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# Understanding Physical Realization (and what it does not entail)

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The notion of *realization* is defined so that we can better understand what it means to say that mentality is *physically realized*. It is generally thought that physical properties realize mental properties (thesis PR). The definitions provided here support this belief, but they also reveal that mental properties can be viewed as realizing physical properties. This consequence questions the value of PR in helping us capture the idea that mental phenomena are dependent upon (i.e., obtain by virtue of) physical phenomena. In particular, Kim's functional model of reduction and Melnyk's functional definition of physicalism are refuted.

For quite some time, the consensus among philosophers of mind has been that mental properties are not reducible to physical properties.[1] However, many non-reductionists still wish to support *physicalism* (i.e., the doctrine that mentality is ultimately purely physical), and for this reason, talk of physical *identification* is replaced with talk of physical *realization*.[2] The fact that any mental property can be physically realized in a variety of different ways is thought to show that mental properties are not identical with physical properties. But so long as mental properties are always *physically* realized, the doctrine of physicalism might still be true.

Suppose we were to accept *reductive* physicalism? Would talk of physical realization then be of any use? If mental properties were physical properties,

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[1]The main argument used to support non-reductive physicalism appeals to the fact that mental properties are *multiply realizable*; that is, any mental property can be instantiated in a wide variety of physical structures. Putnam (1967) and Fodor (1973) are among those who popularized this appeal to multiple realizability.

[2]Van Gulick (1992), for instance, claims that the "relation between mental properties and physical properties . . . is one of *realization* or *instantiation* and not identity" (p. 162).

then mental phenomena would be a special type of physical phenomena, in which case, it would be trivially true that mentality is purely physical. But even so, there would still be no guarantee that mental phenomena occur *by virtue of* physical phenomena, *rather than the other way around.* By claiming that mentality is physically realized, we seem to capture the idea that the physical level is more fundamental than the level of mentality, the latter being ontologically grounded in the former. So even for the reductionist, the notion of physical realization would seem to play a crucial role in capturing the idea that the mental is dependent upon the physical.

It is no surprise, then, that philosophers of mind generally accept what Kim (1998a) calls the "Physical Realization Principle" (hereafter PR), according to which,

PR: mental properties are *realized* by physical properties.[3]

It seems that only a substance dualist would deny PR, for the idea that mental properties are not physically realized implies that mentality occurs within some mysterious realm other than the physical universe. However, despite PR's popularity, Papineau (1995) notes that "there is no agreed philosophical analysis of the notion of realization" and that "[p]hilosophers tend to use this notion much more freely than they explain it" (p. 236). So it is not entirely clear just what PR does or does not entail.

Kim (1998b, 1999) and Melnyk (1996) seem to think that the principle entails quite a lot. According to Kim's *functional model of reduction*, PR along with the idea that mental properties are higher-order functional properties provides all of the basic materials needed to explain the way in which mental properties are *reducible* to physical properties. Melnyk is a non-reductionist. But being a physicalist, Melnyk accepts PR and even contends that on the proper understanding of physical realization, PR can be used to fully define physicalism.

It is arguable, as we shall see, that the notion of physical realization cannot be used to accomplish all that Kim and Melnyk think; in particular, there is reason to deny that it captures everything essential to physicalism. Still, as noted above, PR does seem to describe at least one crucial ingredient of physicalism. At the very least, it appears to capture the idea that mentality is *grounded in* and had *by virtue of* physical properties, the latter being ontologically more fundamental. After all, we do say that the physical hardware realizes the computations of the computing machine, but we never say that the com-

[3]Kim's precise formulation is: "If something x has some mental property M (or is in mental state M) at time t, then x is a material thing and x has M at t in virtue of the fact that x has at t some physical property P that realizes M in x at t" (p. 1998a, p. 74).

putations realize the hardware; and the reason is simply that the computations occur *by virtue of* the hardware, and not the other way around.

However, here it will be shown that the apparent value of PR (in capturing the idea that the mental is grounded in the physical) is only apparent. To establish this point, we first need to precisely define the notion of realization, and in the next section, we will consider two ways one might try to explicate the notion. (One of these definitions entails that realizers are *lower-order* with respect to the properties they realize, and the other definition does not have this implication.) With the help of these definitions, it will then be shown that the notion of realization allows not only that mental properties are realized by physical properties, but also that physical properties can be realized by mental properties! In fact, we will see that every time a mental property is exemplified, that mental property can be viewed as realizing a physical property.

We will then consider two alternative definitions of the realization relation, and it will be shown that neither of these helps us avoid the conclusion that mental properties realize physical properties. This conclusion challenges the functional analyses of Kim and Melnyk, and it is also meant as a word of caution to anyone who seeks to characterize our physicalist intuitions in terms of PR.

*Defining Realization*

According to Kim's functional model of reduction, if we wish to reduce some property F, the first step is to provide a *functional definition* of F. For example, Kim notes that we can functionally define the *gene* as "the property of having some property (or being a mechanism) that performs a certain causal function, namely that of transmitting phenotypic characteristics from parents to offspring" (1999, p. 10). We can also functionally define *pain* by noting that "for an organism to be in pain is for it to be in some internal state that is typically caused by tissue damage and that typically causes groans, winces, and other characteristic pain behavior" (1998b, p. 19).

Once we have provided a functional definition of the gene or pain or whatever else might be the target of reduction, the second step is to locate *realizers* of the property to be reduced. For instance, since DNA plays the causal role of transmitting phenotypic characteristics from parents to offspring, DNA qualifies as a realizer of the gene; and whatever neural activity plays the functional role definitive of pain counts as a realizer of pain. The reduction is not complete, however, until the third step, which is to find a theory that explains how it is that the realizers of a functional property play the causal role definitive of that property. According to Kim, the property of being a gene is reducible to DNA since "[w]e presumably have a story at the

microbiological level about how DNA molecules manage to code and transmit genetic information" (1999, p. 11).

Antony (1999) and Marras (2000) note some difficulties with Kim's model of reduction, and an additional objection will be presented in the next section. But first let us note one component of Kim's model that is clearly unobjectionable — i.e., the manner in which Kim characterizes realization. Realization, Kim notes, is to be analyzed in terms of the notion of a *functional property*. A property is a functional property if there is a functional role definitive of that property, and a *realizer* of a functional property is whatever plays that definitive functional role. So DNA is a realizer of the gene since it plays the functional role definitive of the gene, and neural activity realizes pain by playing the functional role definitive of pain.

Kim also employs the common practice of viewing functional properties as *higher-order* properties. Pain is defined as the *second-order* property of *having a certain property* that plays the right causal role, and the realizers of pain are those first-order physical properties that play that role. Van Gulick (1992) also treats mental properties as second-order when he claims that "having a given mental property M is a matter of having some set of other properties $P_1, \ldots, P_n$ that satisfy the functional relation $R_M$." If there is a "specific set of physical properties $G_1, \ldots, G_n$ that satisfy $R_M$," then M is physically realized by $G_1, \ldots,$ and $G_n$ (p. 164). Block (1990) points out that "[f]unctional properties are properties that consist in the having of some properties or other (say non-functional properties) that have certain causal relations to one another and to inputs and outputs" (p. 155). Likewise, Papinaeu (1993) says that "[i]n order for a mental or other special type M to be realized by an instance of some physical type P, M needs to be a *second-order property*, the property of having some property which satisfies certain requirements R" (p. 25).

Let us follow their lead and suppose that functional properties are best viewed as second-order properties; for every functional property F, there is a functional role R, such that F consists in *having a property that plays R*. Then we can define the realization relation as

> (1) Property F is realized by property G for item x at time t = there is a functional role R, such that F consists in having a property that plays R, and G plays R for x at t.

Suppose that F is pain, and suppose that neural type G plays the functional role definitive of pain for Jill at time t. Then, for Jill at t, neural type G realizes pain.

Definition (1) refers to *functional* roles rather than *causal* roles to allow that some functional properties are non-causal. Since we might view mental properties as *computational* rather than causal (see Putnam, 1975, for example),

Melnyk notes that in addition to "causal–functional" properties there are also *computational–functional* properties. A computational–functional property

> is realised on some particular occasion iff on that occasion there exists some object capable of being in *n* distinct states, where there is a one–one mapping between the *n* states of the object and the *n* program-states . . . , and the distinct states of the object are related to one another, both actually and counterfactually, in exactly the way that those states' corresponding program-states are related to one another by the rules of the program. (1996, p. 391)

To illustrate a third type of functional property, Melnyk notes the property of being a heart. Being a heart consists in performing a certain biological function — i.e., the biological function of pumping blood. One way to understand an item's biological function is to discover what the item evolved to do, which obviously requires understanding the item's *ancestry*. Thus, Melnyk adds that having a biological function ". . . on one view, at least, . . . is a matter of having the right kind of ancestry. And if this notion of ancestry cannot itself be spelled out causally, then we will have to acknowledge a third type of functional property, which might be called *functional–functional*" (p. 392, emphasis added).

Suppose we wish to allow functional properties that are not second-order. Being a soda-machine is a functional property, and it may be construed as second-order; being a soda-machine consists in having some property or other that plays the functional role of dispensing containers of soda when coins are inserted. But being a soda-machine is more straightforwardly viewed as a first-order property; being a soda-machine consists in dispensing containers of soda when coins are inserted. And Block (1990) points out that while dormitivity may be viewed "as a second-order property, the possession of some property or other (for example, a first-order chemical property) that is causally relevant to sleep" (p. 155), it may be construed more simply as the first-order property of causing sleep (p. 163).

If we wish to view functional properties as first-order, then we may define a functional property as follows: F is a functional property if and only if there is a functional role R such that F consists in playing R (rather than "F consists in having a property that plays R"). Then we can define the realization relation as

> (2) Property F is realized by property G for item x at time t = there is a functional role R, such that F consists in playing R, and G plays R for x at t.

Dispensing containers of soda when coins are inserted (or something along those lines) is the functional role, R, definitive of being a soda-machine, F.

So suppose that some constitution G plays role R for machine x at time t (where G is a complex conjunctive property, conjoining all of the individual properties by virtue of which x is a soda-machine at t). Then G realizes the property of being a soda machine for x at t. Producing sleep is the functional role, R, definitive of having dormitivity, F. Suppose that flurazepam plays that functional role for pill x at time t. Then flurazepam realizes dormitivity for pill x at t. In both cases, we are viewing a property as functional and realizable, but we are also treating it as first-order.

One reason for treating functional properties as second-order is to highlight the fact that they are *multiply realizable*. If dormitivity is the property of having some property that produces sleep, then since different first-order chemical properties can produce sleep, different first-order chemical properties might realize dormitivity. But definition (2) also allows that functional properties are multiply realizable. By relativizing to items and times, (2) clearly implies that the property that plays R for x at one time might differ from the property that plays R for x at some other time or for some item other than x (e.g. flurazepam and quazepam both play the dormitivity role). Also note that (2) allows us to treat some functional properties as second-order if we choose to do so. Suppose that F is construed as the second-order property of *having a property that plays functional role R*. Let functional role R* be the property of having a property that plays R. Then there is a functional role — namely, R* — such that F consists in playing R*. If property G plays R*, then G realizes F according to (2), even though F was initially considered second-order.[4]

Reality is often viewed as being *multi-level*; e.g., the properties of elementary physics are lower-level with respect to those of biochemistry, and the properties of biochemistry are lower-level with respect to those of psychology. Now, Melnyk reserves the term "physical" for the properties of physics, and if we use "physical" in this narrow sense, then we need to distinguish

[4]Perhaps it is plausible to view some functional properties as first-order. But what about *mental* properties? Block (1990, p. 164) notes that "[m]any functionalists take pain to be a second-order state, but Lewis takes pain to be the first-order brain state that plays the functional role characterized by the second-order state." On the latter construal, pain is not the property of having some property that plays the right causal role; pain is whatever first-order neurophysiological property plays the right causal role.

One might think that viewing mental properties as first-order helps the functionalist escape epiphenomenalism. Block (1990) and Jackson (1998) in addition to Prior, Pargetter, and Jackson (1982) have expressed the worry that second-order functional properties forfeit their causal powers to their realizers. As Block (1990) illustrates, "[i]f a dormitive pill is slipped into your food without your noticing, the property of the pill that is causally relevant to your falling asleep is a (presumably first-order) chemical property, not, it would seem, the dormitivity itself" (pp. 155–156). However, Block also questions whether a first-order construal à la Lewis really does provide mental properties the right sort of causal relevance (pp. 164–166).

between being physically realized *directly* and being physically realized *indirectly*.[5] As Melnyk puts it, "[w]hat we want, intuitively, to say is that instances of functional properties at the highest level are realised by instances of functional properties at the next level down, that instances of these functional properties are realised by instances of functional properties at a yet lower level, . . . and so on until we reach functional properties whose instances are realised by instances of microphysical properties" (1996, p. 394). So we can say that a functional property is *directly* physically realized if and only if it is realized by a property definable in the vocabulary of physics, and a functional property is *indirectly* physically realized if and only if it "is realised by instances of functional properties, which instances are realised by instances of lower level functional properties, . . . and so on until we reach functional properties whose instances are realised by microphysical properties" (p. 395).

If we wish to accommodate the distinction between direct and indirect realization, then we can view (1) and (2) as accounts of direct realization, and say that F is *indirectly* realized by G if and only if there is a series of properties, $P_1$, $P_2$, . . . , $P_n$, such that F is directly realized by $P_1$, $P_1$ is directly realized by $P_2$, . . ., and $P_n$ is directly realized by G. However, the distinction between direct and indirect realization bears little weight in the discussion that follows. What is crucial to our discussion is the role that Melnyk thinks realization plays in understanding physicalism. According to Melnyk, a doctrine of physicalism "can be formulated using only the notion of realisation; neither claims of supervenience nor claims of token identity nor disjunctive definitions . . . play any part whatever" (1996, pp. 390). But with the help of definitions (1) and (2), it is easy to see that the notion of physical realization cannot be used to accomplish what Melnyk (or Kim) thinks it can accomplish.

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[5]One might be inclined to use the word "physical" more liberally so as to allow that the ordinary objects of everyday experience — e.g., tables, rocks, bicycles, and trees — qualify as physical. But the problem with using "physical" in this way is that it is not entirely clear what these objects have in common that makes each of them physical. We might try to define "physical" by appealing to those general features traditionally associated with matter (e.g., extended in space, solid, inert, impenetrable, and governed by deterministic laws). But, as Crane and Mellor (1990, p. 186) note, by appealing to these traditional features, we risk excluding much of what contemporary physics describes.

A way to avoid these definitional worries is to define a physical property as a property in the domain of physics. Then we can still be physicalists regarding the objects of everyday experience by arguing that their properties depend ultimately and entirely on the properties of physics. (If we take this route, we should define physical properties more accurately as those that are *sufficiently similar* to the properties of *contemporary* physics. "Sufficiently similar" allows that there are properties yet to be discovered by physics. And we want to appeal to *contemporary* physics because, as Post puts it, "we cannot anticipate the evolution of physics for more than a few years at most" and "we do not want to use an obsolete or erroneous concept of the physical" [1987, p. 121]. See Ravenscroft's [1997] defense and clarification of this way of defining "physical property.")

*Mental Properties Realizing Physical Properties*

Realization is typically characterized in terms of functional properties. A property may be viewed as realizable if and only if it may be construed as a functional property. But Lewis (1970) notes that the predicates of a scientific theory are defined in terms of how the properties they denote causally relate to other properties mentioned by that theory. If scientific properties are distinguished from one another by the functional (e.g., causal) roles they play, then just about any scientific property can be considered functional. Even if there were some property F that could not be defined in terms of its relations (causal or otherwise) to other properties, we could, if nothing else, characterize F by saying that to be an F is to play the functional role of *exemplifying F*. So the properties of physics may be considered functional along with those of psychology. Moreover, many physical properties may be considered higher-order. Suppose that object x has momentum *m*. Then x has the property of having a property (i.e., *m*) that plays the following functional role: *being the product of x's mass and velocity*. But the property, *having a property that is the product of mass and velocity*, is a second-order property. So having momentum *m* realizes the higher-order physical property of having a property that is the product of mass and velocity.

Given that some properties of physics may be considered higher-order functional properties, and therefore realizable, one might wonder whether it is possible for a mental property to realize a physical property (in addition to physical properties realizing mental properties). Well, consider the physical property of *occupying space*. There is a functional role — being instantiated in space — and occupying space consists in having properties that play this functional role. So occupying space may be construed as the second-order functional property, *having properties that are instantiated in space*. Since mental properties are instantiated in space, it follows from definition (1) that mental properties realize the physical property of occupying space. Also note the physical property of *containing electrons*. There is a functional role — being exemplified by an item containing negatively charged elementary particles — and containing electrons consists in having properties that play this functional role. So the property of containing electrons may be construed as the second-order functional property, *having a property that is exemplified by an item containing negatively charged elementary particles*.[6] Since mental properties are exemplified by items containing negatively charged elementary particles, it follows from definition (1) that mental properties realize the physical prop-

[6]Because of its complexity, I hesitate to call the property, *having a property that is exemplified by an item containing negatively charged elementary particles*, second-order. However, it is second-order at least with respect to the property, *is exemplified by an item containing negatively charged elementary particles*.

erty of containing electrons. (Definition [2] also yields the result that mental properties can realize physical properties. The physical properties, *is instantiated in space* and *is exemplified by an item containing negatively charged elementary particles*, are lower-order with respect to the higher-order properties described above. Since mental properties play these functional roles, it follows from [2] that the physical properties of being instantiated in space and being exemplified by items containing negatively charged elementary particles are realized by mental properties.)

It is possible, then, for a mental property to realize a property of physics (even a property of *elementary* physics). And note that these are not isolated cases. Occupying space and containing electrons are two of many very general physical properties that are mentally realized. Others are *being causally efficacious*, *containing physical components larger than electrons*, and *having a certain density*. Many highly specific physical properties are mentally realized as well.

Suppose that Jill touches a hot stove. There is a description of this type of behavior couched entirely in the language of elementary physics, and this purely physical description denotes some vastly complex property; call it $P_1$. $P_1$ qualifies as a physical property, since it is the referent of a possible predicate of physics. The second-order property, *has a property that is caused by* $P_1$, is also physical, since the predicate "has a property that is caused by $P_1$" contains only terms that figure in the language of physics. But suppose that at time $t_1$, Jill's pain is caused by $P_1$. Then, according to definition (1), pain realizes the second-order physical property. Also consider the complete description provided by elementary physics of Jill's arm movement at time $t_2$. This description denotes a complex physical property; call it $P_2$. The second-order functional property, *has a property that causes* $P_2$, is also a physical property (since it is the referent of a possible predicate of physics). But suppose that Jill's pain is the cause of her arm movement. In that case, pain realizes the second-order physical property according to (1).

These examples may appear contrived. However, it should be noted that *whenever* a mental property is exemplified, that mental property can be viewed as realizing a physical property. Hellman and Thompson (1975) note that "everything concrete is exhausted by basic physical objects," where basic physics objects are the items of elementary physics (p. 555). Now suppose (as seems to be the case) that their *principle of physical exhaustion* is true, and also suppose that individual x has mental property M at time t. Then the occurrence, x's having M at t, is an aggregate of the items of elementary physics. Call the manner in which this aggregate is comprised at the level of elementary physics, D. Now consider the second-order property, *has a property instantiated in manner D*. Every term contained within the phrase "has a property instantiated in manner D" is a term that figures in the language of physics. So the phrase is a possible predicate of physics, which means that

the second-order property it designates — call it $P_3$ — qualifies as a physical property. Although $P_3$ is a physical property, it is realized by mental property M in this case. And note, again, that M can be any mental property whatever. Since it is plausible to endorse the principle of physical exhaustion for all types of mentality, then it is plausible to think that *every time* a mental property is exemplified, that mental property realizes a physical property.

The fact that mental properties can realize physical properties threatens any attempt to characterize reductionism or physicalism purely in terms of physical realization. Contrary to Melnyk's (1996) analysis of physicalism, thesis PR fails to capture the way in which mental phenomena are thought to depend on physical phenomena. In the case above, mental property M realizes $P_3$, where $P_3$ is the second-order property of *having a property instantiated in manner D*. But Melnyk would surely want to deny that $P_3$ depends on M. Since D is the manner in which M is instantiated at the level of elementary physics, any physicalist would want to maintain that the dependency relation runs in the opposite direction; that is, an individual has M by virtue of having $P_3$. Moreover, since $P_3$ may be considered a second-order functional property, Kim's functional model of reduction seems to yield the result that $P_3$ is reducible to M (rather than the other way around), which is clearly contrary to physicalist intuitions.[7]

But perhaps we have defined the realization relation too loosely. It might be argued that we should strengthen formulations (1) and (2) so as to require that realizers lie at a *lower-level* of structural organization than the properties they realize. Perhaps our definitions will then preclude physical properties being realized by mental items.

*An Appeal to Lower-Level Realizers*

Drawing on Cummins' (1983) model of functional analysis, Marras (2000) proposes that

> [a] functional property *F* is instantiated by a system *S* at a given level in the mereological hierarchy if *S* can be analyzed into a configuration of lower-level components whose properties and mode of organization enable the system to play the functional role definitive of *F*. For each relevant set of functional properties instantiated by *S* there will then be a structure of interrelations among the properties of the analyzing components that will be homomorphic to the pattern of interrelations (the "inten-

[7]Note that in the case of M and $P_3$, all three steps of Kim's functional model can be completed. $P_3$ has been given a functional definition, M is identified as a realizer of $P_3$, and regarding the third step, there is a theory available that explains how M manages to play the functional role definitive of $P_3$. Recall that $P_3$ is the second-order property, *has a property instantiated in manner D*, where D is the manner in which M is instantiated at the level of elementary physics. So the theory that explains how M realizes $P_3$ is precisely the theory that explains how it is that M is instantiated in manner D.

> tional generalizations") holding among the higher level functional properties of *S*. In virtue of the homomorphism between the two levels of structure and in virtue of the fact that one level is mereologically higher than the other, we can say that the higher-level structure is *implemented* in the lower level structure, and that each functional property at the higher level is *realized* by a corresponding property or set of properties in the implementing structure. (p. 157)

Marras is suggesting that it is part of the notion of realization that whenever a property is realized, the realizers must be at a lower level of structure than the property realized. It might be suggested that by requiring that realizers are lower in level than the properties realized, we can prevent cases in which mental properties realize physical properties.

But Kim argues that "*a second-order property and its realizers are at the same level in the micro–macro hierarchy; they are properties of the very same objects*" (1998b, p. 82, emphasis included). Kim notes, for example, that both dormitivity and the chemical property that realizes dormitivity are exemplified by the same object (i.e., a sleeping pill), and it is the same organism that is in pain and has c-fibers firing. For this reason, the hierarchy of levels generated by an analysis of functional properties does not parallel the hierarchy of levels generated by the part–whole relation; as Kim puts it, "*the realization relation does not track the micro–macro relation*" (p. 82). To keep the difference between the realizers–role hierarchy and the micro–macro hierarchy clearly in mind, Kim suggests that we distinguish between *levels* and *orders*, "using the 'order' idiom for first-order, second-order, and third-order, . . . properties, and reserving the 'level' idiom for tracking the micro–macro hierarchy" (p. 83).

Suppose we follow Kim's advice and reserve the "levels" idiom for tracking the mereological hierarchy. Must we then agree with Kim that second-order properties and their realizers are at the same level? Well, rather than viewing realizers as *properties*, we might view them as *events* or *processes*. It might be that what realizes F for x at t is not the property G itself, but the process, *x's having* G *at t*. Then the realizer is lower-level in the following sense: it is a proper part of the object that exemplifies the property that is realized. Suppose, then, that

> (3) Property F is realized by item x's having property G at time t = there is a functional role R, such that F consists in having a *process* that plays R, the process *x's having property* G *at time t* plays R, and x's having G at t is a proper part of x.

Or perhaps we should view the realizer of F as whatever *structure* or *mechanism* plays R in x at t. Recall that Kim defines the gene as "the property of having some property (*or being a mechanism*) that performs a certain causal function, namely that of transmitting phenotypic characteristics from parents

to offspring" (1999, p. 10, emphasis added). If we then require that the crucial structure/mechanism is a proper part of x, we can ensure that realizers are lower-level with respect to the properties they realize — again in the sense that the realizer is a proper part of the object that exemplifies the property that is realized. So perhaps we should say that

> (4) Property F is realized by structure s for item x at time t = there is a functional role R, such that F consists in having a *structure* that plays R, *structure s* plays R for x at t, and s is a proper part of x.

Although (3) and (4) capture the idea that realizers are lower-level, neither definition rules out the examples presented earlier. Suppose, again, that Jill touches a hot stove. There is a description of this type of behavior couched entirely in the language of elementary physics, and this purely physical description denotes some complex property, which we called $P_1$. $P_1$ qualifies as a physical property, since it is the referent of a possible predicate of physics. The second-order property, *has a property that is caused by* $P_1$, also seems to qualify as physical, since the predicate "has a property that is caused by $P_1$" contains only terms that figure in the language of physics. But suppose that Jill's pain is caused by $P_1$. That instance of pain and the relevant bodily region in which it occurs are proper parts of Jill, and this means that the second-order physical property is realized mentally according to (3) and (4). Also recall the second-order property, *has a property instantiated in manner D*, where D describes how Jill's pain is instantiated at the level of elementary physics. Every term contained within the phrase "*has a property instantiated in manner D*" is a term that figures in the language of physics. So the phrase is a possible predicate of physics, which means that the second-order property it designates qualifies as a physical property. Furthermore, that instance of pain and whatever inner bodily region sustains it are proper parts of Jill. So, in this case also, a second-order physical property is realized mentally, according to (3) and (4).

*Conclusion*

I do not deny thesis PR; mental properties are physically realized. What has been questioned instead is the value of PR in helping us capture the intuition that mentality is grounded in the physical realm. We have seen that every time a mental property is exemplified, that mental property may be viewed as realizing a physical property — a property of elementary physics, in fact. So even if physical properties (especially those of elementary physics) are more fundamental than mental properties, their primacy has nothing to do with the fact that mental properties are physically realized; nor has it any-

thing to do with the related claim that mental properties are higher-level functional properties.[8] This conclusion threatens the functional analyses of Kim and Melnyk, and it also offers a warning to anyone who seeks to characterize our physicalist intuitions in terms of PR.

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[8]If property F is realized by property G, then it is tempting to characterize F as *higher-level* with respect to G. So it seems that examples of mental properties realizing physical properties of the sort presented here can also be used to question the popular idea that mental properties are higher-level with respect to physical properties. For more details, see Francescotti (2002, section V).