# Inter-theoretic deduction of explanations

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# Inter-theoretic deduction of explanations

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**Abstract.**
The main aim of this paper is to set out an argument for inter-theoretic deduction. My strategy will start with John Heil's claims about reality, truth-maker realism, and the completeness of physics. On this basis, I would like to point out the motivation for inter-theoretic deduction. By contrast, the multiple realization argument suggests the failure of inter-theoretic deduction. However, I shall sketch out a reductionist strategy that avoids these anti-reductionist consequences: Multiply realized property types turn out to be abstract predicates. One can construct within the special sciences more detailed predicates that are co-extensional with predicates that can be constructed within a fundamental physical theory. From these more detailed predicate types the abstract predicates can be deduced. Hence, by means of this strategy, predicates, and thus explanations, are inter-theoretically deducible.

## I. Starting Point

There are no levels of being. There is just one reality. This is ontological reductionism. This is Heil's ontological point of view, and my starting premise. Any property token of the special sciences is identical with a certain configuration of physical property tokens. A property token of the special sciences may be, for instance, to possess yellow blossoms or to be conscious. A physical property token may be to possess a negative charge, or to possess a certain mass. However, a configuration of physical property tokens is a physical property token as well. Such a configuration of physical property tokens is what is intended in most cases when we say that a biological or a psychological property token is supposed to be identical with a physical property token.

There are different theories about the entities that there are in this one reality. In any case, a theory refers to the world by means of predicates. In order to refer to an entity in the world, there are predicate tokens of different predicate types. Let us take "p" as a physical predicate token, and "P" as its corresponding predicate type. Analogously, "b" is a biological predicate token of a biological predicate type "B", and "m" is psychological predicate token of a psychological predicate type "M".

Theories are our epistemological account of the world. To refer to the world by a predicate token is to apply a certain concept. Any reference to some entity by a predicate token is an application of the concept of the corresponding predicate type. To refer to the world in terms of physics is to apply concepts of physics' specific predicate types. These concepts are different from the concepts of the special sciences. However, any concept aims to describe the entity it refers to. Thus, the concept of "charge" is what physicists tell us about charge. So is the concept of "blossoms" or the concept of "consciousness". In this sense, to refer to an entity *e* in the world by a certain predicate token (e.g. "p", or "b", or "m") is to apply a predicate type (concept) to *e*.

Each predicate type has a certain extension. The extension of a predicate type is each and all of the entities in the world that make true an application of the predicate type in question. One may prefer to take property tokens of a certain property type as the truth-makers of a predicate token of a certain predicate type. This raises the question about the relationship between properties and predicates. To avoid the correspondence principle entailed by the picture theory, we should take property types as theoretical classifications (cf. Heil (2003), p. 26). Thus, any *property type* is set of entities that can be referred by predicate tokens of one and the same *predicate type*. I shall take them as such in what follows.

Before we move on, let us consider Heil's truth-maker realism. In the first place, "(w)hen a statement concerning the world is true, there must be something about the world that makes it true" (Heil (2003), p. 61). At least, it is suggested that there is something in the world that really exists and that makes true certain statements about it.1 In the second place, there are *different* true applications of predicates, and thus, there are different concepts about the world. Simplified, there are true physical, biological, and psychological statements about entities in the world. Let us take in the following a 'true predicate' as an abbreviation of a 'true statement', or a 'true application of a concept'. Taking it that there is ontological

1 I should note that my argument for inter-theoretic deduction is not committed to truth-maker realism. But, taking it that there is ontological reductionism, truth-maker realism provides a quite intelligible framework for my further considerations. I shall take it as such in what follows.

reductionism, there have to be entities out there in the world that make true the application of different predicates. One and the same entity *e* might make true a physical ("p"), a biological ("b"), and a psychological ("m") predicate token.

This raises questions about the relationship between different predicates, and hence, between different theories. Since there is ontological reductionism, the truth-maker relation suggests that there are connections between true predicates. After all, predicate tokens of different theories may be about one and the same entity. Thus, one is led to enquire about the difference between these descriptions. This question becomes more urgent if we accept that physics is capable to explain *any* entity in the most detailed manner. This motivates inter-theoretic deduction of predicate types. This is why I shall begin, in section II, with a more detailed consideration about the relationship between physical predicate types, and predicate types of the special sciences.

Subsequent to this, the multiple realization argument for the widely supposed autonomy of the special sciences will be considered in section III. In fact, Heil is opposed to inter-theoretic deduction. This position reflects the debate about the multiple realization argument that can be traced back to Fodor (1974). The conclusion of the argument is that there are no physical predicate types that are co-extensional with predicate types that are about so-called multiply realized property types. On this basis, inter-theoretic deduction seems not to be possible.

But still, I would like to argue for inter-theoretic deduction. My argument is based on both causal, and explanatory considerations. In conclusion, the multiple realization argument does not exclude reductionist approaches to the special sciences. Any predicate type of the special sciences can be deduced, by means of sub-types, from constructed physical predicate types. Outlining this strategy is the aim of section IV.

## II. The Motivation for Inter-Theoretic Deduction

First and foremost, let us consider physics. Subsequent to this, I shall consider in which way the special sciences depend on physics. From this it follows in the end of this section that inter-theoretic deduction is well motivated.

The success of physics motivates a completeness claim for physics. By this is meant that physics is supposed to be complete in causal, nomological, and explanatory respects. At least, physicists take for granted this completeness. I shall take it as such in what follows. However, since my argument for inter-theoretic deduction is mainly based on causal, and explanatory issues, let me consider only these two completeness claims.

First, there is the *causal* completeness of physics. By this is meant that for any entity *e* that can be described by physics, insofar as *e* has a cause, it has a complete physical cause. 'Complete' means physicists would never have to go beyond physical causation even if physical causation is probabilistic. 'Insofar', because it might follow from quantum physics that uncaused changes are possible. Nonetheless, physicists always search for causes *within* physics. In other words, there are no other, non-physical causes that could fill in any gaps that there may be in physical causation. Suppose that causal relations are probabilistic; physics still completely determines the probabilities. Letting aside uncaused changes, physics furthermore provides the best explanation of physical causal relations. To illustrate one case in point, physicists may consider an entity *e* as an atom-configuration. To explain what happens when this atom-configuration changes its structure or its motion, we seek a complete cause within physics. There might be some causal influence by some other atom-configuration or some waves of light for instance.

However, suppose physics turned out to be incomplete in causal respects. As a result of this, physics would be incomplete in explanatory respects as well. There would be physical property tokens with causal 'aspects' that are not explicable in physical terms. Since I shall focus on causal issues, let me take 'explanation' as an abbreviation for 'causal explanation'. Even more precisely, the a detailed true description physics is able to give about the causal aspects of the entity in question is, in virtue of being embedded in the physical theory, a physical *explanation.*

In this sense, an explanatory completeness depends on a causal completeness. If physics were causally incomplete, physics would not completely determine the probabilities of causal relations. Thus, in order to explain physically some physical property token, one would need to go beyond physics and might be obliged to have recourse to predicates of the special sciences.

Keeping this in mind, let me, secondly, outline the *explanatory* completeness of physics in more detail. By this is meant that insofar as there is an explanation of *e*, there is a complete explanation of *e* in terms of physics. 'Complete' means that in order to explain, physicists never go beyond physical predicates embedded in physical theories. Physicists always search for explanations of *e within* physics. If there is no physical explanation of *e*, there is not an explanation in terms of the special sciences either. However, suppose physics turned out to be incomplete in explanatory respects. As a result of this, physics would be incomplete in causal respects as well. At least, this follows if we take an explanation as a *causal* explanation.

Having said this, us recap and term this ‘completeness of physics’. Physics is complete in causal, and explanatory respects. In a simplified manner, if there is a change in physical properties, there is a complete physical cause for this change as well. If there is a complete physical cause for this change, there is a complete physical explanation of the case in question as well, and vice versa (cf. Heil (2003), p. 20). This is obviously quite different in the special sciences. There, predicates about causally relevant property tokens, and hence their explanations, often include physical predicates embedded in physical theories.

Keeping this in mind, let us turn to *types* of predicates. Types of predicates point out what the entities their tokens refer to have in common. Take ontological reductionism for granted. Thus, every causally relevant property token of the special sciences is identical with a certain physical property token. As a result of this, physics can describe every causally relevant property token of the special sciences. In other words, physics can describe these causally relevant property tokens by a physical predicate token. Now, let us suppose that there are some entities that are described by physical predicate tokens of the *same* type. In virtue of being described by predicate tokens of one and the same predicate type, physics outlines what the entities in question have in common. The entities come under the same physical description. In general terms, predicate types outline what the property tokens they describe have in common.

Before we turn to the motivation for inter-theoretic deduction, let me remind you that, by contrast to physics, the special sciences are incomplete in causal and explanatory respects. By this is generally meant that the special sciences often include physical predicates. Nonetheless, I shall take the special sciences to refer to causally relevant property tokens. Thereby, the special sciences are, even if incomplete, somehow explanatory.

On this basis, let us consider the motivation for inter-theoretic deduction. There are three steps of the argument. First, physics is supposed to give the most detailed explanation of any causally relevant property token in the world. This reflects our knowledge of physics, and takes into account ontological reductionism. In addition to this, in order to explain in the most detailed manner, physics is supposed to be complete. Second, any predicate type, and thus explanation, reveals what the referents of their token predicates have *causally* in common. However, it is widely accepted that any ontological difference is based on a causal difference, and ontological identity is based on causal indiscrimination. Indeed, the argument for ontological reductionism is a causal argument (cf. Kim (2005), chapter 2). From this it follows, third, that explanations of the special sciences cannot refer to something ontological out there in the world that is not identical with a physical property token. There is nothing causally relevant out there in the world beyond that what is captured by physical predicate types, and thus physical explanations. If there were causal relations that were explainable in terms of the special sciences, but not in terms of physics, the 'completeness of physics' would be false. Assume that this argument is cogent. Consequently, there is a systematic relationship between the physical explanations and the explanations of the special sciences. This suggests that any predicate type of the special sciences is co-extensional with some physical predicate type. At least, it is not possible that, on the one hand, the predicate type "B" of some predicate token "$b_1$" about $e_1$ outlines what all the entities that come under the B-tokens, say $e_1$ and $e_2$, have causally in common, but on the other hand, the physical predicate type "P" (of the predicate token "$p_1$" that refers to $e_1$ as well) does not refer also to $e_2$ in virtue of outlining what $e_1$ and $e_2$ have causally in common. From this it follows that inter-theoretic deduction is well motivated. Its aim is to explain physically what predicate types of the special sciences only explain in an *incomplete* manner. After all, the result of inter-theoretic deduction may be to provide homogenous physical explanations of *any* property type of causally relevant property tokens.

## III. The Argument against Epistemological Reductionism

The special sciences are mainly considered to be about causally relevant property tokens. Therefore, let us begin this section with some considerations on the corresponding predicate types. Subsequent to this, I shall consider homogenous explanations, and the necessity of co-extensionality between predicate types for inter-theoretic deduction in more detail. On this basis, the multiple realization argument against co-extensionality will be outlined.

Any predicate type about causally relevant property tokens can be taken to admit of a functional definition. Thus, any of its predicate tokens refer to property tokens that have at least a certain cause and/or a certain effect in common. Therefore, any predicate type outlines what the property tokens it refers to have *causally* in common. Let us consider some predicate tokens, say "$b_1$" and "$b_2$". They may refer to the entities $e_1$ and $e_2$ respectively. In addition to this, both $e_1$ and $e_2$ have causes of the same property type, and they have effects of the same property type. By this is meant that the causes (and the effects respectively) are supposed to be property tokens that can be referred to by predicate tokens of the same predicate type. As we have seen, any property type is a set of entities that can be referred to by predicate tokens of one and the same predicate type. Thus, the predicate tokens “$b_1$” and “$b_2$” refer to the entities $e_1$ and $e_2$ respectively that both have causes (and effects respectively) of the same property type. For that reason, the predicate tokens “$b_1$” and “$b_2$” are of one and the same functionally defined predicate type, say “B”.

Being aware of this, let us turn to homogenous explanations. Assume that the special sciences are ‘somehow’ explanatory. However, explanations are predicates embedded in a theory. Let me remind you that, in order not to complicate the issue, I take a ‘biological explanation’ of $e_1$ to be a biological predicate token (embedded in the theory of biology) that $e_1$ makes true. This biological predicate outlines salient causal relations. In an analogous manner, a ‘physical explanation’ of $e_1$ is a physical predicate token (embedded in the theory of physics) that $e_1$ makes true.

Against this background, let us focus on what makes two explanations homogenous. In general, two explanations are homogeneous if they use the same predicate type. For instance, the biological explanations “$b_1$” about $e_1$, and “$b_2$” about $e_2$ are homogenous if both “$b_1$”, and “$b_2$” are predicate tokens of one and the same predicate type, say “B”. To put this in other terms, the two entities $e_1$ and $e_2$ are biologically explained in the same way. However, to explain entities in a homogeneous manner is of epistemological interest. At least, in order to establish an epistemological account of the world, we usually seek for *homogenous* explanations.

Let us now consider physical explanations and the aim of inter-theoretic deduction. The aim of inter-theoretic deduction is to provide homogenous physical explanations of *types* of property tokens of the special sciences. As we have seen, the entities $e_1$ and $e_2$ are homogenously explained in biological terms whenever they are explained by predicate tokens of one and the same predicate type. Thus, biologists can point out and explain what $e_1$ and $e_2$ have causally in common. However, this explanation is incomplete. There is only, in the last resort, physics that might explain in a more detailed manner. However, in order to explain *homogenously*, the appropriate explanations have to be of the same type. Assume that the special sciences are able to give homogeneous explanations about any of their specific types of properties. Unless physics cannot, in principle, provide a homogenous explanation of each of these property types as well, the aim of inter-theoretical deduction seems to be not feasible. So to speak, whenever a homogenous explanation is possible in terms of the special sciences, we seek for an appropriate physical and homogenous explanation as well. At least, this is the aim of inter-theoretic deduction.

To achieve this aim, the predicate types of the special sciences have to be co-extensional with physical predicate types. Once again, let us suppose that the entities $e_1$ and $e_2$ are homogenously explained in biological terms. Their explanations, "$b_1$", respectively "$b_2$", are of the same predicate type. Let us now take "$p_1$" as the physical explanation of $e_1$, and "$p_2$" as the physical explanation of $e_2$. Unless both "$p_1$" and "$p_2$" are predicates of one and the same predicate type, there is no homogenous explanation in physical terms. This is why predicate types have to be co-extensional with physical predicate types.

Given this, I shall consider the multiple realization argument against inter-theoretic deduction. The multiple realization argument is an argument for the possibility of non-co-extensional predicate types. It is possible that there are at least some predicate types of the special sciences not co-extensional with physical predicate types. From this it follows that appropriate homogenous physical explanations are not possible. Therefore, the aim of inter-theoretic deduction seems to be not feasible in general.

A case of multiple realization can be stated as follows: On the one hand, there are entities that can be referred by predicate tokens of one and the same predicate type of the special sciences. Thus, a homogenous explanation is possible in terms of the special sciences. But on the other hand, these entities differ in physical respects. For that reason, these entities are referred to by predicate tokens of *different* physical predicate types. This is to say that the physical explanations are not homogenous. So to speak, there are causal differences between the entities in question that are only considered in physics. Although these differences are not important from a point of view of the special sciences, the physical explanation takes them into account.2

2 I should note that the multiple realization argument is *committed* to the 'completeness of physics'. Assume that "B" and "P" are not co-extensional because predicate tokens of "B" refer to entities that differ *physically*. However, to differ physically is to differ causally. Let us suppose that physics were incomplete, and thus, there were non-physical causes for these physical differences and no physicist could explain these physical differences. Would any reference to the special sciences help? Probably not for even the special sciences *do not* distinguish between the entities in question. There would be only one type of property tokens that cause *different* effects, respectively, there would be only one predicate type ("B") in order to explain physical *differences*. I doubt that any physicist would be inclined to admit such causes, or explanations.

Let us consider a well-known example that, among others, suggests the possibility of multiple realization: Genes are supposed to be multiply realized. By this is meant that there may be several entities in the world that are referred to by biological predicate tokens of the predicate type “gene”. But, physicists refer to these entities by predicate tokens that are of different predicate types. Say, in a very simplified manner, “molecular configuration $P_1$”, and “molecular configuration $P_2$”. From a biological point of view, “gene” is a *functionally defined* predicate type. Thus, entities are taken to be genes if they have the appropriate cause, and the appropriate effect that qualify them as a gene. However, there are physical differences possible among these entities that may not touch a biological reference by “gene”. In fact, there are different molecular configurations possible that are indistinguishable with respect to having the appropriate cause, and causing the appropriate effect. Indeed, the genetic code is redundant, and hence, physically different molecular configurations may obviously produce the same effects, like yellow blossoms for instance. Therefore, it seems quite clear that physical causal differences do not always imply biological functional differences. From this it follows that the predicate type “gene” is not co-extensional with any physical predicate type. There is no homogenous physical explanation of a gene. Therefore, at least in such cases as in the case of the genes, inter-theoretic deduction seems to fail.

Before we move on to the last section, let me remind you of the implication of any non-co-extensionality between predicate types: Unless there is no causal difference between entities, there is no argument to refer to these entities by predicate tokens of *different* physical predicate types (cf. Kim (1998), p. 18-19). Let me take in what follows ‘causal’ difference to refer to physical differences between entities, and ‘functional’ differences to refer to differences that are considered by predicates of the special sciences.

## IV. Inter-Theoretic Deduction by means of Functional Sub-Types

In this last section, I shall sketch out a reductionist strategy that avoids the anti-reductionist consequences of the multiple realization argument. My argument contains four main steps. First of all, any physical causal difference between entities leads to functional differences between the entities in question. Thus, any physical difference is detectable in terms of the special sciences as well. To put in other terms, predicate types of the special sciences about multiply realized properties abstract from functional details. This is the core of my strategy, and I shall consider some possible objections before moving on to the subsequent steps of the strategy. On the basis of the ability to detect functional differences, second, the special sciences can introduce functionally defined sub-types of the mentioned predicate types. These sub-types take into account any possible functional differences. Consequently, these sub-types are co-extensional with physical predicates types. As a result of this, third, I shall argue that any abstract predicate type is deducible from a more detailed predicate type. For that reason, fourth, any predicate type is deducible from one of its sub-types that are co-extensional with physical predicate types. This is inter-theoretic deduction. Against this background, the limits and possible implications of this reductionist strategy will be outlined.

Any physical difference is detectable by the special sciences as well. I shall formulate the argument for this claim in two different ways.

First, let us consider a general formulation that suggests this implication. Let us take for granted that in our world, say $w_1$, there are many multiply realized properties. By this is meant that on the one hand, there are entities that can be referred to by predicate tokens of one and the same predicate type of the special sciences. But, on the other hand, these entities are referred to by predicate tokens of *different* physical predicate types. For instance, there may be multiply realized genes, and multiply realized states of pain. Let us now suppose a world that is physically distinct from our world $w_1$, say $w_2$. World $w_2$ is physically so that no properties of the special sciences are multiply realized. In $w_2$, each gene of a certain biological type is identical with a molecular configuration of one and the same physical type. The same applies to any type of pain, and so on. As a result of this, the predicate types of the special sciences in $w_2$ are co-extensional with physical predicate types. Thus, the descriptions of $w_1$ and $w_2$ only differ from a physical point of view. So to speak, in $w_2$, there is for any biological predicate type "B" a co-extensional physical predicate type "P", whereas in $w_1$, there are the physical predicate types "$P_1$" and "$P_2$". Having said this, our present concern should be to focus on the following question: Is it possible that there will never occur any difference in the description in terms of the special sciences as well? Is it possible that the reference by predicate types of the special sciences to $w_1$ and to $w_2$ will always remain the same? Since most property types are supposed to be multiply realized, I am about to question that there would *never* occur *any* difference.3 Bearing this point in mind, let us consider the second formulation of the argument.

For any physical causal difference between entities, there is an environment conceivable in which the physical difference implies a functional difference. For instance, there is always an environment possible in which the physical differences between genes imply selective advantages, or disadvantage, and thus a functional difference (cf. Rosenberg (1994), p. 32). Let us consider this example in some more detail. Suppose that a certain type of gene, say gene for yellow blossoms, is multiply realized. Thus, tokens of this gene type are property tokens of two different physical property types, say of $P_1$, and of $P_2$. By this is meant that the entities that are referred to by "gene" are either referred to by predicate tokens of "$P_1$" or by predicate tokens of "$P_2$". However, genes of the physical type $P_1$ may possess, for instance, a high resistance due to ultraviolet light. Compared to this, genes of the physical type $P_2$ may possess a low resistance due to ultraviolet light. Sure, this physical difference would not be detected in environmental conditions like in our world some hundred years ago. However, there is an environment conceivable in which the physical differences in question lead to a functional difference. Consider an environment with a very intensive radiation of ultra-violet light. In such an environment, the way in which genes cause yellow blossoms depends on whether the genes are resistant due to ultra-violet light, or they are not resistant due to ultra-violet light. In a simplified manner, there is a difference in time and/or the need of resources in order to cause the yellow blossoms. To illustrate this point, let us say that flowers with genes that fall under the physical type $P_1$ cause yellow blossoms 'as expected'. Compared to this, flowers with genes that fall under the physical type $P_2$ may need more time in order to cause the yellow blossoms. These genes have to be repaired several times, and in order to repair the genes from the damages caused by the ultra-violet light, the flower needs resources that 'lack' at other locations of the flower. This is a functional difference that is detectable in biological terms and that is salient for selection. The physicist can conceive environmental conditions so that the scientist of the special sciences would detect functional differences between physically different entities. Since many functional implications of physical differences are already well-known, I doubt that there are physical differences possible that would under *no physical condition* lead to *any* functional difference.4

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3 I would like to add that even Heil makes a quite similar point, even though in terms of qualities and dispositions: "Try changing a fragile object qualitatively, without altering it dispositionally. The object might remain fragile but become fragile 'in a different' way" (Heil (2003), p. 116).

4 I should note that this argument does not depend on the ability of the biologist to distinguish the environmental/physical conditions in its own terms. It is sufficient that some physicist *conceives*, and some

Let me reconsider these formulations of the argument in terms of predicates and explanations. Generally speaking, in order to explain different effects, different causes are suggested. Thus, whenever two property tokens of a multiply realized property type lead to different functional effects, this difference in effects cannot be explained in terms of the special sciences. After all, the special sciences recognize only one and the same type of cause for two different types of effects. Provided that at one day, the special sciences' description of $w_1$ starts to differ from the special sciences' description of $w_2$. How could we explain this first difference since there should be just one type of cause? This problem raises questions about the *coherence* of the special sciences, and, hence, cries out for further, in the last resort physical, explanations. This problem becomes even more obvious for the second formulation of the argument. How could we *coherently* explain possible functional differences by reference to the same type of entities?

Being aware of the problem, I shall consider possible objections to this core of the strategy. First of all, one may maintain that the special sciences are sometimes not that precise, their epistemological classifications are sometimes vague, and maybe, that is why their laws are not strict but so-called ceteris-paribus laws. So much the worse for any reductionist that starts from the incompleteness of the special sciences, and ends up there! This kind of objection is wrongheaded because it doesn't touch my argument: In principle, any causal physical difference leads to a functional difference that is detectable by the special sciences. And secondly, the aim of inter-theoretic deduction is not that the special sciences should explain any physical difference, or determine environmental conditions as precise as physics. To the contrary, it is physics that should explain homogenously what is un-explicable in terms of the special sciences. And indeed, physics may explain homogenously whenever no functional differences are possible. This is the explanatory aim of inter-theoretic deduction. Therefore, let us move on to some other possible objections.

One may employ my formulations of the argument to conceive contrary cases. For instance, one may conceive physical differences that only appear for a certain length of time. On the one hand, there certainly are environmental conditions in which many physical differences do not lead to biological functional differences. One may only think about common environments in our world in which differences in resistance due to ultraviolet light

biologist *detects* them. Detecting functional difference is a sufficient reason to introduce functional sub-types. To reconsider the example, it does not matter whether or not 'ultra-violet light' is a biological or physical predicate. Moreover, suppose that the special sciences are not able to formulate the environmental conditions that lead to functional differences of, in their terms, indistinguishable entities. They only detect functional differences of property tokens of the same type. Such cases cry out for further explanations that can be only provided by physics.

imply no functional differences. Thus, at least within a certain length of time, no functional difference may occur. In regard to this, I would like to note the following: The *possibility* of functional differences still remains. To put it terms of Heil, there is a disposition for functional differences. Taking it for granted that there are truth-makers for dispositional talk, this is reason enough to distinguish between the entities in question. On the other hand, there might be physical differences conceivable that disappear after a certain length of time. Genes may differ with regard to some microphysical systems, but these may decay after a hardly measurable short time. Therefore, it might not be reasonable to postulate a disposition for functional differences. How to deal, hence, with such physical differences? In regard to this, the only point I want to make here is the following one: It would be quite unlikely to take these physical differences to be relevant with respect to giving homogenous physical explanations. That is to say, any abstraction from physical details should be admissible as long as the physical explanation remains coherent – at least, in order to provide a homogenous explanation of types of the special sciences. So to speak, genes may be multiply realized by different molecular configurations. But, if the physical differences are 'irrelevant' in order to constitute a gene, one may leave them aside. Let me distinguish between 'relevant' and 'irrelevant' physical differences. 'Relevant' physical differences are physical differences that make it impossible to explain homogenously and coherently. After all, in order to explain the function of genes in physical terms, additional microphysical systems are commonly not considered. In a simplified manner, any token of a gene consists of a huge configuration of physical systems. However, any physical system, like the additional electron, can be theoretically deleted in order to provide a homogenous explanation of genes. They are 'irrelevant' in order to explain coherently. Generally speaking, physicists have to 'cut' some predicates out of the conjunctions of predicates in order to reach co-extensionality with predicate (sub-) types of the special sciences. These are constructed predicates, and I shall take physical predicates as such in order to provide inter-theoretic deduction (cf. Hooker (1981), § 3). To recap the counterarguments, either (dispositional talk of) functional differences are reasonable, or the physical differences are 'irrelevant'.

Let us turn to the implication of functional differences that are detectable by the special sciences. Any functional difference that is detectable by the special sciences can be considered by appropriate predicate types of the special sciences. It is, hence, possible to introduce sub-types of predicates. These predicate sub-types take into account any *possible* functional difference of 'relevant' physical differences. As a result of this, the introduced functionally defined sub-types of predicates are co-extensional with physical predicate types. Let me call them 'relevant' physical predicate types, and consider this strategy in four main steps.

First, let us recap the ability of the special sciences to detect physical differences. Any physical differences lead to functional differences. That is to say that they are detectable in terms of the special sciences. If there is a multiply realized functional property type, the appropriate property tokens differ in causal physical respects. Given the comparison of worlds with multiply realized property types to worlds without multiply realized property types, or given certain environmental conditions, any 'relevant' physical differences lead to functional differences as well. Thus, they are detectable in terms of the special sciences as well.

Second, and subsequent to the previous point, the special sciences are able to introduce functionally defined sub-types of predicates. In a simplified manner, functionally defined predicates that are about multiply realized properties do not take into account possible functional differences. Compared to these abstract predicates, their sub-types consider any possible functional difference of 'relevant' physical differences. Let me begin with an example. Biologists may, oversimplified, distinguish between genes that are more resistant due to ultra-violet light and genes that are not that resistant. 'Resistance due to ultra-violet light' is considered to be an abbreviation of functional differences that may occur in environments with high intensive radiation of ultra-violet light. Taking it that any 'relevant' physical difference is detectable, the functionally defined sub-types of predicates are necessarily co-extensional with these 'relevant' physical predicate types. Because the matter is so crucial, I am going to risk excess by restating the point once more: The special sciences can consider any 'relevant' physical difference in their own terms, and hence, introduce appropriate functionally defined sub-types of predicates *co-extensional* with 'relevant' physical predicate types. The predicate tokens of any of these physical predicate types refer to entities that do not possess 'relevant' physical differences. 'Relevant' physical differences are physical differences that would make impossible homogenous and coherent explanations. Aware of this ability of the special sciences to introduce functionally defined sub-types of predicates co-extensional with 'relevant' physical predicate types, let us move on and consider the relationship between types and sub-types.

To outline the relationship between abstract predicates and detailed predicates is this third step of the strategy. Clearly, any multiply realized functionally defined predicate type abstracts from possible functional differences that are considered by its uniform realized functionally defined sub-types. In conclusion, abstract predicate types are deducible from their more detailed sub-types. Any predicate type that is about multiply realized properties is deducible from each of its sub-types. The argument can be stated as follows: A detailed predicate can be taken as a relatively long conjunction of single predicates. Taking it that the relatively long conjunction of predicates is true, any predicate of these predicates has to be true as well. Therefore, it is possible to infer from a more detailed predicate sub-type its more abstract predicate type. For instance, it is possible to deduce "gene for yellow blossoms" from "gene for yellow blossoms that is resistant due to ultra-violet light". To abstract from details is a theory immanent question.

Fourth, let me combine the two previous steps. Functionally defined sub-types are co-extensional with 'relevant' physical predicate types. After all, since any 'relevant' physical difference leads to functional differences that can be considered in terms of the special sciences, there is no argument that hinders constructing sub-types co-extensional with 'relevant' physical predicates. In addition to this, any abstract predicate type can be deduced from each of its detailed sub-types. Therefore, any predicate type of the special sciences is deducible from physics.

Suppose that a predicate type (or one of its sub-types) of the special sciences refers to entities that are referred to by predicate tokens of different physical predicate types. Against the background of the proposed reductionist strategy, there may be two possibilities: Either, the biologists are not yet smart enough to be aware of the possible functional differences. This is an empirical question. Or, physicists may realize that the appropriate physical differences are 'irrelevant', and hence, they can be ignored in order to formulate 'relevant' physical predicate types. Thus, the formulation of co-extensional predicates seems in principle always feasible. Therefore, taking it that co-extensionality is in principle always feasible, each predicate type of the special sciences is deducible, via the sub-types of predicates of the special sciences, from physical predicate types.

Let me briefly recap the necessary premises and arguments for my strategy, and consider its limit and its possible implication for Heil's ontological point of view. First, any theory of the special sciences can consider, in principle, more detailed predicate sub-types that take into account any possible functional differences. These are predicate sub-types about property tokens without 'relevant' physical differences. This argument takes for granted that there is ontological reductionism, the 'completeness of physics', and that predicate differences necessitate causal differences. Consequently, predicate sub-types of the special sciences are co-extensional with 'relevant' physical predicate types. Therefore, any sub-type can be nomologically correlated with a physical predicate type. From this it follows that a homogenous physical explanation is possible of the entities a sub-type refers to. Therefore, inter-theoretic deduction is in principle possible between 'relevant' physical predicates types and sub-types of the special sciences.

Second, any abstract predicate type can be deduced from any of its more detailed sub-types. From this, it follows that inter-theoretic deduction is possible from 'relevant' physical predicate types to predicate types of the special sciences (via sub-types). The predicate sub-types are co-extensional with 'relevant' physical predicate types. From each of these detailed predicate sub-types, the more abstract predicate type can be deduced. This is a theory immanent question of abstraction from details, hence, a conceptual issue. Furthermore, any predicate sub-type can be constructed out of its more abstract predicate type as well. In order to construct these sub-types, biologists for instance, only have to take into account any possible functional differences. Given this, 'relevant' physical predicate types are necessarily co-extensional with these functional sub-types.

However, the special sciences can, by means of abstract predicate types, *homogenously* explain multiply realized property types. Contrary to this, physics cannot *homogenously* explain these multiply realized property types. Therefore, the explanatory aim of inter-theoretic deduction might still fail. Being aware of this, let me consider a prima facie dilemma for Heil's ontological point of view:

Take for granted that there is ontological reductionism, and explanations are causal explanations. Now, it seems that there are only two possibilities: First, an abstract predicate type only explains *something ontological* that is captured by *each* of its sub-types. Since there is truth-maker realism, this would avoid eliminativism about any abstract predicate type. But, any sub-type would be sufficient in order to describe and explain the world in terms of the special sciences. To favour abstract predicates is therefore only grounded in practical reasons. However, Heil is probably not inclined to claim that abstract predicates are, in principle, unnecessary in order to describe and explain. In order to avoid this consequence, let us consider the second possibility. Any abstract predicate type explains something ontological *over and above each* of its sub-types. But, how could this be possible, since each sub-type is explanatory more detailed that its type? Suppose two predicate sub-types differ in their explanations, but nonetheless it is possible to infer from each sub-type the abstract predicate type. How could it be possible that this abstract predicate type explains something that is not captured by *each* of its sub-types? To put it in terms of Heil, how can predicates about dispositions explain something *over and above* predicates about qualities since dispositions should be identical with qualities?

Let me reconsider this prima facie dilemma and the proposed strategy of this paper. Taking for granted ontological reductionism, explanations are causal explanations, and physics is supposed to be complete and to provide the most detailed explanations of any entity. However, to avoid the correspondence principle entailed by the picture theory, we should take any property type as a theoretical classification (cf. Heil (2003), p. 26). Consequently, we should avoid to base ontological claims on the different abilities of theories to provide true abstractions. There clearly are abstract predicates of the special sciences that provide *homogenous* explanations of multiply realized properties. Physics is not able to explain them *homogenously* without becoming incoherent, or false. There is no physical predicate co-extensional with the appropriate abstract predicates of the special sciences. However, since the strategy of this paper, and the outlined dilemma for Heil's ontological point of view is cogent, any abstract predicate is, in principle, reducible to physics. The special sciences can consider sub-types of each of its predicate types, and these sub-types are co-extensional with 'relevant' physical predicate types. In order to not eliminate abstract predicates, Heil's ontological point is necessary. To claim that any abstract predicate is captured by each of its sub-types would be already to apply the correspondence principle entailed by the picture theory. To maintain that abstract predicate types outline something ontological above each of its sub-types would be already to apply the correspondence principle entailed by the picture theory as well. To conclude, the lesson of the multiple realization argument and Heil's ontological point of view is that, abstractions are, since they are true, not necessarily abstractions from ontology. This is conservative reductionism.

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