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IS SUPERVENIENCE ASYMMETRIC?

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After some preliminary clarifications, arguments for the supposed asymmetry of supervenience and determination, such as they are, are shown to be unsound. An argument against the supposed asymmetry is then constructed and defended against objections. This is followed by explanations of why the intuition of asymmetry is nonetheless so entrenched, and of how the asymmetric ontological priority of the physical over the non-physical can be understood without the supposed asymmetry of supervenience and determination.

1. INTRODUCTION

The answer, in a word, is No. Supervenience is not asymmetric – and neither is determination. This conclusion is of course radically at odds with conventional wisdom, intuition, and many very good philosophers. Hence explanations are in order, indeed at some length, and so too is the patience to follow them, step by step.

The first step is to recall that according to physicalism, the physical enjoys a fundamental ontological primacy over the non-physical. In connection with this asymmetric primacy, physicalists assert not only the composition thesis that every concrete thing is composed solely of the basic physical entities, but also the determination thesis that the physical properties of things determine all

their properties. As Jaegwon Kim says, "Any robust materialist position should affirm ... that what is material determines all that there is in the world"[1]. Furthermore, according to Kim, the relevant relation of determinational dependence, which is a component of supervenience, is asymmetric: "Dependence, or determination, is usually understood to be asymmetric... In most cases of interest supervenience seems in fact asymmetric"[2].

Kim's argument for this supposed asymmetry of the determination relation proves inconsistent with at least one further property he gives the relation, as we see in §§2-3. So too for supervenience. In particular, a premise of the argument conflicts with the relation's transitivity. Nor does the literature appear to contain any considerations congenial to physicalists that would negate transitivity in favor of Kim's argument for asymmetry. To the contrary, physicalists require the transitivity of determination/supervenience in order to marshal adequate empirical support for their claim that the physical determines/subvenes all there is in the world.

Worse, the supposed asymmetry of determination and supervenience proves inconsistent with any identity or equivalence between the nonphysical properties of a thing and its physical properties, according to §4. Because such identity and/or equivalence does hold for (at least) some non-physical properties, determination and supervenience are not asymmetric. Reductivists, therefore, including Kim, can ill afford either asymmetric determination or asymmetric supervenience. So too for eliminitivists, who require the higher-level properties that survive elimination to be identical with or at least (nomically) equivalent to physical

[1] Kim ((1984), p. 162).

[2] Kim ((1990), p. 13); Kim ((1984), p. 166). Kim has plenty of company in assuming asymmetry, including Petrie ((1987), p. 127); Grimes ((1988), p. 157); DePaul ((1987), pp. 433 and 438); Miller ((1990), pp. 695-696); Papineau ((1990), p. 67); Poland ((1994), §1.2 and 2.3). One also hears the assumption frequently in conversation.

properties. But even nonreductive physicalists will be sobered, if they expected determination and supervenience to be asymmetric, since they agree that some higher-level properties are indeed identical or at least equivalent to physical properties, just not all.

If determination and supervenience are not asymmetric, explications of them cannot be faulted for failing to entail asymmetry, as a number of them have been, whatever their other merits. This includes explications according to which determination and supervenience are nonreductive and/or "global"[3]. On the other hand, anyone who rejects the asymmetry shoulders a twofold burden. Some explanation must be given of why the contrary intuition is so entrenched and widespread. And some explanation must be given of how the asymmetric ontological primacy of the physical is to be understood, if determination and supervenience are not asymmetric. The purpose of §5 is to provide the needed explanations.

This task is complicated by the tendency of different philosophers to understand "ontological primacy" in different ways, using the phrase in divergent unanalyzed senses. We need therefore to distinguish the main senses, in §5, and then, for each such sense, provide a positive account of the ontological primacy of the physical, and of the corresponding dependence of the nonphysical, according to which such primacy is asymmetric but determination and supervenience are not. Here I exploit neglected relations among determination/supervenience, explanation and the empirical evidence for the physical determination/supervenience of all that there is in the world. These relations enable us to understand why the intuition of asymmetry of determination and supervenience is so entrenched and widespread, as well as why the supposed asymmetry is not required by the ontological primacy of the physical.

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[3] Hellman and Thompson (1975), (1977); Horgan (1982), (1984); Lewis (1983); Post ((1987), Ch. 4); Post ((1991), Chs. 5-6); Post (1995). None of these explications entails asymmetry of determination.

2. SUPPOSED PROPERTIES OF DETERMINATION

A relation is never asymmetric "absolutely" but only in a given set or field. For example, in the set of integers the relation "≤" is neither asymmetric nor symmetric; it is false that given any x and y in this set, $x \leq y \rightarrow y \not\leq x$, and false also that for any such x and y, $x \leq y \rightarrow y \leq x$. But the relation "≤" is symmetric in a singleton set of integers, say {3}, since for any x and y in this set, $x \leq y \rightarrow y \leq x$ (that is, $3 \leq 3 \rightarrow 3 \leq 3$).

Thus we need to be clear about the set or field in which the physicalist's determination relation is supposed to be asymmetric. Here we may follow Kim, who treats the relation as holding between properties from various sets of properties. For example, in a *general* claim of supervenience, as he calls it, the properties in "a given family of properties, say mental properties, supervene on [hence are determined by] another family, say neurobiological properties"[4]. In this kind of case, the properties between which determination and/or supervenience holds form sets that amount to whole families of properties – say the mental, the neurobiological, the physical.

But, as Kim says, physicalists need also to make *specific* claims of supervenience and/or determination. For example, they might claim that the specific property of being in pain supervenes on (hence is determined by) the activation of specified nerve fibers. In this kind of case, the properties between which determination and supervenience hold – those of being in pain and of certain fibers' being activated – form subsets (often singleton subsets) of whole families (the mental, the neurobiological). As Kim says, physicalists need to make these specific claims of determination in connection with *explaining why* the general claims hold and *providing evidence for* them[5].

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[4] Kim ((1990), p. 25).

[5] Kim ((1990), pp. 25-27). Cf. Kim ((1987), pp. 321-322), and Kim ((1989), p. 42), on the need for specific "local determinations."

On this view, then, which is widespread, the field of the physicalist's relation of determinational dependence is the set of properties of things, both those properties that form whole families (the mental, the physical) and those from specific subsets of a family (say being in pain, certain fibers' being activated). But it will not matter for what follows whether the field is thought of in terms of properties, predicates, conditions, facts, phenomena, or states of affairs, all of which have their advocates. What will matter is that not only whole families of these but specific subsets of them are included in the field of the determination relation. So too for supervenience.

Let us follow Kim in a further particular as well. There is a difference between *covariance* and *dependence*, as there is between correlation and cause. A relation of covariance holds between properties of kind *A* and those of kind *B* when those in *A* covary, either "accidentally" or of necessity, with those in *B*. Specifically, we are only asserting covariance when we assert that there is no difference of sort *A* without a difference of sort *B*, or, modalizing, that difference in respect of *A* entails difference in respect of *B*. Dependence, on the other hand, requires more than covariance even when the covariance involves a strong modality.

For example, chemical kinds and their microphysical structures seem necessarily to covary with each other, in the sense that given identities like water = H_2O, there can be no difference between two things in respect of the property of being water without some difference in respect of the property of being H_2O, and vice versa (or, equivalently, any two worlds alike as regards which things have the property of being H_2O are alike as regards which things have the property of being water, and vice versa). Thus the covariance in this kind of case appears not to be asymmetric. Yet we want to say that the chemical kind "water" is asymmetrically dependent on the microphysical structure H_2O. Covariance can be non-asymmetric, whereas dependence seemingly cannot. Furthermore, questions of asymmetry aside, "it seems clearly possible

for there to be three sets of properties *A*, *B*, and *C*, such that *A* and *B* depend on *C*, *A* covaries with *B* but *B* does not covary with *A*, and *A* does not depend on *B*"[6]. This is largely because it could be *in virtue of* having certain properties in *C*, not *B*, that something has certain *A*-properties; it is the *C*-properties that play the relevant explanatory role.

In line with this distinction between covariance and dependence, we may again follow Kim, as we have been, in using the word 'determination' to mean not some variety of covariance but a kind of dependence. "For there to be property dependence there must be property covariation," but the converse does not hold, and "it is the dependence aspect of supervenience, not the covariation aspect, that can sanction many of the usual philosophical implications drawn from, or associated with, supervenience theses"[7], including the asymmetric primacy of the physical.

What other properties should the physicalist's relation of determinational dependence have? According to Kim, the relation involves not only *ontological* directionality but *explanatory*. "That upon which something depends is ... explanatorily prior to ... that which depends on it". The lower-level or base property on which the higher-level depends is explanatorily prior because a thing's "having the relevant base property *explains* why it has the [higher-level] property". It is *because*, or *in virtue of the fact that*, the thing has the base property that it has the higher-level, supervenient property. Thus if properties of kind *B* determine those of kind *A*, then a thing's having certain *B*-properties is that in virtue of which, in the sense of explaining why, it has certain *A*-properties[8].

Call this supposed feature of the determination relation that of *implying an in-virtue-of or explanation relation*. The in-virtue-of relation is implied in the sense that if the determination relation obtains between (sets of) properties ϕ and ψ, so does the in-virtue-

[6] Kim ((1990), pp. 14-15).
[7] Kim ((1990), p. 16).
[8] Kim ((1990), p. 16).

of or explanation relation: if ϕ determines ψ, then a thing's having ϕ explains its having ψ, and it is in virtue of having ϕ that it has ψ. This feature of implying an in-virtue-of or explanation relation enables Kim's argument for the asymmetry of determination: The in-virtue-of or explanation relation is asymmetric, since if x's having ϕ explains why x has ψ, then x's having ψ does not explain why x has ϕ. Because this asymmetric relation is implied by the determination relation, the latter must be asymmetric too[9].

Kim gives determination two further properties that will be relevant here. One is that "this determinative relation [say from body to mind] is an objective matter; it does not depend on whether anyone knows anything about it, or what expressions are used to talk about mind and body"[10]. This suggests that the relation is extensional, since a mark of the extensional is that the relation obtains (or not) regardless of what expressions are used to talk about or denote its relata. In any event, "supervenient determination ... is a metaphysical thesis about an objectively existent dependency relation between the two domains; it says nothing about whether or how the details of the dependency relation will become known so as to enable us to formulate explanations, reductions, or definitions"[11]. In line with this, let us say that the physicalist's determination relation has the property of being "objective", whether or not it is also extensional.

Another property Kim gives determination is transitivity. Determination is a component of, or implied by, supervenience, in the sense of supervenience that include dependence[12]. But "Supervenience, whether in the sense of covariation or in the

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[9] Kim ((1990), p. 16). Others who assume an implied in-virtue-of relation include DePaul ((1987), p. 430); Grimes ((1988), p. 156 (D)); Poland ((1994), §1.2 and 2.3).

[10] Kim ((1984), p. 175).

[11] Kim ((1984), p. 175).

[12] Kim ((1990), p. 9).

sense that includes dependence, is transitive"[13]. It follows that determination is transitive too (for the relevant cases, in which there are ϕ, ψ and χ such that ϕ determines ψ and ψ determines χ). Surely Kim is right about transitivity. When physicalists assert the determination of one sort of property by another, they presuppose transitivity. For example, they want to say that because the quantum-physical properties determine the quantum-chemical properties, and the latter determine the biochemical properties, it follows that the quantum-physical properties determine the biochemical.

Furthermore, as Kim himself might add, without this transitivity of determination, physicalists would be unable to marshal adequate empirical support for their claim that the higher-level scientific facts are determined ultimately by the physical facts. To see why, consider the claim that the physical facts determine the facts at the level of psychology[14]. A natural way to justify this claim empirically – perhaps the only way – is to look at a number of sciences between physics and psychology. The facts of physics can more readily be shown to determine those of its near neighbors, such as quantum chemistry. The latter can more readily be shown to determine the facts in sciences a bit further removed from physics, such as biochemistry. These in turn can more easily be seen to determine those in sciences still further removed, and so on, until finally we reach the psychological facts. Provided determination holds at each step of the way in this chain, we may infer by transitivity of determination that the physical facts determine the psychological.

Sometimes, of course, the higher-level phenomena are determined (and explained) not by matters in a single lower-level science but only in a cluster of lower-level sciences, in each of which the facts are determined (and explained) in turn by some

[13] Kim ((1990), p. 24).

[14] The following account draws on the more detailed one in Post ((1987), Ch. 5), and Post ((1991), Ch. 6). See also Kincaid (1990).

closer still to physics. What get pairwise connected at each step, strictly, include such clusters of sciences, not always single sciences[15]. But for simplicity let us continue to speak as though it is single sciences that get pairwise connected and form chains.

For in any event, the problem of providing adequate empirical evidence for the determination of the psychological by the physical divides into a number of intermediate problems that concern relations between sciences that are near neighbors. Scientists in a couple of neighboring fields will often already have explored key relations between them, including evidential relations in light of which we may infer determination of one by the other. This amounts to a division of labor, in which physicalists can let the particular sciences do much of their work for them. If determination were not transitive, this division of labor would be of no use to physicalists who want to marshal adequate empirical support for the claim that the psychological facts are determined ultimately by the physical facts. Without transitivity of determination, physicalists would have to shoulder the heroic and probably hopeless burden of spelling out some *direct* or *unmediated* connection between psychology and physics – a connection that would leapfrog the intervening sciences and enable us to infer determination of psychological fact by physical. The prospects of some such leapfrog approach should strike us as dim (as we see in detail in the next section, in connection with interlevel theories)[16].

Summing up, the properties Kim ascribes to the physicalist's determination relation include the following. The field of the relation (and also of supervenience) consists of properties, both those that form whole families and those that form specific subsets

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[15] Post ((1987), pp. 216 and 221).

[16] Leapfrog approaches like Papineau's (1990), which would deduce physical determination of the mental from "the completeness of physics", do not explain why anyone in doubt about the physical determination of the mental should believe the intended "completeness" of physics. Cf. Crane ((1991), p. 34).

of them. The relation is both objective and a relation not merely of covariance but of directional dependence, having an asymmetry derived from an implied in-virtue-of or explanation relation. But the conjunction of these supposed properties of determination, as we see next, proves inconsistent with the transitivity Kim also assumes and physicalists require. So too for supervenience, insofar as supervenience shares these properties.

3. DETERMINATION, SUPERVENIENCE, EXPLANATION, AND TRANSITIVITY

For simplicity, we start with determination. The argument of this section will then apply, essentially unchanged, to supervenience, insofar as supervenience shares the relevant properties.

Suppose determination has an asymmetry that derives from an implied in-virtue-of or explanation relation. That is, if ϕ determines ψ, it is asymmetrically in virtue of, hence explained by, having ϕ that something has ψ (for any ϕ and ψ in the field of the determination relation). It can be proved that for any relation R, if (i) R implies relation Q (in the sense that for any ϕ and ψ, $R\phi\psi \rightarrow Q\phi\psi$) and (ii) there are ϕ, ψ and χ such that $R\phi\psi$ and $R\psi\chi$ but not $Q\phi\chi$, then R is not transitive[17]. In particular, if the relation D of determination implies an in-virtue-of relation V, in the sense that $D\phi\psi \rightarrow V\phi\psi$, and there are cases in which $D\phi\psi$ and $D\psi\chi$ but not $V\phi\chi$, then D is not transitive, a result that is inconsistent with the transitivity Kim assumes and physicalists require.

[1]Since there are cases in which in which $D\phi\psi$ and $D\psi\chi$ but not $V\phi\chi$, the supposition of an asymmetry of D that derives from an implied in-virtue-of or explanation relation V is incompatible

[17] Outline proof: Assume that (i) $(x, y)(Rxy \rightarrow Qxy)$, and (ii) $(\exists x, y, z)((Rxy \,\&\, Ryz) \,\&\, -\, Qxz)$ – say $Rab \,\&\, Rbc$ but not Qac. It follows by US and tautological inference that $(Rab \,\&\, Rbc) \,\&\, -\, Rac$, which entails not $(x)(y)(z)((Rxy \,\&\, Ryz) \rightarrow Rxz)$, which means R is not transitive.

with the transitivity of determination[18]. The likely place to look for such cases is where the implied relation V is non-transitive and $D\phi\psi$ and $D\psi\chi$; indeed it can be shown that if V is non-transitive for ϕ, ψ, χ when $D\phi\psi$ and $D\psi\chi$, then D is non-transitive, inconsistent with the transitivity of determination.

To see why the relevant kinds of explanation are not transitive, note to begin with that the relevant kinds are "interlevel" explanations, in which some higher-level property N is supposed to be explained by some lower-level properties B_i. Now consider the following kind of interlevel explanation. Often we want to say both that in some sense the *best* explanation of why x has N is that x has B_i and that B_i determine that x has N, where the properties B_i are from some science more fundamental, or closer to physics, than the science from which N is drawn. Given the unifying and explanatory role of the more fundamental properties or phenomena B_i (among other things), an interlevel explanation in terms of B_i of why x has N is to be preferred, other things being equal, to any other explanation, and in that sense is the best explanation. In addition, and partly in light of this explanatory evidence, we want to say that B_i determine that x has N.

For example, there are occasions or contexts in which, at least from the point of view of the physicalist, (i) not only is the best explanation of why a certain cell has the biological property N that the cell has certain biochemical properties B_i, but B_i determine that x has N; and (ii) not only is the best explanation of the biochemical properties B_i in terms of certain quantum-chemical properties P_i, but P_i determine that x has B_i. If transitivity held, we would have to say that the best explanation of why the cell has N is that it has these quantum-chemical properties P_i. But this contradicts the hypothesis that the best explanation of why it has N is that it has the biochemical properties B_i; presumably there can be only

[18] The case in which what is implied is a relation not of *explanation* but only of explanatory *priority* is considered in §5.

one *best* explanation[19]. So not only does this transitivity fail, we have a case in which $D\phi\psi$ and $D\psi\chi$ but not $V\psi\chi$, from which it follows that D is not transitive. Since this conflicts with the transitivity of determination, we must conclude that the in-virtue-of or explanatory relation is not implied by determination after all.

Perhaps the moral here is simply that the relevant notion of interlevel explanation involved in the implied explanation relation is never that of the *best* explanation. But this move would come at too high a price. When physicalists say that x's having N is determined by and thus had in virtue of the more fundamental properties B_i, frequently they do also have in mind that the best explanation of why x has N is that x has B_i. To repeat, given the unifying and explanatory role of the more fundamental properties or phenomena B_i (among other things), frequently an interlevel explanation in terms of B_i of why x has N is to be preferred, other things being equal, to any other explanation, and in that sense is the best explanation. If we were to insist on the transitivity of explanation, we could no longer say that the lower-level properties in virtue of which x has N provide, in this sense, the *best* explanation of why x has N. Since we do want to retain this notion of the best explanation here, the relevant interlevel explanation relation cannot be transitive if or insofar as it involves a notion of the best explanation. So let us consider some other varieties of interlevel explanation.

According to some varieties, the explaining factors merely make it sufficiently *probable* that x has N. Among these varieties are deductive-statistical, inductive-statistical and certain statistical-relevance explanations. Such varieties of explanation become relevant when the lower-level B_i are said to determine not that x has N, but the *chances* of x's having N. Now suppose for the sake of argument that we set .6 as the sufficient degree of probability of x's having N. Suppose further that the probability that x has B_i

[19] Post & Turner ((2000), pp. 78-80).

given that x has P_i is .6, and the probability that x has N given that x has B_i is also .6. Then the probability that x has N given that it has P_i is only .36. Transitivity fails for this variety of explanation,[20] but more to the point, we again have a case in which $D\phi\psi$ and $D\psi\chi$ but not $V\phi\chi$, and again we must conclude that the in-virtue-of or explanatory relation is not implied by determination after all.

Perhaps the moral here is that an implied in-virtue-of or explanation relation can be transitive only if the properties in virtue of which x has a certain chance of having N do not explain why x has N by way of making it sufficiently probable that x has N (unless we set the probability at 1). But again the price is too high. There are important interlevel explanations that are both statistical or probabilistic in character and relevant when lower-level properties determine the chances of x's having N. Such explanations are involved in, among others, meteorology, the social sciences, and population genetics. And of course physics itself is no stranger to the statistical and the probabilistic.

Perhaps, however, there is some other relevant kind of interlevel explanation that is transitive, neither best explanation nor probabilifying explanation. It would seem not. Consider to begin with the interlevel explanation of temperature in terms of mean molecular kinetic energy. Strictly speaking, the bare physical fact that the molecules in my coffee have a certain mean kinetic energy does not by itself explain, because it does not itself imply, that the coffee is piping hot. What is required in addition is some correspondence rule or bridge principle that connects mean molecular kinetic energy with temperature. Likewise, the bare physical fact that certain protein molecules on a cell's surface have bonded to certain other molecules does not itself explain, because it does not itself imply, that there has been communication of significant bio-

[20] Cf. Lehrer ((1970), pp. 122-123); Jaeger ((1975), pp. 482-484); Klein ((1976), pp. 806-807); Post ((1980), pp. 39-40). Neander & Menzies ((1990), pp. 464-465), give related reasons for rejecting transitivity of causal explanation in certain cases.

logical information to the cell from its environment. We need an appropriate correspondence rule or bridge principle connecting the two, if we want the assertion of interlevel explanation actually to be an explanation or to explain.

What this suggests is that an assertion to the effect that the lower-level properties B_i explain the higher-level N is elliptical. What is called interlevel explanation of N by B_i is typically explanation of N by B_i within or relative to an interlevel theory. For it is only within interlevel theories that we find the appropriate bridge principles, those that enable us to connect B_i with N so as to warrant the elliptical assertion that N is explained by B_i. What explains N, more strictly, is the conjunction of B_i with some principle connecting B_i with N.

Even the latter assertion is somewhat elliptical, since what the relevant principle is and just how it is to be interpreted and applied depend on the theory. So we should say that what explains N, strictly, are B_i conjoined with a bridge principle within a specified interlevel theory T. For example, it is only within the interlevel theory we call a kinetic theory of temperature, and given the appropriate bridge principle it contains, that my coffee's being hot has an interlevel explanation in terms of the mean kinetic energy of its molecules. Likewise, it is only within a molecular biology that cell communication has an interlevel explanation in terms of the biochemical properties of certain molecules. Interlevel explanations ride on interlevel theories.

Whether and in what sense an interlevel explanation is an explanation or does explain, and to what extent it is or does, obviously depend heavily on whether and to what extent the relevant interlevel theory satisfies certain conditions. This in turn is mostly a matter of how successful the interlevel theory is in connecting a higher-level theory *T2* (say, cell biology) with a lower-level theory *T1* (say, biochemistry). The most successful interlevel theories are those that among other things effect the greatest degree of "unification" of *T1* and *T2* (as in the case of molecular biology). Such

interlevel theories involve at least the following sorts of connections between *T1* and *T2*:[21]

(1) The ontology of *T1* exhausts that of *T2* (by way of every object described by *T2* being composed of or token-identical with an object or sum of objects described by *T1*).
(2) *T1* and *T2* are logically compatible.
(3) The referents of the basic predicates of *T1* determine those of *T2*.
(4) We can say *how* it is that (3) holds.
(5) *T1* and *T2* are heuristically dependent on each other – each uses the other to suggest fruitful lines of research.
(6) *T1* and *T2* are confirmationally dependent on each other – each uses the other in the design of experimental tests.
(7) Each uses, explicitly or implicitly, explanations from the other.

When we study the standards actually used for evaluating how successful a scientific interlevel theory is, (1)-(7) are among those (implicitly) used by scientists engaged in evaluating (and constructing) interlevel theories (physical chemistry, molecular biology, physiological psychology, and so on). Conditions (5)-(7) are generally of more concern to such scientists than (1)-(4), which may be of more concern to philosophers. In any event, an interlevel explanation is an explanation, or explains, only in the sense that, or to the extent that, (1)-(7) are satisfied by the interlevel theory on which it is parasitic.

Now consider a chain of interlevel explanations. In particular, consider one in which there is (i) an interlevel explanation of a cell-biological property N by biochemical properties B_i; (ii) an

[21] (1)-(7) are drawn from the more detailed account in Kincaid (1990), who draws in turn on Darden & Maull (1977), Maull (1977), and Kitcher (1984). Interlevel theories are an especially important kind of "connective theory" discussed in Post ((1987), §5.1).

interlevel explanation, in the same sense or to the same extent, of B_i by quantum-chemical properties C_i; and (iii) an interlevel explanation, again in the same sense or to the same extent, of C_i by quantum-physical properties P_i. If transitivity held for interlevel explanation, it would follow that there is an interlevel explanation, *in the same sense or to the same extent*, of the cell-biological property N by the properties P_i at the level of quantum physics. If we did not require that there be such an explanation *in the same sense or to the same extent*, we would be guilty of equivocating on 'explanation', using it in one sense at one place (or places) in the chain, another at another, and any claim that such explanation is transitive would inherit this equivocation.

Suppose, then, that any interlevel explanation in the chain is an explanation only in the sense that, or to the same extent that, (1)-(7) are satisfied by the interlevel theory on which it is parasitic. It follows that if transitivity held for interlevel explanation, there would have to be an interlevel theory connecting quantum physics directly with cell biology, which theory satisfies (1)-(7) to the same extent as do the other interlevel theories on which the interlevel explanations in the chain are parasitic. So far as I know, there exists no such leapfrog interlevel theory, no such quantum-physical cell biology (as opposed to quantum-physical theories possibly of quite narrow subfields of cell biology). But let us waive the objection that no such theory exists, and assume for the sake of argument that it is at least possible in principle for an interlevel theory to be constructed that leapfrogs all the way from quantum physics to cell biology. The crucial question then is whether or to what extent this leapfrog theory would satisfy (1)-(7).

Suppose we grant that this leapfrog quantum-physical cell biology would satisfy (1) and (2), and grant further, at least for the sake of argument, that it would satisfy (3) and (4) to the same extent as do the other interlevel theories in the chain. That is, the ontology of quantum physics would exhaust that of cell biology; quantum physics and cell biology would be logically compatible;

the referents of the basic quantum-physical predicates would determine those of the cell-biological predicates; and we could even say how this comes about.

What of (5)? Would quantum physics and cell biology be as heuristically dependent on each other as are such near neighbors as cell biology and biochemistry, biochemistry and quantum chemistry, quantum chemistry and quantum physics? Probably not. What of (6)? Would quantum physics and cell biology be as confirmationally dependent on each other as are such near neighbors as cell biology and biochemistry, biochemistry and quantum chemistry, quantum chemistry and quantum physics? Probably not. What of (7)? Would quantum physics and cell biology use explanations from each other to the degree characteristic of cell biology and biochemistry, biochemistry and quantum chemistry, and quantum chemistry and quantum physics? Probably not.

Note also that the issue of whether and to what extent a leapfrog quantum-physical cell biology would satisfy (5)-(7) is largely an *empirical* issue, which can only be judged by (i) looking at the characteristics of the relevant theories – quantum physics, quantum chemistry, biochemistry, cell biology – as they have actually been developed so far by working scientists; and (ii) in light of these characteristics, appraising the promise or otherwise of suitable interconnections among them – interconnections that would support the judgment that the leapfrog theory satisfies (5)-(7) as well as do molecular biology and the other interlevel theories involved in this chain.

True, it is not impossible that some day some leapfrog quantum-physical cell biology could be developed that satisfies (5)-(7) to the same extent as molecular biology and the other interlevel theories in the chain. But it is improbable. And even if by chance some such leapfrog did appear, there are other and much longer chains of interlevel explanations and theories we would need to consider, stretching from physics to psychology, linguistics, semantics,

tics, and anthropology, among others. How likely is it that there could be an interlevel theory that (i) leapfrogs all the way from physics to linguistics, and (ii) connects the two so that they are as heuristically, confirmationally and explanatorily interdependent as quantum physics and quantum chemistry, or biochemistry and cell biology?

It looks as though interlevel explanation is not transitive[22]. So too, therefore, for the needed interlevel in-virtue-of or explanation relation. Note also that according to physicalists, each level ψ in the chain determines the phenomena at the next higher level ψ, all the way up. Hence we have a situation in which there are ϕ, ψ and χ such that $D\phi\psi$ and $D\psi\chi$ but not $V\phi\chi$ (where V is the interlevel in-virtue-of or explanation relation at work here).

The result of trying to save the supposed asymmetry of determination by appealing to an implied interlevel in-virtue-of or explanation relation is non-transitivity of determination. Nor are we free to conclude, "So much the worse for transitivity." Rejecting transitivity of determination would deprive physicalists of the division of labor, noted in §2, that is necessary for marshaling adequate evidential support for their claim that the physical determines everything nonphysical. Otherwise physicalists would have to establish some direct, leapfrog connection between physics and psychology, physics and anthropology, physics and linguistics, from which we could infer that the physical determines the psychological, the anthropological, the linguistic.

So far in this section we have been talking about determination. But we could equally well have been talking about supervenience, insofar as supervenience shares the relevant properties with determination. Simply replace each occurrence of the term 'determination' (or one of its cognates) throughout the argument so far with an occurrence of 'supervenience' (or one of its cognates), and the argument will apply to supervenience as well as to determination. The result of trying to save the supposed asymmetry of

[22] As suggested by Post ((1987), pp. 227-228).

supervenience by appealing to an implied interlevel in-virtue-of or explanation relation is non-transitivity of supervenience, which is inconsistent with the transitivity required for marshaling adequate evidential support for the physicalist's claim that everything non-physical supervenes on the physical.

Even though the argument of this section shows how an asymmetry that derives from an implied explanation relation is incompatible with the transitivity of determination and of supervenience, of course it does not show that asymmetry as such is incompatible with transitivity. The alleged asymmetry of the physicalist's determination and supervenience relations could derive from something other than an implied explanation relation. On the other hand, the literature seems to contain no other derivation of or argument for the alleged asymmetry. Rather than argument, what one finds are appeals to intuition, to what physicalists seem to have in mind, or to some general similarity between determination/supervenience and various relations held to be asymmetric[23].

Occasionally, however, something like the following argument, often heard in conversation, may lie tacitly in the background: Physicalists want to say that the physical determines the mental but the mental does not determine the physical; so the determination relation must be asymmetric; so too for supervenience. But consider a parallel argument: We want to say that the set E of even integers is a subset of the set J of integers, but J is not a subset of E; so the subset relation must be asymmetric. The premise here is true but the conclusion false; there are sets that are subsets of each other. The tacit argument, interpreted this way, rests on a *non sequitur*.

Perhaps instead the tacit argument is this: For each family Ψ of properties other than the physical, the physical determines

[23] Cf. Petrie ((1987), p. 127); Grimes ((1988), p. 157); DePaul ((1987), pp. 433 and 438); Miller ((1990), pp. 695-696); Papineau ((1990), p. 67); Poland ((1994), §1.2, 2.3).

every property in ψ, but no property in ψ determines the physical; therefore, the determination relation is asymmetric; so too for supervenience. This too fails. Compare: For each family ψ of positive integers n other than 1, $1 \leq$ every n in ψ, but no n in ψ is ≤ 1; therefore, the $\leq$ relation is asymmetric. True premise, false conclusion.

One can imagine a further argument that begins by reminding us of the distinction between covariance and dependence. Since we are talking of determinational dependence, not covariance, and since dependence is an asymmetric relation, so therefore is determination. A serious problem with this line is that not all varieties of dependence are asymmetric; the two halves of a free-standing stone arch, for example, depend on each other to stay up – a case of co-dependence. Unless we are told more about the intended variety of dependence and just how it differs from dependence in the stone-arch case *or in other cases of mutual dependence*, the supposed asymmetry does not follow. Another and more serious problem is that even if we find a dependence relation that is clearly asymmetric, one needs to *show that it is actually implied by the physicalist's determination relation.* This is not easy to do, as we see in §5. And again all this applies to supervenience as well.

Talk of dependence brings us to a related argument, or set of considerations, typically tacit, to the effect the nonphysical depends on the physical – that the physical enjoys a certain priority or primacy over the nonphysical, a priority that consists largely in the fact that the physical determines the nonphysical but not vice versa; therefore, the determination relation is asymmetric. But compare: the number 1 enjoys a certain priority over the other positive integers n (it is, after all, the first), a priority which consists in large part in the fact that $1 \leq n$ but $n \not\leq 1$ for each n other than 1; therefore, the $\leq$ relation is asymmetric. True premise, false conclusion.

Of course there might be a kind of priority of the physical over the nonphysical which, when conjoined with further matters, entails that determination and/or supervenience should be asymmetric. But we are told nothing about just what this kind of priority is and how it is supposed to entail the would-be asymmetry. If, as is often the case, the priority is presumed to derive from an implied in-virtue-of or explanation relation, it is incompatible with the required transitivity of determination/supervenience, as seen. Whether there is some still further brand of priority that entails asymmetry seems not to have been addressed. In any case, in §5 we return to this matter of priority, and in particular to whether the ontological priority of the physical entails asymmetry of determination or of supervenience. Meanwhile, instead of examining further arguments for the asymmetry of determination and/or supervenience, let us consider an argument *against* their asymmetry.

4. DETERMINATION, SUPERVENIENCE, IDENTITY AND ASYMMETRY

The following example of a specific determination claim serves to introduce a further property of the physicalist's determination relation, one so far unremarked. The mean kinetic energy of the molecules in my coffee, let us suppose, is what specifically determines the coffee's temperature. But kinetic energy = $1/2mv^2$. So the mean kinetic energy of the molecules = the mean $1/2mv^2$ of the molecules. In view of the latter identity, it would seem to follow that the mean $1/2mv^2$ of the molecules in my coffee determines its temperature; so too for (most) relations of supervenience. Generalizing, if ϕ determines ψ and $\chi = \phi$, then χ determines ψ; substitutivity of identity holds for the subject place in 'ϕ determines ψ', as this predicate is used by physicalists; so too for supervenience. Or rather let us assume so and see what follows, then consider whether we'd like to change our minds.

What about substitutivity for the object place? Suppose that certain biochemical properties B_i determine the neurobiological property of certain nerve fibers' being activated. Suppose further that the property of these fibers' being activated is identical with the psychological property of their owner's being in pain. It would seem to follow that the biochemical properties B_i determine the psychological property of the owner's being in pain; so too, again, for supervenience. If so, and generalizing, it appears that for physicalists, if ϕ determines ψ and $\psi = \chi$, then ϕ determines χ; substitutivity holds for the object place as well. Or rather, as before, let's stifle any misgivings for now and see what follows.

Pain may or may not be type-identical with certain nerve fibers' being activated. But in other cases it sometimes does happen not only that a higher-level property N is determined by and/or supervenes on a specific few lower-level properties B_i, but also that N proves identical with the conjunction KB_i of B_i. For example, not only is the temperature of my coffee determined by mean molecular kinetic energy, it is identical with it (or so we may assume at least for purposes of illustration). Likewise, not only is the property of being a middle-A sound determined by oscillation in air pressure at 440 Hz, it is identical with it (let us assume). So too (perhaps) for the property of being red and the property of having a certain triplet of electromagnetic reflectance efficiencies, the property of my having a sensation of red and the property of there occurring a spiking frequency of 90 Hz in my gamma network, and so on[24]. In cases of this kind, we might even want to say that the determination/supervenience obtains *by way of the identity*. If challenged to explain just how the determination of one by the other comes about, we might point out that after all, one is identical with the other, which entails determination[25]; so too for supervenience.

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[24] Churchland ((1985), p. 14).

[25] As in effect does Kim ((1990), pp. 25-26).

In cases of this kind, since N is determined by and/or supervenes on KB_i and $N = KB_j$, it follows by the assumed substitutivity of identity that KB_i is determined by and/or supervenes on N. That is, we substitute 'N' and 'KB_j' for each other in 'N is determined by KB_j' and in 'N supervenes on KB_i'. In general, whenever ϕ determines ψ, and $\phi = \psi$, ψ also determines ϕ; and whenever ψ supervenes on ϕ, and $\phi = \psi$, ϕ also supervenes on ψ; asymmetry fails. The alleged asymmetry of determination and of supervenience breaks down whenever a higher-level property is both determined by and identical with some conjunction of lower-level properties (so too for relational properties). Granting substitutivity of (nomological) equivalents, it also breaks down when the higher-level property N is only equivalent to KB_i (meaning that there is a true (nomological) universalized biconditional between the two).

Thus it seems that reductive physicalists, Kim included, can ill afford to endorse asymmetry either of determination or of supervenience. So too for eliminitivists, who require the higher-level properties that survive elimination to be reducible to physical properties by way of identity or of equivalence. But the same is true even of nonreductive physicalists, since they agree that some higher-level properties, just not all, are either identical with or equivalent to conjunctions of physical properties.

This result – that physicalist determination and supervenience are not asymmetric – is so counter-intuitive that many philosophers will insist there must be something seriously wrong with the foregoing "substitutivity argument." Some might insist, for example, that the moral to be drawn from the argument is merely that the determination relation is *anti*-symmetric: for any ϕ and ψ in its field, if $\phi \neq \psi$, then if ϕ determines ψ, ψ does not determine ϕ; so too for supervenience. The trouble with this move – aside from being ad hoc – is that property equivalence does not guarantee property identity, and there are cases in which $\phi \neq \psi$ but ϕ is (nomologically) equivalent to ψ and it is by way of this equivalence

that ϕ determines/subvenes ψ. In cases of this kind, $\phi \neq \psi$, ϕ determines/subvenes ψ, and, by substitutivity of equivalents, ψ is determines/subvenes ϕ. Anti-symmetry fails as well.

[2]Someone might instead object[26] that if cases of identity really did pose this problem for the supposed asymmetric determination/supervenience, such cases would pose a parallel problem for asymmetric explanation and explanatory priority; and since explanation and explanatory priority are certainly asymmetric, this reduces the foregoing substitutivity argument to absurdity. The trouble with this objection is that there is no parallel problem for explanation, because substitutivity fails for the relevant relations of explanation; we cannot infer from '*B* explains *N*' and '*N* = *B*' to '*N* explains *B*'. For suppose that a higher-level *N* is explained by a lower-level *B* (or that having *N* is explained by having *B*), in the sense that *B*, conjoined with the correspondence rules or bridge principles in some empirically adequate interlevel theory *T*, nomologically implies *N*. In this case, *B* explains *N* but *N* does not explain *B*; in view of the role *B* plays in *T* (or in our use of *T*), *B* is asymmetrically explanatorily prior to *N*. This asymmetry holds even when the bridge principles in *T* happen to entail identity between *N* and *B*, as many think happens in a kinetic theory of temperature, so that temperature = mean molecular kinetic energy. In such a theory (or our use of it), mean molecular kinetic energy is what explains temperature, not vice versa, even though temperature = mean molecular kinetic energy; despite the identity, temperature does not play the same role in the interlevel theory (or our use of it) as does mean molecular kinetic energy. Thus we cannot infer from '*B* explains *N*' and '*N* = *B*' to '*N* explains *B*'; substitutivity of identity does not hold for 'ϕ explains ψ' or for 'ϕ is explanatorily prior to ψ'.

Despite all this, suppose we were to ban substitutivity for determination and supervenience, and thus go non-extensional.

[26] As someone has, though not for attribution.

Suppose in particular that someone could characterize an appropriate interlevel determination/supervenience relation that is non-extensional in such a way as to block substitutivity.

This would protect asymmetry from the substitutivity argument, but at too high a price. One of the physicalist's characteristic ontological theses, at the heart of physicalism, is that all the phenomena are determined/supervenient on the physical phenomena. And as Kim says (noted in §2), physicalist supervenient determination is an objective affair. Reality is so arranged, it happens, that as a matter of objective fact, independent of our evidential and explanatory schemes, and independent of what expressions are used to talk about things in reality, how the things are as regards their non-physical properties is determined by and/or supervenient on how things are as regards physical properties. If 'determine' and 'supervenes' were non-extensional in the sense contemplated by those who would ban substitutivity, then the very formulation of this objective ontological component of physicalism would involve a violation of the extensionality that physicalists require, at least as an ideal, both in the language of physics and in the terms they use to express their ontological position.

This extensionalist ideal does *not* imply that the languages of higher-level theories – psychology or semantics, for example – must be extensional, or even that they must be reducible to the extensional. It implies only that the physical determination/supervenience of the higher-level intensional affairs be compatible with the extensionality physicalists want at least at the level of physics. In particular, the matter of which sentences at the level of psychology or semantics are true, even when those sentences themselves contain an intensional idiom, is determined by/supervenient on the physical phenomena extensionally construed. Any such account of intensionality in terms of physical determination/supervenience would fail if the very determination/supervenience relation presupposed were itself to harbor the intensionality that was to be accounted for. A physicalist who would advo-

cate intensionality of determination and supervenience in order to defend their supposed asymmetry would manifest curious priorities.

5. DETERMINATION AND ONTOLOGICAL PRIMACY

If the physicalist's relations of determination and supervenience are non-asymmetric, why is the contrary intuition so entrenched and widespread? And without their asymmetry, how are we to understand the asymmetric ontological primacy of the physical? Any answer is complicated by the tendency of different philosophers to mean different things by "ontological primacy". According to some, ontological primacy involves explanatory primacy: if ϕ is ontologically prior to ψ, then ϕ is explanatorily prior to ψ. So let us begin with explanatory primacy, returning eventually to other things that might be meant by "ontological primacy".

It is illuminating to reflect yet again on the case in which both $\phi = \psi$ and it is by way of this identity that ϕ determines ψ. In this kind of case, it is especially clear that a bare assertion of determination does not, by itself, entail any kind of asymmetric primacy. For if ϕ determines ψ, and $\phi = \psi$, then, in view of substitutivity, ψ determines ϕ just as much as ϕ determines ψ; so too for supervenience. Here there is no directionality or priority. And yet when physicalists assert, as many do, that the property of being a middle-A sound is identical with and therefore is determined/supervenient on a 440-Hz oscillation in air pressure, it is the latter that is supposed to be prior, in some sense, to the former.

What sort of priority or primacy is this, and what is its source, if not asymmetry of determination/supervenience? The assumed identity connection between certain higher-level properties and the lower-level properties suggests there might be a correspondence rule or bridge principle nearby. And indeed when we inquire what *evidence* there is for the claim that the two kinds of property are related by identity, we soon encounter not only ob-

served correlations between them but prominent interlevel theories, such as a kinetic theory of temperature or a molecular theory of water. The relevant bridge principles in the kinetic theory either take the form of, or else support or warrant, assertions of identity between temperature and mean molecular kinetic energy (or so it has been widely assumed).

Clearly, a crucial kind of evidence for an assertion of interlevel identity is an empirically adequate interlevel theory whose bridge principles support the assertion. But interlevel theories are also designed to *explain*. Among other things, they are designed to explain the higher-level properties in terms of the lower-level. Such theories therefore involve explanatory directionality or primacy – an asymmetry whose source is not the bridge principles, since they are often two-way conditionals or even identity statements or (other) statements of 1-1 correlations, but elsewhere, perhaps not (explicitly) in the theory itself or in its logical form, but outside the theory, whether in certain causal relations it may express or the use we make of it.

Now suppose that a higher-level property *N* proves identical with some lower-level property *P*. Identity, being symmetric, by itself entails no primacy. Nevertheless, the lower-level *P* is explanatorily prior to *N* by virtue of the role *P* plays in the relevant interlevel theory (or our use of it). Identity is symmetric, and yet when physicalists assert that temperature is identical with mean molecular kinetic energy, it is the latter that takes priority, thanks to the explanatory directionality of the interlevel theory on which the identity assertion is epistemically dependent or parasitic. The priority involved is explanatory priority, and its source is an interlevel theory. (The situation in which there is no interlevel theory on which the identity assertion could be epistemically parasitic is considered below.)

Identity is a clear case – so clear it could be a paradigm – of an ontological relation that is non-asymmetric and yet is used by an physicalists (and others) in contexts in which the lower-level

property P with which some higher-level property N is identical nonetheless enjoys the priority; $N = P$, yet P is prior to N. Even though identity is non-asymmetric, the relation is used in contexts in which the higher-level property is supposed to be asymmetrically dependent on the lower-level property with which it is identical. Like remarks apply to relations of equivalence between higher-level and lower-level properties, and thus to relations of property reduction that amount to identity or equivalence.

What goes for identity and equivalence, in this respect, goes for determination and supervenience. An important part of the evidence for the assertion that P determines/subvenes N – often the only evidence – is an empirically adequate interlevel theory that connects the P-phenomena with the N-phenomena[27]. Even when the bridge principles of such a theory do not take the form of or support assertions of identity (or of equivalence or any property reduction), typically they do support assertions of determination/supervenience[28]. Thus typically when a higher-level N is determined/supervenient on certain lower-level properties P_i – which determination/supervenience, being non-asymmetric, by itself entails no priority – still the lower-level P_i are explanatorily prior to N by virtue of the role they play in an interlevel theory. The priority involved is explanatory priority, and its source is the empirically adequate interlevel theory on which the determination/supervenience claim is epistemically dependent. Given this intimate epistemic tie between determination/supervenience and interlevel theories according to which the lower-level properties are asymmetrically explanatorily prior, it is easy to understand how the impression could arise, and the intuition become widespread, that determination and supervenience themselves are asymmetric.

There is another way in which the determination/supervenience claim typically depends on an interlevel theory. Often we

[27] Post ((1987), p. 217).

[28] Post ((1987), §5.1), and Post ((1991), pp. 103-139). Cf. Kincaid (1988), (1990).

already have substantial observational evidence that N is determined/supervenient on the lower-level properties P_i. What we really want to know is *why* or *how* it is that N is determined/supervenient on P_i. What mechanisms or processes or relations are involved, what factors explain this? Typically the answers to these questions are to be found in an appropriate interlevel theory.[29] Thus the determination/supervenience claim typically is not only epistemically but *explanatorily* dependent on an empirically adequate interlevel theory according to which the lower-level properties are explanatorily prior to the higher-level. And again it is easy to understand how the impression or intuition could arise that determination and supervenience must themselves be asymmetric.

There remains a problem for the foregoing account of how determination/supervenience can be non-asymmetric even though it is the determination/supervenience base that enjoys explanatory priority. So far we have only seen how the account works for determination/supervenience between levels connected by an interlevel theory, as are biochemistry and cell biology. What about determination/supervenience between levels not so connected?

They can fail to be connected in either of two ways. One we've already seen, where the two levels are connected not by an interlevel theory but by a chain of them; we'll return to this kind of case in a moment. The other involves levels that by contrast are indeed near neighbors but as yet there exists no interlevel theory to connect them. This was the case with thermodynamics and particle mechanics before the development of a kinetic theory of temperature, the case with genetics and biochemistry before the development of molecular genetics, and so on. These were cases where as yet there was no empirically adequate interlevel theory

[29] Post ((1991), pp. 109-130). Cf. Post ((1987), §5.1.), Melnyk ((1991), p. 578), among others, overlooks this sort of reply, further elaborated below, to the demand to know "what accounts for [the] assertability" of determination.

on which an interlevel determination/supervenience claim could be epistemically and explanatorily parasitic. And yet in light of observational evidence even at the time, we might well want to assert, as some did assert, that a particular higher-level property N is determined/supervenient on some specific lower-level P_i, where it is the latter that are supposed to enjoy some priority over N. What kind of priority is this, and what is its source, given that there was no explanatory interlevel theory that connected P_i with N?

Very often, perhaps typically, when scientists discover, observationally, that N is determined/supervenient on P_i, they do so in the course of some broader research program aimed at constructing, eventually, an interlevel theory of the higher-level properties of which N is an instance in terms of the lower-level properties of which the P_i are instances. They anticipate that within the coming interlevel theory the lower-level P_i will play an appropriate explanatory role and thereby be explanatorily prior to N. Thus the priority is again explanatory, and its source is again an interlevel theory, though one that is not yet (fully) articulated, which will provide further and richer epistemic support for the determination/supervenience claim, and better understanding of why it holds, than is provided by merely observational evidence for the determination/supervenience of N on P_i.

Even where no elaborately developed interlevel theory is expected or hoped for, typically there will be a general presumption, as much metaphysical as scientific (atomist, say, or materialist, or naturalist), that the lower-level phenomena will in some sense explain the higher-level[30]. It is within some such general explanatory framework, metaphysical or otherwise, that the determination/supervenience claim typically is made and from which the explanatory priority of P_i derives.

What about the case in which two levels are connected by a chain of interlevel theories, as are physics and psychology? No

[30] Hooker ((1987), pp. 112-113, 122, 131).

leapfrog interlevel theory exists that is both empirically adequate and connects physics directly with psychology (except possibly for physical theories of quite narrow subfields of psychology). Even if some such leapfrog were to be constructed, it would be unlikely to satisfy (3)-(7) of §3 to the same extent as do the empirically adequate interlevel theories that warrant assertions of determination/supervenience between near neighbors. The hopeful leapfrog would be unlikely, therefore, to warrant the assertion of determination/supervenience between physics and psychology. Yet physicalists want to say not only that the physical determines/subvenes the psychological, but that the physical is explanatorily prior to the psychological. How can they, in the absence of a suitable leapfrog theory?

The physical need not be explanatorily prior to the psychological in the same way a lower-level ϕ is explanatorily prior to a neighboring higher-level ψ when ϕ and ψ are connected by an interlevel explanatory theory. Instead, physics can be explanatorily prior to psychology, and indeed to any other (distant) higher-level science, by way of lying at the end of a certain chain of sciences (or theories) between physics and the (distant) science, which sciences (or theories) are connected pairwise by explanatory interlevel theories. The point is *not* to infer from the chain of pairwise interlevel explanations that there is an interlevel *explanation* of the psychological by the physical (via some leapfrog physical psychology). This would violate the non-transitivity of the relevant notion(s) of explanation. Rather, given that each level in the chain is explanatorily prior to the next higher level, we infer that the lowest level (physics) is explanatorily *prior* to the highest. Explanatory priority is transitive even when explanation is not.

Someone might reply[31] that if explanatory priority is transitive, there could be no objection to an in-virtue-of relation that (i) involves only this element of explanatory priority; (ii) is implied by

[31] As someone has, though not for attribution.

the determination/supervenience relation; and (iii) being asymmetric, induces asymmetry of the determination that implies it. And it is true that the argument of §3 against an implied in-virtue-of relation would not work here. That argument was aimed at an in-virtue-of relation that obtains when there is not only explanatory priority of the lower-level properties over the higher-level, but an actual explanation of the latter by the former. Thus it is tempting to appeal to an implied in-virtue-of relation that involves only explanatory priority, in order to conclude that determination/supervenience must be asymmetric after all.

The reply ignores the substitutivity argument of §4, according to which physicalist determination/supervenience cannot be asymmetric. Granted the argument, there must be some flaw in the reply. There is. If (i)-(iii) were to count as a sound argument for asymmetry of determination/supervenience, a parallel argument could be constructed to show that identity too is asymmetric, which is absurd. Here is the parallel: Identity, like determination and supervenience, typically is asserted by physicalists in contexts in which the lower-level property *P* with which the higher-level *N* is identical enjoys explanatory priority because it is in virtue of having *P* that something has *N*. So identity, like determination/supervenience, carries with it an implied in-virtue-of relation that involves an element of explanatory priority. Since the latter is asymmetric, identity is asymmetric as well.

Obviously something has gone wrong. There is nothing wrong with assumption (i) that there is an in-virtue-of relation that involves only explanatory priority, and nothing wrong with assumption (iii) that by being asymmetric, this in-virtue-of relation would induce asymmetry of any relation that implies it. That leaves (ii), the assumption that the explanatory priority (or the in-virtue-of relation that implies it) is *implied* by the identity relation, in the sense that for any ϕ and ψ in its field, whenever $\phi = \psi$ then ϕ is explanatorily prior to ψ. True, identity of ψ with ϕ typically is asserted by physicalists in contexts in which ϕ is explanatorily prior

to ψ. But it is asserted by them in other contexts as well, and it hardly follows that whenever $\phi = \psi$, ϕ is explanatorily prior to ψ; contextual implication is not unmediated implication. The identity can (and often does) obtain even when there is no explanatory priority involved, as in same-level cases like recursiveness = Markov computability, a farady = Avogadro's number of electron charges, and so on.

Here then is another respect in which determination/supervenience resembles identity: neither implies a relation of explanatory priority (as opposed to contextually implying it). Physicalists do typically assert determination/supervenience of ψ on ϕ in contexts in which ϕ is explanatorily prior to ψ. Nonetheless it can be true that ϕ determines/subvenes ψ even when ϕ is not explanatorily prior to ψ. For example, if temperature is both determined/supervenient on and identical with mean molecular kinetic energy, it follows by substitutivity that temperature determines/subvenes mean molecular kinetic energy; yet temperature is not explanatorily prior to mean molecular kinetic energy. And further like identity, determination/supervenience can obtain whether or not there is a chain of interlevel theories, or even the hope of one, on which a determination/supervenience claim could be evidentially and explanatorily dependent.

Thus the transitivity of explanatory priority, contrary to the reply, is no threat to the general picture presented here of the asymmetry of the explanatory priority of the physical combined with the non-asymmetry of determination/supervenience. The picture again is this. The transitivity of determination/supervenience allows us to infer physical determination of the distant higher-level phenomena from the pairwise determinations/supervenience between intervening sciences that are near neighbors. These proximate pairwise determinings/supervenings are in turn epistemically and explanatorily dependent on empirically adequate interlevel theories. In this way the claim that the physical determines the distant phenomena is epistemically and explanato-

rily dependent on an intervening chain of empirically adequate interlevel theories. So far from being a *premise* for the physicalist, or a metaphysical *brute fact*, as some have charged[32], determination (along with global supervenience) is a hard-won empirical *conclusion* wrestled from generations of interlevel theory-construction between the sciences. Furthermore, the physical is explanatorily prior to the distant phenomena in the sense that the physical lies at the end of some such explanatory chain.

Hence the asymmetric explanatory priority of the physical – or, equivalently, the explanatory dependence of the nonphysical – has its source not in some alleged asymmetry of determination/supervenience, but elsewhere, in the asymmetry of the explanatory priority involved in chains of interlevel theoretic explanations, on which chains our assertions of physical determination/supervenience are epistemically and explanatorily dependent. Moreover, what excludes the reverse determination/supervenience of the physical on the nonphysical is not the physicalist's concept of determination/supervenience, including any alleged asymmetry, but the world. What the chains of empirically adequate interlevel theories give us evidence of, among other things, is what in the world determines/subvenes what. In particular, they give evidence that while the physical determines/subvenes everything nonphysical, the reverse, as a matter of empirical fact, does not happen[33].

However, explanatory priority is not the only kind of primacy the physical can enjoy over the nonphysical. Nor need it be

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[32] Kim ((1990), pp. 24-27); Melnyk (1991); Schiffer ((1987), pp. 153-154). The remark in Post ((1987), p. 187), that physical determination might be an ultimate fact about the world that neither has nor requires explanation, has to do with a separate issue, namely what to say about the cosmic question, 'Why, when it could have been otherwise, is ours a physically determined world in the first place?' – a question I there argue is in the much same boat as 'Why is there a world at all?'

[33] Post ((1987), §5.1, p. 329).

involved in one's notion of ontological primacy (and perhaps it should not be). Until now I have argued only that if it is involved, the resulting asymmetry of ontological primacy is entirely consistent with the non-asymmetry of determination/supervenience. So let us consider, as promised, some other things that might be meant by "ontological primacy".

Sometimes the physical is said to be prior in the sense that it determines/subvenes everything nonphysical but never vice versa. As noted toward the end of §3, this can make it look as though determination/supervenience must be asymmetric. But as we also noted, the inference to asymmetry is a *non sequitur*. We may rightly accord primacy to the physical, in the sense that the physical objectively determines/subvenes everything nonphysical but not vice versa, without presupposing that determination/supervenience is asymmetric.

What else might be meant by 'ontological primacy'? Suppose that an ontology is among other things a theory of what it is to be[34]. According to the physicalist theory, to be (anything at all) is to be physical, in the sense that for any concrete thing, to be is to be (i) composed of entities of the kind studied in physics, and (ii) in such a way that all the thing's properties are determined by physical properties, not vice versa (ignoring abstracta, if any). So the claim that the physical enjoys ontological primacy over the nonphysical might amount to the assertion simply of (i) and (ii). But thesis (i) – the composition thesis – can be expressed, and explicated, without invoking any determination relation, let alone an asymmetric one[35]. The determination thesis (ii), as we've been seeing, can likewise be expressed without presupposing asymmetry of determination. So the physical can be asymmetrically ontologically prior to the nonphysical in the sense of (i) and (ii) even

[34] Benardete ((1989), Chs. 1-3); Post ((1991), Ch. 1).

[35] Hellman & Thompson (1975); Post ((1987), pp. 120-125 and pp. 166-173).

though the determination relation asymmetric. Like remarks apply to supervenience.

Another sense in which entities of kind *P* might be ontologically prior to those of kind *N* is that the latter could not exist if the former did not. But this sort of asymmetric ontological primacy is captured by the composition thesis: if everything concrete is composed of the basic physical entities, then if the latter did not exist neither would the former; destroy what a concrete thing is composed of and you destroy the thing. Furthermore, the basic physical entities could have existed even if conditions in our universe had blocked the evolution of complex "nonphysical" beings (those that have nonphysical properties) for the physical entities to compose. Since composition can be explicated without determination, asymmetric ontological primacy is again consistent with non-asymmetric determination; so too for supervenience.

Some physicalists who talk of the ontological primacy of the physical seem to mean (i) and (ii) combined with an explanatory thesis (which may be to re-introduce a pragmatic/epistemic notion, depending on one's theory of explanation). The primacy of the physical consists in everything's being composed of the physical entities in such a way that the physical properties not only determine/subvene but are explanatorily prior to the nonphysical properties. But we've lately been seeing how and in what sense the physical properties can be explanatorily prior to the nonphysical, via chains of empirically adequate interlevel theories, and how this explanatory primacy of the physical, plus the corresponding dependence of the nonphysical, can be understood without asymmetry of determination/supervenience.

Finally, note that for each of the foregoing senses of ontological primacy, the assertion merely that the physical determines/subvenes the nonphysical is not meant, by itself, to capture or express ontological primacy in that sense, but at most only in conjunction with further if closely related matters. It is partly for this reason, in addition to the reasons given above, that for each of

these senses there is a positive account of primacy in that sense which implies no asymmetry of determinational dependence or of supervenience. Unless someone offers a further sense of primacy that might imply the alleged asymmetry, arguments from the primacy of the physical to the would-be asymmetry of determination/supervenience are a poor bet. And aside from troubles with arguments for asymmetry, there would remain the substitutivity argument of §4 against it. It follows that explications of determination and supervenience, including those according to which they are nonreductive and/or global, cannot be faulted for failing to entail asymmetry. To the contrary, the fault would seem to lie with explications that require it.

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