

Emergentism and musicology: an alternative perspective to the understanding of dissonance

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***Abstract.** In this paper we develop an approach to musicology within the discussion of emergentism. First of all, we claim that some theories of musicology could be insufficient in describing and explaining musical phenomena when emergent properties are not taken into account. Actually, musicology usually considers just syntactical elements, structures and processes and puts only a little emphasis, if any, over perceptual aspects of human hearing. On the other hand, recent research efforts are currently being directed towards an understanding of the emergent properties of auditory perception, especially in fields such as cognitive science. Such research leads to other views concerning old issues in musicology and could create a fruitful approach, filling the gap between musicology and auditory perception.*

1. Why emergentism contributes to explain musical phenomena?

In 1754 Giuseppe Tartini (1692-1770) constructed his musical treatise based on the phenomenon of the *combination sounds*: when two sounds are played together a third sound may be perceived, and its frequency is the difference between the frequencies of the two original sounds. He believed that the third sound perceived existed acoustically, and used this phenomenon to differentiate dissonance from consonance. This difference was the starting point of his musical system.

In the 20th century some theories did something similar to Tartini, but in different contexts and with different targets. These theories tried to explain or to create musical rules from exclusively acoustical (physical) phenomena, or sometimes even without it when based exclusively in mathematical rules. These theories try to achieve a musical formalism that usually puts listening aside, as in serialism, generative theories of music, AI models of compositional thought, of pitch-class theory. Of course we do not deny the clear importance of these theories. But, as nowadays we know that the Tartini combination sound is not acoustical but psycho-acoustical (the third sound perceived do not exist acoustically, being a phenomenon created by basilar membrane), we can state that a better knowledge of listening can contribute to a deeper explanation of musical phenomena. Specially by means of emergentism, because it takes in account both inner and outer aspects of perception. It does not explain phenomena by reducing it to some single physical properties or to the stimulus itself, what would make some properties to disappear. And it tries to explain the appearance of some phenomena without

metaphysical argumentations. Some musical properties, as the combination sound or some classical harmonic phenomena, and even the music itself, are simply inexplicable exclusively from acoustic properties or from formal rules applied to some acoustical units. Another viewpoint is needed to explain such phenomena, and that is one of the most important contributions emergentism can offer to musicology.

2. Kinds of emergentism.

In ordinary language, the term ‘emergence’ is employed just to mean that something appeared that was not existent before, but beyond this ordinary use the term ‘emergence’ is employed, in the so-called emergentist philosophies, in a technical sense. In this technical sense, the term ‘emergence’ and its derivatives are applied to a variety of categories, including properties, dispositions, structures, entities, behaviours, phenomena, etc, but all these different uses can be easily related and traced back to the notions of ‘emergent property’ and ‘emergent structure’ (El-Hani 2003b). Stephan (1998) provides us with a classification of the diverse types of emergentist philosophies found in the philosophical and scientific literature. He postulates six different versions of emergentism: weak emergentism, synchronic emergentism, weak diachronic emergentism, strong diachronic emergentism, diachronic structure emergentism, and strong diachronic structure emergentism. Of course, there are many aspects involved in this taxonomy, and we will very briefly point them out, taking as a basis both Stephan’s work and papers on the issue published by one of the authors of this paper.

Three important notions are involved in this scheme: irreducibility, novelty and unpredictability. Nevertheless, other notions are implicitly involved as well. *Weak emergentism* comprises three basic theses. First, physical monism, that leads to a belief in the generality of physics and the inclusion of higher levels, such as the biological, mental or social levels, and their emergent properties, dispositions, structures and behaviours, within the physical level. Second, that there are systemic properties, properties that a system has but none of the system’s parts possess, and emergent properties are a particular kind of systemic properties. Third, any emergent property is depend nomologically on basal conditions found in the micro-structure of the system which instantiates it, so that we can say that emergent properties are synchronically determined by the system’s micro-structure.¹ Synchronic determination may lead to the event that two emergent properties, *A* and *B*, which seem to be causally dependent on each other, can be actually both caused by a given sequence of arrangements of the system’s constituents and their properties in the micro-structure of a system, *C*. The behaviour observed when such a system turns from *A* to *B* is nomologically caused, in this case, by a difference in the arrangement and properties of the system’s micro-constituents, *C*.

Synchronic emergentism holds the assumptions described above and adds the notion of irreducibility. There are two different notions of irreducibility in the literature,

¹ Previously, this idea has been stated in a weaker version, as the thesis of ‘mereological supervenience’. The reason why this latter thesis is to be regarded as weaker than synchronic determination lies in the issue that it does not entail, as it is usually thought, the *determination* and *dependence* of the system’s properties on its micro-structure (El-Hani 2003b). Supervenience simply states a pattern of covariance between two sets of properties, and we cannot directly derive a metaphysical relation of dependence/determination from property covariance (for treatments of this issue, see, e.g., Kim 1993, 1997; Heil 1998; Bailey 1999).

as irreducibility can be grounded on the unanalyzability of systemic properties or on downward causation. In the first notion of irreducibility, to a systemic property to be irreducible it must be unanalyzable in terms of the behaviour of a system, no matter if this behaviour is described micro or macroscopically, *i.e.*, the emergence of such properties does not follow from the behaviour of the system's components. As such emergent properties would be unanalyzable, they would certainly be irreducible. One typical example, maybe the only one, is found in the philosophy of mind, namely, in arguments about the irreducibility of qualia as allegedly intrinsic, non-relational properties. The second condition that can lead a property to be irreducible is the non-deducibility of the behaviour of the system's parts: in this case, the specific behaviour of the system's components, which synchronically determine a given systemic property, does not follow from the parts' behaviour in isolation or as aggregated in different kinds of systems. Thus, the systemic properties determined by that specific micro-structure would be irreducible. It is at this juncture that the notion of downward causation, much debated in the last years, enters the scene. If either the condition of unanalyzability or the condition of non-deducibility through downward causation are satisfied, there is a case for the irreducibility of systemic properties

Diachronic emergentism adds two different assumptions to weak emergentism: novelty and unpredictability. Novelty is defined in the sense that "already existing building blocks will develop new constellations; new structures will be formed that constitute new entities with new properties and behaviours" (Stephan, 1998, p.645). The basic idea is that new structures can arise from different ways of arranging already existing elements, and these new structures, found in new kinds of systems, instantiate novel properties and behaviours. Notice the important tenet that structure emergence is the basis for property emergence. For the major part of emergentists, novelty is associated with unpredictability, and, in this sense, they differentiate something which is simply new from something which is genuinely new, because it is not the only the case that it happened for the first time but also that its happening could not be predicted from previous knowledge. In this sense, something that is genuinely new is theoretically unpredictable, although it can be the case that, once it happened, it is inductively predictable, given that emergent properties depend nomologically on the micro-structure of a system, and, thus, one can predict, by inductive reasoning, that if a specific micro-structure is instantiated in a given kind of system, a specific emergent property will also be instantiated. Some emergentists do not combine the notion of novelty with that of unpredictability, as, for instance, Bunge (1977), Blitz (1992), and El-Hani (2000, 2003a,b). For these emergentists, something is new if never happened before in the course of history independently of its (un-)predictability (El-Hani 2003a,b).

An emergent property can be unpredictable if it is instantiated by a given kind of structure in a given kind of system, and that structure is unpredictable, or if even when the structure is predictable, the emergence of the property is in itself unpredictable, because that property is irreducible. As concerns structure unpredictability, Stephan (1998, p. 647) affirms that "the rise of novel structures is unpredictable in principle, if their formation is governed by laws of deterministic chaos. Likewise, any novel properties that are instantiated by those structures are unpredictable in principle". Nevertheless, his arguments depends on making inferences about what a Laplacian demon or supercalculator could or could not know, and this makes the whole argument

a weak one, as we have no clear criteria to make such kind of inferences about that creature of fancy (El-Hani 2003b). El-Hani (2003a) advocates an understanding of emergence which acknowledges the possibility that an emergent property be shown to be predictable from the knowledge about a system's parts, and, even so, be properly characterized as 'emergent'. He considers that an emergence theory which casts aside the notion of unpredictability is more convincing, since the demonstration that emergent properties are theoretically unpredictable would only make the theory stronger, while the opposite would be true if the theory regarded emergent properties as unpredictable from the knowledge of the parts. It is indeed difficult to hold the idea of an in-principle theoretical unpredictability of emergent properties or structures, as the thought experiments needed to support this idea, involving fantastic creatures such as Laplacian demons, depend on assuming some stance about the determinism or indeterminism of the universe. For instance, if determinism is not true, a Laplacian demon will be incapable of predicting the emergence of a given property or structure, no matter its complete knowledge. But, as the debates about determinism are quite complex and controversial, and seem to be far from any generally accepted solution, this would be too heavy a burden for a concept of emergence to bear. An account of emergence that does not rest on such a major assumption about the nature of the universe is clearly preferable. And arguments which negotiate the amount or kind of knowledge a Laplacian demon should have, as those advanced by Stephan (1998), seem too feeble to support any cogent conclusion (El-Hani 2003b).

We should emphasize here some additional issues in the scope of musicology. Diachronic emergentism seems to be more adequate in this case, as it considers the evolving time, and music deals directly with time evolution. Nevertheless, other aspects are involved with musical activities, such as qualia, and in this case synchronic emergentism seems suitable. Therefore, if one has a well formulated problem about some musical property, he or she can devise an adequate emergentist account of this musical property bearing in mind the right variety of emergentism, and, for this purpose, Stephan's taxonomy is a valuable tool.

Anyway, the above comments point unequivocally to strong emergence theories combining at least an aspect of novelty (with or without unpredictability) with the notion of irreducibility. In this respect, El-Hani and Pihlström (2002) summarize the central tenets of a strong diachronic emergence theory as follows:

(i) [Ontological physicalism] All that exists in the space-time world are physical fields, and the basic particles recognized by physics and their aggregates;

(ii) [Qualitative novelty] Evolution is a universal process of change that produces qualitative novelty in all domains of reality;

(iii) [Emergence of complex higher-level entities]: Systems with a higher level of complexity emerge from the coming together of lower-level entities in new structural configurations (the new 'relatedness' of these entities);

(iv) [Property emergence] Qualitative novelties appear when material systems attain an appropriate level of organizational complexity, instantiating a genuinely new kind of relatedness which realizes, by its turn, genuinely novel properties at the level of the system as a whole. Two features should be stressed in the relationship between emergents and their basal conditions: (a) a given set of emergent properties (which can be unitary) is instantiated when, and only when, certain appropriate basal conditions are satisfied by the micro-structure; (b) a given set of emergent properties (which can be

unitary) must, as a matter of law, be instantiated when the right kind of relatedness is present in a material system, so that whenever those basal conditions are satisfied, that specific set of emergent properties should be observed;

(v) [Theory of levels] Reality can be described as a structure of irreducible levels, each level consisting of systems characterized by at least one emergent property;

(vi) [Irreducibility/unpredictability of the emergents] Emergent properties are irreducible to, and unpredictable from, the lower-level phenomena from which they emerge;

(vii) [Downward causation] Higher-level entities manifest genuinely novel causal powers, so that lower-level events take place differently within them.

3. An example in music: the view of consonance-dissonance relation as an emergent phenomenon.

Wright & Bregman (1987) put the interval (and also the timbre) as an emergent property in the sense that its quality is more than the sum of the components, based on the theory of auditory of stream segregation². The principles of auditory stream segregation are: the proximity principle, the similarity principle, the belongingness principle, and the synchronicity principle (for further details, see Bregman & Campbell, 1971). These principles are employed to explain the specific configurations the sounds must assume in order to some perceptual pattern formation processes be present. The patterns are emergent in the sense that they arise over some specific conditions, as experimentally observed (Bregman & Pinker, 1978), and once a pattern emerges it drives the perception of the basic constituents, merging notes in a stream or segregating them, in a downward causation fashion.

Thus far, Wright & Bregman (1987) devised specific musical stream segregation principles to the control of dissonance. The acoustic factors are imperative in the pattern formation process in perception, but they are not sufficient to explain the musical treatment of dissonance. In the specific case of controlling the emergence of dissonance in music, beyond the pure acoustic factors there are principles derived from the stream segregation theory that are usefully applied in areas like counterpoint.

4. Conclusions.

Wright & Bregman's approach to a theory of dissonance is not an alternative to traditional understanding, but a complement of it. The explanation of dissonance is not reduced to a static mathematical property of harmonics ratios, but appears as an approach based on dynamical, emergent and context-sensitive properties. In this sense, voice movements in harmony and counterpoint, many times considered as ornamentation or a method to deal with voice enchainment, are rather regarded as particular cases that apply the general law of segregation and fusion of sounds by hearing. These movements are essential to guide musical listening, being all but simply

² Thus, they appeal to a notion of non-additivity as a basis for qualifying the interval as an emergent property. Nevertheless, an emergentist approach, be it in musicology or in other research field, does not have much to gain from the claim that emergent properties are more than the sum of the properties of a system's parts, i.e., that emergent properties are non-additive, since non-additivity can be properly embedded in a reductionist account that takes the relational structure of a system in consideration (see Levine et al. 1987 and El-Hani & Pereira 1999 for critical discussions of the holistic motto that the whole is more than the sum of the parts).

a foreground ornamentation. They are a very good example of how a high level can design a low-level music structure, and, thus, of what we would call, in an emergentist approach, a downward causal influence. The interaction of both levels is essential, and indeed generates the emergence of specific phenomena to the listening, being the perception of consonance and dissonance discussed above one of the most outstanding examples.

When dissonance is in a context-less situation, as an auditory experiment, it should be taken as a non-additive property. The resulting dissonance of a chord is more than the sum of the parts (notes), for example, a dominant seventh chord has one triton and a diminished seventh chord has two, but we cannot say that the last is twice dissonant than the former. We claim that dissonance can be clearly regarded as an irreducible property (being its irreducibility justified by arguments stronger than that of non-additivity) when it's in a musical context. It will be irreducible in the sense that just acoustics cannot fully explain our always-shifting perception of dissonance in the audition of a music piece. We need to consider perceptual behaviors, like the principles of auditory stream segregation discussed above. Those principles are dependent on both acoustic properties of phenomena and psychophysiological properties and dispositions of the perceptual system.

When considering the dynamical musical context within a particular interval is heard, we find a possibility of elaborating stronger versions of emergentism. Inside a music piece the dissonance is a diachronic emergent property, dependent of time and context. All the features involved are physical ones, as ontological physicalism entails, but, when they are perceived, pattern formation processes come into existence, and, then, we get into a new level of analysis bringing the notions of novelty, unpredictability and irreducibility to the scene. Here the notion of novelty is related to the notion of unpredictability from the acoustical component parts, in the sense that there is not a reliable way to preview the amount of dissonance that will be experienced by a listener. But notice that this is only practical, not in principle unpredictability, and, thus, only a weak diachronic emergence theory might be formulated, on the grounds of a notion of novelty. Some aspects seem to be dependent of the (higher-level) perceptual process and the expectancy of the listener in a specific musical context, and this seems to be a more cogent way to a strong emergence theory, based on downward causation-based synchronic emergentism.

That's why a determined condition is dissonance outside a given context and it is not dissonance inside a given context. Within a musical context, the dissonance leaves its existence as just an acoustic phenomenon and begins to be considered as a musical pattern entity, a musical structure. This musical structure is a concatenation of several musical levels³ (from notes to global form) evolving over the time of a music piece driving the perception of dissonance as a systemic property. The musical structure is the basal condition which instantiate an emergent property, the dissonance, in accordance with the fourth central tenet presented by El-Hani and Pihlström (2002): (a) an emergent property is instantiated when, and only when, certain appropriate basal conditions are satisfied by the micro-structure, being the case that these basal conditions are adequately accounted for by the theory of auditory stream segregation (Bregman &

³ When we say musical levels, we mean that there are mental levels involved in it as well. Music deals with inner and outer aspects at the same time, being the perception the bridge between those aspects.

Campbell, 1971); and (b) an emergent property must be instantiated when the right kind of relatedness is present in a material (acoustic) system, so that whenever those basal conditions are satisfied, that specific emergent property should be observed. Indeed, this latter feature can be experimentally observed, as shown by Wright and Bregman (1987).

Emergentist thinkers in general postulate that reality can be described as consisting of several irreducible levels, each with at least one emergent property characterizing the entities classified as pertaining to them (El-Hani & Pihlström 2002). We believe that this thesis is closely related to the musical experience of a listener, from the local-level of acoustic to the apprehension of a work as a meaningful whole. In this multifaceted framework, above the acoustic level is the interval's features level, which has irreducible properties, such as the dissonance-consonance relation, and at the same time, there are other levels above the interval's feature level, involving contrasts of motives and periods, for instance, until we reach the higher level, that of the whole piece. And, beyond the coexistence of the various levels, the higher levels can exert an influence, which maybe can be grasped as a kind of causal power, on the inferior levels.

In many emergence theories, a core notion is that of downward causation, meaning that a higher-level phenomenon can cause or determine lower-level phenomena, being such a determination explained as a constraining influence on the behavior of the parts by El-Hani (2003a). If we combine upward and downward causation, we will obtain a circular causality that can explain the perceptual behavior of musical listening. Listening as an activity over time is based on the past perceived structures, which models the expectancy of incoming structures. Similarly, our perception can focus on different levels of the musical structure, and this suppleness changes the way we get the work as whole. Moreover, the way we understand the whole creates a new perceptual disposition, in behavioral terms, to the listening of lower-level musical elements. In our point of view, downward causation is a very suitable notion to the explanation of the music listening process, considering music as a dynamical phenomenon dependent both on acoustic (outer) and mental (inner) aspects. In this sense, downward causation might be under consideration in musicology, given the belief that musicology must consider perceptual aspects in its explanations. In the case of dissonance, one example of downward causation can be observed in ostinato sequences. As Wright and Bregman (1987) point out, the use of pattern repetitions can understate the roughness of dissonant intervals, due to a perceptual focus on the patterns relationship rather than on the concomitant intervals. So, the local level acoustic structure devises an emergent perceptual behavior (upward causation) that, in turn, causes a specific apprehension of the acoustic structure itself (downward causation).

As we discussed above, on the one hand, traditional theories of dissonance conceive it as a property reducible to physics, with neither a temporal dependence nor an aspect of unpredictability. On the other hand, to take dissonance-consonance relation as just a matter of cultural determination does not clarify its nature or applicability. In our perspective, we believe that, when one deals with dissonance as an emergent property, one is working in an approach in which such a property tends to be better understood and characterised. When one goes down to the physical level, dissonance is simply lost or at least misunderstood, given the absence of a sufficient account of its dynamical, contextual and perceptual behaviour aspects. This seems to be a case in which multilevel descriptions combined in a single explanatory picture are much more fruitful than any one-level description, be it a lower- or higher-level one (see El-Hani 2003a). It

is in this sense that we claim that the emergentist philosophies can provide important and fruitful approaches to musicology.

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