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# Can Any Sciences Be Special?

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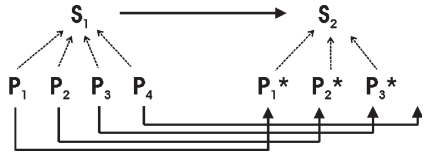
## INTRODUCTION

Non-reductive physicalism accepts the primacy of the physical while aiming to avoid the constraints of traditional reduction. It respects physicalism via the doctrine that all properties metaphysically supervene on physical properties. It avoids traditional reduction via the thesis that many properties cannot be type-identified with physical properties.

The viability of non-reductive physicalism has been extensively discussed over the half-century since it was first explored by Putnam (1960, 1967) and Davidson (1970). Most of the debate has focused on whether non-reductive physicalism can accommodate non-physical *causes* (cf Kim 1993; Robb and Heil 2003: sect 6.) However, there has been far less discussion of whether non-reductive physicalism can accommodate non-physical *laws* (though see Block 1997; Kim 1992; Macdonald 1992; Millikan 1999; Papineau 1985, 1992). In this chapter I wish to focus first on the issue of non-physical laws. This will turn out to cast some useful light on the question of non-physical causation.

Not all non-reductive physicalists think that there are non-physical laws. Davidson, for example, does not (1976). Even so, it is widely supposed that there can be laws in 'special sciences' like biology, psychology, and economics even though their categories do not reduce to physical types. The *locus classicus* for this position is Fodor's 'Special Sciences' (1974). Fodor made his analysis graphic in what must be the most-reproduced diagram in philosophy.



The idea is that $S_1$ and $S_2$ are special kinds. $S_1$ -> $S_2$ is a special law. Thus $S_1$ might be an increase in demand for some good, and $S_2$ an increase in price. $P_1$, $P_2$, . . . are the different physical ways that $S_1$ might be realized, and $P^*_1$, $P^*_2$, . . . different physical ways in which $S_2$ might be realized. (Thus think of all the different physical systems that can underpin economic exchanges—all the different kinds of monetary and non-monetary forms of exchange.)

Realization should here be understood in terms of metaphysically necessary supervenience: $P_1$ realizes $S_1$ in the sense that it is metaphysically necessary that any system that has $P_1$ will have $S_1$. At the same time, not every system that has $S_1$ will have $P_1$, or any other physical kind, since there are always other physical ways ($P_2$, . . .) in which $S_1$ can be realized. This is why $S_1$ is not type-reducible to any physical kind, even though it metaphysically supervenes on the physical facts.

At the physical level, the different realizers of $S_1$ generally give rise to realizers of $S_2$. Thus, when $S_1$ is realized by some $P_i$, this will instigate physical processes that give rise to a $P^*_i$, which in turn then determines $S_2$. These physical processes are thus consonant with the special law $S_1$ -> $S_2$.

A $P_i$ -> $P^*_i$ link need not hold in every single case. Some of the $P_i$s that realize $S_1$ will fail to give rise to a $P^*_i$ that determines $S_2$. This is why, according to Fodor, the laws of the special sciences only hold *ceteris paribus*. The physical shadowing of the $S_1$ -> $S_2$ law will not be perfect, and so the law will have exceptions.

## SPECIAL LAWS IN QUESTION

I have always been puzzled by Fodor's picture of the special sciences (Papineau 1985, 1992). Here is the obvious worry. If the realizations of $S_1$ are all so physically different, then how come they all give rise to a similar result, namely, some physical state that determines $S_2$? Will it not be an unexplained coincidence that they should all display this common result? Unless more can be said about what ties the $P_i$s together at the physical level—as would be provided by a traditional reduction—will the variability of the $P_i$s not undermine the idea that $S_1$ is regularly followed by $S_2$?

Here is an example that will illustrate the point (cf Papineau 1993: ch. 2.) Suppose we find some initial evidence that people who eat reheated Brussels sprouts ($S_1$) come to suffer from inflamed knees ($S_2$). However, when we investigate this phenomenon, we find that there is no common feature that accounts for this syndrome. Rather, in one case the sprouts harbour a virus ($P_1$) that infects the knees ($P_1$*). In another the sprouts contain a high level of uric acid ($P_2$) that leads to gouty attacks ($P_2$*). In a third the sprouts involve some toxin ($P_3$) that depletes the cartilage that protects the knee joints ($P_3$*). And so on.

This story doesn't hang together. It beggars belief that reheated Brussels sprouts should always give rise to inflamed knees, yet the physical process that mediates this should be different in every case. Surely either there is some further feature of the sprouts that can explain why they all yield the same result, or we were mistaken in thinking that there was a genuine pattern in the first place, as opposed to a curious coincidence in our initial sample of cases.

Yet this looks just like the picture that Fodor is inviting us to accept for special scientific laws. So I am inclined to say just the same about Fodor's picture. Either there is something more to say about why $S_1$ should always give rise to $S_2$, or it can't be a genuine pattern to start with.

Does it help that Fodor's special science laws are only supposed to be *ceteribus paribus* and not strict? Not really. Note that the puzzle about the reheated Brussels sprouts leading to inflamed knees doesn't depend on this being an invariable pattern. In the absence of a uniform explanation, it would be just as puzzling if *most* people who eat reheated Brussels sprouts get inflamed knees—or even if reheated Brussels sprouts merely *raises the probability* of inflamed knees. Any such correlation would seem to call for a uniform explanation. It would be mysterious that reheated Brussels sprouts should so much as increase the probability of inflamed knees, if the mechanism were different each time it did so.

Some readers may wonder whether an analytic functionalist account of special science concepts can resolve the puzzle. Analytic functionalism defines concepts in terms of causal structures. Thus it might be definitionally required that something only counts as an '$S_1$' if it gives rise to an $S_2$. For example: something might only count as a 'pain' if it leads to efforts to avoid the source of the pain; something might only count as 'inflationary pressure' if it generates a fall in the value of money, and so on. Given this kind of definition, it will scarcely be a surprise if many different physical kinds $P_i$ realize $S_1$ and yet all give rise to a $P_i$ * that determines $S_2$. After all, if they did not do this, then they would not count as realizations of $S_1$ in the first place. Something that doesn't generate avoidance behaviour just isn't a 'pain'; something that doesn't lead to a fall in the value of money isn't an 'inflationary pressure'; . . . So, given this, it will be inevitable that all $S_1$s will lead to $S_2$s, notwithstanding their variable realization, for that's what it takes to count as an '$S_1$'.

Unfortunately, nothing in this line of thought helps explain variably realized special science *laws*. It may explain how definitional truths can be variably realized, but that is a different matter. Genuine laws can be expressed by synthetic statements with the antecedent definitionally independent of the consequent, as opposed to the analytic truths that result when '$S_1$' is defined as a precursor of $S_2$. And that is precisely why there is a puzzle about their variable realization. Given that the antecedent circumstance $S_1$ in a genuine law can be identified independently of whether it produces the consequent $S_2$, we expect there to be some further account of why such $S_1$s are always (or at least

unusually often) followed by $S_2$s—and that is what the variable realization seems to preclude.

## KINDS OF KINDS

Despite the points made so far, it may seem that there cannot really be a problem about variable realized laws as such. After all, surely there are plenty of familiar examples of such laws. What about the law that a temperature of 100°C will make water boil? Are there not many different molecular movements that can realize a water temperature of 100°C? Yet clearly there isn't any puzzle about why water boils in all these cases.

But this is a different kind of set-up. To see why, we need to be a bit more explicit about the idea of 'variable realization'. For a category S to be variably physically realized, it isn't enough that the instances of S display *some* differences at the physical level. We wouldn't want to say that being square, say, is variably physically realized just because different square things have different masses. Nor should we say that being in pain is variably physically realized just because different people have different-sized C-fibres. For a category S to be genuinely variably realized, the requirement is not the weak demand that there be some physical differences between the Ss, but rather that there should be *no* physical property that is peculiar to them. The members of a genuinely variably realized kind will share no physical property that is not also shared with non-members.

With temperatures, there is, of course, just such a common physical property. All samples of water at a given temperature have the same mean molecular kinetic energy, notwithstanding any further differences between the specific motions of their constituent molecules. And that, of course, is why there is no puzzle about why water boils at 100°C. Despite the different molecular motions involved, all water at 100°C shares the same mean molecular kinetic energy, and this allows a uniform physical explanation of the boiling. By contrast, if there is no common physical feature to some category, then there is no room for such a traditional type-type reduction of any patterns it enters into.

Might Fodor just be saying that special science categories are like temperature? That is, might he simply be pointing out that there can be physical differences between different instances of some special type, like an increase in demand for some good, just as there are differences between different samples of water at 100°C, and that this is consistent with their having some physical commonality that will explain why they fit into some uniform pattern?

But this suggestion is not consistent with other claims Fodor makes. Thus consider his original response to the obvious query raised by his diagram: why isn't the disjunction $P_1$ v $P_2$ v $P_3$ . . . a physical property with which $S_1$ can be type-identified, thereby yielding a traditional physical reduction of $S_1$? Fodor's

response is that even if we can formulate this disjunction, it will not represent a genuine physical *kind*, as opposed to a heterogeneous collection of different physical kinds. Correspondingly, even if we can write down the generalization $P_1$ v $P_2$ v $P_3$ . . . -> $P_1$* v $P_2$* v $P_3$*. . . , this won't constitute a genuine physical *law*, as opposed to a representation of a bunch of different physical processes. There is, of course, an element of circularity here, in that the standard explications of kinds is that they are categories that figure in genuine laws, while the standard explications of laws are that they are patterns that involve genuine kinds. But any such circularity does not affect the point currently at issue, which is that Fodor is explicit that there is no single physical kind that characterizes all instances of his special Ss.

## A DILEMMA FOR FODOR

Given the points just made, the challenge facing Fodor can be put in the form of a simple dilemma. If the realizations of special $S_1$ and $S_2$ are genuinely variable and don't form kinds, then doesn't this immediately imply that the empirical generalization $S_1$ -> $S_2$ will not be a law, but rather a collection of heterogeneous processes? Alternatively, if the realizations of $S_1$ and $S_2$ do form kinds, doesn't this mean that $P_1$ v $P_2$ v $P_3$ . . . -> $P_1$* v $P_2$* v $P_3$*. . . will be a genuine law that constitutes a traditional reduction of $S_1$ -> $S_2$? (Cf Kim 1992.)

Fodor responds to this putative dilemma in his splendidly named 'Special Sciences: Still Autonomous After All These Years' (1997). He argues that the dilemma begs the question. True, he allows, special categories are not identical to *physical* kinds, and so any generalizations involving them will not be *physical* laws. But that's not decisive, he insists. For it is still possible that these categories constitute *special* kinds, in virtue of entering into *sui generis special* laws. Fodor takes it to be a datum that psychology, economics, and the other special sciences contain genuine laws covering categories that can't be type-reduced to physics. Given this, he concludes that the categories of such sciences are *kinds* all right, in virtue of entering into these special laws. From this perspective, the Brussels sprouts example is misleading: it appeals to our intuitive knowledge that there is no real law in the case and that *reheated Brussels sprouts* is thus not a medical kind. By contrast, Fodor suggests, in areas where there are real laws covering physically heterogeneous categories, like psychology and economics, we have every reason to ascribe kindhood to those variably realized categories.

At first pass, this response may seem reasonable enough. There is no immediate reason why the only laws of nature should be physical laws. After all, it is clearly consistent with supervenience physicalism that there should be a finite few cases in which, say, eating reheated Brussels sprouts leads to inflamed knees via disparate physical processes. So there can scarcely be any outright

contradiction in supposing that such a variably realized pattern should be repeated indefinitely.

However, note that special categories do not just enter into laws connecting them with other special categories. They are also systematically related to *physical* categories. For example, a drought in cocoa-producing areas will raise the price of chocolate. Economic growth without environmental regulation will lead to an increase in atmospheric $CO_2$. And so on. (Indeed, such interaction is surely part of the underlying rationale for physicalism: if special categories did not interact causally with physical ones, there would be no reason for supposing that they must supervene on the physical realm to start with (Papineau 2002: ch 1).)

But this now reinstates the dilemma once more. If special categories are going to feature in physical laws, then does this not mean that the disjunction of their physical realizations itself will need to be a physical kind? As before, there is clearly something wrong with the idea of a *physical* law that is variably realized at the *physical* level. If kinds are categories that feature in laws, then the special categories that feature in physical laws will need to be type-identical with physical kinds.

We can make the point graphic by considering situations where a variably realized special category has some uniform physical cause and physical effect. For example, if a human's arm is immersed in ice-cold water, this will engender pain, and this will lead the human to remove their arm from the water. But now suppose that the category of human pain is not physically reducible. Then there will be quite different physical processes mediating between the initial physical cause and the final physical effect. What then ensures that all these different intermediary processes converge on the same final effect? It is not as if the pain exerts some independent causal influence to bring this about—that would require interactive dualism and 'causal gaps' in the physical realm. Rather, the causal influence of the pain in each instance is exhausted by the causal influence of its physical realization. But then we seem to be left with a mystery. The initial cause, the freezing water, generates a divergent range of intermediary neurological effects, but then these inexplicably converge on the same physical result, removal of the arm from the water.

## METHODOLOGICAL ISSUES

So far my argument has proceeded on an abstract metaphysical level. But if it has any substance, some definite methodological implications must follow.

Fodor's terminology of 'autonomy' suggests that the special sciences will be threatened as independent academic disciplines if their categories are reducible to those of physics. The thought is that type-reduction would mean that any special laws would simply be special cases of the physical laws that reduce

them, and the special sciences therefore little more than sub-departments of physics.

But is this a serious worry? There is, of course, a sense in which the reducibility of some special science means that it is not independent of physics—in principle its laws will follow from physical laws. But this in-principle possibility need have no practical implications. For the in-principle derivability may be practically unfeasible, in which case the reducibility of the special science will make no methodological difference to its practitioners. They will still proceed to investigate the relevant special laws using direct empirical evidence. This is surely how it goes in many science departments. Nobody doubts, I take it, that chemical, meteorological or geological laws have uniform physical explanations. But at the same time nobody tries to derive these laws from basic physics, at least once we are dealing with systems more complex than the hydrogen atom. Instead, special scientists investigate the relevant complex systems directly, using observation and experiment to ascertain the laws they obey—which is why we have separate chemistry, meteorology and geology departments in universities.

My methodological concern is the opposite of Fodor's. I am not worried that the special sciences will be undermined if they are reducible to physics. My concern is rather that they will be undermined if they are *not* reducible to physics. The argument so far suggests that only physically reducible categories can enter into genuine laws. If special sciences need laws, physical reducibility will therefore be a precondition of special sciences. This reducibility need make no methodological difference to the practice of the science, for the reasons just given. But there had better *be* a type-reduction, at the metaphysical if not the methodological level, otherwise there will be no laws to investigate empirically.

Many philosophers take it to be obvious that special categories cannot be type-reduced to physical categories. If this is right, the argument so far suggests that there will be no special laws. The non-reducibility will ensure all the autonomy Fodor could wish for. But it looks as if the special sciences will have nothing left to study.

## SELECTIONAL PATTERNS

There is a gap in my argument so far. As a number of writers have observed (Block 1997; Macdonald 1992; Papineau 1985, 1992), one possible explanation for variably realized laws involving physical kinds is that they are the result of *selection processes*. Consider this example. In all electrical hot water heaters, the current is switched off at some temperature below boiling point. But when we look at the physical process that mediates between the high temperature and the switching off, we find that it is different in each case. Each heater contains a thermostat, but there are many different kinds of thermostat, each using

different physical components in different combinations (including bimetallic strips, expansion gases, mercury bulbs, and thermocouples).

Given this, we can imagine someone asking why so many different physical processes should all lead to the same effect—namely breaking the circuit. If there is no uniform physical explanation for this commonality, is it not a mystery that all the divergent effects of temperature increases should converge on this single effect?

But of course in this case there is an obvious answer. All these different physical processes were *designed* to produce the same effect. The people who construct heating systems make sure they contain a thermostat. They want a device that will shut off the current when the temperature gets too high, and any of the different thermostats on the market will serve for this purpose. That's why we can have a genuine law with physical antecedent and consequent even though the intermediate process is variably realized. Designers want the antecedent to produce the consequent and there are different ways of achieving this.

I have illustrated the point with an example of human design, but the point generalizes. There are other selection processes in nature apart from conscious design by intelligent agents, such as the intergenerational selection of genes, or the selection of cognitive and behavioural elements in the course of individual learning. These selection processes can also give rise to variably realized laws.

Take the paradigm of a putatively variably realized special scientific category—*pain*. It is widely supposed that pain is variably physically realized across different life forms, yet nevertheless enters into laws mediating between physical causes and effects, such as the law that bodily damage gives rise to pain and the law that pain in turn leads to avoidance of the source of the damage. Here, too, there would be an obvious answer if someone asked why all the disparate physical processes caused by bodily damage have the same effect. Natural selection favours organisms that have *some* mechanism that mediates between bodily damage and the avoidance thereof. It doesn't care too much about how this is done. Or, to speak less metaphorically, natural selection will foster any mechanism that plays the pain role within a given species. This is why pain mechanisms can be different across different species, yet all underpin the same damage-avoidance law.

Here is another example. Animals who maintain individual territories will respond to the presence of conspecifics with some territorial display that makes the invaders retreat. Here there is a regular antecedent–consequent pattern—invasion followed by retreat—but the displays that play the intermediary role on this pattern will vary widely from species to species. But once more the explanation is clear enough—natural selection will encourage any display that plays this role, even if it is different from species to species.

We can expect something similar at the level of individual psychology. Grown-up human beings in the West respond to untied shoelaces by tying them. Yet

they have different ways of doing this, whose only common feature is that they get the shoelaces tied. How do all these different responses to untied shoelaces produce the same effect? Again the answer is obvious enough. Humans learn in large part by trial and error. If by chance they light on some behaviour that produces a successful result, then they will persist in this behaviour. That's why different humans end up with different ways of tying shoelaces. Learning ensures that they will find some way of doing the job, but doesn't mind exactly how they do it.

Many other examples offer themselves. Most mature humans will have some way of recognizing and thinking about common objects (cats, dogs, telephones, bicycles) but there is no reason to suppose that they use the same brain states to achieve this. Most mature humans will have some technique for solving common intellectual problems (numerical addition, planning tomorrow's activities, balancing their budgets) but these will vary across individuals. Most mature humans will have some way of putting others at ease, but they won't all do this in the same way. And, in general, people with shared ends will generally work out some way of achieving their common aim, but will light on different means of doing this (cf Millikan 1999).

In all these cases, the variability of the means that lead to some given result can be explained by selection processes operating during individual development. Humans and other complex animals are learning machines. They embody a hierarchy of processes that operate at many different levels to preserve items that produce such-and-such effects. These items may well be physically different in different individuals, but this won't matter to the selection mechanisms, provided they produce the reinforcing effects. So the means by which the effects are produced will be variably realized at the physical level across different individuals.

## SPECIAL SCIENCES

Do these kinds of selection-based patterns vindicate the possibility of 'special sciences' in the sense of sciences whose categories are variably realized at the physical level?

One possible worry is that the kind of selection-based patterns described in the last section are not precise enough to count as laws. After all, pains don't always lead to avoidance of the source of damage, territorial displays don't always succeed in repelling invaders, and untied shoelaces don't always get tied. These regularities look more like rules of thumb than anything worth dignifying with the name of 'law'.

I don't think this is a decisive consideration against the possibility of 'special sciences'. It may be some reason for withholding the terminology of 'laws', but there are surely plenty of sciences in good standing whose laws need to

be understood probabilistically or as *ceteris paribus* claims. This was why the problem I originally posed for Fodor's picture was not how there can be strict exceptionless special laws, but rather how there can be so much as projectible correlations involving variably realized kinds. And the selection-based patterns from the last section certainly amount to projectible correlations. They carry information about as-yet unobserved cases, and they support counterfactuals. (Any damaged animal will respond by avoiding the source of the damage; if some animal were damaged, it would avoid the source of the damage . . .) These projectible patterns may be a lot less precise than the fundamental laws of physics, but they still display the characteristic properties that distinguish genuinely projectible patterns from merely accidental regularities.

However, selection-based patterns arguably fall short of the requirements for a genuine 'science' in a different respect. Paradigm examples of natural kinds enter into *lots* of laws, not just single ones. For paradigm natural kinds, we can project a wide range of properties. Thus, chemists can study many properties of gold: its density, colour, melting point, electrical conductivity, and so on. And this hinges on the fact that all samples of gold have a uniform physical realization. It is precisely because all gold has the same atomic structure that there are many different further features that all samples of gold have in common.

The point is not restricted to basic chemical kinds, but applies to any kind with a uniform physical realization. For example, there are many general truths about chickenpox: its gestation period, characteristic symptoms, ease of transmission, susceptibility to various drug treatments, and so on. Again, it is because of a common structure at the physical level that we are able to assume that all these different features will hold good across different instances of chickenpox.

This kind of multiple projectibility will not apply to the variably realized kinds that enter into selection-based patterns. Take pain, considered as a category that is variably realized in different species. This enters into the law that pain leads to damage-avoidance, as this is part of the role for which pain mechanisms are selected. But there is no reason to expect that the category of pain will enter into any further laws. Thus there won't be any cross-species laws about the sensitivity of pain mechanisms to stimuli, their susceptibility to analgesics, or the time it takes pains to abate. Precisely because the physical basis is different, such things will vary across different species.

The same point applies to other variably realized categories. There is no cross-species science of territorial behaviour, nor any cross-person science of shoelace-tying or bicycle-recognition. And this is precisely because these categories are variably realized. We can say that, in general, territorial behaviour will tend to repel invaders, but the fact that different species repel invaders in different ways blocks any other generalizations about territorial behaviour as such. The same goes for shoelace-tying and bicycle-recognition. We know that all normal people

can do these things, but there are no further general facts about the means they adopt, precisely because the means vary across individuals.

We can emphasize the point by comparing variably realized categories with some of their more specific instantiations. Take human pain, as opposed to cross-species pain. Given that it seems highly likely that this has a uniform realization across humans,[1] it makes perfect sense to investigate the many properties of human pain as such (sensitivity to stimuli, effective analgesics, and so on). Again, there would seem to be no barrier to a complex of laws about the territorial displays of some particular bird species—goldfinches, say—covering triggers to aggressive behaviour, song patterns, seasonal variation, and many other things. Here, too, there are many laws because the physiological basis of the behaviour is presumably constant across robins. There could even be a range of general truths about a particular individual's shoelace-tyings or bicycle-recognitions, given that there is likely to be a uniform physical basis for these abilities within any given individual.

Biologists distinguish between *analogous* and *homologous* traits. Analogues are independently derived products of convergent evolution that serve a common purpose, like the wings of insects and birds. Homologues are traits that share a common descent, even if they now serve divergent functions, like the flippers of seals and the hands of humans. The last few paragraphs explain why homologous categorizations are standardly taken more seriously by biologists than analogous ones (cf. Brigandt and Griffiths 2007). Analogues do enter into common patterns, but they are once-off selection-based patterns. Both insect and bird wings lead to flight, but beyond that there is not much they have in common, because they have no common underlying physical basis. Homologues, by contrast, will be physically similar, even if they serve divergent functions, and because of that they will share a wide range of further developmental, structural and other similarities.

## HUMAN SCIENCES

Where does this leave human sciences like psychology, economics, and political science? Does the fact that variably realized categories fail to underpin multiple laws undermine these disciplines' claims to science?

A first point to make here is that we should not take it for granted that the human sciences are *special* sciences, if this is understood as meaning that their kinds are variably realized at the physical level. For it seems highly likely that many of the categories that matter to these sciences are uniformly realized at

[1] Remember that this doesn't mean that there are *no* physical differences between individuals' pain mechanisms—just that there is enough physical commonality to yield uniform physical explanations of patterns involving pain.

the physical level *within* humans, even if they are variably realized across other species.

I have already made the point in connection with human pain. There is every reason to suppose that the pain mechanism is uniformly realized across humans, and that as a result there will be a rich nexus of laws about human pain. The same applies to many other cognitive abilities. Sensory mechanisms in general are uniformly realized across humans, which is why there is a substantial set of laws about human perception. The basic mechanisms that underpin human learning are physically similar across humans, which is why we have a wide range of generalizations about human learning as such. Again, it seems plausible that the basic mechanisms of reasoning—the processes that govern interactions between learned and other cognitive states—will be uniformly realized in all humans, and that here again we can expect a serious collection of generalizations about human reasoning.

It should not be supposed that the only attributes that are uniformly realized in humans are those that are genetically determined. Many of the physically uniform processes that occur in human ontogeny will hinge on interaction with environments as well as on common genetic endowment. (This may well include interaction with other humans as well as with the physical environment.) The question at issue is whether the overall developmental process produces a uniform physical structure, not whether this structure is determined by the human genome on its own.[2]

To the extent that human categories are uniformly physically realized, then, they will function as scientific kinds in the fullest sense. There will be a wide range of projectible general truths about various facets of human pain, human vision, human learning, and human reasoning, etc. (Indeed, to the extent that the physical basis for these mechanisms is shared with other mammals, as with many sensory abilities and some basic forms of learning, much of this range of projectible generalizations will carry over to these cases too.)

Still, many human sciences go beyond matters that are uniformly realized within humans. Maybe certain branches of psychology restrict themselves to processes underpinned by physically uniform mechanisms. But many other human sciences aim beyond this. Such subjects as economics, sociology and even social psychology do not just study sensory and other basic cognitive mechanisms. They also aim to generalize about the varied products of these mechanisms, including many of the different things that people learn about and subsequently reason over.

[2] Some philosophers explicate 'innate' as 'a product of normal development that is not due to learning' (Samuels 2002). If we assume that the products of learning are generally not uniformly physically realized, for reasons indicated in previous sections, then anything that is physically uniform across humans will need to be 'innate' in the suggested sense, since not due to learning. However, it is highly controversial whether 'due to normal development but not learning' is a legitimate reading of 'innate' (Mameli and Papineau 2006).

For instance, economists will generalize about the way people buy more when the price goes down, sociologists about the way that dispersed empires keep bureaucratic records, social psychologists about the way that people recognize and defer to authority. And here things will work differently. The patterns observed in such cases will not be the manifestation of common physical structures, but of similar selective pressures operating in different contexts. The humans involved will have been shaped to achieve the same results, but they will often have different ways of doing so. There are different ways of buying more of a product, of keeping bureaucratic records, of identifying people who wield authority, and so on. And this will limit the range of general truths we can expect to find in such cases. We might be confident that certain categories of people will all have some way of achieving some end, but characteristically there will be little to say about the many idiosyncratic ways in which they achieve this.

Does all this mean that the human sciences are not really *sciences* in the full sense? I don't think that this is a particularly fruitful question to press. As we have seen, the subject matter of the human sciences contains both physically uniform cognitive mechanisms and variably realized selectional categories. Correspondingly, some human kinds will enter into a thick nexus of projectible laws and others into a few thin selection-based laws. Once we are aware of this, there seems little point in continuing to ask whether economics as a whole, say, is a 'science'. The answer is that it resembles a paradigm science like chemistry in some respects, but not others.

The more interesting issue is to discover how much of the human sciences is grounded in uniform physical mechanisms and how much depends on common selectional pressures. I have been writing as if the dividing line is reasonably clear-cut, but on reflection it is by no means obvious where it lies. This is because the subject matter of the human sciences is largely constituted by human cognition, and the role of learning and other selective processes in the ontogeny of human cognition is a highly disputed matter. I would say that this should be a central issue for those thinking about the methodology of the human sciences. If we want to know about the kind of general truths we can hope to find in the human sciences, it is crucial that we work out which might rest on uniform physical mechanisms and which are the products of selection.

## MORE AND LESS PRECISE CAUSES

I turn now to the question of whether special properties—that is, properties that are not identical to physical properties—can be causally efficacious. This issue has received a lot more attention in the literature than the possibility of non-reduced special laws. The discussion of laws so far in this chapter will cast some new light on the issue.

I shall assume that causes are in some sense property-involving. This will be true if causes are facts, or 'Kim-events', or even if they are Davidsonian-events, that enter into causal relations in virtue of some of their properties (see Papineau 2007: section 1.4.) The differences between these views will not matter for the arguments that follow. I shall talk henceforth as if causes are facts.

The problem facing special causes is that their physical realizations threaten to pre-empt them as causes. According to the causal completeness of the physical realm, every physical effect has a full physical cause (insofar as it has a cause at all). But if special properties are not type-identical to physical properties, then it is difficult to see how facts involving them can be identified with those physical causes,[3] and this argues that they are not themselves causes of those physical effects. And if this is so, then they will also be disqualified as causes of any facts that so much as supervene on the physical facts, for a cause of any such supervenient fact must surely proceed by causing the physical realization which determines that supervenient fact.

Sometimes this worry is raised unnecessarily. For example, it is sometimes suggested that the temperature of 100°C cannot be the cause of the boiling, because it is out-competed as such by the specific molecular movements. (The property of being at 100°C cannot be type-identified with the molecular movements, since other volumes of water will share the temperature property but have different molecular movements.) However, the natural answer here is to insist that the 100°C temperature is a perfectly good cause in its own right, given that it is a uniform physical kind that enters into the paradigm physical law that water at 100°C (at standard pressure) commences to boil.

We should not assume that, whenever some category is variably realized at some more precise physical level, as here with temperature and molecular movements, that the more precise physical facts will always outcompete the general property as the cause of any physical effects. There seems to be no good basis for this assumption. The metaphysical constitution of the causal relation is not well understood, but there is good reason to suppose that it is constituted at the level of thermodynamic phenomena, rather than at the level of the basic dynamics of fundamental particles. After all, causation has a preferred direction in time, which is true of thermodynamic processes, but not of basic dynamical ones. If this is right, then there will be a level of physical precision—the level of temporally symmetric basic dynamic processes—where causation disappears, so to speak. Clearly, precise physical facts at this basic level will not eclipse more general supervenient physical facts as causes. So we cannot, in general, assume that the more precise physical facts will always causally outcompete more general ones.

We might wonder, given the point just made, whether the vindication of a more general cause as the cause of some physical effect—such as the 100°C and

[3] But see Macdonald and Macdonald 1986, 1995.

the boiling—will always eclipse the more precise fact—the specific movements of the water molecules—as a cause of that effect. I have no view on this matter. Maybe there is a good argument that will establish this point. In the example at hand, it is certainly not out of the question to hold that the particular molecular movements do not cause the boiling—after all, the water would have boiled just as well even if the molecular movements hadn't been the same, provided the temperature was still 100°C. But in what follows I shall not assume that there must only be one cause in such cases. I shall leave it open that both the temperature and the molecular movements can happily qualify as causing the boiling.

## VARIABLY REALIZED CAUSES

I say that the temperature counts as a cause because there is a physically uniform law connecting it to the boiling. In this case, then, the causal efficacy of a variably realized category derives from the presence of a uniform physical law connecting it to the effect. But what of those special categories that are not uniform physical kinds, such as cross-species pain, or deference to authority, or increases in supply? Can they be causally efficacious, even though they do not enter into uniform physical laws?

Much of the recent literature has been distracted from this issue by worries about overdetermination. Kim has insisted that it is unacceptable to have a physical effect caused by both a variably realized kind and its realizer (see Kim 1993). Orthodox non-reductive physicalists have retorted that this kind of 'overdetermination' is perfectly benign, due to the intimate connection between the kind and the realizer, and not to be conflated with real overdetermination by two genuinely distinct causes, as when someone is simultaneously shot and struck by lightning (Bennet 2003).

But this orthodox answer does not yet address the prior question of what qualifies the special fact as a cause of the physical effect in the first place. Let us allow that there would be nothing wrong with the 'benign overdetermination' of physical effects by both special causes and the physical realizations. Still, why count the special fact as a cause at all? In the case of the variably realized 100°C, we had a uniform physical law connecting the temperature with the boiling. But with variably realized special facts, there will be no such uniform physical law, precisely because they are variably realized at the physical level.

If pressed on this question, most non-reductive physicalists would probably respond that the special fact qualifies as a cause in virtue of relevant counterfactual truths—if I hadn't felt a pain, I wouldn't have pulled my hand out of the fire. But, notwithstanding all the recent enthusiasm for counterfactual theories of causation, it is by no means clear that the mere truth of such a counterfactual is sufficient to vindicate a special fact as a cause.

Consider this case. Let us define 'ricketiness', in a car, as present if some of the parts that are supposed to be joined together become disconnected. Now suppose that my car is rickety because the wire that joins the ignition to the starter motor is broken. The general property of ricketiness, that is present in any car with any disconnected parts, is here realized by the broken ignition wire. As a result my car does not start. Now it is true that if my car were not rickety, it would start. If it were not rickety, the ignition would still be connected to the starter motor. But does the ricketiness per se cause the non-starting?

It is easy to misread this question. On one understanding of 'ricketiness', it refers to the specific realizer property that is present in this case, of having a broken ignition wire. And it is certainly true that this realizer property causes my car not to start. But that is not the issue. The question is whether the variably realized role property caused the non-starting—that is, the property that is shared, not just by cars with broken ignition wires, but also those with loose door handles, faulty boot locks, and so on. And, once we have this question clearly in focus, a positive answer seems implausible. Surely it's not the ricketiness per se that stopped my car from starting. Plenty of cars are rickety, yet start perfectly well. What stops my car from starting is not that it has *some* part disconnected, but the more specific fact that the ignition wire is disconnected.

What seems to be needed, then, is some kind of general connection between the special fact and the relevant physical effect, over and above the special fact's supervening on a physical cause of the effect. If the (cross-species) pain stands to my arm movement merely as my car's (role) ricketiness stands to the non-starting, then there does not seem to be a good case for counting it as a cause of my arm movement.

## THE CAUSAL IRRELEVANCE OF SPECIAL LAWS

I suspect that many philosophers are persuaded implicitly to think of the (cross-species) pain as a cause of the arm movement because they know that there is a law connecting pains with arm movements. It's not just that my pain is realized by a physiological process that causes my arm movement. It is also a general truth, holding across species, that pain leads to removal of the relevant body part from the source of the damage. This marks a contrast with the ricketiness example. It is not generally true, across rickety cars, that ricketiness leads to non-starting. So this makes it plausible to think that the pain is more seriously connected with the arm movement than the ricketiness is with the non-starting.

However, I don't think that this line of thought will serve to vindicate the pain as a *cause* of the arm movement. True, there is a serious empirical law connecting the pain with the arm movement. But the trouble is that it is a selection-based law. And on reflection it seems clear that this kind of variably realized selection-based law is the wrong kind of connection to ground a causal relation between the

pain and the movement. Think about the aetiology of the law. Biological natural selection favoured different pain mechanisms in different life forms *because* these different mechanisms all had the right causal profile—they were activated by damage and gave rise to avoidance. The selection-based law was thus an upshot of the causal powers of the different pain mechanisms. Given this, it would seem odd to regard it as grounding some further causal powers. It's not as if the cross-species category of pain is constituted as a cause of avoidance movements in virtue of its role in the selection-based law. Rather, the law was cobbled together by natural selection, so to speak, because all the different realizations of pain already had just the right causal qualifications.

The point generalizes to the many variably realized special categories that enter into selection-based laws. These laws will mean that they are generally followed by specific effects, and to this extent they will be distinguished from categories like ricketiness, which isn't per se generally followed by non-starting. But this by itself doesn't seem to warrant counting these special categories as *causes* of the relevant effects, any more than we should count the ricketiness as the cause of the non-starting. The selection-based laws are based on pre-existing causal powers, and don't add to them.

All in all, I'm inclined to conclude that non-reduced special kinds are not causes. Even if they are connected to their putative effects by selection-based laws, they are not really different from ricketiness. They range over cases with quite different causal structures. The selection-based laws are a red herring. They are not the kind of laws that can constitute anything as causally efficacious.

Of course, this point can be obscured, as with ricketiness, if we read terms like 'pain' as used in a specific context as referring to the physical property that realizes the pain role in that context—that is, as referring to the physical property that uncontentiously causes the arm movement. In fact, I am quite open to the thesis that this is the most natural way to understand 'pain' talk. (After all, given the argument of this section, this is the only way to have 'pains' causing behaviour, so to speak.) But the point remains that the role property per se does not cause the behaviour.

A related point is that a special property can well be causally explanatory even if it is not causally efficacious (see Jackson and Pettit 1990). I would say that all explanations of particular facts need to mention the cause of those facts. But you can mention a cause without explicitly citing the property that makes it causally efficacious. Now, not all such indirect mentions of causes will be explanatory. It is not explanatory to say that X was due to the cause of X. But some indirect mentions of causes certainly are explanatory. Thus I might explain the high temperature of the room by reference to the setting on the thermostat, the improved performance of my car by its new carburettor.

It is plausible that explanation is related to prediction and causal control, and that therefore explanations need to cite properties that fit into laws—even if those cited properties themselves are not causally efficacious. Variably realized

properties that enter into selection-based laws would seem to fit this bill perfectly well. These laws may not display the substance of the relevant causes, but they serve well enough to indicate what consequences to expect and how such things might be brought about. This is why, in addition to explanations citing artefacts, we find explanations citing all the other kinds of variably realized categories that enter into selection-based laws. Her shoes aren't loose because she has learned how to tie her laces. He pulled his arm away because he felt a pain. Falcons detect prey with their excellent eyes. And so on.

## CONCLUSION

Let me sum up briefly. Non-reduced special kinds cannot play a role in full-fledged sciences involving a rich network of laws. Still, selective processes mean that they can enter into once-off laws. However, this is not enough to constitute them as causally efficacious as opposed to explanatory properties.

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