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Multiple Realizability and Reduction: A Defense of the Disjunctive Move

Abstract

If one accepts something like the Nagelian account of reduction, the *multiple realizability* of mental properties seems to render psychophysical *reductionism* impossible because there appear to be no one-one-correlations between mental and physical predicates (or properties) that could provide us with suitable bridge-laws. One response on behalf of psychophysical reductionism is the *Disjunctive Move* which appeals to bridge-laws connecting mental predicates with disjunctions of their physical realizers. The famous problem with the *Disjunctive Move* is that given the apparently diverse ways of physically realizing mental properties, the disjunctive predicates in question do not seem to designate *scientific kinds*, and since laws must connect kinds, the biconditionals in question cannot be *laws*, and therefore *a fortiori* not *bridge-laws*. This paper defends the *Disjunctive Move* against the two most important objections along this line: First, the suspicion that the biconditionals in question cannot be bridge-laws because they are not *explanatory*; second, the suspicion that they cannot be bridge-laws because the individual disjuncts are causally heterogeneous, so that the corresponding biconditionals are *unprojectible*.

In the philosophy of mind, *multiple realizability* is the claim that a mental property can be realized by various, mutually distinct physical properties: an event in my brain might be a thought that Iowa is west of Indiana in virtue of belonging to the physical event-type *activation in neural area a*, while, say, an event in a conscious robot's CPU might be a thought that Iowa is west of Indiana in virtue of belonging to the physical event-type *activation in silicon chip c*. The claim is not only that events that belong to the same mental event-type may belong to different physical event-types; the claim is that events may belong to the same mental event-type although there is no physical event-type they *and only they* belong to.

If mental properties are multiply realizable, psychophysical *reductionism* seems to be out of question: how could there be psychophysical reductions if there is nothing physical in common to all and only the physical

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realizers of a given mental property? In the context of the account of reduction dominant in the philosophy of mind during the Seventies, for instance, according to which reductions require bridge-laws of the form '$(\forall x)\ (Fx \equiv Gx)$' or '$(\forall x)\ (Gx \supset Fx)$' (see Nagel 1961), the multiple realizability of mental properties—the fact that there are physical properties $P_1, \ldots, P_n$ $(n > 1)$ for a mental property M such that P_i realizes M in some creature at some time—showed that bridge-laws of this kind are unavailable, thereby rendering psychophysical reductions impossible. One response on behalf of reductive physicalism was the *Disjunctive Move*, i.e. the appeal to bridge-laws of the form '$(\forall x)\ (Mx \equiv (P_1x \vee \ldots \vee P_nx))$', where $P_1, \ldots, P_n$ are all the possible physical realizers of M. There is a well-known problem with the *Disjunctive Move*, however. Given the apparently diverse ways of physically realizing mental properties, the disjunctive predicate in question does not seem to designate a *scientific kind*, and since laws must connect kinds, true biconditionals of the form '$(\forall x)\ (Mx \equiv (P_1x \vee \ldots \vee P_nx))$' cannot be *laws*, and therefore *a fortiori* not *bridge-laws*.

There seem to be two major obstacles for the *Disjunctive Move* to work. First, the suspicion that the biconditionals in question cannot be bridge-laws because they are not *explanatory*. Second, the suspicion that they cannot be bridge-laws because the individual disjuncts are causally heterogeneous, so that the biconditionals are *unprojectible* and do not connect genuine, causally homogeneous *kinds*. This paper defends the *Disjunctive Move* against these objections. Section 1 formulates the central idea of the *Disjunctive Move* and its rationale. Section 2 suggests an alternative formulation which helps to avoid much of the intuitive resistance against it. Sections 3 and 4 address the charges that biconditionals like '$(\forall x)\ (Mx \equiv (P_1x \vee \ldots \vee P_nx))$' are neither explanatory nor projectible.

1 Reduction, Psychophysical Bridge-Laws and Disjunctive Properties

What does it mean that the mental *reduces* to the physical? That x is *derivable* from or explainable in terms of y, rendering reduction a relationship between theories, propositions or predicates, or that x is *identical* to y, rendering reduction a relationship between events, facts or properties? Early philosophy of mind appealed to Ernest Nagel's account according to which a *theory* T_1 reduces to a theory T_2 iff the laws of T_1 (or a suitably corrected version of them) are *deductively derivable* from the laws of T_2 (Nagel 1961, ch. 11). Since the laws of psychology and physics are framed in terms of at least partially disjoint vocabularies, the derivation of psycho-

logical theory from physical theory thus requires suitable *bridge-laws*, i.e. *empirical hypotheses* that express *material* rather than *logical* connections (Nagel 1961, 352-356; 1998, 913).[1] Bridge-laws of the form '$(\forall x)$ $(Fx \equiv Gx)$' connect coreferential predicates, bridge-laws of the form '$(\forall x)$ $(Fx \supset Gx)$' connect predicates of the reducing theory with predicates of the reduced theory such that the extension of the latter falls into the extension of the former. Philosophy of mind concentrated on bridge-laws of the former kind: psychological predicates, it was said, must be linked with physical predicates by biconditionals like (1) (the subscript '*N*' indicating nomological necessity):

(1) $\Box_N(\forall x)\ (Mx \equiv Px)$

If a mental property *M* is *realized* by a physical property *P*, an object's satisfying '*P*' is (at least) nomologically sufficient for its satisfying '*M*'. Psychophysical realization thus establishes (2):

(2) $\Box_N(\forall x)\ (Px \supset Mx)$

The reduction of *M* to *P*, however, requires a bridge-law of the form '$(\forall x)$ $(Mx \equiv Px)$' or '$(\forall x)$ $(Mx \supset Px)$'. Yet, if *M* is *multiply realizable* by P_1, …, P_n $(1 < n)$, there is no physical property all and only the nomologically possible creatures satisfying '*M*' share and (3) and (4) are false:

(3) $\Box_N(\forall x)\ (Mx \supset P_ix)$
(4) $\Box_N(\forall x)\ (Mx \equiv P_ix)$

Assuming that *M* can be reduced to *P* only if '*M*' and '*P*' are nomologically coextensive, the falsity of (4) might seem to render psychophysical reductions impossible. This, however, is a *non-sequitur*. (4) is false if *M* is multiply realizable, but psychophysical reductions are impossible only if (1) is false, and the falsity of (4) is compatible with the truth of (1). That no

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[1] Suppose a law '$(\forall x)$ $(F_1x \supset G_1x)$' of T_1 is to be reduced to a law '$(\forall x)$ $(F_2x \supset G_2x)$' of T_2. If 'F_1' and 'G_1' do not belong to the vocabulary of T_2 and 'F_2' and 'G_2' do not belong to the vocabulary of T_1, the T_1-law cannot be derived from the T_2-law (and other propositions couched in the vocabulary of T_2) unless there are bridge-laws like '$(\forall x)$ $(F_1x \equiv H_1x)$', '$(\forall x)$ $(G_1x \equiv H_2x)$', '$(\forall x)$ $(F_1x \supset H_1x)$' or '$(\forall x)$ $(G_1x \supset H_2x)$', where 'H_1' and 'H_2' belong to the vocabulary of T_2.

predicate 'P_i' is nomologically coextensive with 'M' does not entail that this holds for all physical predicates, given that the set $\Pi_M = \{P_1, \ldots, P_n\}$ of M's physical realizers is only a small subset of all physical properties. In other words: M cannot be reduced to any of its physical realizers, but that does not show that it cannot be reduced to any physical property at all. One candidate for a physical predicate 'P^*' which makes (1) true, despite the falsity of (4), is the disjunction of all the 'P_i' (see Kim 1979, 1984, 1990). 'P^*' is not part of quotidian discourse, but easily definable (the subscript 'L' indicating logical necessity):

(5) $\Box_L(\forall x)\,(P^*x \equiv (P_1x \vee \ldots \vee P_nx))$

Together with (2) and the assumption that $\Pi_M = \{P_1, \ldots, P_n\}$ is *exhaustive*, (5) entails a nomologically necessary biconditional linking 'M' with 'P^*':

(6) $\Box_N(\forall x)\,(Mx \equiv P^*x)$

The *Disjunctive Move* holds that if the existence of biconditional bridge-laws linking mental and physical predicates is, as Nagel has held, sufficient for psychophysical reductions, multiple realizability need not be incompatible with psychophysical reductions. Here is the argument:

(P1) Psychophysical reductions are possible if there is a biconditional bridge-law linking each mental predicate with a physical predicate.
(P2) For each disjunction '$P_1x \vee \ldots \vee P_nx$' there is a logically coextensive physical predicate 'P^*'.
(P3) For each mental predicate 'M' with $\Pi_M = \{P_1, \ldots, P_n\}$ $(1 < n)$, '$P_1x \vee \ldots \vee P_nx$' and '$M$' are nomologically coextensive.
(C1) For each mental predicate 'M' with $\Pi_M = \{P_1, \ldots, P_n\}$ $(1 < n)$, there is a nomologically coextensive physical predicate 'P^*'.
(P4) If there is a nomological coextensive physical predicate 'P^*' for each mental predicate 'M', there is a biconditional bridge-law linking each mental predicate with a physical predicate (viz., '$(\forall x)\,(Mx \equiv P^*x)$').
(C2) Psychophysical reductions are possible.

Clearly, the argument is valid.[2] P1 expresses the Nagelian account of reduction. Provided that 'P^*' is a physical predicate if each 'P_i' is a physical predicate, P2 is uncontroversial. P3 is true because Π_M is the exhaustive set of *M*'s physical realizers. Apart from that, opponents of reductionism (who believe in physical realization) accept (7), and thus (8), so that they could deny P3 only by rejecting (9).

(7) $\Box_N(\forall x)\,(P_i x \supset Mx)$
(8) $\Box_N(\forall x)\,((P_1 x \vee \ldots \vee P_n x) \supset Mx)$
(9) $\Box_N(\forall x)\,(Mx \supset (P_1 x \vee \ldots \vee P_n x))$

Rejecting (9), however, would require that some nomologically possible worlds contain *unrealized* or *non-physically realized* mental properties, and that is unacceptable (at least) for those opponents of reductionism who believe in the truth of so-called 'non-reductive physicalism' (Jaworksi 2002, 291). Thus, if P4 is correct, psychophysical reductions are compatible with multiple realizability because biconditionals like (10) can serve as bridge-laws:

(10) $\Box_N(\forall x)\,(Mx \equiv (P_1 x \vee \ldots \vee P_n x))$

The challenge for the opponents of the *Disjunctive Move* is thus to show why biconditionals like (10) containing disjunctive designators can *not* be bridge-laws, so that P4 is false.[3]

2 Disjunctive Properties and Disjunctive Designators

To many, the *Disjunctive Move* seems only like a sophisticated loophole; a loophole, moreover, that involves heavy metaphysical armor. I think it is

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[2] C2 follows from P1, C1 and P4 on the assumption that no nomologically possible world contains unrealized or non-physically realized mental properties; on that assumption see below.

[3] Clapp 2001 and Jaworski 2002, and Walter 2003 provide at least partial defenses of the *Disjunctive Move* (Clapp acknowledges that the *Disjunctive Move* demonstrates the *in principle* reducibility of psychology to physics but insists on its *de facto* irreducibility). Kim is largely skeptical about the prospects of the *Disjunctive Move* (see Kim 1992, 1998); other critics include Fodor 1974, 1997; Marras 1993; Owens 1989; Putnam 1975; Seager 1991; Zangwill 1995.

actually less absurd than is usually supposed and there need not be anything metaphysically suspicious about it.

The main problem can be brought to the fore by realizing that the *Disjunctive Move* is often formulated in a disadvantageous way which prompts a lot of misguided criticism:

> [T]he picture we have is that for [each mental] property *M*, there is a set of properties, P_1, P_2, … such that each P_i is necessarily sufficient for *P*. Assume that this list contains all the … properties each of which is sufficient for *M*. Consider then their disjunction: P_1 or P_2 or … (or $\cup P_i$, for short). … It is easy to see that this disjunction is necessarily coextensive with *M*. … So *M* and $\cup P_i$ are necessarily coextensive, and whether the modality here is metaphysical, logical, or nomological, it should be strong enough to give us a serviceable 'bridge law' for reduction. (Kim 1990, 152; predicates relabeled)

This passage describes the *Disjunctive Move* as suggesting to disjoin the *properties* P_1, …, P_n to create, as it were, a new *disjunctive property P**. Ausonio Marras, when criticizing the *Disjunctive Move*, also suggests that *M* is to be identified with the disjunction of its physical realizers:

> Kim has argued that if we take *the disjunction of all the P-properties* that [realize] a given *M*-property, such a disjunction will constitute necessary *and* sufficient conditions for the *M*-property. Thus, if we take *P** to be any such (possibly infinite) disjunction of … *P*-properties, the following will be true:
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> (NC) If *M*-properties [are realized by] *P*-properties, then for each *M*-property *there is a property P** such that, necessarily, $(\forall x)$ $(P^*x \equiv Mx)$. (Marras 1993, 216; emphasis S.W., logical symbols altered)[4]

Formulating the *Disjunctive Move* in terms of *disjunctive properties*, however, inevitably leads to the question whether "disjunction [is] a permissible mode of property composition" (Kim 1990, 152) and creates the false impression that it comes at high metaphysical costs.

Usually, the distinction between predicates and properties does not matter much and one can talk about properties like *having existed at the moment Kennedy was assassinated* without causing philosophical damage. Problems emerge when such talk is supposed to yield substantial ontologi-

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[4] For a similar way of putting things see Heil 1992, 64 and Zangwill 1995, 153.

cal payoff. Properties are surprisingly independent of predicates: not every predicate picks out a property and there might be no well-entrenched predicate for every property. While it is clear what a disjunction of *predicates* is, it is unintelligible what it could mean to disjoin properties P_1, …, P_n to yield a new *disjunctive property* P^*, and even if it made sense, P^* would presumably indeed be something metaphysically suspicious. Lately, Kim agreed that, taken literally, talk about disjunctive properties is nonsense,[5] because "[b]y quantifying over properties, we cannot create new properties any more than by quantifying over individuals we can create new individuals" (Kim 1998, 104).

A more modest interpretation of the *Disjunctive Move*, I think, ought to disjoin the physical *predicates* 'P_1', …, 'P_n' to yield a *disjunctive designator* '$P_1x \vee \ldots \vee P_nx$' which is then said to be nomologically coextensive or coreferential with 'M'. Understood thus, the *Disjunctive Move* need not invoke metaphysically suspicious entities or non-standard logical operators. The suggestion is *not* to form a *disjunctive predicate* '$P_1 \vee \ldots \vee P_n$', but to form a *disjunctive designator* '$P_1x \vee \ldots \vee P_nx$' (compare the difference between the *disjunctive designator* 'x is red $\vee$ x is green' and the *disjunctive predicate* 'x is red or green'). Thus understood, the *Disjunctive Move* would simply claim that disjunctive designators like '$P_1x \vee \ldots \vee P_nx$' and mental predicates like 'Mx' pick out the same (or at least nomologically coextensive) properties, thereby enabling psychophysical reductions.

Given that properties are determined by the way the world is and not by one's conception of it, it should not be surprising that some complex predicates pick out ordinary properties. That the disjunctive designator 'x is a Jugatae $\vee$ x is a Frenatae' picks out *being a moth* does not make *being*

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[5] At one point, he seems to eschew disjunctive *predicates* while endorsing disjunction as an operation on *properties*: "such operations as infinite conjunctions and infinite disjunctions would be highly questionable for predicates, but not necessarily for properties—any more than infinite unions and intersections are for classes" (Kim 1984, 73). However, he later points out that "properties are not inherently disjunctive or conjunctive any more than classes are inherently unions or intersections, and …. any property can be expressed by a disjunctive predicate. Properties of course can be conjunctions, or disjunctions, *of* other properties" (Kim 1992, 321). If I understand Kim correctly, he is saying that we might call the property expressed by a disjunctive predicate a 'disjunctive property', but that we should keep in mind that there is nothing *inherently disjunctive* about that property—we might be familiar with it under another predicate. If this is what he is saying, he is close to the interpretation of the *Disjunctive Move* offered in the main text.

a moth a disjunctive property in any metaphysically interesting sense. Nor does '*x* is not thirsty' pick out a *negative property* in any metaphysically interesting sense; the individuals satisfying it share a complex property of the metabolic system involving the level of the hormone vasopressin for which there just happens to be no adequate atomic predicate. Just as one need not posit moths over and above Jugatae and Frenatae, one need not posit *being a Jugatae or a Frenatae* over and above *being a moth*. If a disjunctive designator in the vocabulary of a lower-level science turns out to pick out the same property as a predicate in the vocabulary of a higher-level science, there is a clear sense in which a *reduction* has taken place; the psychophysical reductions based on the *Disjunctive Move* need thus not be completely airy-fairy and they need not invoke any metaphysically mysterious entities.

The crucial question is then whether '$P_1x \vee \ldots \vee P_nx$' and '*M*' do pick out the same property in the psychophysical case. The problem is that it is doubtful that '$P_1x \vee \ldots \vee P_nx$' picks out a genuine property at all. Not all disjunctive designators pick out a genuine property—'*x* is a Jugatae $\vee$ *x* is a Frenatae' arguably does, but '*x* is a raven $\vee$ *x* is a writing desk' (see Armstrong 1978) arguably does not. Sections 3 and 4 discuss two arguments which claim to show that (bi)conditionals in terms of disjunctive designators cannot be laws. These arguments can also be understood as trying to establish that disjunctive designators like '$P_1x \vee \ldots \vee P_nx$' do not pick out genuine properties. If sound, they would therefore block the *Disjunctive Move* in both its formulations.

3 The Explanatory Response

In order to deny P4, it must be shown that (bi)conditionals containing disjunctive designators cannot be *laws*. First of all, laws must support counterfactual conditionals and enable successful predictions. But even if (bi)conditionals containing disjunctive designators satisfy these criteria (Kim 1992, 319; Owens 1989, 198; Seager 1991, 94), two other characteristic features of laws cause trouble. 'All *F*s are *G*s' is a law only if, first, it is *confirmed* by its positive instances (i.e. observations of *F*s which are *G* increase confidence that the next observed *F*-item will also be *G*), and, second, it is *explanatory* ('All emeralds are green' is a candidate law only because something about *being an emerald* explains why all emeralds are green).

Opponents of the *Disjunctive Move* argue that (bi)conditionals containing disjunctive designators cannot be laws because they are neither explanatory nor confirmed by their positive instances. Section 4 addresses the second objection. This section discusses the *Explanatory Response* to the *Disjunctive Move* according to which (bi)conditionals in terms of disjunctive designators are "*totally useless for explanatory or reductive purposes*" (Marras 1993, 216-217) and "cannot appear in laws because 'laws' involving such disjunctions are not explanatory … they do not meet our interests in explanation" (Pereboom & Kornblith 1991, 126).

If the following argument is sound, the *Disjunctive Move* fails because P4 is false:

(P1*) (Bi)conditionals can be laws only if they are explanatory.
(P2*) (Bi)conditionals containing disjunctive designators are not explanatory.
(C1*) (Bi)conditionals containing disjunctive designators cannot be not laws.

It is at least unclear that P1* is true. In its favor, one might suggest that whether 'All *F*s are *G*s' is a candidate law depends upon whether it is explanatory: since something about *being an emerald* explains why all emeralds are green, 'All emeralds are green' is a candidate law, while 'All males in the main library have five coins in their pockets' is not a candidate law because there is nothing about *being a male in the main library* that could explain one's having five coins in one's pockets. Yet, suppose decades of examination reveal no exception. Wouldn't 'All males in the main library have five coins in their pockets' eventually be considered a candidate law even if it is not explanatory in any straightforward sense? There seems to be a *critical mass* of inductive evidence beyond which the possibility of mere chance is discarded, no matter how unrelated the factors initially seem. Apart from that (this is the argument of Jaworski 2002, 302), suppose Martians give earthian scientists a complete physical theory *T* from which they can derive all phenomena their current best theories can explain (plus several more), although it remains totally mysterious to them why the fact that things are as described in *T* gives rise to how things are.

Ought they deny that the (bi)conditionals of *T* are laws simply because they are not explanatory (to them)?[6]

Be that as it may, the real problem is P2*. According to Hempel's DN-model of explanation, explanations are deductive derivations of explanandum-propositions from explanans-propositions together with statements describing initial conditions (see Hempel 1965). If only derivability mattered, there would be no reason why (bi)conditionals containing disjunctive designators could not be explanatory. Given (10), any explanandum-proposition π deductively derivable from (11) is also derivable from (12):

(11) $\Box_N(\forall x)\,(Mx \supset \pi)$
(12) $\Box_N(\forall x)\,((P_1x \vee \ldots \vee P_nx) \supset \pi)$

If the *Explanatory Response* is to get off the ground, figuring in Hempelian derivations can thus not be *sufficient* for being explanatory. If 'All emeralds are green' is explanatory but (bi)conditionals containing disjunctive designators are not, this must be because the former, but not the latter, has whatever is required in addition to derivability. That Hempel's purely syntactic account of explanation is too weak has long been acknowledged. However, there is no unanimous consensus about how to single out explanatory derivations from non-explanatory ones. The *Explanatory Response* suggests that genuine explanations must be *relevant*, i.e. 'meet our interests in explanation'. For instance, it is in principle possible to derive from the laws of fundamental physics and micro-physical descriptions of Putnam's famous board and peg a micro-level description of the fact that the peg does not fit through the hole. Yet, that description will not be *explanatory* because it is too complicated and brings in too many 'gory details' (see Waters 1990) which are *irrelevant* because they might have been different without any change at the macro-level, but not *vice versa*. Regardless of their micro-level make-up, the peg will not fit through the hole if the former is one inch in diameter and the latter a fraction less than an

[6] Here is a real-life example that might illustrate Jaworski's point: Our current best theory of quantum electrodynamics predicts infinite values for parameters like mass, although measured values are always finite. *Renormalization group theory* handles this difficulty in a seemingly *ad hoc* way; we know *that* renormalization works, but we do not know (currently) *why* (Sklar 2000, ch. 3). Yet, would we deny that the generalizations of renormalization group theory are law-like only because the readjustments on which it relies are *ad hoc* and fail to be explanatory?

inch across, and this is why the micro-physical details do not seem to be explanatory. However, counterfactual relevance of this kind is not *per se* necessary for explanatory value. If I get cancer after smoking cigarettes containing carcinogenic a_1, my inhaling a_1 might *explain* why I got cancer even if the latter is counterfactually independent of the former because had I smoked cigarettes containing carcinogenic a_2 instead, I would have gotten cancer, too.

> If there turn out to be several carcinogenic ingredients and different cigarettes contain different ones, this does not make the molecular inquiry explanatorily irrelevant to the question of why people get cancer. The fact that *P* is multiply realizable does not mean that *P*'s realizations fail to explain the singular occurrences that *P* explains. A smoker may not want to hear the gory details, but that does not mean that they are not explanatory. (Sober 1999, 549)

One might respond that micro-level accounts are irrelevant because they *miss important generalizations*: micro-level stories about particular pegs and boards miss the important commonality that pegs with one inch in diameter do not fit through holes with a fraction less than an inch across. However, that explanations leave something important out does not *per se* render them irrelevant or non-explanatory. An explanation claiming that the peg does not fit through the hole because Neptune is in the sign of Aries is clearly *irrelevant* in a sense in which the micro-level explanation, though incomplete, is not. That macro-level accounts provide *unifying* explanations does not render non-unifying micro-level accounts irrelevant. Quite the contrary, it can be illuminating to discover that the same effect can be brought about differently, making the appeal to the micro-level details highly explanatory.

Perhaps the mind-body case is special with respect to the alleged lack of explanatory value of (bi)conditionals containing disjunctive designators. Consider the following objection:

> When [Hannah] walks down the street to buy an ice-cream cone, we explain her behaviour by appealing to the content of her beliefs, and desires: she wanted an ice-cream cone and she believed one could be purchased down the street. Replacing this explanation by one which contains an open-ended disjunction of physical predicates—if [Hannah] is in state P_1 or P_2 or P_3, etc. she will move with trajectory T_1—indeed leaves our interests in explanation unsatisfied. (Pereboom & Kornblith 1991, 127)

Being told that Hannah instantiates '$P_1x \vee \ldots \vee P_nx$' does not make one *understand* why her behavior *b* occurred, because in contrast to a mentalistic account of *b* no *explanation* is given by appeal to '$P_1x \vee \ldots \vee P_nx$'. However, that Hannah went down the road because she instantiates '$P_1x \vee \ldots \vee P_nx$' might be found explanatory by neurophysiologists investigating how different pathways culminate in the same behavior, and it shows that other physical conditions are *not* among the pathways to be investigated (remember that $\Pi_M = \{P_1, \ldots, P_n\}$ is the *exhaustive* set of *M*'s realizers).

What Pereboom and Kornblith say in the passage above does not show that an account couched in terms of '$P_1x \vee \ldots \vee P_nx$' is not explanatory at all, but that it does not explain *why Hannah went down the road*, i.e. it fails to explain *b qua* intentional behavior. Suppose for the sake of argument the *Disjunctive Move* indeed required that an account in terms of '$P_1x \vee \ldots \vee P_nx$' explain *b qua* intentional behavior, although I can see no reason why this should be so, and that it indeed failed to do so. Still, in order for the *Explanatory Response* to be effective, it would have to fail *because* it contains a *disjunctive designator*. Yet, the problem might simply be that a piece of intentional behavior is explained *physicalistically*, not that the explanation contains a disjunctive designator. That Hannah instantiates '$P_1x \vee \ldots \vee P_nx$' might not explain *b*, but not *because* '$P_1x \vee \ldots \vee P_nx$' is a disjunctive designator.[7] Physicalistic accounts of intentional behavior might simply fail to be explanatory because they do not reveal an agent's *reasons*. This would (perhaps) be a problem for reductive physicalism, but if this is the *only* problem, the *Explanatory Response* is no more problematic for the *Disjunctive Move* than the truth of substance dualism would be: if *no* physicalistic explanation of intentional behavior is possible, the *Disjunctive Move* might fail, but only because reductive physicalism *per se* is untenable. In order to reject the *Disjunctive Move* by appeal to the *Explanatory Response* in the context of a general commitment to physicalism, one would have to argue that non-disjunctive, in contrast to disjunctive, physicalistic explanations of intentional behavior are explanatory, and the

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[7] Incidentally, mentalistic accounts of behavior—Hannah walks down the street because she wants an ice cream cone, and believes she can purchase one down the street, or because she believes they are spying on her and wants them to think she enjoys ice cream, or because she wants to see the ice cream man and believes walking to get a cone an excellent pretense—seem explanatory *even if* they contain disjunctive designators (Jaworksi 2002, 300).

typical opponents of the *Disjunctive Move* have never offered any reason for this.

One rejoinder would be that physicalistic explanations in terms of disjunctive designators fail to explain *physicalistic* explananda, too, but this is false for at least some cases (Owens 1989, 198). Another rejoinder would be to concede that some physicalistic explanations in terms of disjunctive designators—'x is carcinogenic $a_1 \vee x$ is carcinogenic a_2', for instance—are explanatory but to insist that '$P_1 \vee \ldots \vee P_n$' is more like 'x is a raven $\vee$ x is a writing desk' and not explanatory. Without any argument, however, this response is *ad hoc*. One argument would be that all and only the individuals satisfying 'x is carcinogenic $a_1 \vee x$ is carcinogenic a_2' but not all and only the individuals satisfying '$P_1 \vee \ldots \vee P_n$' or 'x is a raven $\vee$ x is a writing desk' have something in common from a physical point of view, and this brings us to the second objection, to the question whether the individuals satisfying '$P_1 \vee \ldots \vee P_n$' do share a significant commonality.[8]

4 Causal Heterogeneity

According to Fodor, (bi)conditionals containing disjunctive designators cannot be laws because "a necessary condition on a universal generalization being lawlike is that the predicates which constitute its antecedent and consequent should pick out natural kinds" (Fodor 1974, 108). But which predicates pick out natural kinds? According to Fodor, a predicate does not determine a kind if it picks out no property at all or an illegitimate property (Fodor 1997, 158). Yet, it is unclear what a real but illegitimate property would be, and quite apart from that, one cannot say that '$P_1x \vee \ldots \vee P_nx$' fails to determine a kind because it does not pick out a property when the alleged fact that it fails to determine a kind is supposed to show eventually that it does not pick out a property (and hence *a fortiori* not the same property as the mental predicate 'M'). At another point, Fodor says that each science s contains sets of "theoretical and observation predicates such that

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[8] Still another rejoinder might be that the disjunctive designators in the psychophysical case have *infinitely* (or at least *indefinitely*) many disjuncts, i.e. that they are 'open ended' (see Pereboom & Kornblith 1991; Zangwill 1995; thanks to an anonymous referee for rasing this question). However, I argue in the next section that there are constraints on which, and therefore how many, physical properties can realize a given mental property, so that it is highly unlikely that there is an infinite (or even indefinitely huge) number of realizers for each mental property.

events fall under the laws of the science by virtue of satisfying those predicates" (Fodor 1974, 101), suggesting that '*F*' determines a kind of *s* just in case *s* posits a law containing '*F*' (Fodor 1974, 102). In the current context, however, this is also circular: (bi)conditionals containing disjunctive designators cannot be laws because they involve the non-kind '$P_1x \vee \ldots \vee P_nx$' and '$P_1x \vee \ldots \vee P_nx$' is not a kind because it does not figure in laws. A third reason for thinking that '$P_1x \vee \ldots \vee P_nx$' cannot determine a physical kind is that predicates pick out kinds only if they are *homogeneous*, i.e. only if the individuals satisfying them have something significant in common *from the point of view of the science whose vocabulary the predicates belong to*. When viewed thus, kinds are individuated on the basis of causal powers: objects with similar causal powers form a kind (Kim 1992, 326). The *Disjunctive Move* therefore seems to fail: a disjunctive designator like '$P_1x \vee \ldots \vee P_nx$' is heterogeneous and hence does not pick out a kind.

> Some monetary exchanges involve strings of wampum. Some involve dollar bills. And some involve signing one's name to a check. What are the chances that a disjunction of physical predicates which covers all these events (i.e. a disjunctive predicate which can form the right hand side of a bridge law of the form '*x* is a monetary exchange ≡ …') expresses a physical natural kind? The point is that monetary exchanges have interesting things in common … But what is interesting about monetary exchanges is surely not their commonalities under *physical* description. (Fodor 1974, 103-104)

Since (bi)conditionals containing disjunctive designators can be laws only if the latter pick out kinds, the foregoing considerations seem to show that P4 is false. Kim raises a similar objection (Kim 1992, 322-327; 1998, 106-110), arguing that the (bi)conditionals of the *Disjunctive Move* are not confirmed by their positive instances and thus *unprojectible*. According to Kim, (13) is not confirmed by its positive instances, and thus not a law, because "jade comprises two distinct minerals with *dissimilar molecular structures*, jadeite and nephrite" (Kim 1992, 319; emphasis S.W.).

(13) All jade is green.

The discovery that jade is effectively a conjunction of two minerals, jadeite and nephrite, Kim claims, reveals that (13) is unprojectible and not a law of its own. The dissimilarity that renders (13) unprojectible is again a dissimilarity in *causal powers*: generalizations about jade cannot be confirmed on the basis of the observation of a finite number of positive in-

stances because these will be either jadeite or nephrite and no evidence for an *F* being a *G* is also evidence for an *H* being a *G*, if the *F*-items and the *H*-items are physically heterogeneous (Owens 1989, 199; Seager 1991, 96):

> [W]e can imagine this: on re-examining the records of past observations, we find, to our dismay, that all the positive instances of (L) [i.e. 'Jade is green'; S.W.] … turn out to have been samples of jadeite, and none of nephrite! If this should happen, we clearly would not, and should not, continue to think of (L) as well confirmed. … [A]ll the millions of green jadeite samples *are* positive instances of (L): they satisfy both the antecedent and the consequent of (L). … however, (L) is not confirmed by them, at least not in the standard way we expect. And the reason, I suggest, is that jade is a true disjunctive kind, a disjunction of two heterogeneous nomic kinds which, however, is not itself a nomic kind. (Kim 1992, 320)

If it turns out after the observation of a large number of green jade samples that they have all been jadeite, says Kim, these observations do not confirm 'All *jade* is green'. However, as Fodor has pointed out, this at best shows that disjunctive designators fail to be projectible *if* the data basis is biased, and even atomic predicates are unprojectible if the data basis is biased:

> Suppose we've been considering whether oak trees shed their leaves in winter; and suppose it turns out … that all our positive instances are observations of oak trees on the north side of hills. Then we would no longer think of the generalization about oak trees losing their leaves in the winter as unambiguously well-confirmed; oak data confirm oak generalizations only if they are an unbiased sample of the oak population … There is … something wrong with [(L)]; something that makes it not a law. But [it] isn't that biased samples fail to confirm it. *Biased* samples don't confirm *anything*. (Fodor 1997, 151-152)[9]

According to Kim, 'All African or non-African emeralds are green', in contrast to 'All jade is green', qualifies as a law because '*x* is an African emerald $\vee$ *x* is a non-African emerald', in contrast to '*x* is jadeite $\vee$ *x* is nephrite', is *not* heterogeneous and therefore projectible:

> There is nothing wrong with disjunctive predicates as such; the trouble arises when the kinds denoted by the disjoined predicates are heterogeneous, 'wildly disjunctive', so that instances falling under them do not show the kind of 'simi-

[9] Fodor's own reason for thinking that (L) is not confirmed by its positive instances is discussed below.

> larity', or unity, that we expect of instances falling under a single kind. (Kim 1992, 321)

According to Fodor and Kim, thus, it is the causal heterogeneity of '$P_1x \vee \ldots \vee P_nx$' which renders it non-projectible and a non-kind. Assuming that (bi)conditionals are laws only if they are projectible and connect kinds, (bi)conditionals containing disjunctive designators can be laws only if they are causally homogeneous. Undeniably, some disjunctive designators—'*x* is a raven $\vee$ *x* is a writing desk' or '*x* is carbohydrate synthesis $\vee$ *x* is heat', for instance—are causally heterogeneous. In order to reject the *Disjunctive Move*, however, it must be shown that '$P_1x \vee \ldots \vee P_nx$' is relevantly similar to those disjunctive designators. And this, I think, is simply not true.

One important argument for the causal heterogeneity of '$P_1x \vee \ldots \vee P_nx$' is the standard story about multiple realizability. Since it seems 'chauvinistic' to claim that only creatures with a certain physiological make-up can exemplify mental properties, the functionalist idea that mental properties like *having pain* are second-order properties—the property of having some property or other that satisfies a given *functional role*—sounds attractive. This in turn suggests that '$P_1x \vee \ldots \vee P_nx$' is causally heterogeneous because functional roles can apparently be satisfied by a wide variety of radically diverse properties, so that "[w]e could be made of Swiss cheese and it wouldn't matter" (Putnam 1975, 134). However, functional roles are typically characterized in terms of the *causal roles* of properties (or their instantiations) within a network of other properties, and *causal* relations clearly seem to depend upon the *physical* nature of the system at issue. Why, then, do functionalists take it for granted that extremely heterogeneous properties can play the same functional/causal role? As Bieri puts it:

> Functionalism … often pretends to invoke a perfectly clear distinction when it talks of function and its multiple realizations. I have always found this surprising. In most versions of functionalism 'function' means 'causal role'. But causal roles derive from a material's causal [i.e. physical; S.W.] properties. (Bieri 1995, 53)

Sometimes there is a more intimate connection between the physical properties of an object and the functional properties it is capable of having. *Carving glass* is the second-order property of having a property responsible for having more than five degrees on the Mohs scale: *being a topaz*, *being a corundum*, and *being a diamond* are different ways for something to have *carving glass*. Nevertheless, objects having that property cannot be

made of Swiss cheese, nor can they be *extremely heterogeneous*: in order to carve glass, an object must have a very specific molecular structural property. Ned Block expresses this in his *Disney Principle*: "[i]n Walt Disney movies, teacups think and talk, but in the real world, anything that can do those things needs more structure than a teacup. … laws of nature impose constraints on ways of making something that satisfies a certain description" (Block 1997, 120). Unfortunately, this alone does not show that '$P_1x \vee \ldots \vee P_nx$' is causally homogeneous.

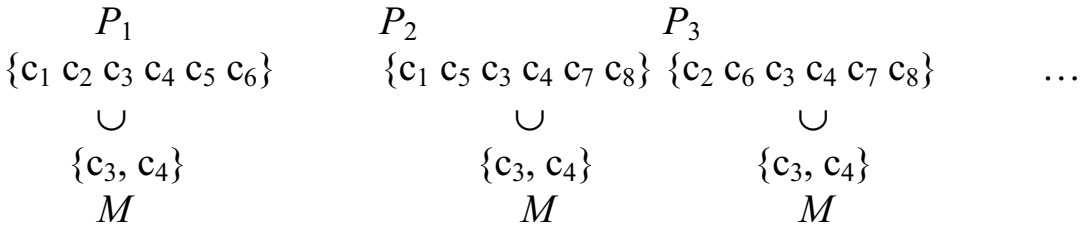
Disjunctive designators are not already causally homogeneous only because the individuals satisfying them have *something* in common: everything has something in common with everything, but 'x is a raven $\vee$ x is a writing desk' is not causally homogeneous only because ravens and writing desks both have, say, a mass. Disjunctive designators are causally homogenous if all *and only* the individuals satisfying them have something in common (and that something is not describable solely in terms of mere 'Cambridge properties'—individuals are not causally homogeneous only because they existed at the moment Kennedy was assassinated). 'x is an African emerald $\vee$ x is a non-African emerald', for instance, is causally homogeneous because all and only the individuals satisfying it have the molecular structure characteristic of emeralds.

Critics of the *Disjunctive Move* think that *qua* homogeneity '$P_1x \vee \ldots \vee P_nx$' resembles '$x$ is a raven $\vee$ x is a writing desk'. I think they are wrong.

If a mental property M is realized by a physical property P, an object's having P necessitates its having M, but not *vice versa*. One can explain this in terms of an account of properties according to which properties are individuated in terms of causal powers and a *Subset Model of Realization* according to which F realizes G iff the set Γ_F of causal powers individuative of F includes the set Γ_G of causal powers individuative of G:

(14) For any physical property P, $P \in \Pi_M$ iff $\Gamma_M \subset \Gamma_P$.

If P realizes M, $\Gamma_M \subset \Gamma_P$, so that any individual that has P in virtue of having Γ_P has Γ_M and thus M. M is multiply realizable if there are physical properties P_1 and P_2 such that $\Gamma_M \subset \Gamma_{P1}$, $\Gamma_M \subset \Gamma_{P2}$, and $\Gamma_{P1} \neq \Gamma_{P2}$. Assuming that M is individuated by, say, the set of causal powers $\{c_3, c_4\}$, this account of realization and multiple realizability can be illustrated as follows (see Heil 1999, 2003):



Adopting this model of properties and realization, defenders of the *Disjunctive Move* can argue as follows. There is a non-empty set of causal powers Γ* for '$P_1x \vee \ldots \vee P_nx$'—but not for '*x* is a raven ∨ *x* is a writing desk', '*x* is carbohydrate synthesis ∨ *x* is heat' etc.—such that (1.) every individual satisfying '$P_1x \vee \ldots \vee P_nx$' has every causal power in Γ*; and (2.) every individual having every causal power in Γ* satisfies '$P_1x \vee \ldots \vee P_nx$'. If this is correct, *all and only* the individuals satisfying '$P_1x \vee \ldots \vee P_nx$' have something in common, viz., the intersection Γ* of the sets of causal powers individuative of the P_i (i.e. $\Gamma_{P1} \cap \ldots \cap \Gamma_{Pn}$) and are thus causally homogeneous, contrary to what the critics of the *Disjunctive Move* claim. But are (1.) and (2.) true? I think they are.

> ***Proof of* (1.):** Suppose *o* satisfies '$P_1x \vee \ldots \vee P_nx$'. Hence, *o* satisfies one disjunct 'P_i' and has P_i and thus every causal power in Γ_{Pi}. But since $\Gamma_{P1} \cap \ldots \cap \Gamma_{Pn} \subset \Gamma_{Pi}$, $\Gamma^* \subset \Gamma_{Pi}$. Therefore, *o* has every causal power in Γ*.

In order to prove (2.), we first need to prove the following *Lemma*:

> ***Lemma*:** If *o* has every causal power in $\Gamma^* = \Gamma_{P1} \cap \ldots \cap \Gamma_{Pn}$, then *o* has all the causal powers in Γ_{Pi} for some *i*.[10,11]

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[10] Clapp 2001, 127-131 also argues that all and only the individuals satisfying '$P_1x \vee \ldots \vee P_nx$' share $\Gamma^* = \Gamma_{P1} \cap \ldots \cap \Gamma_{Pn}$. However, he motivates *Lemma* only by appeal to examples, while it remains unclear why one should accept that *Lemma* holds in these examples if one is not already convinced of the *Disjunctive Move* to begin with.

[11] Of course, it is not generally the case that if something has everything in an intersection, it has everything in some set participating in forming that intersection. In fact, I acknowledge this below by saying that "'$P_1x \vee \ldots \vee P_nx$' differs from '*x* is a raven ∨ *x* is a writing desk' and its likes because the latter does not allow to prove *Lemma*" (see p. 61). The point of the following argument is exactly to show that there is something special about the disjunction '$P_1x \vee \ldots \vee P_nx$' and the corresponding intersection of causal powers which enables us to prove *Lemma* in this case.

***Proof of Lemma*:** Suppose *o* has every causal power in $\Gamma^* = \Gamma_{P1} \cap \ldots \cap \Gamma_{Pn}$. Suppose, *for reductio*, that *o* has not every causal power in Γ_M. There is thus at least one causal power γ such that $\gamma \in \Gamma_M$ but $\gamma \notin \Gamma^*$. Since $\gamma \notin \Gamma_{P1} \cap \ldots \cap \Gamma_{Pn}$, there is at least one P_j such that $\gamma \notin \Gamma_{Pj}$. Hence, some object *o* can have every causal power in Γ_{Pj}, but lack γ and so not have every causal power in Γ_M. Hence, by (14), P_j is not a realizer of *M*. But $\{P_1, \ldots, P_n\}$ is the *exhaustive* set of physical realizers of *M*, so that P_j is a realizer of *M*. Therefore, *o* has every causal power in Γ_M. Hence, *o* has *M*. Since there are no unrealized or non-physically realized mental properties, *o* has a physical property *P* individuated by a set Γ_P of causal powers, and $\Gamma_M \subset \Gamma_P$. Hence, by (14), $P \in \Pi_M$. Therefore, *o* has every causal power in Γ_{Pi} for some *i*.

***Proof of* (2.):** Suppose *o* has every causal power in $\Gamma^* = \Gamma_{P1} \cap \ldots \cap \Gamma_{Pn}$. Then, by *Lemma*, *o* has all the causal powers in Γ_{Pi}, for some *i*. Hence, *o* has P_i and satisfies 'P_i'. Therefore, *o* satisfies '$P_1x \vee \ldots \vee P_nx$'.

The philosophical point behind these considerations is that '$P_1x \vee \ldots \vee P_nx$' differs from '*x* is a raven $\vee$ *x* is a writing desk' and its likes because the latter does not allow to prove *Lemma*. In the latter cases the fact that something has all the causal powers in the intersection does not entail that it has one of the properties picked out by the disjuncts—that something has a mass (or whatever else ravens and writing desks have in common) does not make it a raven or a writing desk. In contrast, all and only the individuals satisfying '$P_1x \vee \ldots \vee P_nx$' are identical in some respect. This is the important difference between, say, '*x* is a raven $\vee$ *x* is a writing desk' and '$P_1x \vee \ldots \vee P_nx$'. If projectibility and kindhood are a matter of causal homogeneity, '$P_1x \vee \ldots \vee P_nx$' can thus be projectible and a kind, and the second objection against the *Disjunctive Move* fails.

One response is that this just proves the obvious because what all and only the realizers of *M* have in common is of course that they realize *M*, while the objection against the *Disjunctive Move* was precisely that this commonality, viz., Γ_M, is *invisible* from a *physical* point of view. The point, it might be said, was that individuals satisfying '$P_1x \vee \ldots \vee P_nx$' fail to be *physically similar* even if they and only they have Γ_M. *Pace* the opponents of the *Disjunctive Move*, however, '$P_1x \vee \ldots \vee P_nx$' at least differs

from 'x is a raven $\vee$ x is a writing desk'. Does it also differ from 'x is an African emerald $\vee$ x is a non-African emerald' because the commonality among the individuals satisfying it is only 'higher-level' and not visible from a physical point of view? If the set of causal powers common to all and only emeralds can be physically characterized and studied, why not the causal powers common to all and only the members of Π_M? Emeralds can be physically characterized because one can formulate physical principles saying which clusters of molecules are emeralds. One reason why this is thought to be impossible in the case of the members of Π_M is that any physical description of them appears to be a "brute enumeration" (Fodor 1974, 104) and "*arbitrary*" (Antony & Levine 1997, 90). However, it is not true that there are *no* physical principles governing the physical realizers of a mental property; if all and only the members of Π_M share causal powers, there *must* be *some* regularity at the (physical) micro-level, for objects have causal powers in virtue of their micro-level constituents, properties and relations.

Moreover, projectibility and kindhood apparently depend upon how the world *is*, not upon how it is *described*—Goodman's *being grue* is unprojectible no matter how it is described. Thus, if the fact that all and only the individuals satisfying '$P_1x \vee \ldots \vee P_nx$' have Γ^* renders them projectible *qua* satisfying 'M', then it renders them projectible *qua* satisfying '$P_1x \vee \ldots \vee P_nx$', because one and the same set of causal powers cannot be projectible and unprojectible. Fodor, however, apparently thinks projectibility and kindhood are linguistic, not worldly, matters and denies that 'M' and '$P_1x \vee \ldots \vee P_nx$' stand and fall together *qua* projectibility. One reason why '$P_1x \vee \ldots \vee P_nx$' is supposed to be unprojectible is that it is "not independently certified" (Fodor 1997, 156). Since this means that it does not occur in any law, this once again raises the difficulty of saying what laws are without appealing to projectibility or kindhood. Recently, Fodor distinguished between 'open' and 'closed' disjunctions (disjunctions are open iff there are metaphysically possible worlds wherein they have realizers they do not have in the actual world; Fodor 1997, 156) and argued that *both* are unprojectible, non-kinds, and unfit for laws.

> It's not hard to see why it's so plausible that there can't be laws about *closed* disjunctions. Presumably the nomic properties that a thing has qua F or G are either properties that it has qua F or properties that it has qua G. That's why, if being jade … is just being jadeite or nephrite … there are no laws about being jade 'as such'; all the jade laws are ipso facto either jadeite laws or nephrite laws. (Fodor 1997, 157)

However, to repeat that point, one cannot argue that a thing cannot have its nomic properties *qua F* or *G* to settle the question whether *F* or *G* picks out a kind, since there would be laws in terms of *F* or *G* if *F* or *G* did pick out a kind. What about *open* disjunctive designators?

> *Open laws suggest missed generalizations*. To offer a law of the form $P_1 \vee P_2 \vee \ldots \supset Q$ is to invite the charge that one has failed correctly to identify the property in virtue of which the antecedent necessitates the consequent. … Someone who offers such a law undertakes a burden to provide positive reason that there isn't a *higher level* but *non*disjunctive property of things that are $P_1 \vee P_2 \ldots$ in virtue of which they bring it about that *Q*. (Fodor 1997, 158; predicates and logical symbols altered)

This objection vanishes if the *Disjunctive Move* is understood as suggested in section 2, i.e. as claiming that '$P_1x \vee \ldots \vee P_nx$' and '*M*' are coreferential. If the projectibility of '$P_1x \vee \ldots \vee P_nx$' depends upon which *property* of the antecedent necessitates the consequent, the *Disjunctive Move* has correctly identified the relevant property by claiming that '$P_1 \vee P_2 \vee \ldots \supset Q$' is a law. Fodor claims that "[f]unctionalists are required to deny that pain is *identical to* the disjunction of its realizers. The reason they are is that the functional property realized, *but not its physical realizer*, is projectible" (Fodor 1997, 155). However, Fodor cannot argue that '$P_1x \vee \ldots \vee P_nx$' and '*M*' cannot be coreferential because the latter but not the former is projectible when the argument for the claim that '$P_1x \vee \ldots \vee P_nx$' is unprojectible relies upon the claim that '$P_1x \vee \ldots \vee P_nx$' and '*M*' cannot be coreferential.

Considerations concerning kindhood and projectibility thus provide no reason why (bi)conditionals in terms of disjunctive designators cannot serve as bridge-laws in psychophysical reductions. Together with the failure of the *Explanatory Response* this at least suggests that the *Disjunctive Move* is still a live option for those seeking to make the multiple realizability of mental properties compatible with the possibility of psychophysical reductions.

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