METAMODELS IN COMPOSITIONAL PRACTICES

The Case of Alberto Posadas's *Liturgia Fractal*

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Foreword by Lawrence M. Zbikowski

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Foreword

Consider, if you will, the world of the composer, a world populated by sounds real and imagined. Indeed, it is the inevitable tension between sounds real and imagined—a tension manifested in the challenge of bringing imagined sounds to actuality and reconciling actual sounds with those imagined—that motivates and drives much of the composer's work. One way to manage this tension, to turn it toward productive ends, is for the composer to put real and imagined sounds in dialogue with other forms of human expression and other currents in human culture. Here an image from a novel, a splash of color in a painting, the errant move of a dancer can resonate with new force, transmuted into sounds that then take on a life of their own. But to regulate this life is not a trivial matter: the arc of the imagination, so clear and certain in its final manifestation, is one that constantly threatens to collapse while under construction. Here the composer may avail herself or himself of a bit of scaffolding to make the process of construction surer: the image from the novel expands into a narrative rich with scenes and situations, the splash of color in a painting unfolds into a geometric array, the errant move of a dancer becomes a rich tapestry of movements and gestures. To be sure, the composer has not, with these extensions, written a novel, produced a painting, or created a choreography—all of these imagined structures simply serve as scaffolding to guide the realization of the imaginative arc—and yet it is a rare composition that, from its first half-heard sounds to the final double bars, has remained untouched by other images, colors, gestures, or concepts. But because such scaffolding *is* scaffolding—an aid to construction but set to one side once the construction is completed—the composer seldom feels that it is worth more than passing mention. All the more reason for a composer to become irritated when those less accustomed to living in a world of real and imagined sound focus all their slender attention on the scaffolding rather than the structure which it facilitated.

Consider then, if you will, the world of the music scholar, populated by "musical works"—that is, the finished products of the composer—and by the circumstances, traditions, and intellectual cross-currents within which such works are embedded. This, too, is a world of resonance, but more often than not these resonances are of far-flung ideas that might not have attracted the attention of those concerned with the production and performance of musical sound. In my own work, for instance, I once compared the tea party scene from Lewis Carroll's *Alice's Adventures in Wonderland*—a party attended by the Mad Hatter and March Hare as well as by Alice—with ideas about musical form and hierarchy that were developed by music theorists of the eighteenth and nineteenth centuries and passed on to their scholarly progeny in the twentieth century. Although all of these theorists gathered around a cultural table laid with the same musical compositions, in certain cases they found it almost impossible to agree on even the most basic features of these works. Their conversations (enacted in treatises and articles across a

span of many years) thus gave rise to cockeyed conversations that might not have been out of place in Carroll's Wonderland. One thing that contributed to the music theorists' own mad tea party was the rapid change in musical culture during the time of Beethoven, Schubert, and Schumann, and for my part I proposed that the key to understanding the characterization of musical works of this period was to understand the language through which they were described, language that borrowed ideas about form from the world of organic life and ideas about hierarchy from the arrangement of bureaucratic structures. Exercises such as this, undertaken at a safe distance from the lives and challenges of the actors with which they are engaged, can be entertaining or at least unobjectionable to musicians familiar with the exigencies of musical practice. The case is, however, more complicated when it comes to composers who are still alive and who may see little value in having their artistic practice first connected with intellectual currents incidental to their musical production and then buried in a labyrinth of words. For it is indeed words that are the common coin of the music scholar: fascinated as such scholars are by sound and its social and cultural implications, their primary occupation is one of wrestling language into a manageable shape so that it might serve to capture some glints of the intellectual kaleidoscope activated by musical expression.

Consider, finally, the world of the cognitive scientist who is focused on modes of human communication. He or she finds music an intriguing and at times counter-intuitive medium. Indeed, no less a figure than Charles Darwin puzzled over the utility of music for the human species. Writing in his *The Descent of Man* of 1871, Darwin observed, "As neither the enjoyment nor the capacity of producing musical notes are faculties of the least use to man in reference to his daily habits of life, they must be ranked among the most mysterious with which he is endowed". And scientists, of course, love a mystery. For cognitive scientists, one of the challenges of exploring this mystery has been finding a way to connect general knowledge about brain processes with highly specific processes (such as pitch matching and rhythmic entrainment) that have long been the focus of research in music psychology. Indeed, despite having a wealth of information about the basic processes through which humans apprehend musical sound it is still not clear what makes some sounds *musical* and others little more than a distraction from the business of making a way through the world. In the world of the cognitive scientist, then, music remains something of a riddle, a mode of behavior that obtains in every known human culture and yet which seems (at least to some) to be little more than a confection to be consumed by the auditory system.

These are, to be sure, three very different worlds, but in the following pages José Luis Besada develops a captivating and compelling conceptual framework through which they can be drawn together so that the reader may come to a fuller appreciation and understanding of Alberto Posadas's *Liturgia Fractal*. Besada does this by taking the notion of a composer's model quite seriously, bringing it into correspondence with the models used by mathematicians (models indeed familiar to many composers) and with conceptual models of the kind employed by cognitive scientists. By doing so, Besada offers to the music scholar a unique perspective on the process and product of musical composition by tracing a path between the composer's scaffolding—in the case of Posadas's cycle, the different fractal models upon which each of the five quartets is based—and the conceptual world that the music inhabits. Key here is the instrumentality of the metamodel, which Besada uses to situate composers' models within the broader intellectual framework provided by synoptic models specific to scientific inquiry in general and cognitive

science in particular. This approach allows Besada to tease out the various threads from which the whole cloth of compositional process is woven and to use them to weave links between the world of the composer, the world of the music scholar, and the world of the cognitive scientist. The result is a thoughtful and challenging work that offers a new way to think about the composition and analysis of music as well as a novel path into the compositions of Alberto Posadas. Indeed, it is a world unto itself.

Lawrence M. Zbikowski

Introduction

> *S*[eeger]*: [...] Most people talk about music in terms of common sense. Most musicians do, too. But they have music learning, that is, direct music knowledge and music feeling far beyond that of nonmusicians. Some nonmusicians, however, are learned in fields of specialization other than music of which some aspects of music are data.*
> *K*[remenliev]*: For example?*
> *S: Among them, mathematics and logic, the physical sciences, the biological sciences, psychology [...]. Nonmusical specialists can, therefore talk learnedly about some aspect of music in ways often as incomprehensible to musicians and to other specialists as to nonmusicians who are not specialist of any kind. [...] The musicologist must try to comprehend as much as possible of all these ways of talking and to integrate them in such a way to reconcile the diverse viewpoints, orientations, methods and aims involved.*
> *K: It is too bad that we cannot talk about music in strictly musical terms.*
> *S: True. But our lexicon of strictly musical terms is very limited.*
> *K: We may have to invent a metalanguage.*
>
> (Seeger, 1977, p. 105)

Intégrales (1923-1925), one of Edgard Varèse's most famous works, was premiered in New York the 1st of March 1925, under the baton of Leopold Stokowski. The Franco-American composer wrote a few lines for this event, containing an excerpt that implicitly carries a radical dissent from literature-inspired *programme* music:

> I often borrow [my titles] from higher mathematics or astronomy only because these sciences stimulate my imagination and give me the impression of movement, of rhythm. For me there is more musical fertility in the contemplation of the

> stars—preferably through a telescope—and the high poetry of certain mathematical expositions than in the most sublime gossip of human passions.
>
> (L. Varèse, 1973, p. 228)

Although such excerpt continues with the denial of a genuine scientific transfer while composing, always supported by his self-referential conception of music, Varèse's voice pioneered—among others during the 20th century—a true call for attention to science. Ninety years have passed since this famous statement, and both music[1] and scientific scenes have proliferated and radically mutated. On the one hand, the musical practices of contemporary composers are far from being homogeneous today; on the other hand, science has achieved an extreme degree of diversification. The junction between these two domains is therefore a reflection of the double heterogeneity observed: many contemporary authors find their inspiration in a huge range of exogenous models, borrowed from many scientific fields, occasionally speculative ones.

The Two Cultures

Does such situation mean that those musicians are *de facto* doing science while composing? Obviously not, and we also agree, in a wider scope, that "composition is not research" (Croft, 2015). The nonidentity of composition and scientific research does not solve however a question of legitimacy. For instance, Pierre Barbaud—pioneer of the Algorithmic composition in Europe[2]—considered an almost isomorphic link between music and mathematics, leading him to state that "everything coherent is musical" (Barbaud, 2011, p. 212). At the opposite pole, a mystical conception of music that "borders more on magic than on empirical science" (Jankélévitch, [1961] 1983, p. 8) tacitly delegitimizes the transfers discussed above. Both attitudes seem to somehow reflect the controversy between "the two cultures" that Charles Snow set forth in the fifties:

> Literary intellectuals at the one pole—at the other the scientists, and as the most representatives the physical scientists. Between the two a gulf of mutual incomprehension—sometimes [...] hostility and dislike, but most of all lack of understanding. They have a curious distorted image of each other. Their attitudes are so different that, even in the level of emotion, they can't find much common ground.
>
> (Snow, 1959, pp. 4-5)

[1] We will often use the term 'music' throughout this text as a synecdoche, making reference to art music or to the common expression 'contemporary music'.

[2] Whose formalized thoughts are recently receiving deeper attention (Andreatta, 2013, pp. 1253-1259; Viel, 2014, pp. 289-328).

The previous utterances—Barbaud's and Jankélévitch's, both chosen for being so extreme—show up radical preconceptions impeding a true debate. The topic is patently much more complex and subtler than an identity or an incompatibility between musical and scientific thought or practices, inviting to shape a succinct discussion with the help of philosophy and the sociology of science.

Generally, few philosophers of science would openly admit that music is a "scientific discipline" (Barbaud, [1968] 1971). It could perhaps be the case of Paul Feyerabend (1967) and his epistemological anarchism, dynamiting the boundaries between sciences and arts. Nevertheless, this *tabula rasa* of categories does not make their specificities converge but it neutralizes them.[3] Meanwhile, musicological attempts to fit other notorious—but not 'ecumenical'—frames into their discourses have often taken questionable—and sometimes sloppy—licenses. We will illustrate these scenarios with a brief sample, touching the maybe two most famous epistemological postulates about scientific research—Karl Popper's and Thomas Kuhn's, incompatible with each other—during the 20th century.

First, Célestin Deliège (2007, pp. 17-18, 28) has borrowed Popper's falsifiability so to discuss compositional practices in terms of stylistic results, but misinterpreting this criterion as a synonym of falsification.[4] Anyway, an analogy of falsifiability around compositional practices—and specifically those inspired by science—is doubtful. In order to prove it, let us compare such creative practices and the final work with a scientific theory and its empiric testing. A composer can make choices contradicting his former—maybe scientific—sources, but they do not refute the process; he has after all the right to adopt *ad hoc* criteria—violating his own 'rules'—for his work. In return, and with regard to science, Popper ([1934] 2005, pp. 19-20) insisted on erasing *ad hoc* scientific hypotheses as far as possible. A similar argument can be used to discuss falsifiability around music theory and analysis, also taking into account the problem of inductivism. [5] Additionally, the Viennese philosopher conceived science as a "progressing from problems to problems [...] of ever increasing depth" (Popper, [1963/1972] 2002, pp. 300-301). This conception overflew his arguments to dismantle a possible analogy—based on historicist orientations, like Theodor W. Adorno's (1930) position—between music and science around their respective progress (Popper, [1974] 1992, p. 76).

Second, Kuhn's (1962/1969) theories have been also brought in musicological discourses: from the classic idea of an "aesthetic paradigm" proposed by Carl Dahlhaus ([1978] 1989, p. 2) to more recent formulations, such as a "revolution of musical languages" (Lai, 2002) or an "artistic paradigm" (López-Cano, 2013). Nonetheless, the historian of science already warned about the risks while implementing this sort of arrangements borrowed from his epistemological framework. For that purpose, his main argu-

[3] Feyerabend ([1984] 2003) has also compared the idea of progress—false for him—in sciences and arts, supported by Alois Riegl's theories.

[4] A common mistake that Popper ([1934] 2005, pp. 66-67) already set down.

[5] Let us consider for example the pitch-class set theory (Forte, 1973). This theory recruits algebraic abstractions in a coherent frame, but the segmentation during analysis could be considered as a ensemble of *ad hoc* criteria (Nattiez, 2008). Nevertheless, Nattiez's alternative segmentations do not refute Forte's ones: paradigmatic analysis would also operate with *ad hoc* criteria (Agawu, 2008, pp. 168-172). We could go on, revealing an aporetical problem around music analysis when it is considered as a strictly scientific proceeding.

ment precisely concerned paradigmatic changes, adducing that "science destroys its past" (Kuhn, 1969, p. 407) while art does not. Moreover, a paradigmatic interpretation of the stylistic musical changes over time could betray Kuhn's relativistic position, reversing its sense into a modernist teleology (Besada, 2016, pp. 115-121). For instance, this sort of distortion has already been detected in the visual arts discourses (Jones, 2000).

Once the previous maladjustments discussed, we will point some affinities between musical and scientific practices, willing to overthrow several prejudices about the second ones. The scientific research is not an aseptic labour carried out by automatons. The "moral economy of science" (Daston, 1995) tends to privilege quantification, empiricism and objectivity, making not too much room to several affective values, at least in terms of the displayed results. It does not mean however that emotions and aesthetic judgements vanish during scientific research. Ludwik Fleck ([1935] 1979) already formulated his *Denkstil*—thought-style—idea taking into account aesthetic values, and nowadays emotions are an important topic for the sociology of science (Barbalet, 2011; Parker & Hackett, 2014). Moreover, neuroscience has proved that reason and emotion share neural activity regions in our brains (Damásio, 1994, p. 70). Anyway, and with regard to the aesthetic judgements, we must stress that scientific ones differ from artistic ones: they can orientate the research as a tool, but the quest of an aesthetic pleasure is not *per se* among the main goals of science (Kuhn, 1969, p. 405).

All these arguments have tried to show how musical composition and scientific research are different tasks but sharing some aspects in an intersection. In order to denote their common ground, we will elude specific terms like Kuhn's paradigms or Fleck's *Denkstil*. We will rather conjecture the existence of a *shared episteme*—this last word understood in Michel Foucault's sense—allowing analogical transfers. The French philosopher prefaced one of his most renowned texts giving a clear orientation for this expression:

> I am not concerned, therefore, to describe the progress of knowledge towards an objectivity in which today's science can finally be recognized; what I am attempting to bring to light is the epistemological field, the *episteme* in which knowledge, envisaged apart from all criteria having reference to its rational value or to its objective forms, grounds its positivity and thereby manifests a history which is not that of its growing perfection, but rather that of its conditions of possibility.
>
> (Foucault, [1966] 1989, pp. xxiii-xxiv)[6]

Our hypothesis about a shared episteme convening music and sciences reflects the French philosopher's purport for the term. *Mutatis mutandis*, we will rather try to highlight the conditions of possibility of a compositional transferring, but neither its rational value, nor its objective forms.

[6] Author's emphasis.

Composers Meeting Science: Hypothesis and Research Questions

As we stated at the beginning of the introduction, composers inspired by science form a collective far from being homogeneous. This picture shows an impossible normalization spanning a wide range of factual compositional practices. Nevertheless, the common denominator as to composers' scientific inspiration deserves deep musicological attention. We shall state as a research hypothesis that, in spite of their obvious diversity, a minimum of situations or stages—in analogical terms—stand out among creative processes shared by musicians who borrow scientific models when they compose. This hypothesis directly entails two research questions:

- What minimal cognitive dispositions and formal implications might take part in any transferring from a scientific model to a musical one during composers' creative practices?

- Given the previous question, what methodological and analytical stands should musicologists take in order to efficiently address the study of musical works originating from those practices?

This book is divided into two parts, respectively subdivided into four and seven chapters. The first part introduces the theoretical elements, trying to answer the precedent questions. Chapter 1 settles its epistemological basis, giving an accurate use of the term 'model'—borrowed from mathematical model theory—in order to open a discussion about representative, interpretative and metalinguistic issues, and also coining the idea of an 'esthesic cover' of science by music. Chapter 2 surmises a possible cognitive framework binding scientific conceptions and music concepts during compositional practices. It convenes cognitive linguistics and mathematical category theory so as to postulate the existence of a metaphorical space which could provide the necessary conditions of the transferring. Chapter 3 explores the formal implications of such transfer, considered as a metamodeling process. A metamodel is a model *per se* above another model: thus, metamodeling as meant at this essay is the construction of a compositional model, emerging from the esthesic cover of a scientific one. Chapter 4 marks out how both paths would finally merge into a feedback circuit governing the compositional strategies used during the transference. It ends with a discussion about the position the musicologist should adopt while taking the previous arguments into account, enumerating a list of possible challenges that can be summed up with two main analytical goals: the reconstruction of the compositional metamodels and the study of divergence.

The second part of this book is dedicated to a case study—Alberto Posadas's string quartet cycle *Liturgia Fractal* (2003-2007), that we will introduce in the next section—in order to test the protocols proposed at the end of the first part. Chapter 5 gives a comprehensive overview of the Spanish composer's metamodeled practices, and discusses the possibility of a fractal metaphor over the music. Once the contextualization is achieved, Chapters 6 to 10 show an extensive analysis of Posadas's compositional practices to write

his string quartets. All those analyses are structured in the same way: firstly, a description of the summoned mathematical model; secondly, a reconstruction of metamodeled compositional practices; thirdly, a discussion about the detected divergences. Chapter 11 ends up with a crossed overview of all string quartets, also taking hearing processes into account. In that sense, it studies the possible gap between formalized practices from the composer's side and recognition skills from the audience. Additionally, an Appendix provides graphic reproductions of several of Posadas's compositional sketches.

The Case Study: Alberto Posadas's *Liturgia Fractal*

Several reasons steered us to choose Alberto Posadas (b. Valladolid, Spain, 1967) as the case study for this book. First, the most obvious one, *conditio sine qua non* to make this choice: he draws upon different extramusical sources in order to nurture his compositional practices, and scientific ones are the more persistent throughout his catalog. As a matter of fact, the composer himself often uses the term 'model' while describing these practices, not only science-inspired ones. Another family of models is introduced by visual arts, in order to transpose spatial elements into music parameters. In this regard and so far, painting and Ancient architecture have been the two most attractive disciplines to him (Besada, 2011). Finally, his last modeling path is supported by the acoustical scrutiny of musical instruments and their extended techniques, largely inspired by the French spectral music, a path the composer began to explore with his piece *Cripsis* (2001) (Díaz-Fuente, 2011). Second, Posadas has left profuse traces of his creative processes linked to such inspirations, and they are accessible to the analyst. His compositional sketches helped to further discriminate science-inspired practices from other possible stylistic or technical decisions. Moreover, several interviews have been a fruitful tool for our cognitive inquiries. We will summarize later all the elements configuring the genetic dossier. Third, he is a living and active composer, and his age is not an accidental choice. Posadas has reached his first creative maturity, when certain compositional practices tend to settle, but still feels thrusted by a genuine artistic quest.

Liturgia Fractal is maybe the most representative Posadas's score among science-inspired ones. After the successful premiere of his first quartet, *Ondulado tiempo sonoro...* (2003), the Spanish composer received a triple commission—Festival MUSICA (Strasbourg, France), Casa da Música (Porto, Portugal) and Centro para la Difusión de la Música Contemporánea (Madrid, Spain)—to conclude the cycle. Thereby, he consecutively wrote the quartets *Modulaciones* (2006) and *Órbitas* (2006), the concerto for solo violin and string trio *Arborescencias* (2007) and the last quartet *Bifurcaciones* (2007). The whole cycle has already been subject to some—mainly descriptive—musicological comments (Fournier, 2010, pp. 1204-1208; Gan-Quesada, 2014, p. 285).

Posadas drew up a short text for the premiere, willing to explain to the audience some of the intentions that led him to compose his quartets. The following excerpt reproduces the core of such *programme* notes:

> *Liturgia Fractal* is a cycle of five string quartets in which each quartet is based on a different fractal model. Working with a fractal model, as something of an allegory of the way waves move, is based on the concept of a cycle as a 'natural entity'. The

> combination of the idea of self-similarity (fractal) with that of spreading-out (wave) reflects the search for a sound which develops organically, as if it were just another part of nature.
> [...]
> *Ondulado tiempo sonoro...*, the first quartet, functions as a seed for the rest. This work presents the most important musical material and parameters around which the rest of collection revolves. Each quartet adds new material to that which was used before, and this material then appears in the following quartets as well. In this way, each of the pieces seems like a sort of 'transformed overall sum' of the one before.
>
> Alberto Posadas[7]

We will come back to this excerpt throughout the analytical part of this book.

Epistemic Perspective

Can we talk about art with the tools of science (Chouvel & Lévy, 2002)? As we have already mentioned, the term 'model' will be at the core of our discussion. Nevertheless, its multiple meanings can entail a wide range of disparate musicological orientations. Just considering the French bibliography, we can find the term entitling volumes that approach intertextuality (Escal, 1984) or even deterritorialization (Gorge, 2004) in Gilles Deleuze and Félix Guattari's sense, both examples far away from our purpose. Conversely, we will stand somehow nearby the way several composers-theorists have used it, as for example François-Bernard Mâche (1983), André Riotte—with Marcel Mesnage (2006)—or Tristan Murail (2004).

Anyhow, and due to our model theory terminological borrowings from mathematical logic, we will be even closer to some American composers-theorists, particularly Milton Babbitt (2003) and Benjamin Boretz (1995). We will also share with them a theoretical scope trying to balance out neopositivist issues and pragmatic attitudes, but in our case basically discussing the impact of extramusical sources—mainly scientific ones—over compositional practices. We will try however to make this position cohabit with current cognitive approaches. As stated above, the notion of 'metaphor' will also support our arguments: we could recall Max M. Black's (1962) binding of models and metaphors, but an updated review of these matters is mandatory. Two main theories will be convened in this context: George Lakoff and Mark Johnson's Conceptual Metaphor Theory ([1980] 2003), and Gilles Fauconnier and Mark Turner's Conceptual Integration Networks ([2002] 2008). Previous research about music and cognition by Lawrence Zbikowski (2002) has been illuminating for this purpose. Additionally, several remarks about metalanguages, often present in music semiology, will be evoked.

[7] The original text was written in Spanish, and reproduced in French for the audience. We will always refer to the English translation, available at the commercial recording of the cycle [Kairos 0012932KAI (2009)].

Analytical Perspective

The second part of this book being a study over *Liturgia Fractal*, a short discussion about the analytical method—that is to say, "to analyze analysis" (Donin, 2009a)—must be provided. The ambiguous term 'analysis' shelters numerous musical and musicological practices, from propaedeutic heuristics routed to performance and composition to ambitious systematic formulations nurturing music theory. In fact, our will—far away from both mentioned extremes—to heed extramusical influences over compositional practices could ultimately be regarded as a perspective falling out of analysis in its most canonical definitions.[8]

The main methodological tool attempting to achieve our analytic goals depends on genetic criticism of music. This discipline has rapidly evolved in the last decades, from a reconsideration of the value of the sketch studies (Kerman, 1982)[9] to the newest methods engaging living composers. We should mention in this regard the ethnographical devices jointly proposed by musicologist Nicolas Donin and cognitive anthropologist Jacques Theureau. They have largely discussed the most favorable methods and conditions in order to retrieve valuable data from compositional practices; among them, several ones are displayed via a situational simulacrum of the mental conditions of the creative act (Theureau & Donin, 2006; Donin, 2009b). We have not exactly followed their protocols, but some of their considerations have been fruitful for our purposes. Moreover, and still concerning genetic criticism, we have found in epistemocritic—the branch of literary criticism discussing mutual borrowings between scientific writings and literature (Pierssens, 1990)—a research attitude not too distant from ours.

Coming back to the sketch studies, William Kinderman (2012) has stated that "criticism that ignores primary sources easily finds itself at the mercy of tantalizing but untrustworthy metaphors" (p. 19). On the contrary, our aim to understand the transfer from scientific givens to compositional practices has voluntarily plunged into an ocean of metaphors—not ours but the composer's—during analysis. To this end, the genetic dossier around *Liturgia Fractal* was constituted by the following items:

- The complete score, published by Éditions Musicales Européenes.

- A quality audio version, recorded by Quatuor Diotima for the Austrian label Kairos, also taking the composer's text from the booklet.

- A copy of the whole set of manuscripts and sketches conserved by Posadas.

- A copy of the computer tools and the digital or graphic givens the composer has developed and used during his creative practices.

[8] We are simply remembering Ian Bent's (1980) definition of the term, as "that part of the study of music which takes as its starting-point the music itself, rather than external factors" (p. 341).

[9] A musicological branch that has not forgotten contemporary music (Hall & Sallis, 2004).

• An audio file with all the interviews we have had with the composer touching his string quartet cycle: these conversations took place during winter/spring 2009 and summer 2013.

• A summarized copy from a section of the composer's library concerning science—mainly popular volumes—, with special attention to his own handwritten notes on these books.

Beyond these primary sources, the genetic dossier is somehow completed by some secondary ones. Among the most relevant ones, we must foreground the inquiry of other Posadas's scores. Moreover, we have dealt with several books and articles concerning the composer's scientific interests as well as touching the work of some musicians that someway share with him modeling standpoints.

All the genetic analyses around *Liturgia Fractal* have been exhaustive; nevertheless, their display throughout the second part of this book will be synthetic, and limited to certain examples particularly suitable. We are convinced that a precise and well chosen sample—even a single bar for a specific matter—may be analytically more eloquent that the exhibition of the tiniest details throughout an entire score. We are maybe far from Pierre Boulez's (1989) "fulgurant analysis" (p. 37), but we will try to belittle spurious givens that could hinder our analytical perspective and intentions. In that sense, we must stress that genetic analysis is here the—indispensable—mean to achieve our aims but not the goal itself.

Finally, we should remember that genetic criticism of music can betray some aesthetic judgements over the studied work (Donin & Theureau, 2006, p. 63). This warning, connected to the previous discussion about the non trivial links between music and science, invites to quote Joseph Kerman's well-known review about music analysis:[10]

> Aesthetic judgment is concentrated tacitly in the initial choice of material to be analyzed; then, the analysis itself, which may be conducted with the greatest subtlety and rigor, can treat of artistic value only casually or [...] not at all. [...]
> In fact, it seems to me that the true intellectual milieu of analysis is not science but ideology.
>
> (Kerman, 1980, pp. 313-314)

This tricky fact was already highlighted by Carl Dahlhaus when he commented the relationships between analysis and value judgements:

> Aesthetic judgments, at least cogent ones, are sustained by factual judgments which in turn depend on analytic methods demonstrating the musical attitude of a period.

[10] To be put in parallel with Kofi Agawu's (2004) reply, where the Ghanian musicologist pledged for an experimental value of music analysis, potentially fruitful for music theorists and composers.

> An inversely, analytic procedures, including those without preconceptions, are tied to aesthetic premises.
>
> (Dahlhaus, [1970] 1983, p. 7)

Moreover, we must acknowledge that any musicological discourse—and specifically music analysis—is conditioned upon "narratives of disciplinary legitimation", a fact that Kevin Korsyn has chiefly shown. His arguments concern the current status of the American musicological fields, but the following statements can equally touch the discourse emanated from the contemporary music milieu and its subsequent analytical manners:

> One place where the identity of research communities emerges is through what I call *narratives of disciplinary legitimation.* [...] Since musical research is often addressed to a professional audience, these narrative strategies create potential sources for someone to construct an identity as a music historian, ethnomusicologist, theorist, or member of a more specialized subgroup. They can interpellate the subject, who can respond with various degrees of identification or distance.
>
> (Korsyn, 2003, pp. 61-62)[11]

We have already stated that composition and music theory are not falsifiable according to Popper's strict definition; as a corollary, we assume that our analytical perspective is not realistically science, nor are Posadas's compositional practices. Anyway, and even acknowledging that there could be a subjective preference leading to the selected case study, we will try to minimize as far as possible our aesthetic judgements over *Liturgia Fractal* while exposing our analyses: they would have almost nothing to deal with the cognitive and formal issues we will chiefly discuss.

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[11] Author's emphasis.

(Universidad de Navarra) further comments upon cognitive issues have been specially fruitful. Finally, Jean-Charles Beaumont is the responsible for the proper quality of this English version.

I wish to emphasize Alberto Posadas's gentlehood with me. He has never put any limit to access his documentary sources, and there has been no attempt of censureship concerning my will to make a critical study.

My postdoctoral status at Ircam during 2015-2016—as a laureate of the Laboratoire d'Excellence CAP—has given me an ideal position to prepare this book. My heartfelt thanks to Nicolas Donin and all the Analyse des Pratiques Musicales team for their warm welcome and the unsurpassable conditions to work.

FIRST PART:
TOWARDS A METAMODELING

Chapter 1
The Epistemological Framework

> *The sciences do not try to explain, they hardly even try to interpret, they mainly make models.* [...] *The justification of such a mathematical construct is solely and precisely that it is expected to work.*
>
> (von Neumann, 1955, p. 157)

Can the clouds—as extramusical objects—influence different composers' creative acts in similar ways? A comparison among Claude Debussy's evocations, György Ligeti's textural elaborations and Iannis Xenakis's formal constructs[1] give back a negative answer. Although some iconic or indexical implicit features around this natural phenomenon can be detected for all three cases, Xenakis's formalizing should be considered from a symbolic standpoint.[2] Indeed, the presence of science through some of its concepts and its notation during a composer's creative process may decisively connote the course of his activity.

From a viewpoint close to visual arts, these clouds could be regarded as iconic models the composers would yearn to evoke. The aim of this chapter is abundantly far—even if we will punctually approach it—from this perspective: here, the notion of model will have a symbolic nature to the fullest extent, analogous to its meaning linked to the study of formal languages. This position requires the foundation and the development of a coherent conceptual apparatus which allows a consistent adaptation of the term 'model' within a musicological context. Moreover, this argumentation must adopt a functional orientation so that it may effectively assist the analysis of science-inspired compositional practices. Consequently, this chapter will determine the epistemological framework, as well as a starting terminology, in order to reach these goals.

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[1] The cloud example, concerning these three composers, is not ours but Pierre Boulez's (1989, pp. 134-135). The French composer used the term "outside vector" to refer to extramusical inspirations. We will come back to Boulez's exemplar triad at the opening of the following chapters.

[2] Our use of the terms 'iconic', 'indexical' and 'symbolic' obviously comes from Charles S. Peirce's ([1931-1960] 1974, pp. I.193-197) canonic trichotomy. An iconic sign has qualities that could be defined as pictorial, an indexical one keeps a partial resemblance with the object—like a trail—and a symbolic one is linked to the object through an interpretative habit.

1.1 Did You Say Compositional Model?

As pointed in the Introduction, several composers refer to the term 'model' in order to render a portrayal of their creative practices. Nevertheless, each one of them subjectively harnesses this expression for his own profit, pursuing to be coherent—not always successfully—with his musical thought. Indeed, without resorting to an extensive etymological discussion, the term covers multiple meanings commonly used, and can open a huge semantic field. Even scientists are far from a terminological consensus around this term. Its use often depends on the technical context of each discipline: modeling activities substantially vary among the multiple branches of science, from strict formal definitions to vague heuristic approaches. It is therefore crucial to mark off a particular use of the term in this context, but that could likewise embrace a broad room of interpretation, available for musicologists and music theorists.

Model theory can provide a starting epistemological frame to attempt several coherent definitions for musicology. This field of logics and mathematics was born during the first third of the 20th century, propelled by the efforts made by people such as Leopold Löwenheim, Thoralf Skolem or Kurt Gödel. In fact, the Löwenheim-Skolem theorem is sometimes considered the birth of model theory (Badesa, 2004). We could summon several historic definitions for 'model' (Carnap, [1934] 1967, p. 271; Tarski, [1956] 1983, pp. 416-417), but a more concise and informal one, simply catching the epistemic aim of the term, will be more useful to open this discussion:

> A model is a structure in which sentences with a particular logical form are true.
>
> (Staley, 2014, p. 45)[3]

How does this structure work? A more extended description, informal again although introducing the metalinguistic issue—the fundamental matter at the core of model theory—can subserve to explain it:

> Model theory studies the relation between the formulas of a formal language and their interpretations or models. Thus, model theory requires having a formal language, a concept of satisfaction from the formulas of this language and the distinction between the formal language and the metalanguage in which the relation between the formulas and their models are discussed.
>
> (Badesa, 2004, pp. 59-60)

Thereupon, a *model* is, in mathematical terms, a mechanism that enables, by means of precise rules, a particular interpretation of formal language constructions. A plausible

[3]The author provides a more accurate definition at page 54.

reading of the description above also denotes its materialistic orientation: the metalinguistic layer gives a concretionary sense for a set of abstract objects and their logical relationships.

Obviously, this approach does not allow an immediate adaptation within the musicological domains, given the presence of several (meta)linguistic and logical matters that are inapplicable to music in a strict sense. However, two notions emanate straight away from this perspective—one implicitly, the other explicitly—which are particularly suitable in order to set an analogical adaptation of the mathematical term 'model' in a musical context. First, the requirement of notational elements—a formal language and an explanatory metalanguage in model theory—highlights the representational character of generic modeling processes. Models—in a wide sense that we will define below—are based on representational systems which enable an arrangement to concepts or empiric aspects of reality throughout abstraction. Second, the main modeling potential—that is to say, the relationship between the two linguistic layers in model theory—is interpretative. Representation and interpretation articulate thus modeling operability as complementary poles.[4] Models, from a more generic perspective, act therefore as mediators (Morrison & Morgan, 1999) between abstraction and new knowledge production or tangible materiality.

We must underline the subtle difference of meaning for the term 'model' when comparing the sense it has for mathematic logicians and its common use in the fields of experimental sciences. A mathematical model has a proliferative orientation, while empiric ones generally tend to assume reductionist criteria with respect to the issues they analyze. In effect, the first path takes formal conceptualizations as a starting point followed by a material or practical interpretation; the second case faces an often highly complex reality wherein the model discriminates, filters and abstracts several aspects or features so as to obtain an optimal—that is, economic—representation pursuing research goals. The relationship between these two possible meanings could suggest a dual flux in regard to a materiality versus abstraction.

The last comment is not trivial at all, since most musicological studies concerning analysis and claiming the use of this terminology converge—consciously or not—with the regular sense findable in empirical sciences. This parallelism becomes specially true when musicologists provide visual devices in order to abstract aural or symbolic music features. We will take as a starting point the opposite orientation—the proliferative one—, but this approach cannot be neglected. In this regard, and recalling the distinction—in Peircean terms—between an iconic and a symbolic standpoint facing models evoked at the beginning of this chapter, Frederick Suppe's epistemic critic and compromise—mainly inspired by Ernest Nagel's philosophy—must be quoted:

> There is no doubt that the formalism of theories *can* be interpreted in terms of iconic models and that doing so often is heuristically fruitful in suggesting hypotheses, developing theories and so on. [...] Considerations of heuristic fruitfulness do not establish that they enjoy this status [to be *essential* or *integral*] in theorizing since

[4] Compare this assertion with Alain Badiou's (1969, p. 137) opposition between a positivist and a dialectic-materialist perspective around models, and with Frederick Suppe's (2000, pp. S103-S104) discussion about syntactic and semantic values of models.

> they can be heuristically fruitful without being essential and integral components of theories.
>
> (Suppe, 1977, p. 99)[5]

Once the chosen epistemic background outlined, we are in position to submit a set of definitions that will run through the whole text, large enough to bear a widespread variety of possible cases. Evidently, such definitions would not be as strict and formal as the mathematical one that has assisted our former arguments. Henceforth, we will refer to *scientific models*—alternately models of science—as the mechanisms or devices able to represent a scientific knowledge through the support of an underlying formal or pseudo-formal language—depending on the methodological practices of each scientific field—, and allowing an interpretation to produce new knowledge by means of deduction, prediction, simulation, or through other strategies that may be specific to each science in question. We will refer to *musical models*[6] as the mechanisms or devices able to represent certain aspects of music through the eventual support of an underlying writing system, precise enough to allow an interpretation by means of performance, composition, analysis or within the scope of any other musical practice or any other music study field. Finally, as a special case of the latter, we will refer to *musical models developed by composers during their creative practices*—or plainly compositional models—as those expressly conceived and developed by composers with the aim of bringing forth their own music.

A linguistic borrowing can bring out the specificity of compositional models as a particular case of musical ones: they may be regarded as idiolectic models. An idiolect is the individual linguistic pattern a person uses among the speakers of her or his dialect or language, that is to say, an intimate variant of the former. Umberto Eco has seized this term so as to depict the defining features of an artist's style through her or his own production as well as compared with his peers:

> The rule governing all deviations at work at every level of a work of art [...] is the *aesthetic idiolect*. [...] Insofar as it produces new norms accepted by an entire society, the artistic idiolec may act as *a meta-semiotic judgement changing common codes*.
>
> (Eco, [1975] 1979, p. 272)[7]

Our conception of compositional models as idiolectic ones is somehow close to Eco's aesthetic idiolect, taking specially into account its potential dynamism. Indeed, it does

[5] Author's emphasis.

[6] We do not suggest the alternative expression 'models *of* music' so as to avoid inaccuracies with a possible variant like 'models *in* music'. The second ones are supposed to concern an internal activity, while the first could be external. For example, a compositional model—that we will promptly define—would be a model *in* music whilst a musicological one—discussed in Chapter 4—would belong to the models *of* music. The more generic and neutral expression 'musical models' embraces both cases.

[7] Author's emphasis

not mean that compositional models of each author should be substantially regarded as local restrictions—in a mathematical sense—of generic musical models shared by a community. In fact, each composer's models may have a certain *ex nihilo* component vis-a-vis his surrounding musical practices. However, this subjective room does not preclude a wide intelligibility by the composer's peers or even by a larger community, either through the author's express will to explicitly show his creative practices—for example, throughout his theoretical texts—or by inferential ways depending on a direct on an indirect analytical study. Thereupon, the idiolectic value we bestow to compositional models should be regarded above all as a concept—in a mathematical sense again—linked to immersion, rather than restriction.

1.2 Demarcation Criterion

Once the precedent definitions given, it may be convenient to establish an epistemological discrimination among the different orientations that may occur during the transfer between different models involving music and sciences. For example, the interpretation a mathematician or a musicologist could make over a musical model—such as formal abstractions around scales—and composers' interests about scientific models often differ in terms of conceptual prosecution, methodology and production. Even when a single author intends to generate scientific knowledge and artistic creation playing somehow both roles—sometimes in a deliberately ambiguous border—, these productions do not share the same nature. Therefore, and in the image of the philosophy of science, it is pertinent to formulate a demarcation criterion between both activities.

For that purpose, we will call upon Alain Badiou's theses explicitly regarding to mathematical model theory. The first one identifies two possible conceptions of the term:

> *First thesis*: There are two epistemological instances of the word 'model'. One is a descriptive name of scientific activity; the other is a logical mathematical concept.
>
> (Badiou, [1969] 2007, p. 52)[8]

The logic core of model theory and our broader definition of scientific models somehow befit with the French philosopher's foregoing thesis. Next, he proposes a covering hierarchy between both instances, akin to the aforestated metalinguistic stratification:

> *Second thesis*: When the second instance serves to support the first one, there is often an ideological cover of science, that is to say, a philosophical category, the model category.
>
> (p. 52)[9]

[8] Our translation. Author's emphasis.

[9] *Idem.* It is important to stress, in order to understand Badiou's theses, that he previously defines 'concept' as a scientific notion, and 'category' as a philosophical one.

Finally, Badiou chiefly highlights the epistemological issues derived from the precedent theses:

> *Third thesis*: The current task of philosophy is to disentangle, within the uses of the model category, a *subservient* one, which is but a variant, and a positive use, invested in the theory of the history of science.
>
> (p. 52)[10]

More modestly, our musicological position tends to distinguish the possible epistemic fluxes when scientific and compositional models approach. To this end, Badiou's second thesis is particularly suitable as a propositional mould so as to differentiate the possible transferring orientations. Its epistemological notion of 'cover'—evidently borrowed from mathematic terminology—can help to discriminate two elemental categories of transfer, owning different supports and productive mechanisms:

- When the epistemological instance about musical models serves to support the scientific activity, there is often a *gnosiological cover* of music, potentially able to beget new scientific (or even musical) models.

- When the epistemological instance about scientific models serves to support the musical activity, there is often an *esthesic cover* of science, potentially able to beget new musical models.

Note the specular link between both categories, a fact that could lead to an eventual capacity of implicit feedback.[11]

Both chosen expressions—'gnosiological' and 'esthesic'—deserve an afterthought, specially the second one. The first one replaces the idea of an 'epistemic cover' so as not to be redundant with Badiou's terminology. Furthermore, several authors consider 'gnosiology' as a more neutral term than 'epistemology' with regard to a critic scope over knowledge. This fact must be underlined in our context: indeed, the production of scientific knowledge from musical models does not necessarily open the door to qualitative or aesthetic judgments about the starting music. For example, the inferences a mathematician can extract from the study and the abstraction of musical models are potentially able to generate a mathematical model, but at last unbiased and emancipated from its musical origin. Otherwise, we privilege the term 'esthesic' rather than 'aesthetic' in order

[10] *Idem.*

[11] In this way, the demarcation is somehow dual—while specifically limited to a mathematical scope—of Guerino Mazzola's (2007, p. 5, 173) categorical approach relating music and mathematics. Mazzola considers that music links formulas with gestures with an orientated arrow, while the opposite direction is governed by mathematics. Anyway, the author is quite skeptical about the cohabitation of both orientations as they are being studied today.

to avoid misunderstandings: the second cover does not intent to make a direct reference to art theory or philosophy but calls up its etymological root, that is to say, the $\alpha\acute{\iota}\sigma\theta\eta\sigma\iota\varsigma$ as perception from the senses. Thus, the idea of an esthesic cover does not evoke at all a hypothetical quest about beauty in science; it proposes in return a *sensitive interpretation* of scientific models through music, by means of creative production.

Anywise, the discussion still remains open. Indeed, the term 'esthesic' is strongly connoted in music after Jean Molino's (2009) and Jean-Jacques Nattiez's (1987) semiological contributions. From this point of view, our definition of an esthesic cover will seem paradoxical for a music semiologist, because it concerns a phase that those authors would attach to the poietic level. Hence, a succinct discussion about our research topic but concerning the classic tripartition must be provided.

Nattiez's proposal is not a completely rigid division in watertight compartments. First, the author makes a clear difference between the poietic and the esthesic levels, but also suggests the importance of a diachronic connection among works or stylistic periods, linking both levels in an oriented temporary scheme (Nattiez, 1987, pp. 183-184). Second, while criticizing Michel Foucault's (1969) epistemology, the musicologist equally proposes an analogous diachronic scheme for the history of sciences (Nattiez, 1987, pp. 221-223). Now, we can somehow imagine a 'Nattiezian scholar' willing to delimitate our research topic within a semiological frame. According to the above comments, he or she could maybe feel tempted to oppose both diachronic schemes so as to relate them (see Figure 1.1). Inside this new hypothetical frame, the model transferring could probably be defined as an input from the scientific esthesic level upon the music poietic level. Nevertheless, it is quite hard to imagine that our fictional musicologist would use an expression such as 'esthesic cover' while analyzing music; the closest coined expression—always respecting Nattiez's analytic categories—for this context would maybe be 'external poietics *depending on*—or *driven by*—the esthesic level of science'.

We must stress that our purpose is far from trying to redefine the canonic semiological concepts over music, we are simply justifying our different intentions concerning the term 'esthesic'. Nevertheless, the fictional diagram we have suggested will be useful for further discussion about our epistemological framework.

Finally, and coming back to the 'gnosiological versus esthesic' demarcation, we must underline that we have privileged the $\alpha\acute{\iota}\sigma\theta\eta\sigma\iota\varsigma$ rather than the $\gamma\nu\acute{\omega}\sigma\iota\varsigma$—the gnosis, i.e. the knowledge—so as to set the division in both categories. The reason is plain: it clearly pivots on our research goals. A subtler analysis about the implications of a gnosiological cover exceeds indeed the current topic, but it is evident that alternative demarcation criteria—specifically further refinements—could fit over this frame.[12] In fact, the addi-

[12]In this sense, we can for example adduce François Nicolas's discussion about the relationships between music and mathematics. The French composer and philosopher clearly discerns between the musicological applications on the music and a musical mathematization as completely different cases (Nicolas, 2012, p. 23). The first one embraces the use of mathematics as a tool for music analysis, while the second one points to the emergence of mathematical models arisen from a musical context. Our gnosiological cover perfectly fits with the second case, but not always with the first one. Laxer criteria acknowledging musicological contributions as scientific ones (Vecchione, 1991)—a possibility that we disagreed, as discussed in the Introduction—would admit the inclusion of such second case. On the other hand, the idea of a musical—"*musicienne*"—experimentation (Nicolas, 2012, pp. 23-30) is only partially akin with our esthesic cover. We just need to remember Nicolas's (1988) objections against Xenakis's scientific-inspired compositional practices.

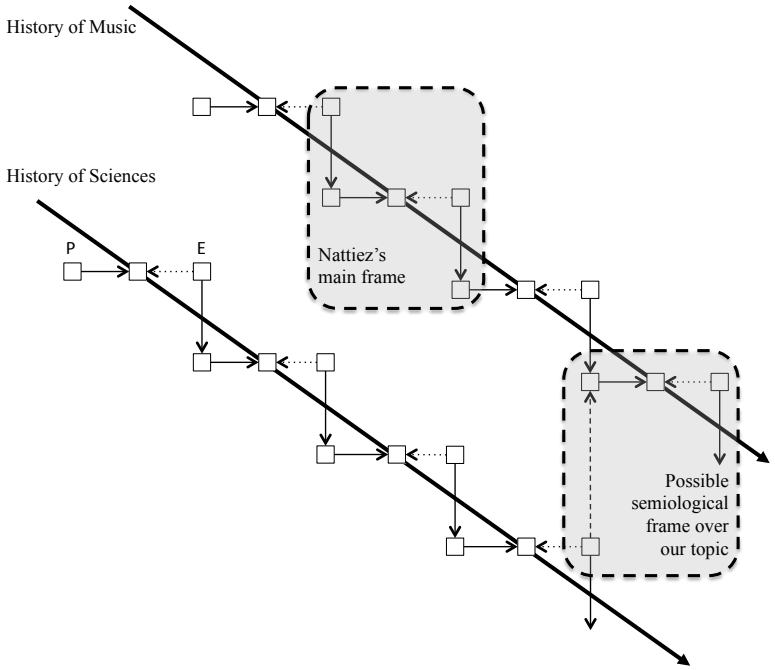

Figure 1.1. Hypothetical semiological frame to discuss the model transferring from science to music, according to Nattiez's diachronic schemes.

tion of musical models—in brackets in our definition—as an eventual byproduct coming from a gnosiological cover tries to rightfully incorporate the scholar studies lying for example on a boundary between systematic musicology and mathematics,[13] the latter arisen as a corollary of the American music theory during the second half of the 20th century.

1.3 Music and (Meta)language

As stated above, the linguistic and metalinguistic notions that support model theory open a serious pitfall while trying to adjust them into a musicological context. We can

[13]Note that the Mathematics Subject Classification has added, in its MSC2010 edition, the code '00A66 Mathematics and music' in order to cover these sorts of scholar contributions.

set forth the problem with a somehow simplistic question: can we conceive the music as a metalanguage able to interpret the—more or less—formal languages that underlies scientific models during a composer's esthesic cover?

This question will be implicitly resumed in Chapter 3, but a brief comment about the relationship between music and language is mandatory for that purpose. Such relationship has historically generated an intense scholar debate with no consensus, given often the presence of a priori ideological assumptions—in favor of or against—skewing the arguments. In addition, several favorable attitudes about this subject have sometimes fallen into the "old and largely futile game" (Lerdahl & Jackendoff, 1983, p. 5) of an analogical but superficial detection of shared patterns. Their subsequent mistake has often been to extrapolate such analogies as if they were generalizable laws. Our position wishes to break away from all these connoted discourses, trying in return to take stock of some cognitive and neurological studies that have dealt with this issue but providing some empirical evidence.

Aniruddh Patel (2008) and Stefan Koelsch (2013a) have revealed some of the most significant affinities between these two domains.[14] On the one hand, both scholars agree to emphasize the absurdity of looking for analogical syntactic rules shared by music and language. They argue in return the existence of cognitive skills during musical listening significantly related to the strategies responsible to apprehend speech syntactic structures. Thus, several mechanisms concerning feature extraction and detection, processing analysis, syntactic integration and restructuring, and an anticipation during an active listening seem to be shared. Further, both skills would activate the same brain regions in neurological terms. Indeed, Koelsch postulates that these statements could be extended over the formal languages processing,[15] an important fact concerning our topic. On the other hand, both authors also consider meaningless a full equivalence between language and music semantics. Listening to music involves however the activation of brain regions also responsible for linguistic semantic processing. This fact implies that, although music does not carry itself a concrete meaning comparable to natural languages, it would be able to induce the listener to evoke meanings or emotions, verbally expressible in a more or less accurate way. Patel (2008) specifically states that "lacking specificity of semantic reference is not the same as being utterly devoid of referential power" (p. 328). In short, music and language seem to be two different entities, but certain coincidences in terms of cognitive processing and neural activity show an affinity that cannot be at all neglected. Koelsch (2013a) propounds indeed the existence of a "language-music *continuum*" (pp. 244-249), where both entities would be its poles. Chapter 2 will summon

[14] Both authors provide original evidence or summarize other author's accomplishments, but mainly concerning tonal music and ethnomusicological studies. In return, their works give almost no room to contemporary music.

[15] The medical psychologist surmises his Syntactic Equivalence Hypotesis, formally summarized in the logic expression below (Koelsch, 2013a, p. 154):

$$\exists\{x|(x \in M_{syn}) \wedge (x \in L_{syn}) \wedge (x \in Act_{syn}) \wedge (x \in Math_{syn}) \wedge (x \notin A_{dev}) \wedge (x \notin L_{sem})\}$$

Where M_{syn} means musical syntactic processing, L_{syn} the linguistic one, Act_{syn} the action one, $Math_{syn}$ the mathematical one, A_{dev} the acoustic deviation and L_{sem} the linguistic semantical processing. That is to say, the four referred syntactic mechanisms share brain regions, while the acoustic and the semantical aspects of hearing would be neurologically independent.

several cognitive metaphor theories applied to music; the comments above would implicitly hold them, at least as a plausible framework.

This enlightening evidence is not however sufficient itself facing our discussion about compositional models. In point of fact, the aforementioned studies mainly refer to mental processes that occur during listening. In return, the set of activities a composer develops during his or her creative practices—although hearing can be involved in this process, either through an internal listening or by means of performers or electronic simulations—takes place in a previous step. We need therefore to circumscribe the linguistic issue into the modeling domain so as to carry through a second theoretical approach.

One of the most defining features within the Western musical tradition is the existence of writing systems, often mediating between thought and numerous musical practices. Such systems must nowadays be understood from a broad perspective, encompassing both traditional notation and newer supports, those ranging from sound recording to computation. All these supports are closely linked to the notion of a musical model, through representation and interpretation by a feedback process which depends on the mutual influence between thought and writing; their existence and evolution have been decisive without question to shape the Western history of music. However, such scriptural constructs—specially the more traditional ones—are not comparable to formal or natural languages in propositional terms. No music tradition has been found—excepting some drumming or whistling techniques that deliberately imitate language—with embedded propositional structures such as quantifiers, modal terms or connectors (Koelsch, 2013a, pp. 158, 184). In return, those writing systems highlight a resemblance with the linguistic domains that must be stressed from a modeling viewpoint: they operate as an "abstraction device" (Nicolas, 1986, p. 99) conveying the mutual exchanges between intellect and materialization.

All in all, music and language are two different realities but sharing certain elements—maybe not the most trivially alleged ones—, and the presence of writing in the Western musical tradition reinforces this link from the perspective of an abstract representation of thought. Thus, we cannot assert that music could become a metalinguistic construct able to interpret more or less formal languages underlying scientific models, but this answer for the starting question must be qualified. Musical writing and its implicit abstraction may participate, hand in hand with proper linguistic systems, to develop devices similar to metalanguages during the esthesic cover of a scientific model.

A final note, borrowed again from semiotics, may help to clarify the metalinguistic issue. Considering a translation perspective, the transfer from a proper linguistic system to music should be classed as an intersemiotic one:

> Intersemiotic translation or *transmutation* is an interpretation of verbal signs by means of signs of nonverbal sign systems.
>
> (Jakobson, 1959, p. 233)[16]

[16] Author's emphasis. Let us remember that the quoted article proposes three translation categories: the intralingual one inside a single language—like synonymy—, the interlingual one between languages, and finally the referred intersemiotic one.