COMMENTS AND CRITICISM

ON MULTIPLE REALIZATION AND THE SPECIAL SCIENCES

In "Multiple Realizations"[1] Lawrence Shapiro aims to protect the special sciences–i.e biology, psychology, the behavioral and the social sciences–from the consequences of his denial that multiple realization is widespread in nature.

It is widely held that disciplines are autonomous when their taxonomies are "substrate neutral" and when the events, states and processes that realize their descriptive vocabulary are heterogeneous. This will be particularly true in the case of disciplines whose taxonomy consists largely in terms that individuate by function. Having concluded that the multiple realization of functional kinds is far less widespread than assumed or argued for, Shapiro cannot avail himself of the argument for the autonomy of the special sciences which relies on multiple realization. This makes urgent the question of whether we must "now give up the idea that functionalist taxonomies have any scientific value?" [p. 650]. He acknowledges that we must either deny that the special sciences are autonomous, because higher level kinds have only a single realization and can thus be reduced, or else we must deny that there are empirical laws in the special sciences. "In other words, either special sciences have no ontological independence from lower level sciences or, worse, they have no empirical laws, which is to say that they are not empirical sciences at all. [p. 650]" Shapiro's reductionist/eliminativist dilemma for the special sciences is unreal. For he has not canvassed the most important source of multiple realization in nature, and this source obviates his dilemma for most of the special sciences. Moreover, the route he offers between the horns of his dilemma leads pretty directly to impalement on its eliminativist horn. Or so I shall try to show in this comment.

I. THE SOURCE OF MULTIPLE REALIZATION IN NATURE MAKES FOR CAUSALLY RELEVANT DIFFERENCES

Shapiro argues that if a disjunction of physical states shares a distinct common causal feature in virtue of which each realizes a functional state, then the functional state will be reducible after all, in spite of the multiplicity of its realizers. Thus, no direct inference from multiple realization alone to irreducible autonomy can be vouched safe. But Shapiro has overlooked the fact that the source of multiple realization in nature has at the same time assured that in the long run multiple realizers will have causally relevant differences from one another. or at least causal differences great enough to obstruct the sort of empirical laws which Shapiro requires for an empirical science.

The ubiquity of multiple realization across the domains of all the special sciences is the result of natural selection.[2] Multiple realization kicks in as soon as natural selection begins operating on physical processes. Since humans are biological systems, the domains of all the special sciences that deal with humans are fated to the multiple realizability which the evolutionary origin of ***Homo sapiens*** reflects.

Natural selection "chooses" variants by some of their effects, those which fortuitously enhance survival and reproduction. Selection for adaptation and function begins at a relatively low level in the organization of matter. As soon as molecules develop the disposition, chemically, thermodynamically or catalytically, to encourage the production of more tokens of their own kind, natural selection comes into force. Some molecules become replicators–template or catalyze or otherwise encourage the production of copies of themselves, and these molecules interact with their environments so that changes in them–mutations–will result in changes in their rates of replication in their environments. As a result of random physical processes--mutations–among such replicating and interacting molecules, there are frequently to be found multiple physically distinct structures with some (nearly) identical rates of replication, different combinations of different types of atoms and molecules, that are about equally likely to foster the appearance of more tokens of the types they instantiate. It is the nature of any mechanism that selects for effects, that it cannot discriminate between differing structures with identical effects. When natural selection encourages variants to become packaged together into larger units, the adaptations become functions.[3] And functional equivalence combined with structural difference will always increase as physical combinations become larger and more physically differentiated . This blindness of selection to structure is no guarantee of causal heterogeneity in the realizers. But it certainly makes it overwhelmingly probable. Over finite periods of time nature can select at most for functional similarity, not perfect identity. Any two or more physical systems that solve a "design problem" well enough to allow for some minimal level of survival and reproduction rates will be selected. If there are at least two local optima in an adaptive land-scape, and if mutation, recombination, drift and selection can find them, the result will be causally different multiple realizations.

There is another aspect of natural selection that makes causally heterogeneous realizers highly likely. Evolutionary "design-problems" have the reflexive character of what Dawkins and others have called "arms races", dynamic strategic competitions in which every move generates a counter-move so that conditions are never constant. From an early point in evolution, the environments which select for any one function began to change more rapidly. For each new solution to a design problem–each new functional trait–becomes part of the environment, setting a new design problem for other functional traits–within the same biological lineage or beyond it in a competing lineage. In the competition for limited resources endemic to the biosphere any variation in the lineage of a gene, individual, group or species which enhances fitness (i.e. adaptation/function) will be selected for. Any response to such a variation within the heritable repertoire of the competitor gene, individual, group, or species, will in turn be selected for by the spread of the first variation, and so on. If the "space" of adaptational "moves" and counter-moves is very large, in the long run every functional kind will at least sometimes be realized by multiple causally distinct realizations.

What this means of course is that any generalization linking a single functional kind to a set of physical realizations will be at best a temporarily true claim about a historically limited pattern to which, over evolutionary time periods, the number of exceptions will mount until its subject becomes extinct. Take a simple example, such as "All genes are composed of DNA molecules." The discovery of the retroviruses showed that this generalization needed to be revised to "All genes are composed of DNA or RNA molecules." But RNA and DNA are both composed of the same nucleic acids (qualification: not exactly the same, but similar ones with different effects on information fidelity in the case of uracil and thymine). Presumably it is this common causal fact about them which accords them the same function of hereditary information storage and developmental control. Alas (even leaving aside the significant qualification), the discovery that prions, proteins which cause BSE or "mad cow disease" and catalytically transmit their (secondary structure) shapes across the generations down a line of descent, shows that the molecules with hereditary function are not all nucleic acids. But of course the prion's stratagem for persistence leads to a counter-stroke by the nucleic acid- lineage (e.g. some nucleic acid based organisms cease feeding on the brains of their victims, or cease feeding their cattle ground-up prion-infected offal). There is a vast space of available adaptive strategies among competing molecules, genes, organism, populations, species. Therefore fulfilling the same function cannot forever remain a matter of employing the same or similar causal mechanisms. At most one can claim that multiple realizers may only temporarily have a common causal feature which results in their instantiating a functional type. Eventually, mother nature will find a causally new way to perform the function and the class of realizers will no longer be causally homogeneous.

Are temporary empirical regularities are good enough to allow for the reduction of the functional kinds of the special sciences to their physical realizers Shapiro hopes for? After all, in the context of evolutionary change, "temporarily" might be a matter of millions of years.[4] Thus, to use Shapiro's example [pp. 646-647], over the period that interests physiology, the realizers of visual image formation may be physically diverse while sharing a single feature (the lens) causally relevant to image formation. But notice several things: First, in the domain of any of the special sciences, where competing systems respond to one another's stratagems more rapidly, natural selection pretty well assures that the realizers of some functional kind will become different in casually relevant respects over time scales that make even "temporarily true" reductions unlikely. The realization bases of the functional kinds of social and behavioral science will certainly not stand still long enough to allow for the casual homogeneity and consequent reduction Shapiro envisions. Second, the "generalization" expressing the reduction of a function will be a temporary, historically bounded one, not a law of the sort Shapiro requires [p. 654]. Such a historically limited temporarily true statement will have explanatory power *by itself* only on a novel account of scientific explanation (I return to this point in section II).

Third, and most important, it is unlikely that even temporarily true reductions will be available for the functional kinds that interest Shapiro most. For he is particularly eager to undermine the inference from the multiple realization of mental states by brain states to autonomy of psychology from neuroscience. But if the relationship between molecular biology and genetics, development, and cell physiology is any guide, the prospects for causal homogeneity are low. The molecular realization base of classical genetics is already sufficiently causally heterogeneous as a result of natural selection over three billion years that all reductive generalizations linking genetic functions to molecular realizations are riddled with exceptions. As in genetics, reductions in functional anatomy may start out looking smoothly reductive: “genes code for hereditary information because they are composed of nucleic acid bases”, “eyes produce visual images because they are composed in part of (physical) lenses”. But the more detailed and complete the explanation we seek of how a gene, an organelle, a cell, a tissue, or an organ accomplishes its function, the more disjunctive, and causally heterogeneous the explanation becomes. Since cognition is much more complex than vision, digestion, fission, meiosis, or protein synthesis, we should expect evolution to have made its realizations more heterogeneous by orders of magnitude. And it is this heterogeneity which reducing the psychological to the neural must deal with. After all, the search for psycho-physical laws will not be satisfied by gross anatomical localization of encapsulated cognitive modules. We have this already to some extent. Psycho-physical laws need to link occurrent intentional states with their neural realizations.

Shapiro asks “Without considerable knowledge about how the brain produces a mind, why be so sanguine that there are in fact many *truly* distinct ways to build a mind? [p. 646]”
The answer to this question may now be a little clearer. In the philosophy of psychology the multiple realizability thesis is a hypothesis advanced to explain the absence of discoverable psycho-physical laws in a way compatible with physicalism. True, the best evidence for it must eventually come from detailed studies of the brain, but initially, we have a good deal of indirect evidence for it from elsewhere in biology.

II. HOW NOT TO PRESERVE THE AUTONOMY OF THE SPECIAL SCIENCES

Shapiro’s dilemma consists in what he calls “two undesirable results” [p. 650]

> horn 1: reductionism: functional, or as he says, “higher level kinds” have single realizations, ***ergo*** no autonomous empirical laws about higher level kinds, and so no special sciences.

versus

> horn 2: eliminativism: higher level kinds have multiple realizations, thus no empirical laws connecting higher level kinds with realizers, and ***a fortiori*** no laws connecting higher level kinds with one another, ***ergo*** no empirical laws at all, autonomous or otherwise, and no autonomous special sciences.

It is worth noting that horn 1, reductionism, is by no means a clearly “undesirable result”. Indeed

Shapiro later seems to admits as much [p. 653]. But if the arguments of section I above are correct, in most domains laws expressing the reduction of higher level kinds of special sciences to lower level kinds that Shapiro envisions [p.654] are not on the cards, since the higher level kinds will be multiply realized by causally heterogeneous mechanism and processes.

One way to circumvent this dilemma is to deny that laws, empirical or theoretical, are indispensable for a science, special or otherwise. This a very popular "move" in contemporary philosophy of science, especially in the philosophy of biology. In large measure owing to the fact that biology is bereft of laws of the sort we are familiar with from physics, philosophers of biology have been at pains to argue that laws are not required in biology. If such arguments are accepted for biology, they will be equally available for the special sciences. [5]

Denying that there are laws in biology is unattractive because it comes with a concomitant obligation to provide a new account of how explanation proceeds in biology in their absence. In light of the fact that the autonomy of the special sciences is more precisely, their *explanatory* autonomy, the obligation to provide such an account of explanation becomes quite pressing for those attracted to this option. The account will have to show how an autonomous special science can explain without invoking proprietary laws even implicitly.

However Shapiro does not opt for this way out of his dilemma. He repeatedly insists on the indispensability of laws in a science. But his way of attempting to pass between the horns of the dilemma in fact securely impales him on the eliminativist horn. His solution is to argue that functional kinds have important roles in science even when they have no common effects. He invites us to consider the functional type 'eye', on the assumption that it is multiply realized by causally different underlying mechanisms:

> Despite the fact that we can say nothing more about eyes (in general) than that they have the function to see, it is still a matter of interest what kinds of things can see. We derive a deeper understanding of a given kind of eye from its comparison with other organs that are capable of the same function. Thus, for instance in trying to understand how a camera eye works it is useful to study its similarities and differences with the compound eye. Doing so provides evidence about which of the properties of the camera eye are causally relevant to the function of seeing

and which are not. In short, functional kinds in the special sciences, despite the fact that they never enter into (nonanalytic) laws of the form 'All Ps are also ___', are of value because they collect and order the domain of a special science in a way that facilitates its investigation.

In short, the taxonomies of the special sciences describe classes of explananda. And their value consists in this role. But this rationale for the kind terms of the special sciences will not do the work which the exponents of the autonomy of special sciences require. It only forces Shapiro to empale himself on horn 2, eliminativism.

The whole point of the argument from multiple realizability to the autonomy of the special sciences is that the taxonomies of these disciplines include kinds that are ***explanatory***, that figure in explanantia, not simply in explananda. Exponents of the autonomy of the special sciences, especially psychology, from Fodor to the present, have sought ***explanatory*** autonomy for these disciplines. They have held that we would miss generalizations if we surrendered their taxonomies, and that missing these generalizations we would be unable to provide adequate explanations for the processes in the domains of these disciplines.[6] The point is particularly clear in the philosophy of biology. Consider two examples of how proponents of the autonomy of biology state the view.

Elliot Sober writes:

> ...what answer can we give to the question of whether physics can explain everything that biology can explain? [an example of horn 1 of Shapiro's dilemma] First, we need to divide the question in two: (1) If there is a biological explanation for *why some particular event occurred*, is there also a physical explanation? (2) If there is a biological explanation of *what several particular events have in common*, is there also a physical explanation? Perhaps the answer to (1) is yes; as for (2), the answer I would give is no.[7]

According to Sober, biology provides explanations, not just explananda, and these explanations are autonomous, because their concepts are. 'Fitness', Sober notes, is supervenient on a wide disjunction of different packages of environment-organism relations; it is multiply realized by them. Nevertheless, he insists,

> 'fitness''s irreducible usefulness arises from its contribution to the construction of theories that allow us to subsume [i.e. explain] a huge variety of single events within a common framework.

This explanatory virtue of the fitness concept is a consequence of that property's *supervenience*.[8].

And for good measure, Sober extends the point to psychology: "Science does need to attribute abstract mental states to organisms if it wishes to carve out generalizations at that level of abstraction...we can in principle predict and explain your behavior from the vantage point of your current mental state and also from the vantage point of your current physical state.[9]

In a series of papers stretching from 1984[10] to 1999 Philip Kitcher has argued for the same conclusions, employing in particular the example of pair-separation in meiosis as a complete, adequate, and irreducible explanation of genetic recombination in spite of the fact that meiosis is a multiply realized functional kind. In its most recent version the claim takes the following form: Consider explanandum

(7) Genes on different chromosomes, or sufficiently far apart on the same chromosome, assort independently.

According to Kitcher there is an explanation for G that employs the functional taxonomy of classical genetics which proceeds as follows:

(PS) Consider the following kind of process, a *PS*-process (for *pairing* and *separation*). There are some basic entities that come in pairs. For each pair, there is a correspondence relation between the parts of one member of the pair and the parts of the other member. At the first stage of the process, the entities are placed in an *arena.* While they are in the arena, they can exchange segments, so that the parts of one member of a pair are replaced by the corresponding parts of the other members, and conversely. After exactly one round of exchanges, one and only one member of each pair is drawn from the arena and placed in the *winners box*.

In any PS-process, the chances that small segments that belong to members of different pairs or that are sufficiently far apart on members of the same pair will be found in the winners box are independent of one another. (G) holds because the distribution of chromosomes to games at meiosis is a PS-process.

This I submit is a full explanation of (G), and explanation that prescinds entirely from the stuff that genes are made of.[11]

As Kitcher had previously argued, "Antireductionists are not only able to contend that there are autonomous levels of biological explanation. They can also resist the weaker reductionist view that explanation always flows from the molecular level up."[12]

There are two conclusions to draw here, one that bears on Shapiro's proposal for dealing with his "dilemma"; the other is a wider one. Shapiro's proposal will not do, for it in effect condemns special sciences to an eliminativist fate. Shorn of an explanatory role, once their usefulness in taxonomizing explananda has been exhausted, they have no further function. The real moral of the fact that, in Shapiro's words, functional kinds "never enter into (nonanalytic) laws of the form 'All Ps are also ___'," is that they are nomological danglers. It is for this reason that Shapiro is ultimately empaled on horn 2, eliminativism.

The wider lesson recalls the alternative suggestion mentioned above, about how to slip between the horns of Shapiro's dilemma. There I noted that we could avoid reductionism and eliminativism if explanation in the special sciences proceeded without the explicit participation of laws. The trouble with this approach is that it requires a whole new account of how the special sciences explain. In the end, it appears, the obligation to provide such an account will be unavoidable. For it is the same obligation incurred by the invocation of "temporary", historically limited non-nomological reductions as explanatory which was discussed in section I above.

Shapiro is right that functional kinds never enter into (nonanalytic) laws of the form 'All P are also ___'. But in the absence of laws of the form 'All Ps are also ___' exponents of the autonomy of the special sciences will need a new account of explanation, one which provides for their ***unaided*** explanatory power in the absence of laws expressed in their proprietary taxonomies.

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Notes

1. This journal, XCVII, (2000): 635- 654. Further quotations in the text are to this paper.

2. Shapiro recognizes that natural selection has some bearing here. He writes at one point, “Natural selection has figured out different psychological means to the same psychological ends” [p. 642]. But this statement figures as a mere concession to exponents of multiple realization of mental states.

3. I adopt here the “selected effects” account of function due originally to Larry Wright, Teleological Explanation, Berkeley, University of California, 1976. Shapiro appears to be committed to this account as well.

4. This is one upshot of Marc Lange’s argument in, “Are there natural laws concerning particular species”, this journal, XCI ,(1994): 430-451.

5. P. Kitcher writes: “...success in achieving exceptionless generalizations is by no means a sine qua non for good science....Darwinian evolutionary theory has served us as an example” Advancement of Science, Oxford, Oxford University Press, 1992, p. 121. According to E. Sober, “*general* source laws are hard to come by in evolutionary theory”, The Nature of Selection Cambridge, MIT Press, 1984, reprinted University of Chicago Press, 1994, p. 51, italics in original. See also See John Beatty, “The evolutionary contingency thesis” in G. Wolters and J. Lennox (ed.s), Concepts, Theories and Rationality in the Biology (Pittsburgh, University of Pittsburgh Press, 1995), pp.45-81 and Lange, op.cit., note 3.

6. See for instance, Patricia Kitcher, “In Defense of Intentional Psychology”, this journal, LXXXI (1984): 89-106, which invokes analogies to the explanatory role of multiply realized functional kinds in biology, as illustrated below.

7. The Philosophy of Biology, second edition, Boulder, Co., Westview, 2000, p. 78, emphasis in original.

8. The Nature of Selection, p. 126, emphasis in original.

9. Ibid. p. 128.

10. “1953 and all that: A Tale of Two Sciences”, Philosophical Review, 93 (1984):335-373.

11. “The Hegemony of Molecular Biology”, Biology and Philosophy, 14 (1999), pp. 199-200.

12. “1953 and All That”, p. 371.