Natural Selection and Multiple Realisation: A Closer Look.

Abstract: The target of this paper is the claim that natural selection accounts for the multiple realisation of biological and psychological kinds. I argue that the explanation actually offered doesn't provide any insight about the phenomenon since it presupposes multiple realisation as an unexplained premise, and this is what does all the work. The purported explanation mistakenly invokes the "indifference" of selection to structure as an additional explanatorily relevant factor. While such indifference can be explanatory in intentional contexts it isn't a causal factor at all in non-intentional nature. The upshot is that once the necessary initial assumption about heterogeneity is accepted there is no further explanation to do.

1. Introduction

It is commonplace that biology presents us with functional categories that are either known to be, or assumed to be, heterogeneous when it comes to physico-chemical implementation. This heterogeneity is quite evident in general approaches to animal behaviour (e.g. Ridley, 1995). So, for instance, when biologists speak of Batesian mimicry they intend cases where "...a harmless species (the 'mimic') resembles a dangerous species (the 'model') and is thus protected from predators" (Kikuchi and Pfennig 2010, 1041). This characterisation is then taken to capture what is important as for the evolution of such traits, while being silent on the exact realisation. It is entirely clear that physically distinct organisms may exhibit Batesian mimicry, and so that the ecological role biologists focus on in the definition is multiply realised. Unsurprisingly, there is more leeway for multiple realisation the more abstract functional characterisations we acknowledge. This is illustrated by the fact that human eyes and octopus eyes are functionally similar in general outline but functionally dissimilar at a more fine-grained level of functional characterisation (Couch, 2005, Richardson, 2008). Also, multiple realisation is widely assumed, not least in the wake of functionalism in the philosophy of mind, to be a quite general predicament in the sciences where minds and their products form the subject matter (Putnam, 2002/1967, Block and Fodor, 1972, Lennon and Charles, 1992).

Some have argued that this state of multiple realisation, and the accompanying difficulties about reduction[1], is due to the fact that biological systems are subject to

natural selection (Rosenberg, 1989, 1994, 2001, Macdonald, 1992, Papineau, 1992, 1993, 2010, Block, 1997, Brandon and Rosenberg, 2003). This position will be presented in some detail in the next section. I am entirely sympathetic to the view that nature (rather than the biologists) is to blame for the fact that biology doesn't quite look like physics. I'm also willing to grant that multiple realisation is an important feature when it comes to giving a constitutive explanation of what makes biology different. However, I will argue that the proposed explanation doesn't tackle the rise of this predicament. The explanation proceeds by assuming multiple realisation as an unexplained premise, and this assumption carries all the explanatory weight. The purported relevance of selection stems from presenting the "indifference" of selection to physical realisation as explanatorily relevant. However, while indifference to underlying structure may be an explanatory factor in intentional contexts, as I illustrate, there is no counterpart in non-intentional nature.

As regards the explanandum as such: I am fully aware that there is debate concerning the extent of multiple realisation, much due to lack of agreement about what counts as relevant differences and similarities (e.g. Bechtel and Mundale 1999, Shapiro 2000, 2004, 2008, Heil 2003, Polger 2004, 2008, Couch 2005, Richardson 2008). It is nowhere argued, however, that no biological kinds are multiple realised, at least not to my knowledge. More importantly for my present purposes, assuming multiple realisation will not be a problem dialectically as the position I criticise clearly presupposes that there is such a phenomenon to explain. Those who are sceptical about multiple realisation are free to take the discussion as concerning what appeals to selection can explain in principle.

2. The Targeted Position.

Alexander Rosenberg has in several places addressed the question what distinguishes biology from chemistry and physics as regards reduction (1989, 1994, 2001). Here is how he sets out the explanatory task (1989, 247, see also 1994, 25):

> [T]here is the substantive biological question why reduction of the sort envisaged by logical empiricism is impossible in biology. This question is a request for a causal explanation, one which cites biological facts that result in the many-many relation.

[1] Now, it seems that reduction isn't all that smooth in chemistry and physics either (Yi, 2003, Schaffner, 2006, Hendry and Needham, 2007). Given this, biological kinds must be taken to bring additional trouble.

Rosenberg then proceeds to invoke natural selection to explain multiple realisation. The key point is that effects are what count for selection and that "...at apparently every level above the nucleic acid, there are frequently to be found *physically distinct* structures with some *identical* or nearly identical functional properties..." (1989, 248, emphasis is original). In the next paragraph Rosenberg claims (emphasis is original):

> It is the nature of any mechanism that selects for effects, that *it cannot discriminate between differing structures with identical effects.* Functional equivalence combined with structural difference must in the nature of the case increase as physical combinations become larger and more physically differentiated from one another.

At a later occasion Rosenberg states: "Multiple realization kicks in as soon as natural selection begins operating on physical processes." (2001, 366).

Ned Block presents an argument very much like Rosenberg's. Block holds that we are to expect more variation on the level of realisation than on the design level because "…evolution enforces similarity only at the design level…" (1997, 17).

David Papineau, on his part, starts out from the common functionalist stance that mental states are causal intermediaries between perceptual input and behavioural outcomes. He then adds the plausible view that mental states are multiply realised at the physical micro-level. From this, the following puzzle arises (Papineau, 1993, 35):

> If there is nothing physically in common among the realizations of a given mental state, then there is no possibility of any uniform explanation of why they all give rise to a common physical result. And that's what I find puzzling.

He then aims to provide a "...non-reductive explanation for why variably realized psychological states often produce uniform physical effects." (1993, 44). It is here that natural selection enters the picture. Here is how Papineau illustrates the issue (1993, 44, the same example occurs in 1992, 61):

> All vertebrates who breed within a fixed location will act towards invaders of that territory in such a way as to frighten away those invaders. ...[L]et R be the invasion of the territory, S the characteristic behaviour, and T the departure of invaders. Then,

> plausibly, for such animals, R→ S → T. Yet there is no physical reduction of S: there is nothing physically in common between all the different forms of territorial behaviour displayed by vertebrates, apart from the fact that they all make intruders go away.
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> ...[T]here is scarcely anything puzzling here. The obvious explanation for the fact that these physically different kinds of behaviour all have the uniform effect of frightening away intruders is that natural selection has favoured those behaviours precisely *because* they frighten away intruders.

Graham Macdonald argues that functional explanation in biology "...leaves it open which mechanisms are responsible for the effects which are selected." This, he claims "...provides a reason why the function can be realized in physically different ways." (1992, 85-86).

Although there are differences between the accounts they share the idea that natural selection is part of the explanation of why biological/psychological kinds are multiply realised. I should say that I had no complaints about this reasoning when I first encountered it. It struck me at the time as quite plausible, even rather obvious. This verdict has not survived, however, and I will now turn to motivate this change of mind.

3. Initial puzzles about the explanandum as stated

The key element in these accounts is the idea that there are variables that are unconstrained by the factors that determine survival and reproduction. Multiple realisation is then held to be explained by reference to this fact. But there are questions to be raised concerning the exact explanandum. One reason to think so is that not only advantageous traits are multiply realised. There are traits that are (mostly or always) evolutionarily non-advantageous that are multiply realised across populations as well. When biologists consider and compare the chances of various "strategies" they may consider quite disadvantageous varieties as well. They then clearly leave open the question of exact realisation of "bad traits" as well. For instance, there is a quite general explanation of the disadvantageousness of albinism that holds regardless of the exact implementation of albinism. Furthermore, albinism is multiply realised at the genetic level.[2] But the explanation for the heterogeneity underlying albinism can hardly be the

[2] E.g.: "Albinism is a group of genetic disorders characterized by deficient synthesis of melanin pigment".

one suggested in the previous section. We cannot explain the state by saying, to use Block's expression, that nature enforces similarity only at the design level, or by saying, in Rosenberg's vein, that selection cannot discriminate between different structures that have identical effects.

From this we can gather that the explanatory task is at least under-specified. There has to be sources of multiple realisation that are independent of the considerations the authors in question appeal to. It seems, then, that the authors have in mind a kind of explanation that trades on the fact that there are variables that are unconstrained by considerations about fitness, but that applies only to advantageous traits. Now, the crucial difference between advantageous and disadvantageous traits is that the former tend to persist and spread. This suggests that the explanation must hold exclusively for advantageous traits in virtue of this fact.

4. About the explanatory contrast

A problem with locating the explanatory power to what accounts for persistence is that it would seem to be an explanation that presupposes what is to be explained. This is quite explicit in Rosenberg's account. Rosenberg, as we saw above, invokes the fact that "... there are frequently to be found *physically distinct* structures with some *identical* or nearly identical functional properties..." Thus, there are, he says "...frequently *ties* for first place in the race to be selected." (1989, 248, emphasis in original). It seems that selection is invoked to account for how a state of multiple realisation can persist, given that there for whatever reason are ties to begin with. But one might think that all the interesting work is done by whatever it is that explains why there are ties to begin with. Moreover, we have no reason to think that the explanation of why there are ties to begin with is sensitive to whether the varieties tie for first or last place in the fitness race. So, the explanatory target of these appeals to selection remains insufficiently identified. We are facing an explanation of multiple realisation that starts off by stating that distinct structures with similar functional properties are frequently found. On the face of it, this doesn't look like an explanation of why there is multiple realisation rather than not.

The problem concerns the relevant explanatory contrast. It is reasonable to assume that if it is claimed that a factor F accounts for the state S then F is relevant, at least

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(Spritz 1994, 1469).

probabilistically, in answering the question: Why S rather than non-S? So, if we want to account for why there is heterogeneity the relevant contrastive question would be: Why different manners of implementation rather than just one? Then, it would seem that an explanation that assumes from the outset that functional properties tend to be multiply realised doesn't have the right contrastive structure. Nevertheless, the authors at issue apparently take their explanation to be of the right kind.

Consider first Rosenberg's invocation of lack of discrimination on the part of selection. Rosenberg clearly sees that there is nothing in the principle of natural selection that precludes strict inter-level type identities, but he rules out that possibility as unlikely. He writes: "This blindness of selection to structure is no guarantee of causal heterogeneity in the realizers. But it certainly makes it overwhelmingly probable." (2001, 366). So, he seems to be saying that the "blindness" of selection is a probability-raiser. Ned Block makes what I take to be the same point in saying (1997, 17): "Since evolution enforces similarity only at the design level, we should expect more variation at the levels of realization than at the design level." That is, the lack of "enforcement" at the realisation levels is taken to justify an expectation about heterogeneity.

David Papineau's account exhibits the same feature. However, it also comes with a slight complication not found in Rosenberg's or Block's presentations, and this may give the impression that Papineau has a distinct explanandum in mind. Papineau presents his explanation as dealing with why physically different structures or processes yield the same effect. As it stands the question is raised concerning a number of given structures, and it concerns why "...these physically different kinds..." have a uniform effect. So for instance, Papineau discusses water heaters and claims to address the question why physically different realisations of thermostats all have the uniform effect of stopping the heating at a threshold temperature (1993, 44). The answer is then, he claims, that the devices were designed to stop heating. However, I gather that he misstates the explanandum. The procedure of design doesn't make it the case that a number of given structures come to have the same effect rather than having different effects. Surely, engineers cannot do anything to alter the effects a fixed structure has (barring alterations of environmental conditions). If we are not happy with a structure's effects we will have to change it into a different structure or find another one that is different. Thus, Papineau doesn't really address the question why the resulting physically different things have similar rather than different effects. His question must rather be why there are, in a particular functionally characterised sample, several kinds of structure rather

than just one. Then, like Rosenberg and Block, his answer must be that the appearance of several solutions is probable given that the effect is all that matters.

Graham Macdonald holds that functional, *qua* selectional, explanation leaves room for multiple realisation. When he says that "...the possibility of different mechanisms instantiating the same function will always be present" (1992, 90) he seems to be suggesting that this possibility is a probability-raiser for heterogeneity. It is at least not clear what the point of invoking the possibility would be unless this is suggested.

So, although there are differences in exposition, Rosenberg, Block, Papineau, and Macdonald all seem to hold that selection per se is a factor that raises the probability of multiple realisation. If it does, the explanation has the right contrastive profile, since multiple realisation will then be more probable given selection.

It is clear that the account will work, if at all, only if multiple realisation is presupposed, since there is no generally valid inference from “indifference” to heterogeneity. Saying that selection is "blind to structure", or that it "enforces similarity only at the design level", can only mean that differences, at whatever level, that do not affect fitness are irrelevant from a selectionist point of view. Explanatory irrelevance of such a kind is clearly a ubiquitous phenomenon. So, for instance, there are interactions between chemical elements that trade on valency while being "insensitive" to other properties. Then, *if* there is "valency-neutral" heterogeneity there may be structurally dissimilar entities playing similar roles in chemical bonding. However, we can hardly infer, even probabilistically, that there are several slots, rather than just one, in a particular column of the periodic table from pondering the "blindness" involved. For such information we will have to attend to other sources. Similarly, there is much variation among planets that is irrelevant in accounting for gravitational properties. However, I take it that it would be odd to claim that the existing variation among planets in non-gravitational respects could have been predicted merely from considering that gravity places no constraints on the variables in question. The “indifference” involved must be taken to be an “indifference” between the options homogeneity and heterogeneity, not as in itself rendering the latter option more probable.

To make the problem concerning the explanatory contrast more vivid we can reconsider Papineau’s example with the water heaters. What if we choose a different function than the heating of water? Assume that a team of engineers are interested, for some functional purpose, in the property of having a half-life of 5730 years, regardless of how it is implemented. Assume further that the universe doesn't "know of" any other

means of implementing this property than trough C_{14}. Now, the mere fact that the engineers are interested only in the effect has no tendency to give us a sample within which a half-life of 5730 years is multiply realised. So, the fact that there are no constraints regarding exact implementation seems to be a probability-raiser for multiple realisation, if at all, only if heterogeneity can be independently assumed.

So, the accounts in question need to plug in heterogeneity from the start in order to have it at all. But what is it then that makes multiple realisation more probable than uniform realisation, apart from the fact that the latter alternative is independently taken to be false?

I take it that a motivating idea underlying the proposals is the following: Different populations, even of quite different species, will often face the same kinds of environmental challenges. So, for instance, creatures of very different makeup will benefit from being hard to detect for predators. Then, if beneficial effects having to do with camouflage can be realised in many ways, we may expect the living world to come to contain a variety of ways of implementing that function. This is true as far as it goes. However, what this explanation accounts for is why there is an increase in heterogeneity over time, given that (many) adaptive effects can be multiply realised. If multiple realisation, and the very possibility of accumulation of structure, is assumed to begin with one may clearly expect that sameness in conditions of life will make for a world with multiply realised "solutions". After all, it would be odd to predict a persisting state of structural homogeneity once we acknowledge that "solutions to adaptive problems" are independently expected to be multiply realised.

If this is what is intended, however, the explanation is not very accurately advertised. One should at least make explicit that the very fact that there are ties for first, or last, place to begin with is left unexplained. Furthermore, as this explanation is quite trivial one may wonder how it illuminates the phenomenon of multiple realisation. What is left to explain once it is assumed that there will be different "solutions" to the same "adaptive problems"?

This question leads us to the role that the authors in question assign to the "indifference" to structure, or lack of "enforcement" at the implementation level. The idea seems to be that it isn't enough to assume that there will be different ways of producing functionally similar effects, we need to invoke the indifference of selection as well. I will argue that this is mistaken since what is thereby appealed to is not a causal factor at all. I will discuss this point at some length in section 6. First, however, I will

illustrate that indifference can indeed be a relevant factor when it comes to explaining heterogeneity. However, the explanatory credentials there are derive from intentionality.

5. How insensitivity can be relevant to explain heterogeneity

Consider the following: Individuals A and B have the job to, independently of one another, select organisms that have trait T, regardless of how the trait is realised. A's selection procedure works entirely according to the task. B, however, has deep-rooted but subconscious biases concerning the exact realisation of T. Assume that T is in fact multiply realised in the global population. Due to A's one-dimensional selection procedure, A's sample will include different ways of implementing T. Due to B's subconscious biases, however, B's collection will include only one manner of realisation, and so be homogeneous. In this context it appears to make sense to say that the greater heterogeneity of A's sample is due to A's indifference to how T is realised. Given this comparative claim we can say, counterfactually, that if A had been sensitive to the manner of implementation A's collection would have been more homogeneous. So, an explanatory connection between indifference and heterogeneity is established, and the indifference involved is clearly a variable factor. Of course, the explanation deals only with the heterogeneity there is in A's sample, not with the one found on a global scale. Clearly, then, it is an explanation that answers the contrastive question about heterogeneity vs. homogeneity only concerning the resulting samples.

Then, if we can conceive of selection as something that plays the role of A an explanation that invokes indifference would perhaps be vindicated. That is, it wouldn't explain the origins of multiple realisation but, I suppose, why there is, with time, heterogeneity in the existing sample of persisting traits. But then, if the explanation is supposed to trade essentially on indifference, or lack of enforcement, and if intentionality is ruled out, what exactly is the posited factor?

6. Searching for the blind mechanism

A central feature of the purported explanations of multiple realisation at issue here is clearly the invocation of the "indifference" of natural selection to underlying structure. Rosenberg claims, to repeat: "It is the nature of any mechanism that selects for effects, that *it cannot discriminate between differing structures with identical effects.*" (1989, 248, emphasis is original). Block makes the same point by speaking of evolution as constraining the design level only (1997, 17). David Papineau clearly relies on the point

that the relevant "design processes" are sensitive only to the useful effects, both when discussing territorial behaviour among vertebrates and when discussing thermostats (1993, 44). Similarly, Graham Macdonald takes it to be important that functional categorisation is insensitive to the details of implementation (1992, 90).

I take it that the proposed explanation of multiple realisation must invoke, first, the generation of novel varieties. At this stage there may be ties for first place fitness-wise. This fact is not explained by appeal to the "indifference" of selection; indeed it cannot be since, as illustrated above, disadvantageous traits are multiply realised as well. Secondly, we apparently need a further factor that ensures equal chances of persistence among those that tie for first place, otherwise the explanation would end at the moment we accept, without explanation, that there are ties for first place. Thus, this second factor is seemingly invoked to account for why there isn't any systematic weeding out among the equally fit. This is then what is carrying the weight of the explanation on offer.

Consider the following case: Assume that we have two species of organisms in which Batesian mimicry develops, although the manner of implementation differs. The targeted view doesn't explain why there are different realisations of Batesian mimicry to begin with. However, it apparently claims that in order to explain the persistence of heterogeneity we need to add a selecting factor that is insensitive to the differences in implementation. The idea must then be that without an appropriately indifferent factor (i.e. like A in the former section) one of the functionally equivalent but structurally dissimilar varieties might be eliminated, and if so heterogeneity would be precluded. So, what exactly is this factor?

Consider the standard derivations of the principle of natural selection that have been around ever since Darwin, including the axiomatisation that Rosenberg prefers (1994, 106). These derivations are claimed to state the requirements for selection. However, they do not mention the requirement that nature select "blindly" on the basis of fitness differences rather than, for instance, on the basis of structural differences of no import fitness-wise. What would the latter situation be like? One cannot manipulate nature such that its pruning will be systematically sensitive to differences that are irrelevant for fitness. We don't have any particular causal factor to thank for the "insensitivity" involved, as the idea of the alternative is incoherent. Talk of nature as selecting on the basis of fitness differences can only be interpreted as referring to a statistically inevitable consequence of the stated conditions, not as invoking an additional causal

requirement. Talk of nature as selecting "indifferently" can then only be interpreted as saying that some differences are irrelevant for the outcome. The "indifference" is thus not an independent variable in this case, whereas the indifference of person A (of previous section) to manners of implementation is. So, we cannot claim that multiple realisation depends counterfactually on the "blindness" of selection to structure since there is no counterfactual condition.

None of this is to deny that evolutionary explanation is probabilistic and that there is randomness in the elimination of varieties. However, random elimination is not, of course, a coherent general expectation. Nor is it, being random, expected to promote homogeneity of implementation.

The claim that natural selection explains multiple realisation appears to emanate from the tradition of viewing selection as an independent casual factor. This view is in fact quite problematic (e.g. Walsh, 2000, 2007, Walsh, Lewens, and Ariew, 2002, Matthen and Ariew, 2002, 2009, Brunnander, 2007), and I take the current discussion to illustrate this.

7. Concluding remarks

It is likely that the authors whose proposals I discuss here are mainly out to express the idea that an increase in heterogeneity underlying functional traits is to be expected given the relative generality of many environmental challenges, and given that "ties for first place" are assumed to begin with. There is nothing wrong with this idea as such. However, there is a problem with presenting it as explaining why there is multiple realisation rather than not. If this is the probability-raising the authors have in mind I think they are guilty of false advertising. The central problem is that there is really nothing to add once it is assumed that nature has many ways of making advantageous (and disadvantageous) traits. This is not explained, but is what does all the explaining. However, the proposals apparently hold that there is explanatory work left to do, and this is accomplished by invoking indifference, or lack of constraint, as being relevant. But while indifference can be a variable property of agents in intentional selection, the "indifference" of selection is not an explanatory variable at all. Whereas agents may be more or less capable of selecting strictly in accordance with the explicit criterion, nature simply has no choice. There is no alternative world where nature is systematically sensitive to physical differences of no import fitness-wise. Multiple realisation is thus not counterfactually dependent on "the blindness of selection" as the "non-blind"

counterfactual condition is impossible. Once it is acknowledged that there are ties for first place no further factor is required to account for the heterogeneity there is in the living world. So, the invocation of the indifference of selection to structure doesn't accomplish anything that isn't accomplished already by what is presupposed from the outset. And what was presupposed from the outset was multiple realisation, which was to be explained.

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