Mechanistic Explanations in Music Theory: Lessons from Biology and Physical Geology

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Abstract

A lively debate in philosophy of music concerns the following question: does music theory produce only interpretive statements, or does it produce scientific explanations as well? Peter Kivy has argued that music theory produces only interpretations, while Mark DeBellis has responded by offering examples of purported scientific explanations of musical works. In last year's Proceedings of the European Society for Aesthetics, Zsolt Bátori argued that Mark DeBellis' examples are not scientific explanations, citing differences between DeBellis' example and certain scientific explanations. In the current discussion, I argue that Bátori's conclusion is motivated by a limited consideration of scientific explanations that overlooks mechanistic explanations in biology and physical geology. While Bátori demonstrates successfully that DeBellis' examples lack certain properties that many scientific explanations possess, these very same properties are lacked by mechanistic explanations in biology and physical geology as well. The arguments of Kivy and Bátori's fail, ultimately, to prevent us from characterising DeBellis' examples as mechanistic explanations of the sort found in biology and physical geology.

1 Introduction

One of the many debates that have benefited from the contributions of Peter Kivy concerns the following question: does music theory produce only interpretive statements, or does it produce scientific explanations as well? Kivy (1990) argues that music theory deals exclusively in interpretations. In contrast to Kivy's position, Mark DeBellis (1995) has argued that some music theoretic statements are scientific explanations[1]. Such purported explanations are likened to mechanistic explanations found in the sciences.

Although DeBellis' examples seem to constitute a clear refutation of Kivy's position, Zsolt Bátori has, in the 2012 Proceedings of the European Society of Aesthetics, argued that they do not. Bátori's argument rests on the assumption that DeBellis' examples are not scientific explanations because they differ crucially from scientific explanations: he argues that DeBellis' examples purport to explain audible musical phenomena by appealing to underlying musical phenomena that are *perceivable*, while the scientific mechanistic explanations he has in mind appeal to *imperceivable* underlying microstructures. While Bátori is successful in showing that DeBellis' examples are not scientific explanations of a certain type (i.e., those that refer to an imperceivable lower level), this success is limited by the fact that these examples fit another type of mechanistic explanation. I argue that Bátori's argument is motivated by a limited consideration of cases that overlooks mechanistic explanations commonly found in biology and physical geology. When such cases are examined, it becomes clear that perceivable lower levels

[1]The locution 'X is a scientific explanation' can here be understood loosely as 'X has the form of a scientific explanation', or 'X resembles a scientific explanation in all relevant respects'.

are not unique to DeBellis' examples; perceivable lower levels are found in mechanistic explanations in the sciences as well. Consequently, Bátori has not argued successfully that DeBellis' examples are not scientific explanations, but, merely, that they fail to satisfy a criterion that many mechanistic scientific explanations would fail as well.

2 A Dilemma

Bátori's (2012) presentation of Kivy's (1990) argument can be reconstructed as follows:

i. Assume: all properties of musical works are audible.

ii. Assume: if music theory produces scientific explanations of musical works, then these explanations are likely to be mechanistic explanations.

iii. Assume: in mechanistic explanations, macrostructure entities are explained through appeals to microstructures, and microstructures are imperceivable (i.e., inaudible).

iv. Law of Excluded Middle: the microstructures referred to in music theoretic discourse are either perceivable or they are imperceivable.

v. Dilemma: scientific explanations of musical works are unlikely to refer to perceivable microstructures (due to [ii.] and [iii.]); and scientific explanations of musical works cannot refer to imperceivable microstructures (due to i.).

vi. Conclusion: it is unlikely that there can be scientific explanations of musical works.

Kivy's (1990) project was to engage with music theory insofar as it was relevant to music appreciation (roughly, the activity of perceiving the aesthetic properties of a work while listening to it). Specifically, he maintained that statements from music theory could aid in music appreciation, such that improving one's understanding of music theory could improve one's ability to perceive aesthetic properties (e.g., coherence, thematic unity, & etc.) when listening to works. Assumption [i.] can be understood, then, as a reflection of a limited scope; Kivy was simply not interested, during that particular project, in the capacity of music theory to aid in our non-aural appreciation of music[2], and this removed any motivation to treat musical works as the bearers of non-aural properties. This sentiment is expressed by Kivy, when he writes "as the present essay concerns the musical work as heard, what cannot be heard is not part of the work, nor is what was not intended to be heard" (194). Non-aural properties of works, should they exist, would be simply irrelevant to the bare relationship between music theory and the direct appreciation of perceptible sounds.

Assumption [ii.] is motivated by an appeal to plausibility:

> Although, of course, there are several ways and methods of scientific explanation, there is at least one kind that seems to be an initially plausible candidate for being analogous to what music theory is often argued (or assumed) to do. Specifically, it is the kind of scientific explanation, as explicated by Searle, which aims to account for the readily available, perceptible "surface" properties of some phenomena in terms of their microstructure. In this special case of cause and effect relationship, the surface feature is both realized in (or consists in) and caused by the micro-level properties (Bátori 2012, 71).

[2]One could, for example, appreciate the history of a work.

In the foregoing, I will refer to all explanations in which higher-level phenomena are explained in terms of the lower-level entities of which they are composed[3] as *mechanistic explanations*. What should be clear from the above quotation is that Bátori is not directly committed to [ii.], but to a much more specific claim, from which [ii.] is a logically weaker abstraction.[4] Instead of merely discussing the general picture of mechanistic scientific explanation, he makes claims about realisation (realised property instances are borne by the individuals that realise them) and causation (realised property instances are caused by the property instances that realise them).

More relevant than claims about realisation and causation, however, is Bátori's commitment to [iii.]: he takes it to be characteristic of mechanistic explanations in the sciences that lower-level entities are *microstructural*, such that they are imperceivable to us while higher-level phenomena are *surface phenomena* that are perceivable. While much could be said about the predicate "imperceivable", for the purposes of this discussion it is not necessary that "imperceivable" has significance beyond our current epistemic limitations as human observers. We can understand "ϕ is imperceivable", then, as "ϕ is imperceivable to experienced human observers". By "experienced" I mean that the human observers have been trained to observe ϕ and distinguish ϕ from things that are not ϕ. Consequently, the inability of a person with no musical training to perceive a $\text{ii}^{\emptyset 7}$ chord does not count as evidence against the perceptibility of the $\text{ii}^{\emptyset 7}$. I am intentionally introducing talk of individuation and propositional knowledge into my characterisation of "perceivable". This characterisation of "perceivable", regardless of objections that could be raised in other contexts, is the sense relevant to the current discussion.[5]

If [ii.] is true, then our best procedure for discovering scientific explanations in music theory is to look for statements that seem to explain higher-level surface phenomena of musical works by appealing to their lower-level components. However, the following disjunction [iv.] is trivially true: either such lower-level components are perceivable, or such lower-level components are imperceivable (74). If these components are perceivable, then, due to [ii.] and [iii.], statements that appeal to these in explanations of musical surface phenomena are unlikely to count as *scientific explanations* of musical works (since the microstructure is perceivable). If, on the other hand, the components are imperceivable, then (due to [i.]), statements appealing to these in their explanations of musical surface phenomena cannot be considered scientific explanations of *musical works* (since all musical properties, in this discussion, are audible properties). Thus, we find ourselves with a dilemma [v.]: either horn leads us to the conclusion [vi.] that it not likely that music theory can produce scientific explanations of musical works.

Note that the above argument does not show that music theory cannot produce scientific explanations of musical works, but simply that such a production is unlikely. Bátori does not argue that mechanistic explanations characterised by [iii.] are the only scientific explanations that music theory could possibly offer, but simply that these are the most plausible sorts of explanations. However, the argument certainly does show that music theory cannot produce mechanistic explanations that satisfy [iii.].

Nevertheless, DeBellis (1995) offers several example of what he takes to be scientific musical explanations (*qua* [iii.]) (Bátori 2012, 75). Bátori presents one such example as follows, "a change of emotional tone is often explained by a change in mode from minor to major or vice versa; appealing to change of mode means applying music theoretical terms in the expla-

[3]By "composed", I mean any of the various 'making-up' relations (i.e., relations in which one entity is 'made out of' another) in which entities can be said to stand.

[4]Obviously, if one is committed to "it is likely that X is a square", then one is committed to logically weaker abstractions such as "it is likely that x is a polygon". This is the sense in which I take Bátori to be committed to [ii.].

[5]A consequence of this characterisation, however, is that the set of imperceivable entities will change as the epistemic situations of our highly trained human observers change.

nation of surface properties of music" (75). A change from major to minor is perceivable to trained auditors, however; consequently, such modulations cannot play the role of "microstructures" in scientific explanations *qua* [iii.]. If changes between the major and minor modes were not perceivable to trained auditors, then such properties would not count (in this discussion) among the properties borne by musical works (due to [i.]). Thus, explanations appealing to such properties (even if they were to count as scientific explanations) would not be scientific explanations of *musical works*. In other words, mode modulations are either perceivable (in which case they are inappropriate candidates for the microstructure of a mechanistic scientific explanation *qua [iii.]*) or they are not (in which case they are inappropriate candidates for musical explanations): either way, the possibility of scientific explanations (*qua* [iii.]) of music (*qua* [i.]) has been precluded.[6] To be clear, this is not simply an argument against DeBellis' particular examples; the argument leading to dilemma [v.] can be generalised to any proposed example.[7]

3 Lessons From Biology and Geology

If all mechanistic scientific explanations appealed to an imperceivable microstructural lower-level, then assumption [iii.] certainly would be warranted. After all, if it really were the case that both (a.) all scientific explanations of a specific type were found to have a certain property, and (b.) it were to be shown that music theory is incapable of producing statements with that property, then this would count as evidence against the capacity of music theory to produce explanations of that type. Nevertheless, no such support is available for those who wish to employ assumption [iii.]. On the contrary, many scientific mechanistic explanations are such that higher-level phenomena are explained by appealing to *perceivable* lower-level phenomena. Consequently there is no reason why one should assert that musical statements must be mechanistic explanations *qua* [iii.] if they are to count as scientific mechanistic explanations. To show that scientific mechanistic explanations often refer to a perceivable lower level, I offer two examples from biology and physical geology.

My first example is that of the woodhoopoe, an African bird with a complex social hierarchy, presented in Grimm and Railsback's (2005):

> The social groups live in territories where only the alpha couple reproduces. The subdominant birds, the "helpers," have two ways to achieve alpha status. Either they wait until they move up to the top of the group's social hierarchy, which may take years, or they undertake scouting forays beyond the borders of their territories to find free territories. Scouting forays are risky because predation, mainly due to raptors, is considerably higher while on a foray (5).

In this example, there is a higher-level individual (a population of birds) with higher level properties (population size, density, geographical distribution, & etc.) composed of lower-level individuals (individual birds) with lower-level properties (risking being eaten by a raptor, having a specific social position, having a specific age, & etc.).

Grimm and Railsback's procedure is as follows: first they assume that each individual bird is behaving in such a way so as to maximise its chance of survival (taking into account the distribution of bird-level properties, such as 'age' and 'social rank'). Secondly, they examine the

[6] Again, as was stated previously, this does not entail that music theory cannot offer scientific explanations that are *not* characterised by [iii.], but only that it is unlikely to do so.

[7] Any explanation from music theory will either refer to perceivable properties (in which case it cannot be a scientific explanation *qua* [iii.]) or to imperceivable properties (in which case it cannot be about music *qua* [i.]).

distribution of birds predicted by that previous assumption. Next, they compare that distribution with actual distributions of populations of birds that can be found in Africa. They find a match between the population-level distribution predicted by a consideration of bird properties and the distribution found in nature, so they assert that the population-level properties may[8] be explained by the bird-level properties. In other words, the higher-level properties may be explained by the lower-level properties.

My current aim is not to argue, in a paper about aesthetics, for an empirical claim about woodhoopoes. Rather, my point is that this explanation is an acceptable candidate for a mechanistic scientific explanation of the phenomena in question. This is to say, nothing about the *form* of the explanation disqualifies it from being deemed a scientific explanation (and, indeed, Grimm and Railsback present it as the correct explanation for the observed phenomena). However, notice that woodhoopoes are quite perceivable; not only can they be seen, but they can be heard as well (Radford and Du Plessis 2004). Thus, [iii.] is simply not characteristic of this scientific explanation.

Mechanistic explanations that focus on perceivable lower-level entities are not unique to biology: such explanations are found in physical geology as well. Imagine that, while preparing to bake a cake, I pour flour into a funnel above a large, dry, empty mixing bowl. Assuming that I hold the funnel steadily, what will be observed is cone-shaped pile of flour. One physical quantity of the cone-shaped pile is its slope; for flour, this slope will not exceed 45°. In the terminology of physical geology, the *critical angle of repose* of the pile of flour is 45°. Sand dunes, a more common subject for geologic study, have a critical angle of repose of 34°, such that the maximum slope of a sand dune is 34° (Glover 1998).

Sand dunes are composed of sand, and, just as with the case of the woodhoopoes, we can explain the higher-level sand dune property 'having a critical angle of repose of 34°' in terms of the lower-level properties of sand. The critical angle of repose of the sand dune is largely[9] a function of the arctangent of the coefficient of static friction[10] of its constituents: $\tan\theta \approx \mu_s$, where θ is the angle of repose and μ_s is the coefficient of static friction (Lindeburg, 2010). There is nothing mysterious about this relationship; it is rather intuitive that particles that slide easily against each other will be difficult to place on top of each other into a cone-shaped heap with a large slope (imagine trying to form a cone-shaped heap by dropping smooth glass marbles onto each other). It is comparably easier to stack particles that do not slide easily against each other into such a heap. Thus, we explain the higher-level sand dune property of 'having a critical angle of repose of 34 °' by appealing to the lower-level sand property of 'having a particular μ_s'.[11] Since sand particles are perceivable, this case presents further motivation for rejecting [iii.]: this is another scientific mechanistic explanation that explains higher level phenomena in terms of perceivable lower-level phenomena.

4 Implications and Limitations of Scope

Thus it simply is not the case that the lower-level entities referenced in scientific mechanistic explanations are always imperceivable microstructures. On the contrary, mechanistic explanations of biological populations and geological sand dunes appeal to lower-level entities that

[8] Obviously I have been vague here. Additionally, further work would be necessary to determine whether this putative explanation (when fully specified) is superior to other explanations.

[9] This function serves as a close approximation.

[10] Static friction is the force of friction between two objects that are not moving with respect to each other. The product of the normal force and the coefficient of static friction is the maximum amount of friction that can occur between two objects before the objects will move with respect to each other.

[11] Obviously, the coefficient of static friction does not exhaustively explain the critical angle of repose, but it is a salient and critical component of the mechanistic explanation of it.

are easily perceivable (woodhoopoe birds and sand particles respectively). Consequently, the fact that changes from the major to the minor mode are perceivable does not disqualify such phenomena from playing the role of lower-level entities in scientific mechanistic explanations. Rather than distinguishing such musical phenomena from the entities that populate the lower-levels of scientific cases, perceptibility is quite common in scientific lower levels. Thus, while the musical statements of DeBellis may fail to be mechanistic explanations *qua* [iii.], they do not fail to be the sort of mechanistic explanations characteristic of biology and physical geology.[12] Consequently, they do not fail to be scientific explanations.

Returning to the reconstruction of Bátori's original presentation of Kivy's argument, we can accept [i.] and [ii.], but deny [iii.], allowing us to accept the first disjunct of [iv.], such that [v.] and [vi.] no longer hold. To put it simply, we can accept that scientific explanations from music theory are likely to be mechanistic explanations that explain perceivable higher-level musical phenomena by appealing to perceivable lower-level musical phenomena. Now that [iii.] has been rejected, nothing about Bátori's presentation of Kivy prevents us from classifying DeBellis' examples as mechanistic scientific explanations.

I want to close with two qualifications. First of all, it is quite compatible with my position that much, or even most, of what is done in music theory would count as interpretation and not as explanation. I have argued, merely, that we can resist the arguments of Kivy and Bátori who would conclude that DeBellis' music theoretical statements, as well as all other such statements, can not be scientific explanations. Secondly, the claim that music theory produces scientific explanations[13] is distinct from the claim that music theory is science, and this discussion has addressed the first claim, but not the second. A discussion that deals with the second claim will have to adopt a framework regarding scientific demarcation, and then use that framework to evaluate music theory.[14] While I have not here been concerned with this issue of demarcation, the preceding remarks are not entirely irrelevant to it. For should one wish to argue that music theory is a science, one will, quite plausibly, have to demonstrate that music theory can produce scientific explanations. If my arguments have been successful, then I have shown that such a project is not impossible.

[12] One could, of course, deny that biology and physical geology are science. However, such a denial could best be characterised as an ad hoc manoeuvre that would result in an untenable view of science.

[13] Recall that, as indicated in footnote 1, 'X is a scientific explanation' is to be understood loosely.

[14] A Lakatosian (1978) framework, for example, would evaluate whether music theory is a *progressive* research program or a degenerating one, while a Popperian (1989) framework would lead one to evaluate the falsifiability of particular theories proposed by music theorists.

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