprehensive functional realization, I have stated that the main purpose of the flat causal-role theory is to indicate the nature of a

realized property – the “what” of realization. But one might argue that Shoemaker’s (1980) causal theory already provides a viable answer to the question of property identity and individuation. A property is individuated by the powers it contributes to its instances. Hence there is no need for any flat theory of realization to do this metaphysical work.¹² I have two responses. First, while I have said that the main purpose of a flat theory is to indicate the nature of a realized property, that is not its *only* purpose. The flat theory also provides information about the *determination* of a realized property. The part properties jointly determine the role-playing property, which in turn determines the functional property. Second, the objection seems to overlook the fact that causal powers and causal laws are closely tied together in a family of related notions. To the point, where Shoemaker’s theory has forward-looking and backward looking causal powers, causal-role functionalism has forward-looking causal laws that link functional properties to types of effects (or outputs) and backward-looking causal laws that link functional properties to types of causes (or inputs). As a consequence, I see little difference between individuating properties by the one rather than the other.

Of course one might have other reasons to criticize flat causal-role theories. The literature in the philosophy of mind is full of discontents. Indeed, I am not convinced that it represents the best picture either, even for the main purpose designated within the comprehensive functionalist theory. Accordingly, I have elsewhere developed a competing nonreductive account that individuates properties within a broader set of nomic relations that include intra-level causal relations as well as the dimensioned inter-level aspects of realization shorn of any functional role-occupant metaphysics (Endicott 2007). Even so, I believe flat causal-role functionalism is consistent with the dimensioned functional theory, and complements it in the way indicated.

Still, rather than cast doubt upon the flat functional-role aspects of comprehensive functional realization, one might cast doubt upon the dimensioned aspects of the theory. In particular, after presenting his own most recent versions of the subset account of realization for both a single object and coincident objects, Sydney Shoemaker says of Gillett’s dimensioned position:

Such views are right in holding that we need an account of realization that gives a role to the properties of micro-entities and other parts of macroscopic objects, and that we do not get this in the sort of [flat] account presented so far. But the cure for this is not to count properties of

parts of macroscopic objects as realizers of properties of the macroscopic objects. The instantiation of a realizer of a property should be sufficient for the instantiation of that property, and no property of a micro-entity that is part of a thing is such that its instantiation is sufficient for the instantiation of any of the properties of that thing. What is true is that the instantiation of a property of a micro-entity can be part of a macroscopic entity. What we have here is the realization of a property instantiation, not by another property instantiation, but by a microphysical state of affairs involving the instantiation of micro-properties in micro-entities. Such a state of affairs “makes real,” constitutes, the occurrence of a property instance (2007: 32).

So Shoemaker says that realizers must supply a *sufficient* condition for what they realize, and hence Gillett’s dimensioned theory is in error because it counts the proper parts of an object as realizers that, taken individually, do not supply a sufficient condition for what is realized. What is sufficient instead is a larger “microphysical state of affairs” involving the assorted microphysical proper parts and their microphysical properties. Thus, in addition to his two flat accounts of property realization for single and coincident objects that make no mention of microphysical parts, Shoemaker develops an account of “micro-realization” employing microphysical states of affairs that contain microphysical parts and their properties.

I have two responses. First, a technical point, one might question whether realization should always involve sufficient conditions. This is the standard view, and I have assumed it in the past. Nevertheless, in order to account for the converse of multiple realization, I also have developed an account that treats realizers as INUS conditions (Endicott, 1994: 68-71). My suggestion was that, instead of realization laws of the form: for any x , if x has G_1 then x has F_1 , the laws must include an additional base condition G_2 such that a difference in G_2 allows G_1 to determine some other property F_2 but not F_1 (the converse of multiple realizability). So let the realization law be: for any x , if x has G_1 & G_2 then x has F_1 . This makes G_1 *an insufficient but necessary part of a sufficient condition*. However, if F_1 is then multiply realized by properties other than the joint pair G_1 and G_2 , then the pair is not necessary, which now makes the original realizer G_1 an INUS condition -- *an insufficient but necessary part of an unnecessary but sufficient condition*. Even so I will not press this point, since I believe this difference with the standard sufficiency view ultimately turns on difficult and often interest-relative choices between what counts as “realizers” versus “background conditions” for their metaphysical production (ditto, of course, for the corresponding debate over “causes” versus “background conditions”).

Second, and more important, granting the point about sufficiency, I read Gillett as maintaining that the basic realizing part properties P_1 - P_n jointly determine the realized property F , meaning that their joint instantiation by the several proper parts *suffices* for the instantiation of the realized property F . In other words, Gillett can maintain the dimensioned realization law expressed earlier for functional part-whole realization (FPR): for any x and any y_1, \dots, y_n , if y_1, \dots, y_n are the proper parts of x , then if y_1, \dots, y_n have P_1, \dots, P_n , then x has F . Perhaps Shoemaker intends to make a deeper metaphysical point that Gillett's dimensioned theory does not supply the right kind of *micro object* which, when it instantiates a microphysical property, is a sufficient condition for the realized macro object, when it instantiates the realized macro property. That, apparently, is why Shoemaker appeals to a complex microphysical "state of affairs" that contains microphysical property instances as parts. But, happily, the present picture of comprehensive functional realization provides the perfect analogue for Shoemaker's complex microphysical state of affairs, namely, a complex COMBO-style object that instantiates the role-player property G that determines F . Both Shoemaker's state of affairs and the present complex COMBO are constituted by microphysical parts, and both possess a property that is sufficient for the realization of F .

VI. Concluding Remarks

I close with some general remarks about why it is easy to overlook the complementary work of a flat functional role theory and a dimensioned functional theory, viewing them instead as theoretical competitors. First, in its popular second-order version, the flat functional theory appears to address the *same hierarchy of nonreductive facts* as the dimensioned theory by stating that there are two orders of properties, the functional properties associated with causal roles, and the role-playing occupiers. But, in response, the flat second-order theory does not yield the *same* hierarchy, as I explained earlier by the distinction between property "orders" and causal "levels." Only the dimensioned theory addresses different causal levels, as befitting the different powers of parts versus wholes.

Second, it might seem that flat and dimensioned functionalist theories of realization are in competition because *both are theories of determination*. The role-player G determines F , and yet the joint work of the part properties P_1, \dots, P_n also determines F . But, in response, on the synthesis I propose they determine the realized property in different ways, one being direct and the other

indirect. The instantiation of the part properties P_1, \dots, P_n by the subsystem parts a_1-a_n determines a complex COMBO-style object to have a role-playing property G that in turn determines the system s to have the functional property F . The determiners do not compete. They are different links in the great chain of being.

Third, it might seem as though flat and dimensioned functionalist theories of realization are in competition because they seem to answer *the same philosophical problem*, for example, the mind-body problem (how does the mind relate to the brain?), or the many-sciences problem (how does the ontology of a special science relate to the ontology of a more general science?). But these philosophical problems are not single problems susceptible to single answers. Each one involves a complex of issues. Consider the mind-body problem. It divides into at least two different problems that are relevant to the present discussion: (i) *the nature of mind*, and (ii) *the inter-level relation between mind and brain*.

Clearly some theories about (i) do not answer (ii). Substance dualists famously answer (i) with the claim that the mind is an immaterial object. But that does not answer (ii), the relation between an immaterial mind and a material brain, save the implication that minds are not identical to brains. Accordingly, substance dualists seek to give more informative if not entirely plausible answers to (ii), including the Cartesian doctrine of two-way causal interaction, parallelism, epiphenomenalism, and other more recent proposals based upon ideas about emergence and supervenience. Conversely, some theories about (ii) do not answer (i). Theories such as two-way causal interaction, epiphenomenalism, or various forms of supervenience say very little that is interesting about the nature of mind. For example, mind-body supervenience has been held by dualists and physicalists alike. Of course some theories answer both questions at once. The mind-brain identity theory attempts to answer the nature of mind, and it addresses the relationship between mind and brain. But this is not always the case, as the previous examples show.

Accordingly, I submit that flat and dimensioned functionalist theories are designed to answer the different problems just described. On the one hand, by addressing the *what* of realization, a flat functionalist theory is primarily an attempt to answer (i), the question about the nature of mind or the nature of the entities in a special science theory. Yet because the properties in the flat theory are instantiated at the same causal level, it is not primarily an attempt to answer (ii), the question about inter-level relations between the mind and brain or the special and

physical sciences. On the other hand, by addressing the *how* of realization, the dimensioned functionalist theory is primarily an attempt to answer (ii), the question about the inter-level relations. Yet because the dimensioned theory is a theory of inter-level determination, it is not primarily an attempt to answer (i) about the nature of the entities so determined. Each theory thus speaks to a different aspect of the mind-body problem or the many-sciences problem. Of course, nothing I have said is intended to show that *all* flat and dimensioned theories of realization are compatible and complementary in the way described. But I think it is important to know that *some* theories are so compatible, especially when it concerns functionalist theories that have dominated discussions in the philosophy of mind.¹³

Endnotes

¹ See Gillett 2002, 2003. I present the theories of realization in terms of a relation between properties, which sits well with the literature on multiple realization. Gillett presents the theories in terms of property instances. He defines the flat theory as follows: “(I) A property instance X realizes a property instance Y *only if* X and Y are instantiated in the same individual” and “(II) A property instance X realizes a property instance Y *only if* the causal powers individuated of the instance of Y match the causal powers contributed by the instance of X (and where X may contribute powers not individuated of Y)” (2002: 317, 318). See also note 4 below for his definition of the dimensioned theory. Thomas Polger and Laurence Shapiro 2008 believe that definitions cast in terms of individual instances lead to a *reductio* when coupled with the multiple realization of properties. I resolve their *reductio* by supplying the appropriate category-inclusive auxiliary assumption that allows theories of realization to range over individuals as well as properties (Endicott, 2010).

² See Shoemaker 1981 and Kim 1998. Kim’s version is an exceptional case. He is a nominal second-order functionalist and a metaphysical first-order functionalist because he employs the second-order language but gives it a deflationary interpretation whereby “the property of having property *Q*” picks out the same property as “the property *Q*” (1998: 99). Thus he identifies mental properties with first-order physical properties, unlike standard second-order functionalists.

³ For another example of a flat position, consider Shoemaker’s 2001 view based upon ideas about causal powers and set-theoretic inclusion. Roughly stated, a property *G* realizes (or is the realization of) a property *F* if and only if an object *x* has properties *F* and *G*, and the causal powers of the realized property *F* are a proper subset of the causal powers of the realizing property *G*. The realized and realizing properties are possessed by the same individual, as required by condition (I). The powers of the realizing property also match the causal powers of the realized property by virtue of the subset relation, as required by condition (II). But see Shoemaker 2007 for another version of the subset view that accommodates nonidentical but coincident objects.

⁴ Gillett summarizes his own version of a dimensioned position as follows: “Property/relation instance(s) P_1 - P_n realize an instance of a property F , in an individual s , *if and only if* s has powers that are individuative of an instance of F in virtue of the powers contributed by P_1 - P_n to s or s ’s constituent(s), but not vice versa” (2002: 322, with a change in the variables).

⁵ A referee suggests a more ecumenical interpretation according to which Gillett’s dimensioned account subsumes the flat account but adds to it. In other words, Gillett argues that we should reject the flat account in favor of the more encompassing dimensioned theory because the flat view fails to cover many cases. But this interpretation seems hard to square with Gillett’s explicit rejection of at least *some* elements of the flat theory, in particular, the role-playing structural properties that Gillett 2002: 318, fn. 3 grants may be definitive of the standard view (as in his rejection of COMBO discussed in section V. of the present paper). Gillett’s position does not subsume *those* elements of the flat theory. So, in the very least, my proposal differs from his because the role-playing structural entities that he rejects play a central role in the picture of comprehensive functional realization.

⁶ Michael Tye’s 1995: 47 account of realization was also motivated by the same scientific paradigm – the hardness of a diamond. But, as Thomas Polger remarks, Tye appears to utilize the flat role-occupant distinction by interpreting the realizer property to be a role-playing crystalline structure. See Polger 2007: 239, fn. 9. For this reason Tye’s view should not be classified as a dimensioned theory. However, once one becomes explicit about the components of the complex role-playing structure, and includes them into the account of realization, the view becomes the synthesis of flat and dimensioned positions that I describe as comprehensive functional realization.

⁷ Gillett has his eye on the claims made by Laurence Shapiro that standard cases cited to support multiple realization are in fact not genuine cases of multiple realization. See Shapiro 2000 and 2004.

⁸ Gillett 2003: 596 describes them as “relevance criteria” for counting something as a distinct realization. For a discussion of such criteria, see Laurence Shapiro 2008. For the record, I believe

that a flat theorist may also count the mammalian and octopus eyes as different realizations. For example, one could claim that the structural property for the mammalian eye and the structural property for the octopus eye both play the same causal role as understood by a high-level psychological theory of vision which describes the pertinent visual function in terms of abstract information over shared processing items such as a cornea, pupil, and retina, even though the structural properties differ by a lower-level physiological theory that highlights their physical differences regarding the parts that constitute those structures (e.g., the photoreceptor cells in the octopus eye point toward the incoming light while those in a mammalian eye absorb light that is reflected from the back of the eye). See also Gillett 2003: 595, fn.12, where he mentions why some philosophers believe that the two corresponding structural properties may differ even though they play the same causal role.

⁹ The term ‘COMBO’ is Gillett’s (2002: 320), which he uses for entities that a flat theorist will postulate. A referee takes issue with my use of the term for a complex individual on grounds that Gillett explicitly states that COMBO is a structural property à la Armstrong. But, while I grant Gillett often uses the term in that way, in point of fact he uses COMBO for both a property *instance* as well as a *property*, beginning at the first few sentences where the term is introduced: “the Standard view will take a highly complex structure of carbon atoms, and their properties and relations, to be the realizer of H [*F*]. Let us call this structural property *instance* ‘COMBO’ to mark that it is a vast array of interrelated entities. If a structural *property* such as COMBO is taken as a putative realizer, concludes the response, it is no longer implausible that COMBO realizes H [*F*] in a way compatible with the flat account” (2002: 320, italics mine). But nothing turns on the point. One may just as well call the property ‘COMBO’ and its instance something else. Still, I will continue to use the term for the complex individual aggregate of parts, and describe the property *G* as a complex structural property possessed by COMBO.

¹⁰ Another referee asks in effect: if I relax the requirement for token identity, how does the resulting view differ from the dimensioned position? But recall that I defined the functional part-whole version of dimensioned realization as a core notion that makes no reference to a complex aggregate of parts that is coincident with *x*, or a complex structural property *G* that could be identified as a role-player for the functional property *F*. This is as it should be, since Gillett

rejects those metaphysical supplements, as I discuss in section V. They enter only as part of a here liberalized flat story – still causally flat because the coincident object would exist at the same causal level n as the object it is coincident with – a story that combines with the basic dimensioned position in the larger picture represented by the now revised coincident-friendly version of comprehensive functional realization.

¹¹ At one point Gillett mentions that an ion channel has the property of being a voltage-sensitive gate: “We know that, under appropriate background conditions, a potassium ion channel plays a key role in a neuron due to its property of being a voltage-sensitive gate contributing the backward-looking power of opening in response to a change in the charge of the surrounding cells” (2007: 28). But Gillett does not address the significance that second-order functionalists will attach to that higher-level, more general perspective.

¹² Carl Gillett has raised this issue in discussion, and a referee expressed much the same point.

¹³ I thank Carl Gillett, Thomas Polger, Brian McLaughlin, Andrew Melnyk, John Post, and Sydney Shoemaker for discussions on the topic, some tracing back to the Mind-Body & Realization conference at Lafayette College, 2006. I also thank John Carroll and William Lycan for some comments on an earlier draft, and Michael Pendlebury for looking over the present paper.

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