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Analogy and surface vs. structure in musical thought

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INTRODUCTION

Foot is to sock, as hand is to… what? Certainly, most people find it simple to complete this analogical sentence. The example suggestively illustrates the importance of analogy-making for reasoning, while also capturing some of its problematic aspects. For instance, the importance of structural relations when making analogies. To answer the question, the relations between *foot* and *sock* must be drawn up: while the *foot*, as a body part at the extremity of a limb, is inserted into the *sock*, being covered for warmth and protection, so hand, as a body part also at the extremity of a limb, is kept warm and protected by a glove. In the process, the abstracted concept of *garment* arises as a relational commonality between the foot/sock and the hand/glove domains. Also, note that the analogy is not destroyed (instead, it even appears stronger) if we single out the differences that inevitably exist between its terms –such as, that we only walk on feet, that only hands have opposite thumbs, etc.–. In short, analogy is a qualified kind of comparison rather than an identity between necessarily different things.

Analogy in reasoning can be used in such simple examples, but it is also involved in aspects of sophisticated thought and deep contemplation. Besides, analogy is not simply present at times in problem-solving, in insights leading to scientific discoveries, or even as

creative associative language for poetic or discursive purposes. Instead, analogy is found to permeate our minds constantly, even when we go about the most mundane aspects of our lives. It is critical for human thought, and because of its core role in cognition, especially in relation to conceptualization, it has been dubbed "the fuel and fire of thinking" (Hofstadter & Sander, 2013).

There has been significant research arguing that to attend to musical processes requires analogical cognition as well. In this paper, I will particularly focus on the analogy-driven formation of highly abstracted music-theoretical constructs, tracing a dichotomy between representations of surface and structure.

ANALOGY AND MUSIC

A crescent interest in the cognitive underpinnings of analogy brought along the identification of a range of analogies "within music," such as patterns of thematic/functional recurrence (Kielian-Gilbert, 1990), or between parameters like pitch and time (Eitan & Granot, 2007). It is, though, with the mounting view that the human body and the environment are critically implicated in music cognition (see recent overviews, e.g. Cox, 2016; van der Schyff & Schiavio, 2022) that analogy, and especially its cousin *metaphor*, gain renewed prominence as the underlying mechanisms for that implication. According to *conceptual metaphor theory* (Lakoff & Johnson, 1980), metaphors are not only rhetorical flourishes, but they systematically structure our thoughts and actions. Our entire conceptual system is metaphorical, as through metaphors we understand one domain in terms of another. Conceptual metaphors move from the concrete to the abstract and are ultimately to be traced back to a direct physical experience. This view has been fruitful in driving the emergence of new frameworks for music conceptualization (Brower, 2000; Hatten, 1995; Larson, 2012; Saslaw, 1996; Spitzer, 2004; Zbikowski, 2002).

One compelling and paradigmatic proposal for a fundamental role of analogy is that music "works as a sonic analog for dynamic processes" (Zbikowski, 2017). Dynamic processes are drawn from the natural world, from emotion, gesture, sensorimotor patterns evidenced in dancing, and words. In describing and examining analytical examples of sonic analogs, and elsewhere, Zbikowski (2002, 2017, 2018) makes good use of *conceptual blending theory* (Fauconnier & Turner, 2002), another

analogy-like description of the high-level cognitive process where elements and relations from two or more input domains, expressed as interconnected "mental spaces," dynamically combine to produce a new integrated one, the "blend,", along abstract commonalities which form a "generic space,". The various mental spaces are organized as structures of knowledge.

This said, the question remains: is *all* music sonic analogs? Wouldn't this idea undermine music by reducing it to mappings from other domains and nothing else? Indeed, it does appear so at first sight. I share the perspective that music working *only* as a function of non-musical things is a view that underrecognizes music's ability to reconstitute itself and to subsist beyond the contingency of subjectively and historically situated factors. However, it should also be considered that hearing music "as" other domains does not necessarily subordinates music, as long as we don't take analogy for a mere cross-domain correspondence and leave it there. Analogy is not just mapping, but also projection. It is directed to a uniformity, to the generation of fresh knowledge, to the integration in new hybrids. This is one reason why the conceptual blending framework is so compelling, as it puts the tonic accent into domain fusion. In this sense, musical objects constituted as such a hybrid still enjoy a sufficient degree of autonomy. They can then be themselves the source for further analogies, notably in relation with other such hybrids.

Still regarding analogy's role in embodiment, even though it is not hard to encounter many clear instances of music summoning deep images and associations, others exist where despite our best efforts it is not evident *how* to hear music as anything else than music itself. In the more general scheme of things, the nature of the mechanism grounding all conceptual knowledge directly in the human body, while remaining compatible with highly abstracted concepts such as justice or truth, is still heavily debated (Barsalou et al., 2018; Dove, 2015; Yee, 2019). What to say then of the heap of conceptual representations involved in any understanding and aesthetic consideration of the musical phenomenon?

SURFACE AND STRUCTURE

Analogy is a comparison that brings together possibly heterogeneous domains, on the basis of some proximity attributed to them. The

key to this proximity has long been identified with relational structures. Kant, for example, noted that analogy "surely does not signify, as the word is usually taken, an imperfect similarity between two things, but rather a perfect similarity between two relations in wholly dissimilar things" (Kant, 1783/2004, p. 108).

Structure-mapping (Gentner, 1983, 1989; Gentner & Smith, 2013) is a framework for modeling the cognitive processing of analogies, with the central idea that analogy is a mapping between the relational structures of a base domain and a target domain. Knowledge is represented in both domains as systems of (a) objects, (b) their attributes, (c) relations between objects, and (d) higher-order relations between relations. The analogical mapping aims to establish a structural alignment between corresponding elements in the base and target domains. Attributes take one argument only, while relations take two or more. So, for example, *large(x)* is an attribute of object *x*, while *collide(x,y)* is a relation between objects *x* and *y*. When making analogies, we exhibit a bias towards mapping relations, and not attributes, and preferably systems of coherent, interconnected higher-order relations. This *systematicity principle* is not only at work on the mapping proper but also on a further projection or inference step, where facts carried over into the target are selected as to complete the common system of relations.

Regarding music, it is certainly possible to follow closely the tenets of structure-mapping by ascribing attributes to symbolic "music events" and formalizing relations between them (Bourne, 2015, goes in this direction). But more generally, on the musical surface we find a layer of easily apparent, literal properties of the auditory signal. The surface is either non-conceptual or it only relies on lower-level categories, which incidentally are also relatively independent from linguistic descriptions. Further structural layers are formed by immanent relational patterns.

A common observation is that, as we become familiar with a domain, we progress from superficial similarity matches, then to (structural) analogies, and then to the formulation of general schemas and abstractions (Gentner, 1983; Holyoak, 2001).

The question of expertise, though, is a contentious point in the context of analogical retrieval –how, when facing a new situation, one retrieves a familiar situation from memory to serve as the analogy source–. Given that at the heart of analogy is a process that privileges

the mapping of structural relations, it is puzzling to find many empirical studies pointing to superficial similarity, not structural similarity, as having the largest effect in retrieval (see discussion in Raynal et al., 2020). Hofstadter & Sander (2013, pp. 337–340) attribute this to a flaw in the design of the experiments (which typically involve problem-solving by finding resemblances between two images or stories), namely that the situations presented are artificial –in the context of the laboratory, the knowledge acquired about the source is limited, while in real life and over time we build deeper and more generalized connections–. It should not come as a surprise that when Gentner et al. (1993) augmented the experiments to also include a stage of "soundness evaluation," participants rated the structurally similar analogs unequivocally higher, even if they had not retrieved them successfully before, thus confirming that in the end we do value distant, surprising analogies more than superficial matches. More recent research now provides evidence for the dominance of structural similarity in analogical retrieval, pointing to a consideration of participants' domain knowledge (Raynal et al., 2020).

RELATIONAL ABSTRACTIONS IN MUSIC THEORY

As we have seen, analogy entails transcendence, progressing from single-case analogies to more powerful abstract schemas. This happens not only as an individual learns, but also in the context of accumulated collective knowledge.

Turning to music, we find one such example in the way that Jean-Philippe Rameau's introduction of the fundamental bass drove a reconceptualization of the nature of chord inversions which, up to that point, were seen rather as separated, individual entities (Christensen, 1993). With Rameau, the common relation to a generating source, namely what we now know as the chord "root," allows the affirmation of their inversional equivalence. The (analogical) comparison between specific proportions between tones in a triad or tetrad in its various positions, among the systematic structure of harmonic progressions and its functional proclivities, drives the view that for all purposes (which, at least in Rameau's case, are eminently practical) those various chords are equivalent.

More recently, set theory-informed organization of pitches introduced a broader scope of categories, reflecting the practices of twentieth-century music and, in general, its larger number of harmonic

possibilities. But again, of course, some of the granularity is lost in the process. Tonal objects are said to belong to the same class according to invariances on the pitch structure. This produces ampler equivalences, abstracting away, e.g., intervallic inversion, thus grouping together, say, major and minor chords. As harmonic vocabulary is given a critical thematic role, music is organized with pitch structures that crystalize categorical classes, systematically labeled (Forte, 1973) –structural categories that subsist and subsume under them superficially dissimilar (with completely different contour, rhythm, texture, timbre, etc.) musical objects–.

Another paradigmatic example of increasing conceptual abstraction is produced among Klumpenhouwer Networks, or "K-nets" (Klumpenhouwer, 1998; Lewin, 1990). K-nets are pitch structures (networks) represented by graphs that integrate a combination of transpositional and inversional relations. They are considered equivalent based on their isography: if the configuration of arrows and nodes is the same, and the indexes of the transposition and inversion operations are also the same, or only differ according to specific rules that guarantee their invariance, both networks belong to the same network class. Now, the same transformations found within a single network also relate distinct ones, which opens the door to recursion, forming larger networks of networks (or "hyper-networks").

The isography that grounds K-nets represents a simple proportional analogy between homogeneous terms (the pitch collections), while at the same time it is mediated by a more involved heterogeneous analogy between musical pitches and spatial configurations. When we iterate on these analogies, along the multiple hierarchies of recursive K-nets, we gain a fantastic flexibility, permitting the identification and description of meaningful, but not immediately apparent relational structures in the music. But the concrete tonal configurations that constituted the musical surface become all too invisible from the distant perspective of those highly abstracted networks, raising the question of whether the net is cast too wide, with pitch configurations too easily related, and pretty much everything promoted to a small number of individual categories. This copiousness of easy-to-make relations, for which Shaugn O'Donnell uses the term "promiscuity," can be problematic (Buchler, 2007; O'Donnell, 2007), and demand further considerations to the congruency towards the musical surface, while convoking

other aspects such as rhythm, voice leading, orchestration, etc., to justify the pertinence and salience of those relations.

OPTIMAL LEVEL OF ABSTRACTION (KEEPING AN EYE ON THE SURFACE)

The examples show that, while higher degrees of abstraction contribute to efficiency of thinking as they permit grouping previously unrelated things and applying a single scheme to all of them, it is also true that such efficiency is obtained at the cost of making the individual characteristics of the abstracted entities irrelevant. We are thus faced with a Goldilocks kind of problem: what is the ideal amount of abstraction for the task at hand?

This is a problem that we know all too well when engaging in musical analysis, for which it is indispensable to construe and mobilize concepts that must prove themselves against a specific musical work or a corpus of musical works.

I see a parallel between this situation and statistical models, where both overfitting and underfitting are to be avoided. An analysis is overfitted when it follows the data too closely, failing to capture the underlying general patterns; and conversely, it is underfitted when it relies on assumptions about the data that are too simplistic to properly describe it, for example, because it does not consider some necessary parameters. In any case, the model will not perform accurately with additional data, nor will it be reliable in predicting future observations. Similarly, in musical analysis, a model must be drawn up with a sufficient amount of abstraction, so that it can remain meaningful outside of the concrete elements being analyzed; but not so much that it loses any discriminating power over a formless, homogeneous matter, thus becoming inapt for the specific goals of the analysis. Beyond analysis, in the common sense of post-hoc examination of a musical work, abstraction is the path leading from a more specific to a more general way of hearing –respectively associated with "analysis" and "theory" (Lewin, 1969)– while keeping in motion the theoretical/conceptual loop that feeds back into the processes of composing, improvising, performing.

Empirical research on analogy has pointed to a pragmatic constraint on abstracted constructs (Holyoak, 2019) –focusing attention on those parts of the analog that most clearly matter given the reasoner's goals while backgrounding or suppressing those parts that don't seem

so important–. While this may seem a most evident observation, it warrants highlighting that, as music is a complex and multidimensional phenomenon where it is impossible to do a straight cut between idealized activities, such as the various "modes" of listening, performing, composing, dancing, socializing, analyzing, etc., we must consider how the musical experience is modulated in any of these pragmatic contexts.

Additionally, music suggests several possible actions for a person who encounters it. Such *affordances*, in the general sense used by Gibson (1979), point to the principle according to which an artifact's instantly available surface amplifies its deeper nature. Ideally, the surface and the structure should then be closely related. In the domain of music, this suggests that countering a total relativity toward different analytical approaches would involve following the more salient affordances by identifying structures that remain connected to the sound surface.

CONCLUSION

Through analogy, engaging with a present piece of music conjures not only the experience of past pieces of music but all the relations to a cosmos made of interconnected fragments of more general experiences. These analogies take place whether we are aware of them or not, that is, whether we represent them explicitly as analogies or not, thus eroding, e.g., the division between listening and thinking about listening. Analogy also makes the connection between immanent patterns of sound to other relations patent in physiology, psychology, or society.

While neither structure nor surface exhausts the musical objects they represent (and they are not clear-cut layers, to begin with), models such as structure mapping and conceptual blending can help probe the congruency of interpretations that rely on highly-abstracted concepts or associations between music and other realities, as they offer cognitive resonant criteria for establishing and constraining possible mappings and inferences.

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