On subsets, multiple realization and explanatory autonomy of biology

Abstract

The major argument to apply Shoemaker's subset approach to functional properties is to avoid the epiphenomenalist threat (Shoemaker 2001). It may furthermore be read as spelling out what ontological reductionism may precisely mean for higher-level, functionally defined properties. However, such important advantages may come at a high price: it seems that the subset approach finally excludes multiple realization of functional properties and consequently the explanatory autonomy of higher-level sciences, like biology. This paper aims at challenging that implication.

Introduction

The subset understanding of multiple realization can be summarized as follows (cf. Shoemaker, 2001, pp. 78-79): two tokens $\boldsymbol{b}_1$ and $\boldsymbol{b}_2$ come under *one* functionally defined biological type $\boldsymbol{B}$ if both have the *same function subset* ($\boldsymbol{c}_i$). At the same time, $\boldsymbol{b}_1$ and $\boldsymbol{b}_2$ come under *different* physical types $\boldsymbol{P}_1$ and $\boldsymbol{P}_2$ since $\boldsymbol{b}_1$ and $\boldsymbol{b}_2$ differ in some non-functional disposition ($\boldsymbol{c}_1$-$\boldsymbol{c}_n$). This leads to a paradox: it means that the functional disposition $\boldsymbol{c}_i$ is in each case a *subset* among the complete causal profiles of $\boldsymbol{b}_1$ and $\boldsymbol{b}_2$ when described by the physical types $\boldsymbol{P}_1$ and $\boldsymbol{P}_2$, respectively. Consequently, physics may in principle construct a more focused type $\boldsymbol{P}$ as well, one referring only to that very $\boldsymbol{c}_i$ in both tokens as does $\boldsymbol{B}$ (cf. Kim, 2010, pp. 111-112; Shapiro, 2000, p. 647). This, however, is the *denial* of multiple realization. The aim now is to introduce a reductionist framework capable of dealing with multiple realization (section I) and solving this paradox (section II).

I) Dealing with multiple realization

The label "conservative reductionism" results from integrating multiple realization in a particular way: showing that multiple realization does actually *not* block an *in-principle* correlatability (hence "reductionism"), and that this does actually *not* imply replaceability (hence "conservative," *i.e.*, "non-eliminativist") (cf. Esfeld & Sachse, 2011). The argument can be subdivided into four steps:

1) Multiple realization *generally* means that biological property tokens (*e.g.*, $\boldsymbol{b}_1$ and $\boldsymbol{b}_2$) are functionally similar and thus fall under *one* functionally defined biological type $\boldsymbol{B}$ while

being at the same time physically different, and thus fall under *different* physical types (*e.g.*, $\boldsymbol{P}_1$ and $\boldsymbol{P}_2$). Uncontroversially, physical difference means a difference in causal powers/dispositions (Kim, 1999). However, contrary to common understanding the claim now is that for any allegedly non-functional causal difference between $\boldsymbol{b}_1$ and $\boldsymbol{b}_2$, there exist environmental conditions that imply *functional* differences. For instance, even something as small as a single base silent mutation in genes (*i.e.*, one that still leads to the production of identical proteins) may actually affect the fitness of the organism in question in certain environments (cf. Esfeld & Sachse 2007). Therefore, type $\boldsymbol{B}$, when applied to *physically different* biological tokens ($\boldsymbol{b}_1$ and $\boldsymbol{b}_2$), is descriptively/explanatorily adequate only in a *subset* of environmental conditions.

2) By taking into account biologically traceable functional *differences* between tokens ($\boldsymbol{b}_1$ and $\boldsymbol{b}_2$) under *certain* environmental conditions, it is in principle possible to construct, in *biological* terms, so-called functionally defined "sub-types" ($\boldsymbol{B}_1$ and $\boldsymbol{B}_2$) of $\boldsymbol{B}$. These subtypes can be conceived as follows: "type $\boldsymbol{B}$ + supplementary, context-dependent functional specification" (cf. Soom *et al.* 2010).

3) Because of the in-principle possibility of biology constructing such functionally defined subtypes ($\boldsymbol{B}_1$ and $\boldsymbol{B}_2$), *correlations* to physical types can be established. Roughly, if $\boldsymbol{B}$ is multiply realized by a property tokens coming under the physical type $\boldsymbol{P}_1$ and by a property tokens coming under the physical type $\boldsymbol{P}_2$, then a functional subtype $\boldsymbol{B}_1$ (respectively $\boldsymbol{B}_2$) can be constructed, which is correlated/co-extensional with $\boldsymbol{P}_1$ (respectively $\boldsymbol{P}_2$).

4) Recall that the "supplementary, context-dependent functional specifications" spelled out by the subtypes $\boldsymbol{B}_1$ and $\boldsymbol{B}_2$ are biologically relevant only in *certain* environmental conditions. This is why there may be objective reasons not to replace type $\boldsymbol{B}$ (and thus actual biology and actual scientific practice) by subtypes $\boldsymbol{B}_1$ and $\boldsymbol{B}_2$ (which, in turn, may be replaceable by physical types). For instance, by applying insights from scientific explanation understood as unification (Kitcher, 1981) or by referring to causes and causal explanations that are *stable*, *proportional*, and *specific* (Woodward, 2010), one may argue as follows: it is an objective matter *how the world is*, whether rather fine-grained subtype-$\boldsymbol{B}_1$/$\boldsymbol{B}_2$ or physical explanations, or rather coarse-grained, abstract type-$\boldsymbol{B}$ explanations are more adequate.

II) Solving the dilemma

Importantly, the compatibility with ontological reductionism remains obvious when an actual biological type $\boldsymbol{B}$ applies to physically different biological property tokens ($\boldsymbol{b}_1$ and $\boldsymbol{b}_2$): $\boldsymbol{B}$ always refers to the very same *general* functional disposition $\boldsymbol{c}_i$ in all tokens ($\boldsymbol{b}_1$ and $\boldsymbol{b}_2$), whereas the subtypes $\boldsymbol{B}_1$ and $\boldsymbol{B}_2$ always refer both to that general disposition $\boldsymbol{c}_i$ *and* to respectively *different*, supplementary, context-dependent functional dispositions (say $\boldsymbol{c}_{i*}$ of $\boldsymbol{b}_1$ and $\boldsymbol{c}_{i**}$ of $\boldsymbol{b}_2$) that result from the physical differences. This enables one to further clarify how two *identical* functional dispositions (what $\boldsymbol{b}_1$ and $\boldsymbol{b}_2$ share by falling under type $\boldsymbol{B}$) may actually have *different* manifestation conditions: $\boldsymbol{b}_1$ and $\boldsymbol{b}_2$ both contain the very same functional disposition $\boldsymbol{c}_i$, but in each case $\boldsymbol{c}_i$ is married, so to speak, with another disposition: $\boldsymbol{c}_{i*}$ in $\boldsymbol{b}_1$ (tokens of subtype $\boldsymbol{B}_1$), and $\boldsymbol{c}_{i**}$ in $\boldsymbol{b}_2$ (tokens of subtype $\boldsymbol{B}_2$), respectively. Therefore, if $\boldsymbol{c}_i$ of $\boldsymbol{b}_1$ is manifested in some environmental context, whereas $\boldsymbol{c}_i$ of $\boldsymbol{b}_2$ is not, this is simply because $\boldsymbol{b}_1$ and $\boldsymbol{b}_2$ differ in their also having $\boldsymbol{c}_{i*}$ and $\boldsymbol{c}_{i**}$, respectively.

The solution to the paradox now is that physics would *in principle* never construct a more focused type $\boldsymbol{P}$, one referring only to that very $\boldsymbol{c}_i$ in both tokens as does $\boldsymbol{B}$:

1) Conservative reductionism started with the general notion of multiple realization, that biological property tokens ($\boldsymbol{b}_1$ and $\boldsymbol{b}_2$) coming under one functionally defined biological type $\boldsymbol{B}$ are *physically different*, and that physical difference means a difference in causal powers/dispositions.

2) This is still true once the subset approach is combined with the framework of conservative reductionism: the very same $\boldsymbol{c}_i$ in the property tokens $\boldsymbol{b}_1$ and $\boldsymbol{b}_2$ results from physical *differences* in the sense of physically different aggregates. Importantly, though, due to the physical differences between $\boldsymbol{b}_1$ and $\boldsymbol{b}_2$, the same $\boldsymbol{c}_i$ is *always* accompanied by different, supplementary, functional dispositions: $\boldsymbol{c}_{i*}$ in the case of $\boldsymbol{b}_1$ and $\boldsymbol{c}_{i**}$ in $\boldsymbol{b}_2$.

3) Consequently, while $\boldsymbol{B}$ always refers to the very same general functional disposition $\boldsymbol{c}_i$ in $\boldsymbol{b}_1$ and $\boldsymbol{b}_2$, this very $\boldsymbol{c}_i$ has partly *heterogeneous* manifestation conditions in the following sense: $\boldsymbol{c}_i$ of $\boldsymbol{b}_1$ is manifested in some environmental context, whereas $\boldsymbol{c}_i$ of $\boldsymbol{b}_2$ is not because $\boldsymbol{b}_1$ and $\boldsymbol{b}_2$ differ in their also having $\boldsymbol{c}_{i*}$ and $\boldsymbol{c}_{i**}$, respectively.

4) When typing $\boldsymbol{b}_1$ and $\boldsymbol{b}_2$, physics would not make abstraction from such a heterogeneous context dependency unless giving up its goal of ideally *exceptionless* types that result from the perfect similarity of all tokens of one type. Put differently, even if it is *possible* for physics to construct a more focused type ***P*** about only $\boldsymbol{c}_i$, it would not do so *in principle* since that would imply a spatio-temporally *restricted* type (as is ***B***) such that the predictions and explanations coined in terms of ***P*** contain unexplained, unconsidered brute fact exceptions once applied to certain environmental conditions.

Conclusion

The concluding result may even be appreciated by anti-reductionists, since it does not imply that we should actually reduce biology to physics, but the *contrary*. The explanatory autonomy of the actual scientific practice, a biology with its generally functionally defined, and in that sense, both focused and abstract types, is in an *objective*, world-dependent manner vindicated *within* the framework of *subset* conservative *reductionism* that shows how actual and possible biological and physical types are related—and "lived happily ever after".

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