HEARING TIMBRE-HARMONY IN SPECTRAL MUSIC

by

Christopher Gainey

B.M., Peabody Conservatory, 2004
M.M., Peabody Conservatory, 2006
Ph.D., University of Iowa, 2009

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF
THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

in
THE FACULTY OF GRADUATE AND POSTDOCTORAL STUDIES

(Music)

THE UNIVERSITY OF BRITISH COLUMBIA

(Vancouver)

May 2019

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The following individuals certify that they have read, and recommend to the Faculty of Graduate and Postdoctoral Studies for acceptance, the dissertation entitled:

**Hearing Timbre-Harmony in Spectral Music**

submitted by Christopher Gainey in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Music, Emphasis Theory

**Examining Committee:**

John Roeder
Supervisor

Richard Kurth
Supervisory Committee Member

David Alan Dodson
Supervisory Committee Member

Keith Hamel
University Examiner

Valter Ciocca
University Examiner
ABSTRACT

Spectral music is a repertoire that emerges from a compositional attitude that consistently conflates timbre and harmony. The means by which composers of spectral music achieve such conflation are varied, and their music dramatizes the liminality of timbral-harmonic perception in different ways. Despite their aesthetic and technical diversity, these composers assemble and organize harmonies in their music in deference to the psychoacoustic foundations of timbral perception. To foster an appreciation for spectral music and, more generally, the enchantingly abstruse nature of timbral-harmonic perception, I build upon similar foundations in this project to generate analytical accounts of spectral music informed by, but distinct from, the methods used to compose them.

The automatic cognitive processes that afford us a sense of timbre for complex sounds (such as those of musical instruments) also affect how we hear sounds in combination. Our sense of a sound’s timbre partly correlates to the distribution of its component partials—subordinate component frequencies often aurally inseparable in the sound that emerges from their combination. Similarly, the identities of notes in a chord can be subsumed, to some extent, by that chord’s emergent holistic identity. This is especially true of complex sonorities wherein the number of component pitches overwhelms our ability to aurally distinguish them.

Such complex sonorities are staples of spectral music. As in non-spectral works that feature a similarly saturated harmonic language (such as Ligeti’s Atmospheres), individual pitches are often buried in larger masses of sound. What distinguishes spectral music, however, is that the complex chords tend to approximate assemblages of partials acoustically correlated with certain timbral percepts. Using such correlations as a model for harmony
allows otherwise saturated harmonies to express unique gestalt timbres.

In analyses of music by Tristan Murail, Gérard Grisey, Kaija Saariaho, Jonathan Harvey, Claude Vivier, and Magnus Lindberg, I demonstrate how the timbres expressed by complex chords help the listener to distinguish between them and hear them as expressing different levels of timbral-harmonic tension. Then I show how these contrasts support the formation hierarchical timbral-harmonic structures, and how these structures relate to the dramatic arc of the music.
LAY SUMMARY

Spectral music is a compositional trend that calls upon innate aspects of our auditory cognition in creating uniquely resonant sound combinations. For example, in “Partiels”—a seminal spectral work by Gérard Grisey—a trombone gradually fades away as a separate chord fades in. This chord is special because its notes are distributed precisely so that the sound of the chord resembles that of the trombone. In this project, I develop an analytical means for appreciating how such effects contribute to spectral music’s unique liveliness that supports, at a deeper level, an emergent sense of dramatic musical structure. I review theories of harmony and timbre, as well as spectral composers’ writings about their music, in order develop suitable ways to measure and compare the relative tension of chords.
PREFACE

This dissertation is original, unpublished, independent work by the author, Christopher Gainey.
# TABLE OF CONTENTS

Abstract ........................................................................................................ iii

Lay Summary ................................................................................................ v

Preface ........................................................................................................... vi

Table of Contents ........................................................................................ vii

List of Tables ................................................................................................. vii

List of Figures ................................................................................................ xi

Acknowledgements ....................................................................................... xiv

Dedication ..................................................................................................... xvi

Chapter 1: Timbre and Harmony ................................................................. 1

1.1: Introduction .......................................................................................... 1
1.2: Timbre and Harmony as Perspectives on Sounds in Combination .......... 3
  1.2.1: Partial, Harmonic, and Overtone ................................................... 7
  1.2.2: Overtone Class ............................................................................. 10
    1.2.2.1: Powers of Two in the Harmonic Series ................................. 11
    1.2.2.2: Perceptual Meaning and Analytical Relevance of Overtone Classes ......................................................... 14
  1.2.3: Fundamental, Virtual Fundamental, and Chord Root .................. 20
  1.2.4: Spectral Fusion and Harmonicity .............................................. 23
1.3: Timbral-Harmonic Overlap .................................................................. 28
  1.3.1: Harmonic Sense and Timbral Quality ....................................... 30
  1.3.2: Musical Coordinations of Harmonic Sense and Timbral Quality ...... 33
  1.3.3: From Overtones to Music ......................................................... 35

Chapter 2: Timbre, Harmony, and Spectral Music ..................................... 38

2.1: “Spectral” Music .................................................................................. 38
  2.1.1: Listening to Spectral Music ........................................................ 39
  2.1.2: Reading About Spectral Music ................................................... 42
2.2: Tristan Murail ...................................................................................... 44
  2.2.1: Microtonal Approximation in the Opening of Désintégrations ....... 46
  2.2.2: Derivation of Timbre-Harmonies in the Opening of Désintégrations ........................................................................... 48
  2.2.3: Time and Process in the Opening of Désintégrations .................. 56
2.3: Gérard Grisey ....................................................................................... 60
  2.3.1: “Partiels” .................................................................................. 61
  2.3.2: “Prologue” ............................................................................... 68
### LIST OF TABLES

Table 2.1: Symbols used in figure 2.8 ..........................................................81

Table 4.1: Overtone class content of the A#0 series of timbre-harmonies from the opening of *Désintégrations* .................................................................131

Table 4.2: Overtone class content of the C#2 series of timbre-harmonies from the opening of *Désintégrations* .................................................................132

Table 4.3: Frequency proportions produced by dividing $F^*(1-31)$’s primes by powers of 2....................................................................................142

Table 4.4: InV produced by DOSs of $F^*(1-31)$’s primes ..............................................145

Table 4.5: Calculating InV of timbre-harmony 8 from the opening section of “Partiels” ....146

Table 5.1: Overtone content of timbre-harmonies from mm. 24-41 of *Lonely Child* ........179
LIST OF FIGURES

Figure 2.1: A phenomenological representation of the opening gesture of Grisey’s “Partiels” ..........................................................40

Figure 2.2: Two series of timbre-harmonies from the opening of Désintégrations and their relation to harmonic spectra ..........................................................49

Figure 2.3: Correspondences between A#0 bell spectra and the A#0 and C#2 harmonic spectra from the opening of Désintégrations ........................................54

Figure 2.4: A graph of Murail’s precompositional plan for “rallentando curves” in the opening gesture of Désintégrations .............................................................57

Figure 2.5: Temporal profile of the opening gesture of “Partiels” ........................................66

Figure 2.6: An analytical account of the opening of “Prologue” ........................................71

Figure 2.7: Harmonics as points along an axis of “purity” ................................................80

Figure 2.8: An analytical representation of the five component gestures of “Papillon I” ......82

Figure 2.9: Two interpretations of “Papillon I” ................................................................84

Figure 2.10: Timbral-harmonic derivation from a bell spectrum in Mortuos Plango, Vivos Voco ........................................................................................................92

Figure 3.1: Pitch collections from mm. 11-19 of Ligeti’s Melodien interpreted as a series of “tone representations” (from Hasegawa 2006) .........................................................122

Figure 4.1: Dynamic curves from the opening of Désintégrations ........................................129

Figure 4.2: Spectral content of timbre-harmonies from the first stage of the opening section of “Partiels” .................................................................................138

Figure 4.3: Spectral content of timbre-harmonies from the second stage of the opening section of “Partiels” .................................................................................139

Figure 4.4: Inharmonicity in the second stage of the opening section of “Partiels” (timbre-harmonies 6 – 11, ca. 2:30 – 4:00) .................................................................148

Figure 4.5: “Tree Structures” (from Lerdahl 1987) .................................................................150

Figure 4.6: Timbre-harmonies from section VIII of Désintégrations .................................154
Figure 4.7: Inharmonicity values of timbre-harmonies from section VIII of *Désintégrations* .......................................................... 155

Figure 4.8: A hierarchical representation of timbre-harmonies from section VIII of *Désintégrations*, in order of their derivation and according to InV .................. 157

Figure 4.9: A hierarchical representation of timbre-harmonies from section VIII of *Désintégrations*, in order of their deployment and according to InV ............... 159

Figure 4.10: Filtering of timbre-harmonies according to their “ambits” .................... 160

Figure 4.11: The effect of Murail’s addition and removal of pitches on the InV of timbre-harmonies from section VIII of *Désintégrations* ..................................... 162

Figure 4.12: A hierarchical representation of timbre-harmonies from section VIII of *Désintégrations*, in order of their deployment, as altered, and according to InV .................................................................................. 163

Figure 4.13: A juxtaposition of hierarchical structures of duration and timbral-harmonic tension expressed in section VIII of *Désintégrations* ................................ 165

Figure 4.14: A juxtaposition of hierarchical structures of ambit and timbral-harmonic tension expressed in section VIII of *Désintégrations* .................................. 167

Figure 5.1: Derivation of a timbre-harmony from *Lonely Child* ................................ 173

Figure 5.2: Annotated reduction of mm. 24-41 of *Lonely Child* ............................... 175

Figure 5.3: Overtone content and mistuning of timbre-harmony ................................ 177

Figure 5.4: EV calculation for timbre-harmony ......................................................... 183

Figure 5.5: Preliminary hierarchy of timbre-harmonies from mm. 24-41 of *Lonely Child*.. 184

Figure 5.6: Abstract summary of mm. 24-41 of *Lonely Child* .................................. 185

Figure 5.7: Hierarchical account of timbral-harmonic progression in mm. 24-27 .......... 186

Figure 5.8: Hierarchical account of timbral-harmonic progression in mm. 28-34 .......... 188

Figure 5.9: Hierarchical account of timbral-harmonic progression in mm. 37-41 .......... 190

Figure 5.10: Hierarchical account of timbral-harmonic progression in mm. 24-41 .......... 193

Figure 6.1: Hierarchical interpretation of a tonal hearing of “Papillon I” ...................... 200
Figure 6.2: Hierarchical interpretation of a timbral-harmonic hearing of “Papillon I” ........203

Figure 6.3: Timbral-harmonic derivation from a bell spectrum in Mortuos Plango, Vivos Voco........................................................................................................................................................................208

Figure 6.4: Hierarchical interpretation of background structure in Mortuos Plango, Vivos Voco........................................................................................................................................................................210

Figure 6.5: Comparing twelve-note chords used by Lutoslawski and Lindberg ............214

Figure 6.6: Deployment of chaconne cycle in mm. 1-11 of Twine (from Martin 2005) ....216

Figure 6.7: Contour of axes and registral extremes of the chaconne cycle from Twine .......218

Figure 6.8: Deployment of chaconne cycle in mm. 51-55 of Joy (strings only) .................222

Figure 6.9: Background harmonic fields and foreground activity in mm. 51-52 of Joy .......224

Figure 6.10: Realizing a symmetrical pitch structure with overtones in mm. 51-52 of Joy ..225
ACKNOWLEDGEMENTS

To simply list those who deserve my gratitude for their help and guidance in refining this project would be to understate what their contributions have meant to me. I am certainly not alone in that I have found the experience of writing a dissertation to be a challenge. When my confidence flagged, or my work fell short of expectations, my committee members never ridiculed or dismissed the groans I am sure they have heard many times before. Instead, exhibiting almost superhuman patience, they were continually supportive. Along with this support, my committee members read, in detail, every draft of every chapter. I am especially thankful for these efforts and, in discussing my work and bringing their own expertise to bear, they have modelled for me the best of what it means to devote one’s life to music.

The three music theory professors on my committee are a central part of my pantheon of “theoroes”—an inexcusable portmanteau I offer as a sign of my respect. Working with Professor John Roeder, my dissertation advisor, has been a privilege. In addition to helping me sift through and organize my thoughts and perceptions, he inspired me to push further and scrutinize my perceptions in ways that have drastically improved how I hear music. Similarly, Professor Richard Kurth consistently challenged me on my perceptions and interpretations, opening up lines of thinking and hearing I never would have considered had the door, so to speak, not been opened for me. Professor Alan Dodson, the third music theorist on my committee, also provided an unfailingly fresh and enlightening perspective on my perceptions, while showing me how to express abstract ideas in a beautiful and clear manner. Since music is among my primary sources of joy, and I am able to enjoy it more after going through this process, it is not too much to say that Professors Roeder, Kurth, and Dodson have raised my standard of living.
I would also like to thank Professors Keith Hamel, Valter Ciocca, Carl Ollivier-Gooch, and Robert Hasegawa for providing valuable insight during and after the oral defence of this project. Professor Hamel, in addition to enriching the discussions during my defence, was a source of ideas and encouragement during my time as a student at UBC in his capacity as an engaging and nuanced teacher of orchestration. I am grateful to Professor Ciocca for lending his valuable scientific expertise as an audiologist to this project, and to Professor Ollivier-Gooch for successfully and smoothly moderating the defence. Professor Hasegawa, whose work has inspired many of the ideas presented in this project, went above and beyond the usual duties of “external examiner” to provide detailed critique and inspiring commentary that helped me polish my work into its current form.

In addition to the professors directly involved in this project, I would like to thank those who helped in more indirect ways. In developing the analytical stance used in this project, I was fortunate to have the opportunity to refine some concepts in a classroom setting. I am grateful for the input of colleagues and students at the University of Iowa and The Crane School of Music (SUNY Potsdam) who participated in classes and seminar presentations in which I applied the analytical techniques used in this project in a nascent form.

Finally, I must thank the love of my life for her unerring support. Kristin, my far-too-indulgent spouse, endured my frequent bouts of self-doubt, fatigue, and frustration, and had enough energy left over to provide a steady stream of not only emotional support, but also intellectual inspiration. Kristin is a psychologist, an excellent one, and I am in awe of her acumen. I am extremely fortunate to have someone of her particular skills as a sounding board for my music theories.
to Kristin
CHAPTER 1:
TIMBRE AND HARMONY

1.1: Introduction

The perception and appreciation of music is influenced by psychoacoustic factors that are difficult to describe in a coordinated way. The sheer volume of information conveyed through musical sounds—much of which we process automatically—can complicate efforts to generate compelling music theory from psychoacoustic data without significantly narrowing the scope, as in studies that focus on specific aspects of music perception. For example, Wayne Slawson’s engagement with musical timbre focuses on what he calls “sound color” as a practical subset of its component qualities. His approach examines acoustic properties of vowels as correlated with four perceptual dimensions—openness, acuteness, laxness, and smallness—and uses these dimensions to formulate transformational methods for generating audibly related successions of vowel sounds.

Slawson’s theory is compelling and can certainly galvanize one’s compositional imagination. But his focus on contrasts between vowels heard in isolation is too narrow to analyze many sorts of music in which timbre—which we can define loosely for now as the “quality” of the sounds—seems to be important. Generally speaking, every sound emerges in four loosely-defined phases: attack, sustain, decay, and release. Slawson’s conception of sound color zeroes in on the sustain phase, but the coordination of the phases over time profoundly affects timbral perception in a more holistic sense. For instance, empirical research suggests it is more difficult to identify the source of an isolated musical instrument

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2 Ibid., 48-56 and 69-79.
sound when features such as attack transients and vibrato are not present.\(^3\)

The influence upon timbre of cues throughout a sound’s duration demonstrates that engagement with any number of dimensions outside those of Slawson’s subdomain of sound color could be analytically fruitful. But this brings us back to the problem of narrowing the scope. Instead of isolating specific perceptual dimensions as in Slawson’s theory, I propose an alternative means of appreciating timbre. As I will show, theoretical characterizations of timbre often overlap with those of harmony. By weighing the musical relevance of these correlations, and the perceptual dimensions that they highlight, I will develop an analytical stance attuned to forces at work in music that considers timbral-harmonic dimensions in a variety of ways. Although this stance could be applied to many repertoires, my special interest will be to foster a deeper appreciation of “spectral music”—a diverse repertoire whose uniquely beautiful phenomenological ambiguity emerges in large part as a consequence of parallels between timbral and harmonic perception.

In this project, I will present my timbral-harmonic analytical stance as it applies to spectral music in two parts. The first part will consist of three chapters that will develop analytical tools and discuss concepts useful for fostering an appreciation of spectral music’s timbral-harmonic conflation. The second part of the project will apply these tools and concepts in three analytical chapters. In this first chapter, I will lay some groundwork for later discussions and analyses by confronting an imbalance: our analytical tools for

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characterizing harmony are better developed than those we use to discuss timbre. To partially correct for this imbalance, and thus facilitate the timbral-harmonic analyses to come, I will draw on philosophical, psychoacoustic, and musical perspectives—including my own listening—to explore parallels between the two. Along the way, I will define some necessary concepts with terminology that is suited to describing their correlations.

1.2: Timbre and Harmony as Perspectives on Sounds in Combination

Our musical perceptions emerge from a combination of how we intentionally listen to music and how we automatically hear sound. Some of our more intentional aural skills can be acquired and enriched through practice and cultural immersion. For example, we train music students to nurture sensitivity to scale degree function, and its syntactical significance to tonal harmony, by practicing sightsinging, dictation, and improvisation according to certain Western norms. In contrast, the ease with which we learn to distinguish the timbres of different instruments playing the same pitch in the same way (i.e., same loudness, vibrato, etc.) suggests that some skills are more deeply established in our auditory apparatus as automatic responses characteristic of human nervous systems.

A phenomenological distinction between intentional and automatic aspects of cognition separates processes working in tandem. But such a dichotomy, loosely adopted, can nevertheless be useful in revealing how fluid amalgams of intentional effort and automatic processing shape music perception. It would be difficult to hear scale degree function without a deep-rooted sensitivity to differences in pitch. Conversely, our already quite nuanced sensitivity to differences in timbre may be improved with effort. As one learns

\[\text{Pauline Oliveros, Deep Listening: A Composer’s Sound Practice (New York: iUniverse, 2005), xxii-xxiii.}\]
an instrument, for example, one becomes increasingly aware of subtle timbral distinctions less salient to the non-specialist—an enhanced sensitivity that allows one to explore tone production as an expressive resource.

Such not-entirely-intentional cognitive complexity can make it difficult to distinguish between timbre and harmony because they are multidimensional and some of these dimensions overlap.\(^5\) This overlap is particularly evident in the similar ways we characterize both harmony and timbre as experiences of combined sounds—experiences that differ in what they prioritize. Using these priorities to distinguish between timbre and harmony, let us consider provisional definitions of them as different perspectives on sounds in combination. Harmony is a perspective in which individual sounds, though combined to form a chord, nonetheless retain their identity.\(^6\) Timbre, in contrast, is a perspective in which the identities of individual sounds are obscured as they fuse into a unified percept.

As Brian Kane explains in a detailed critique, the composer Tristan Murail, who is well known for his spectral music, uses “atom” in a Democritean sense to denote the “smallest, indivisible particle from which the world is constructed.”\(^7\) Given the way that musical “worlds” are notated, it seems natural to think of these atoms as pitches. Our ability to perceive a sound’s pitch is rooted in our ingrained sensitivity to the harmonic series—a


particular arrangement of component frequencies, called partials (a generic term for any of a sound’s component frequencies that we will define more precisely below). A collection of pitches sounding together can be conceived as a “chord” that resembles a jar of marbles, in the sense that its constituent pitches—even those that are octave related—remain separate and distinct. Indeed, when we hear a chord with only a few pitches it is relatively easy to perceive those components, especially if they are widely spaced. Kane leverages such classical epistemology into an apt characterization of Murail’s compositional ethos. But, considering other sorts of psychoacoustic fusion, and how they relate to parallels between timbre and harmony, it is enlightening to consider Murail’s metaphor according to a more modern meaning of the word atom.

One of the key innovations of Western music theory is the idea that different collections of pitches are manifestations of the same “harmony.” A harmony is a collection of pitch classes, each of them an abstract category that includes all pitches that are related by octave or multiple octaves. For “tonal” music, the categories are named by the letter names of the diatonic scale, possibly modified by accidentals. A harmony itself can be considered as a class to which different chords belong. For instance, chords \{C2, G3, C4, E4\} and \{E2, C3, 

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9 A more obscure, but possibly more apt, metaphor could be that of siphonophores—colonies of individual animals that act as a single organism (e.g., Portuguese man o’ war).

G4, C5, G5} both manifest the same harmony {C, E, G} even though they have different pitches and different numbers of pitches.\(^{11}\) Hearing a chord as an instance of a harmony is useful, among other things, for describing patterns of chord progressions in the “tonal” European art music of the 17\(^{th}\)-19\(^{th}\) centuries.\(^{12}\)

Conceptually collapsing a chord—a complex of pitches—into a harmony—a complex of pitch classes—is, in an abstract sense, a sort of fusion. When we hear the two chords above as C major triads, we aurally interpret the octave duplicates within each chord as manifestations of the same pitch class, and this allows us to hear the chords as manifesting the same harmony. A more visceral sort of fusion occurs when there are so many pitches in a chord, or they are so close together, that it becomes difficult to aurally parse their combined sound. Pitches only retain some of their independence in such chords because unified qualities (e.g., the overall consonance or dissonance of a chord) emerge as a result of their combination. A special kind of fusion—particularly important for the “spectral music” repertoire—occurs when the pitches of a chord are arranged so that they convincingly

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\(^{11}\) I will identify specific pitches in this project with a letter name, an accidental (if necessary), and a number indicating octave location. Middle C is C4, one octave higher is C5, one octave lower is C3, and so on. All pitches between these Cs share the octave location number of the C immediately below them (i.e., Eb3 is the Eb a minor third above C3).

\(^{12}\) The parallel I draw here between a harmony and a pitch-class set is useful, but only in a broad and abstract sense. In tonal analysis, chords that are instances of the same pitch-class set can play different roles and, as a result, we often talk about them as different harmonies. For example, consider the prolongational role of a neighboring first inversion dominant seventh chord as opposed to cadential deployment of the same chord in root position.
approximate the harmonic series.\textsuperscript{13} Such a parallel allows us to hear the chord as fused according to the same mechanism that allows us to hear a complex sound as having a singular pitch. The fusion obscures at least some of the pitches (and their pitch classes). To the extent that there is fusion, the chords themselves increasingly assume the role of perceptual atoms, and the component pitches act as their subatomic constituents.

For example, let us consider the vibrant sheen of Olivier Messiaen’s “chord of resonance”—a complex chord, \{C\textsubscript{4}, E\textsubscript{4}, G\textsubscript{4}, B\textsubscript{b4}, D\textsubscript{5}, F\#5, G\#5, B\textsubscript{5}\}, with eight different pitch-classes.\textsuperscript{14} Assuming twelve-tone equal temperament, it is just four pitch-classes shy of a complete aggregate and one might predict that the pitches would fuse in a way similar to that of a tone cluster. But the pitches realized in the disposition of these atoms in Messiaen’s “chord of resonance” approximate partials of the harmonic series of C\textsubscript{2} and engender a strikingly vivid sonority that fuses in a way distinct from that of a tone cluster. To understand the link between the harmonic series and the nature of this phenomenon, let us begin at the microscopic level and consider partials and pitches in more detail.

1.2.1: Partial, Harmonic, and Overtone

In comparison to the analytical language we use to describe pitches, the terminology surrounding partials seems a dense forest of irregularly applied synonyms. Partial, overtone, and harmonic, for example, are apparently interchangeable according to the norms of


different academic fields. I will continue to use *partial* as a generic term for any of a sound’s component frequencies. In this sense, *partial* is the subatomic correlate of “pitch”—a generic term for unclassified chord members. Let us flesh out this correlation and consider how to describe partials in a way that is comparable to how we describe pitches.

Octave equivalence allows us, in some cases, to treat two chords with different pitches as having the same harmonic function. For example, \{A₃, F₄#, C₅\} and \{C₂#, A₄, F₆\} are both manifestations of the same three pitch classes, \{F#, A, C\}. This combination of pitch classes expresses the quality of a minor triad and is rooted to a specific pitch class, F#. Thus \{A₃, F₄#, C₅\} and \{F₂#, C₄, A₆\} are instances of a class of chords—F# minor triads—that have the same harmonic function and so are interchangeable in purely harmonic accounts of music.

In timbral accounts (i.e., those prioritizing how sounds fuse in combination) the same information has a different significance. Reconceived as partials, the individual identities of pitches are subsumed by their contribution to an emergent gestalt timbre they express in combination. As I will demonstrate abstractly in this chapter, and apply analytically in later

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16 A second inversion triad would have a very different function than a first inversion triad in many tonal contexts. I am cleaving to a Rameauvian perspective here which treats six-four and six-three chords as “imperfect” inversions of a “perfect” (i.e., root position) chord. Jean-Philippe Rameau, *Treatise on Harmony*, trans. Philip Gossett (New York: Dover, 1971), 40-42.
chapters, the timbres of chords may be similar or different in ways not accounted for by pitch class relationships among their components. Indeed, by treating pitches as partials, it is possible to make holistic comparisons of the chords’ emergent timbres, and, through these comparisons, define musical roles based primarily on timbral, rather than harmonic, perception.

To identify and describe these roles, it would be useful to consider chords’ emergent timbres in terms commensurate with those we use to consider two different chords as the same harmony. In short, we will need a means of reduction that will allow us to consider two different chords as expressing a similar gestalt timbre. Octave equivalence ties pitches to pitch classes, but comparable analytical classifications of partials require a different sort of logic tied to the structure of the harmonic series. Although the component frequencies of a harmonic series map onto pitches, the correlations are often inexact, because the harmonic series only approximately fits the quantized domains of common tuning systems.

Complex tones (e.g., those produced by musical instruments) are known to be fused combinations of multiple frequencies, and these component frequencies are called the partials of the complex tone. These partials may be “harmonic” or “inharmonic.” Harmonic partials have frequencies that are whole-number multiples of the lowest component frequency, which is called the “fundamental” of the harmonic partials. Inharmonic partials are not related to a fundamental by whole-number frequency proportions, but rather by other

\[ \text{We will revisit this issue in a discussion of “virtual fundamentals” later in this chapter, and see that, despite being the lowest frequency of a harmonic series, the fundamental is not always the lowest frequency present in a complex harmonic sound.} \]
rational or irrational number frequency ratios. In scientific literature, such as the Chowning article cited above, the term harmonic is often used as a shorthand for “harmonic partial.” In music theory, however, “harmonic” is spoken for multiple times over and this semantic overload could be a source of confusion. To avoid some of this potential confusion, I will use harmonic adjectivally in reference to the harmonic series and its component harmonic frequency proportions, but I will use overtone as the noun denoting “harmonic partial.”

The frequency of each overtone in a harmonic series is an integer multiple of the series’ fundamental frequency. This can cause some confusion since the overtone twice the fundamental is often referred to as the “first” overtone, the overtone three times the fundamental as the “second” overtone, and so on. In this project, I will instead label each overtone in a way that expresses its relation to a fundamental: I will identify a specific overtone as F*n, wherein F is a fundamental frequency and n is a positive integer. Thus, the fundamental is F*1 and the fifth overtone is F*5. When F or F*n can be expressed approximately as a pitch in our equal-tempered twelve-tone (12TET) pitch system, I will substitute the pitch name for F or F*n. For example, in a C2 harmonic series, the fundamental is C2*1 and the fifth overtone is C2*5.

1.2.2: Overtone Class

For music conceived and organized according to 12TET, there are 12 octave pitch classes, and each includes all pitches enharmonically equivalent to the same letter name, with an appropriate accidental if applicable. Overtones, too, may be placed into equivalence classes, but in a different way, because overtones contribute to timbre differently than pitches contribute to harmony. When we say that a specific G (e.g., G3) is part of pitch class G, we do not confer any priority to any of the Gs in the class; in purely harmonic function, G4 is
equivalent to any other G. In contrast, the timbral contributions of overtones whose frequencies are related by powers of two—the frequency analog of octave equivalence—are only similar. This similarity can be understood according to a hierarchy evident within the harmonic series itself. To demonstrate the analytical relevance of this hierarchy, let us consider power-of-two relationships among overtones in the harmonic series, and then consider their perceptual meaning.

1.2.2.1: Powers of Two in the Harmonic Series

When one frequency is exactly 2 times the other, the two frequencies are related by an exact octave. Consequently, overtones that are related by powers of two map onto the same pitch class. In analytical applications of this property of the harmonic series, tuning and temperament issues that arise from different instruments are negligible since the correspondence between octave relations in pitch space and frequencies related by powers of two is unusually robust. My acceptance of powers of two as an analytical guide is a reflection of this pitch/frequency parallel, which scholars such as Robert Hasegawa have also employed in their models of timbre.18

One major structural difference between this property and octave equivalence as it applies to pitch classes is that in the harmonic series octave replications can be extrapolated upward, but not necessarily downward. For example, the frequency half that of F*9—an octave lower in pitch terms—would be 4.5 times the fundamental frequency. But since this is not an integer multiple of the fundamental, this frequency is not part of the fundamental’s harmonic series. Conversely, F*18 and F*36 are respectively one and two powers of two

higher than $F^9$—respectively one and two octaves higher in pitch terms. Both $F^{18}$ and $F^{36}$ are integer multiples of the fundamental and also upper-octave replicates of $F^9$.

Although inharmonic partials do not belong to the harmonic series, their effect can still be felt as the way in which they disrupt its fusion. As in bell sounds, which typically feature both inharmonic partials and overtones of a prevailing fundamental, inharmonic partials are not close enough to any overtone of the prevailing fundamental to be perceived as mistunings of overtones. Instead, the inharmonic partials tarnish the bell’s emergent gestalt identity—an identity rooted in its overtones. In chapter 4, I will consider how inharmonic partials affect such emergent gestalt identities in more detail by discussing their formative influence in musical contexts that, like bell sounds, establish a prevailing fundamental. In such contexts, I will maintain the fundamental as a salient reference point and I will use non-integer multiples of the fundamental (e.g., $F^{4.5}$) to label inharmonic partials. For now, let us focus on classifying overtones—partials whose link to a fundamental is more direct.

Since $F^9$, when divided by two, does not produce an integer multiple of the fundamental it is—unlike the power-of-two related $F^{36}$—an indivisible overtone, as are all odd-number overtones. I will hereafter refer to each odd-numbered overtone as the prime of an overtone class that consists of all the overtones of a fundamental whose frequencies are related by some integer power of two. I will denote an overtone class by italicizing its

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19 This strategy is similar to Celestin Deliège’s use of decimals to “adjust” overtones—whole number multiples of the fundamental—“towards equal temperament.” See Celestin Deliège, “Atonal Harmony: From Set to Scale,” in Contemporary Music: Theoretical and Philosophical Perspectives, ed. Max Paddison and Irène Deliège (Farnham: Ashgate, 2010), 61.

20 Robert Hasegawa uses “partial class,” a very similar theoretical concept, in his work. See Robert Hasegawa,
prime. For example, F*5 is the prime of F*5, and F*6 and F*24 are instances of overtone class F*3, because \(6 = 3 \times 2^2\) and \(24 = 3 \times 2^3\). In reference to collections of overtones, I will place the corresponding integers, separated by commas, in square brackets, as in \(F*[2, 3, 7, 18]\). To identify the overtones classes to which the overtones in an overtone collection belong, I will use italics and parentheses as in \(F*(1, 3, 7, 9)\), which lists the overtone classes represented in \(F*[2, 3, 7, 18]\).

Since the prime of each overtone class is an odd-numbered multiple of the fundamental, the role of even-numbered overtones seems marginalized. But a basic distinction between odd- and even-numbered overtones is already encoded in the correlation between pitch and frequency in the harmonic series. In pitch terms, each prime overtone is a member of the same pitch class as all its power-of-two multiples. This means that as we read upward up from the fundamental each odd-numbered overtone we encounter is a new pitch class and each even-numbered overtone is a reproduction of the pitch class of a lower overtone.\(^{21}\) In other words, the absence of even-numbered primes (so to speak) is a direct reflection of a property of the harmonic series (and of the odd and even whole numbers).

\(^{21}\) The idea that every odd-numbered overtone in the infinite harmonic series is a new pitch class is abstractly correct, but not perceptually accurate as we go higher up the harmonic series, because of the natural limitations on our sensitivity to differences in pitch. Out of context, we will hear odd-numbered overtones, starting from the fundamental, as new pitch classes until the aural distinctions between adjacent primes are less than we are able to perceive.
1.2.2.2: Perceptual Meaning and Analytical Relevance of Overtone Classes

In harmonic accounts of music, two different pitches belonging to the same pitch class have a special aural relationship—the octave and multiple octaves—that allows us to hear them as making the same contribution to a harmony. Any B can be the third of a G major chord, seventh of a C#7 chord, etc. More generally, the contribution of any pitch class can be summarized according to the interval classes it forms with a harmony’s other pitch classes. For example, let us consider two trichords: \{C4, C#2, E7\} and \{D8, D#1, F#6\}. A reduction of these pitches to their pitch classes facilitates their analytical comparison. The shared intervallic content of \[C, C#, E\] and \[D, D#, F#\] can be summarized as the interval-class vector \[101100\] of the set class \(014\) to which both trichords belong.

Overtones of the same overtone class also have a special aural relationship—the power-of-two frequency relationship that is the analogue for the octave and multiple octaves. For example, let us consider the two sets of overtones \(F^*[4, 9, 12]\) and \(F^*[3, 8, 18]\). Because

\[F^*[2, 8] \rightarrow F^*1,\]
\[F^*[3, 12] \rightarrow F^*3,\]
\[F^*[9, 18] \rightarrow F^*9,\]

\(F^*[4, 9, 12]\) and \(F^*[3, 8, 18]\) manifest the same overtone classes—\(F^*[1, 3, 9]\). On paper, this appears to facilitate analytical comparison of two overtone complexes in a way similar to that of reducing pitches to pitch classes. But power-of-two frequency relationships among overtones have a different perceptual meaning than octave equivalence among pitches.

Unlike octave equivalence in harmonic accounts, power-of-two frequency relationships among overtones do not allow us to hear them as making the same contribution to a chord’s emergent timbre. But it does allow us to hear overtones as similar instances of a
particular type of timbral contribution associated with members of its overtone class. To understand the psychoacoustic factors that support such a typology of timbral contribution, let us consider how the fusion of overtones affects the sense of both pitch and timbre, and how these perceptions emerge according to power-of-two relationships among them.

The harmonic series is an ingrained pattern to which we automatically refer in perceiving sounds. If a sound’s component frequencies align, for the most part, with a single harmonic series, then we are able to hear it as having a singular pitch because of the fusion of these overtones. A sound’s overtone content—the subset of the harmonic series heard in the sound—informs our concomitant perception of the sound’s timbre. Generally speaking, overtones become progressively weaker the further they are from the fundamental.\(^{22}\)

Moreover, empirical research suggests that we hear overtones differently according to their position within the harmonic series. Lower overtones sound more “resolved” in that they can be “‘heard out’ as separate tones under certain circumstances.” Higher overtones are, in contrast, “unresolved” in that they “cannot typically be heard out.”\(^{23}\)

The relative “resolved-ness” of an overtone can be considered according to its contribution to the pitch and timbre of the sound. I decided to test my perceptions of such distinctions by using Audacity—an open source digital audio editor with a precise sine wave generator—to generate and compare combinations of overtones. I generated sine waves corresponding to A\(^1\)[1-15], and then transposed them so as to hear the same frequency proportions tied to different fundamentals (e.g., C\(^3\), F#0) in different registers. Since


\(^{23}\) Ibid.
overtones get weaker further from the fundamental, I lowered the amplitude in approximately equal increments commensurate with overtone rank—F*1 had the highest amplitude, F*2, slightly lower, and so on.24

Since even “resolved” overtones can be difficult to hear out, an overtone’s contribution is most easily appreciated through the effect of its absence. Because of the relative prominence of the more “resolved” overtones, their absences weaken the sound’s fusion quite noticeably in comparison with otherwise identical sounds that include them. Sounds missing lower overtones lack some significant support for the perception of the fundamental as the pitch of the sound.25 The contributions of higher overtones—also most easily appreciable through their absence— are experienced more and more as nebulous enrichments of the overall emergent timbre the further they are from the fundamental. This suggests that the contribution of an overtone can be plotted along a single dimension extending infinitely from F*1—the most “resolved” component of a harmonic series. If overtones are arranged incrementally along a “resolved-ness” dimension, then the inverse relation between “resolved-ness” and overtone number does not provide any apparent basis

24 There are more precise ways of modeling the amplitude of overtones. For example, a “triangle wave” is a complex sound that features only odd-numbered overtones and the amplitude of each overtone is proportional to the amplitude of the fundamental [i.e., wherein n is an overtone’s rank, and A is the amplitude of the fundamental, an overtone’s amplitude in a triangle wave would be A*(1/n^2)]. But this is a very specific case that does not speak to the significance of the harmonic series in a broader sense. Given the abstract nature of our discussion, and the general nature of the observations to come, it seems sufficient to merely ensure that overtones get progressively weaker in approximately equal steps.

for classifying overtones.

As I continued testing my perceptions by combining overtones, however, I noticed that my perceptions of their contributions were not so straightforward. Although I perceive overtones as less “resolved” further from the fundamental, I do not perceive them as evenly spaced along this dimension. As I focused on these unequal steps, I began to hear overtones as instances of a type of contribution characteristic of their parent overtone classes. Even though this contribution also informs our perception of pitch, it seems most appropriate to call it a “timbral” contribution in light of our provisional definitions of atomistic harmony and holistic timbre. Indeed, I noticed that prime overtones were the strongest manifestations of these types of timbral contribution.

As I added and removed overtones in different combinations and compared my emergent perceptions, I noticed a general difference between the effects of even and odd overtones. When I combined F*[1-15] one-by-one in ascending order (i.e., F*[1, 2], F*[1, 2, 3], F*[1, 2, 3, 4], and so on) the emergent sensation increasingly resembled a rich instrumental sound that had not only pitch but also a particular timbre. When I added F*2 to F*1 the sound “thickened”—meaning that my sense of the fundamental pitch was strengthened—but the effect on the sound’s emergent timbre was minimal. When I added F*3 to F*2 and F*1, the sound thickened slightly less but its timbre was palpably enriched. I continued to perceive this distinction with the addition of further overtones. Adding F*7 thickened the sound and enriched its timbre, while adding F*6 thickened the sound but minimally affected the timbre engendered by the amalgamated contributions of F*[1-5].

After adding overtones in order starting with the fundamental, I selectively removed overtones from F*[1-15] to explore how their timbral contributions relate to overtone classes
as I have defined them formally above. When I removed all the members of an overtone class from the sound, and then focused on their individual effects as I added them back in, I noticed that I associated each overtone class with a particular type of timbral contribution. The timbral contribution of F*3, for example, is reinforced when F*6 and other members of F*3 are present. When F*3 is missing, the next lowest power-of-two multiple of 3 present in the sound manifests a weaker form of the “F*3-ness” characteristic of its class.

My perceptions of overtones’ timbral contributions suggest that the “resolved-ness” of an overtone is shaped by more than just its distance from the fundamental. Instead, given the timbral enrichment I hear in odd-numbered, but not even-numbered overtones, differential “resolved-ness” is more appropriate as a broad distinction between overtone classes. Thus, F*1—the overtone class that includes the fundamental—is the most “resolved” and it provides the strongest support for our fused perception of a sound’s pitch. The other overtone classes support pitch-engendering fusion less and less the further their respective primes are from the fundamental, and their contribution is increasingly felt more nebulously as timbral enrichment.

I am not sure that my perceptions will exactly match those of other listeners. But other theories concerning parallels between octave related pitches and power-of-two related overtones suggest that listeners hear overtones in a way that is at least consistent with my own. For example, Richard Parnuccu, expanding on work by Ernst Terhardt, theorizes a model for finding chord roots by comparing chords’ constituent pitch classes with pitch class correlates of F*[1-10]. Moreover, Parnuccu reads Terhardt’s work as implying “that notes an octave apart are perceived as strongly related or similar, but not as ‘equivalent’ in the music-
theoretical sense,” and works this implication into his model.26

As a rough analogy for the within-class similarities I perceive among overtones, imagine the prime of each overtone class as a primary color—red, for example. Other members of the same overtone class may be different shades of red, but they are nevertheless instances of the redness characteristic of the overtone class as a whole. Essentially, I am hearing overtones classes as types of timbral contribution, and overtones as instances of these types. Although overtones within each class are not equivalent due to the progressive weakening of overtones in the harmonic series, the similarity of their timbral contributions according to their power-of-two relationships suggests that they might function similar ways in processes that involve timbre.

Both pitch-class and overtone-class representations facilitate analytical comparisons but reflect the different perceptual priorities of atomistic harmony and holistic timbre. As discussed above, the shared set class—(014)—of \{C4, C#2, E7\} and \{D8, D#1, F#6\} reveals an abstract structural equivalence between groups of pitch classes according to interval class content. In contrast, the shared overtone class content—\(F^*(1, 3, 9)\)—of \(F^*[4, 9, 12]\) and \(F^*[3, 8, 18]\) allows us to consider the nature of their similarity. \(F^*4\) and \(F^*8\) express the pitch engendering effect associated with \(F^*1\)—the most “resolved” overtone class—but \(F^*8\) expresses this effect with less strength than \(F^*4\). \(F^*3\)—prime of the rather “resolved” \(F^*3\)—expresses “\(F^*3\)-ness” more vigorously than \(F^*12\), and \(F^*9\)—the prime of the more “unresolved” and timbrally enriching \(F^*9\)—expresses more robust “\(F^*9\)-ness” than \(F^*18\).

1.2.3: Fundamental, Virtual Fundamental, and Chord Root

An overtone’s timbral contribution is partly a function of the ratio of its frequency to that of the fundamental. Frequency proportions map onto our perception of pitch intervals rather well, and one can appreciate a given overtone’s effect in a broad sense through this correlation. Such approximate correlations are delimited, in part, by our internalization of a prevailing tuning system. I hear F*7, for example, as a “compound mistuned minor seventh” in relation to its fundamental according to my learned Western deference to 12TET. There is also a limit on our ability to perceive differences in pitch. This “just-noticeable difference,” though difficult to quantify, means that some of the finer distinctions characteristic of the harmonic series are beyond our capacity for pitch perception.

These psychoacoustic factors support our perception of inexact parallels between frequency proportion and pitch interval, and leave room to explore how such imprecise correlations affect our perceptions. As discussed above, the harmonic series, or, to be more precise, the frequency proportions inherent to the set of positive integer multiples of a fundamental frequency, is an ingrained pattern to which we automatically refer in perceiving sounds. Our deep-rooted sensitivity to the harmonic series allows us, for example, to divine a pitch for a sound corresponding to a fundamental frequency if the relationships among the sound’s constituent frequencies are close enough to the frequency proportions of that

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fundamental’s harmonic series.\textsuperscript{29}

The pitch intervals of Messiaen’s “chord of resonance” map onto harmonic frequency proportions tied to a single fundamental and the chord fuses according to the same psychoacoustic mechanism that affords us a sense of pitch and timbre. Although the fusion is incomplete, the chord’s emergent gestalt quality is audibly anchored to its lowest pitch—a pitch of the same class as the fundamental of the harmonic series the chord resembles. Since the chord’s lowest pitch is not quite a \textit{fundamental}, it is tempting to label this pitch as a manifestation of the chord’s \textit{root} pitch class. But established connotations of this term seem reductive in light of the chord’s enchantingly ambiguous overall effect—a sensuous timbral-harmonic hybrid that emerges as a result of how the fusing effect of a subatomic structure projects into the atomic realm of pitch classes.

Our complex ballet of automatic pattern-matching is so efficient it allows us even to hear a pitch corresponding to an absent fundamental frequency if enough of the harmonic frequency proportions stemming from it are present. The frequency is the greatest common factor (within certain limits) of the frequencies approximated by the pitches of the chord. This illusory perceptual phenomenon has many names—\textit{residue} or \textit{virtual} “pitch;” \textit{phantom} or \textit{missing} “fundamental”—but I prefer \textit{virtual fundamental} because it best expresses my epistemology.\textsuperscript{30} Like Slawson and others, I prefer a “source-filter” model of perception


wherein external reality—sound—is separate from internal reality—aural perception.\textsuperscript{31} In light of this model, the distinction between present and absent fundamentals is, perceptually speaking, moot. Our perceptions are the real-to-us effects of how we cognitively filter the physical world and \textit{virtual} fundamentals are \textit{real} if we perceive them. In light of this, I will occasionally shed \textit{virtual} when the distinction is unnecessary. I have chosen “fundamental” instead of “pitch” to maintain a certain neutrality. As I will demonstrate in this project, the hard-wired processes that facilitate \textit{virtual fundamental} perception are relevant to more than just our sense of pitch.\textsuperscript{32}

Virtual fundamentals and chord roots in triadic music correspond rather well and are, analytically speaking, mostly redundant. Consider a closely voiced major triad with C4 as its lowest pitch. The pitches of this C Major triad approximately correspond to C2*\[4, 5, 6\]. In this sense, the pitch representing the root of the chord, C4, is a member of the same pitch class as C2—the pitch correlate of its absent fundamental frequency. As I discussed above, Terhardt and Parncutt, among others, have seized on such parallels to work out ways of divining a chord’s root. Unlike chord roots, however, virtual fundamentals are tied to our ingrained sensitivity to harmonic frequency proportions rather than a culturally-informed musical syntax. When rootedness is less strongly expressed—as in many chords with more than six pitch classes—we perceive virtual fundamentals in a more diffuse sense. In these cases, it is difficult to attribute pitches to the virtual fundamentals, and they become

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\textsuperscript{32} Parncutt, “Revision of Terhardt’s Psychoacoustic Model,” passim.
convenient shorthands for unifying characteristics of chords other than those involved in clearly expressing fundamental pitches. When psychoacoustic and musical factors supporting such nodes are considered in relation to those of other chords, an impression of the timbral-harmonic forces in play emerges. Attention to such virtual fundamentals facilitates discussions of how we automatically and intentionally make formative connections between complex sonorities.33

1.2.4: Spectral Fusion and Harmonicity

Our predisposition to harmonic frequency proportions allows us to examine aspects of our cognition other than those directly associated with our internalization of musical syntaxes. But such an approach should account for both timbral and harmonic perspectives on sounds in combination. To appreciate the musical relevance of this duality, consider that when enough harmonic frequency proportions are present in a sound, they combine to express an emergent quality, *harmonicity*, that helps us hear a sound as having a distinctive pitch and timbre.34 Sounds with greater *harmonicity* have greater numbers of harmonic overtones in relation to *inharmonic* partials—component frequencies not relatable via an integer multiple to the prevailing fundamental.35 Although overtone class does not directly address inharmonic partials, it does organize overtone content in a way that allows us to


35 Peeters et al., “The Timbre Toolbox,” 2909. “*Inharmonicity* measures the departure of the frequencies of the partials $f_s$ from purely harmonic frequencies $hf_0$. It is estimated as the weighted sum of deviation of each individual partial from harmonicity.”
consider their disruptive effect on overall harmonicity.

In sounds with high harmonicity the spectral content is perceived to be more completely subsumed in the sound’s unified emergent identity. In other words, sounds with high harmonicity are heard to have greater spectral fusion.\textsuperscript{36} It is difficult to pick out overtones within the sound of a bassoon because a bassoon’s spectral content is almost entirely harmonic. The spectra of many bell sounds, in contrast, feature prominent inharmonic partials that interfere with the perception of harmonicity.\textsuperscript{37} Consequently many bell sounds are less stably fused and draw one’s attention to the eccentric behavior of their individual spectral components. One can still hear the sound as having an overall pitch and timbre, but the fusion of these percepts is atomized. For example, is relatively easy to pick out partials in bell sounds.

A rough analogue of this phenomenon is evident in the distinction between chords as complexes of distinct pitch intervals and as holistic qualities.\textsuperscript{38} Just as harmonic frequency proportions express harmonicity through their fusion, a minor third superposed on a major third forms a triad that expresses a unified quality of major-ness. Moreover, major-ness is preserved to some extent across different chords with the same pitch classes. \{C4, E4, G4\} and \{E3, G6, C8\} do not sound the same, but they both sound major. From this perspective, let us examine how overtone classes allow us to highlight properties of pitch combinations separate from those summarized in their abstraction as sets of pitch classes.


\textsuperscript{37} Murail, “Villeneuve,” 200-203.

\textsuperscript{38} McAdams, “Spectral Fusion,” 280.
Even though \{C4, E4, G4\} and \{E3, G6, C8\} are equivalent pitch class sets, they are different when considered according to their closest overtone analogues. \{C4, E4, G4\} maps rather straightforwardly onto \(C2^*[4, 5, 6]\) while \{E3, G6, C8\} could map onto \(C1^*[5, 48, 128]\) or \(E2^*[2, 19, 51]\). The choice of which is the most appropriate representation is based on a number of factors, and I will discuss these in chapter 3 in light of Robert Hasegawa’s work on a similar issue. For now, let us consider what each option reveals about the emergent holistic quality of \{C4, E4, G4\} as it relates to that of \{E3, G6, C8\}.

\{C4, E4, G4\} and \{E3, G6, C8\} feature three pitch classes whose combination evokes major-ness. But the major-ness \{C4, E4, G4\} expresses is different from that of \{E3, G6, C8\}. By considering pitch/overtone correlations we can quantify such a vague qualitative differential. We note that

\[
\begin{align*}
\{C4, E4, G4\} &\approx C2^*[4, 5, 6], & \text{and} \\
\{E3, G6, C8\} &\approx C1^*[5, 48, 128] & \text{or} \\
&\approx E2^*[2, 19, 51].
\end{align*}
\]

Since, as discussed above, overtones convey different shades of the timbral contribution associated with their prime overtones, we can compare overtone sets according to how they manifest sets of overtone classes. When reduced to their overtone classes,

\[
\begin{align*}
\{C4, E4, G4\} &\approx C2^*[4, 5, 6] & \in C2^*(l, 3, 5), & \text{and} \\
\{E3, G6, C8\} &\approx C1^*[5, 48, 128] & \in C1^*(l, 3, 5) & \text{or} \\
&\approx E2^*[2, 19, 51] & \in E2^*(l, 19, 51).
\end{align*}
\]

In this case, the choice of which overtone interpretation of \{E3, G6, C8\} to prefer, at least when comparing it to \{C4, E4, G4\}, is fairly straightforward. \(C1^*(l, 3, 5)\) features lower overtone classes than \(E2^*(l, 19, 51)\). As discussed above, the timbral enrichment I
hear in odd-numbered, but not even-numbered overtones, causes me to perceive the
“resolution” of an overtone primarily through its identity as an instance of a type of timbral
contribution characteristic of its class. Although both $C1^*$ and $E2^*$ interpretations of \{E3, G6, C8\} feature $F^*$—the most “resolved” overtone class whose prime is the fundamental—$F^*(19, 51)$ are more “unresolved” timbral contributions than $F^*(3, 5)$. Since the more
“resolved” interpretation— $C1^*(1, 3, 5)$—supports fusion more strongly, the holistic quality
of major-ness engendered in the combination of E3, G6, and C8 is tied more to its
consistency with C1 than E2 as a unifying harmonic sense.

\{C4, E4, G4\} supports the unifying effect generalizable as a virtual C2 fundamental
more strongly than \{E3, G6, C8\} supports its C1 fundamental. These chords are similar in
that they both feature a single overtone each from the same three overtone classes—$F^*(1, 3, 5)$. $C2^*[4, 5, 6]$ features lower overtones from these classes than $C1^*[5, 48, 128]$. These
lower overtones express the unifying timbral contributions of their comparatively “resolved”
overtone classes more vigorously, and thus provide greater support for fusion. Though both
sets of overtones are harmonic, they do not express the same harmonicity because they do not
equally fuse. The combination of C4, E4, and G4 fuses into a more unified percept and
expresses greater harmonicity because the combination of E3, G6, and C8 maps onto much
higher overtones within the same overtone classes.\(^39\)

Earlier, I pointed out that virtual fundamentals and pitch classes of chord roots in
triadic music are, analytically speaking, mostly redundant, and the above example

\(^39\) Deliège provides intriguing examples that demonstrate further how voicing affects perceived fundamental.
See Deliège, “Atonal Harmony,” 64.
demonstrates my meaning in more detailed terms. A power-of-two relation between fundamentals is consistent with a pitch class correspondence between triadic roots. But similar distinctions are also revealed even when comparing different manifestations of less well-rooted pitch combinations. To demonstrate this, let us consider how the holistic effect of \{B2, D#4, C6\} relates to that of \{C2, D#4, B6\}. Both pitch sets are manifestations of \{B, C, D#\} and thus abstractly equivalent in pitch class terms. But, since

\[
\begin{align*}
\{B2, D#4, C6\} & \approx B1^*[2, 5, 17] \in B1^*(1, 5, 17) \\
\{C2, D#4, B6\} & \approx C0^*[4, 19, 120] \in C0^*(1, 15, 19) \quad \text{or} \\
& \approx F0^*[3, 14, 88] \in F0^*(3, 7, 11),
\end{align*}
\]

they are not equivalent in terms of overtone class.

Again, we are faced with alternative interpretations of one of the pitch sets. In this case the choice is less clear. The F0* interpretation of \{C2, D#4, B6\} features lower overtones, and these are members of lower overtone classes with one important exception—\(C0*1\). This overtone class includes the fundamental and its fusion engendering timbral contribution is particularly strong. By comparison, the absence of \(F0*1\) weakens the F0* interpretation considerably. Conversely, the remaining overtone classes of \(C0^*(15, 19)\) are higher than \(F0^*(7, 11)\) and this comparatively weakens the C0* interpretation. Since both the C0* and F0* interpretations feature overtones further removed from their primes than B1*[2, 5, 17], the harmonicity expressed in the combination of B2, D#4, and C6 is more robust and its fusion is more complete than the combination of C2, D#4, and B6. Out of context, it is difficult to confidently assert either overtone interpretation of \{C2, D#4, B6\}. But, in a fully-realized musical context, further perceptual cues could promote one hearing over another.

This, in a nutshell, is the purpose of overtone and overtone class interpretations: to
provide an analytical referent that allows us to account explicitly for how we use the harmonic series as a referential frequency structure in generating our perceptions of sounds in combination. Although the ways in which sounds map onto this referential structure are approximate, having such a relatively stable analytical referent will help anchor discussions of not only the nature and extent of this approximation, but also how it relates to the “charmingly imprecise nature of our perceptions.”

1.3: Timbral-Harmonic Overlap

My use of loose atomic metaphors, above, highlights an important point: neither timbre nor harmony excludes the other as a viable perspective on sounds in combination. Pitch classes retain only some of their independence in chords because unified qualities (e.g., the “major-ness” of a chord) emerge as a result of their combination. Conversely, timbral fusion may be incomplete, allowing us to pick out individual partials from a sound and hear them as pitches. For example, the sound of a tam-tam, although easy to name, is difficult to describe in any detail. It is unpitched, and the effervescence of its attack emerges from a saturation of partials. As the sound decays, and some transient partials fade away, the writhing and clashing of the remaining partials emerges as a richly woven polyphonic texture. Such incomplete timbral fusion can even present practical challenges for pitched

40 Murail, “Target Practice,” 156.

41 James Tenney makes music out of such emergent subatomic polyphony in his Having never written a note for percussion. The instrumentation of this solo work is not specified, and I have heard two different manifestations: one on a Cajun-style triangle (a.k.a. “tit-fer”) and the other on a tam-tam. While both performances were intoxicating, the richer spectral content of the tam-tam made for a more engaging experience. About ten minutes into the tam-tam performance, I experienced the convincing illusion of an
instruments. For example, tubular bells are notated using specific pitches, but pose challenges for orchestrators because their shaky timbral fusion affects their perceived pitch. 42

The timbral subtleties of the tam-tam and tubular bells are often obscured by other instruments because we rarely hear them in isolation. But such a focused consideration of their sounds can allow one to appreciate similar phenomenological overlaps between holistic timbre and atomistic harmony in larger musical contexts. For example, the striking timbre of the climactic chord in mm. 276-279 of the first movement of Beethoven’s Symphony No. 3 is not adequately explained by its harmonic description as an F M7 chord, but makes sense when one considers how the chord is voiced and orchestrated (e.g., strident minor seconds between pitches representing the root and seventh of the chord are heard in three octaves, and the brass vividly enriches the chord’s middle register). Conversely, in the opening minutes of Philippe Hurel’s Pour l’image and Kaija Saariaho’s Lichtbogen, mostly harmonic spectra orchestral performance, replete with “instrumental” sections and antiphonal effects. Although the triangle performance featured some uniquely beautiful moments, it was difficult to similarly lose myself in its subatomic polyphony because I was always very aware that I was listening to a triangle.

42 cf. Alfred Blatter, Instrumentation and Orchestration 2nd ed. (Boston: Schirmer, 1997), 205. Blatter relates this primarily to tubular bells’ missing fundamental frequencies, implicitly tying the ambiguity of their pitches to the virtual-ness of their fundamentals. But the robustness of virtual fundamental perception under certain circumstances suggests that this explanation does not account for the primary pitch-ambiguating factor. Consider for example, that virtual fundamental perception is the mechanism that solves the issue of reproducing bass sounds through tiny headphones. [William Forde Thompson, “Intervals and Scales,” in The Psychology of Music, 3rd ed., ed. Diana Deutsch (San Diego: Academic Press, 2013), 111] Given the perceived reality of virtual fundamentals, the interference of inharmonic partials featured in tubular bell spectra seems a more likely explanation. [Murail, “Villeneuve,” 200-201, 214]
constrain the pitches and support fusion, but are activated as fluctuating layers of instrumental activity.

In the Beethoven passage, the unique effect of the climactic chord is facilitated by the fact that it follows a homophonic series of distinct chords. By the time we hear the climactic chord, we are primed to hear it as a single unit. Beethoven’s voicing and orchestration enhance the unity of the chord’s homophonic presentation (the slight shift to an antiphonal deployment notwithstanding) and encourage a hearing of the chord as expressing a memorably effervescent gestalt timbre. In the Hurel and Saariaho examples, a constraint that limits pitch content to those that approximate overtones of the same fundamental maintains an overall quality that unifies the waxing and waning surface activity. Although the viability of both timbral and harmonic perspectives in the examples above is evident, in each case one is still left with the impression that one perspective is slightly more relevant than the other. The sound of the tam-tam, along with Pour l’image and Lichtbogen, exemplify how holistic timbre can atomize into harmony, while the Eroica demonstrates how a harmony can fuse to express a gestalt timbre.

1.3.1: Harmonic Sense and Timbral Quality

The psychoacoustic link between the harmonic series and our sense of pitch endows us with a set of frequency proportions to which we automatically refer when we perceive a sound. These proportions map onto a set of referential just intervals that James Tenney hails as “the only perceptual givens in our understanding of pitch relationships.” Such a bold

pronouncement is more flexible than it seems. By tying these “givens” to perception, Tenney allows correlations between frequency proportion and pitch interval to be imprecise. Elsewhere, he hypothesizes that “a mistuned interval (within certain limits) will still carry the same harmonic sense [Tenney’s emphasis] as the accurately-tuned interval does, although its timbral quality [my emphasis] will be different.”

To understand the difference between the two italicized terms, consider two pairs of frequencies that are close to a 3:2 proportion. Imagine the frequencies in one of these pairs better approximates 3:2 than do the frequencies in the other pair. Both pairs would be perceived as perfect fifths, but the two pairs would not be perceived as identical. The pair of frequencies closer to a 3:2 proportion expresses a purer perfect fifth, while the other pair expresses a more distorted, out-of-tune version of this same referential interval. In Tenney’s terms, the intervals engender the same harmonic sense but differ in their timbral quality.

On this account, then, timbre is partly a matter of how frequency ratios compare to the just intervals of the harmonic series. In overtone class terms, as developed above, these intervals


45 Hasegawa, “Gérard Grisey and the ‘Nature’ of Harmony,” 356. Hasegawa ties this tolerance for mistuning to tempered pitch systems by pointing out that “the essential harmonic meaning of the just interval remains, even when it is heard only in an approximate, tempered version.”

46 My description of this process is a supposition is based on Tenney’s distinction between “harmonic sense” and “timbral quality,” but psychoacoustic research supports it. Consider, for example, Bregman’s summary of research into the “Integration of Simultaneous Auditory Components” as it relates to the spectral content of a sound. See Bregman, Auditory Scene Analysis, 232-237.
are similar because each manifests a similar amalgam of two types of \textit{timbral contribution}: a weakened expression of $F^*1$ and the prime of $F^*3$. But this amalgam is affected by mistuning and thus the \textit{timbral qualities} of their combined \textit{timbral contributions} are different.

Individual frequency proportions and pitch intervals, and the perceptions they engender, are often subordinate to gestalt impressions that emerge through their combination. In other words, the harmonic senses and timbral qualities evoked by individual correlations between pitch interval and frequency proportion accrue into our holistic perceptions of complex sounds and chords. In light of our tolerance for mistuning, harmonic sense is more specific than timbral quality in that it is linked to particular just intervals, but also less specific in that this link is quite resilient to mistuning. Conversely, timbral quality emerges from imprecision, but is difficult to quantify.

In light of this phenomenological difference, I will use \textit{harmonic sense} and \textit{timbral quality} in particular ways. Given its resilience to distortion, and its importance to our quantized perceptions of pitch, I will use \textit{harmonic sense} flexibly to reference similar percepts at, so to speak, two different levels of aural magnification. A complex sound, at the subatomic level, consists of many frequencies. Each frequency proportion expresses a \textit{harmonic sense}. If these proportions are consistent with a single harmonic series, then their respective \textit{harmonic senses} fuse into a unified perception of the sound’s pitch, and contribute to overall harmonicity. Some sounds may be perceived more atomistically as consisting of multiple pitches, which together express pitch intervals, themselves \textit{harmonic senses} relatable back to frequency proportions.

Unlike harmonic sense, the gestalt sense of \textit{timbre} that emerges from \textit{timbral quality} is...
qualities expressed in complex sounds is cumulative and not directly relatable to the timbral quality expressed by a single frequency proportion. Instead, our perceptions of timbral quality are subordinate to our emergent perceptions of timbre. But, like harmonic sense, timbral qualities are expressed by combinations of pitches—an effect easily appreciable through the unpleasant experience of “out-of-tune” chord tones. While the notion of what exactly it means to be “out-of-tune” is flexible according to the standards of different musical styles and cultures, an “out-of-tune” note discolors the intervals it forms with other notes in a chord. In this sense it engenders a number of discolored timbral qualities—one for each interval it forms with other notes in the chord. A chord’s component timbral qualities blend into an expression of a chord’s gestalt timbre. The overlap of this term with the unified timbre as expressed by individual sounds, reflects the overlap of harmonic and timbral perspectives on sounds in combination.

1.3.2: Musical Coordinations of Harmonic Sense and Timbral Quality

A stable distinction between harmonic sense and timbral quality is difficult to maintain because they are percepts that emerge together from automatic cognitive processes that affect our moment-to-moment perceptions in ways that are difficult to appreciate. But, in certain contexts, the interplay of harmonic sense and timbral quality in our emergent musical perceptions is unusually apparent. I am acquainted with Black Rock Zydeco—a Buffalo-based band wherein the accordionist alternates between instruments tuned to A4 = 440Hz, and 442Hz respectively. Rather than retuning, the guitarist in the band plays nearer to the bridge when the accordion player uses his 442Hz instrument to match an overall impression of increased brightness in the sound. The harmonic sense of pitch intervals expressed by the accordion and guitar are preserved despite the mistuning, but their timbral quality is affected.
The mistuning cues the guitarist to dilute its negative effects by trying to align his sound timbrally with that of the accordion. Far from sounding unpleasantly “out-of-tune,” the effect is uniquely thrilling and distinguishes this Zydeco band from similar groups.

A similar effect is beautifully featured in the fourth movement of Thomas Adès’s *Asyla*. At measure 13, two pianos sound together with pitched gongs. Although the gongs are tuned, their pitch is less focused than that of either piano—a difference in clarity that widens the perceptual gap between the piano and gong timbres and works against their ability to blend. One of the pianos is detuned by a quarter tone and, rather than further undermining blend, this mistuning mediates between the more focused pitches of the pianos and the nebulous pitches expressed by the gongs. This effectively bridges the timbral gap between either piano and the pitched gongs and allows their sounds to blend more than they would without the mistuning. In the Zydeco band, an intentional shift in timbre dilutes the effect of mistuning. In *Asyla*, a deliberate mistuning dilutes the effect of a difference in timbre. In both examples, a distinction between harmonic sense and timbral quality allows us to appreciate factors that enhance instrumental blend.47 The musicians play “out of tune” in a way that is “in tune” with the needs of the music.48

More timbrally homogenous ensembles encounter special challenges that can also be understood according to a distinction between harmonic sense and timbral quality. For example, achieving an ideally cohesive sound is unusually troublesome in a vocal ensemble because human voices are uniquely flexible instruments. The spectral content of each vowel

47 Sandell, “‘Blended’ Instrument Pairings in Orchestration,” 209-246.

sound is different enough to evoke perceptions of vowel sounds as different timbres. For vocal ensemble conductors, a sensitivity to these timbral differences and how they are related to issues of intonation facilitates the Sisyphean task of getting a room full of people to sing “in tune.” Zeroing in on a pitch (harmonic sense) is only half the battle. A chorus is not truly “in tune” unless their vowel sounds (timbres) align as well.

1.3.3: From Overtones to Music

Focusing on chords out of context allows one to contemplate their qualities in isolation but does not suggest the musical relevance of such qualities. Such relevance is elegantly reflected in Debussy’s piano prelude *La cathédrale engloutie*. Rootedness is certainly audible in this work, and relationships between pitches are tied to a pitch-class hierarchy that supports more-or-less clear tonal centers throughout the work. At times, however, parallel voice leading encourages the fusion of chords into successions of unitary chord qualities anchored to a melodic line. In mm. 28-40, for example, parallel progressions of triadic harmonies support the melody outlined by their highest pitches. Beneath each pitch


50 This observation was facilitated through collaboration with a colleague. After many enlightening discussions of the relevance of vowel sounds to choral performance, Dr. Nils Klykken (a choral conductor at SUNY Potsdam’s Crane School of Music) asked me to compose a piece for chorus and electronics wherein the “text” was limited to vowel sounds. The ensuing rehearsals of *North Country Dawn* were an exhilarating immersion into how the accuracy of each singer’s vowel sounds (timbres) affected the perceived intonation (harmonic senses) of the ensemble.
in this melody, the other pitches of the chord are subsumed in fusion. In other words, the
formative relevance of some pitches in these triads is tied almost exclusively to their
qualitative contribution to their parent sonorities. They are the seeds of qualities that enliven
and enrich a succession of more structurally significant tones.\textsuperscript{51}

In this chapter, I have formulated a method of using the harmonic series as an
analytical referent to explain, in part, sensations evoked by complex sounds and chords. This
method reflects the different perceptual priorities of atomistic harmony and holistic timbre in
that it is rooted in our ingrained sensitivity to harmonic frequency proportions. Specifically,
this sensitivity facilitates inexact, yet perceptually robust, parallels between frequency
proportion and pitch interval, and allows us to hear mistunings of harmonic frequency
proportions as mistunings that express the same harmonic sense, but express a different
timbral quality. These subordinate qualities contribute to emergent perceptions of a sound’s
or chord’s overall harmonic sense and timbre according to the harmonicity expressed in the
spectral fusion of its components.

The lush sonorities of \emph{La cathédrale engloutie} have an epicurean appeal, but the
qualitative dimension of the work remains secondary to the syntax of its underlying tonal
structure. In order to understand the formative potential of sonorities in the absence of a
prevailing pitch hierarchy, it is necessary to focus on repertoire that elevates timbre to a
primary formative role alongside harmony. This chapter has laid abstract groundwork for the
timbral-harmonic analytical stance I am developing in this project and spectral music is an

\textsuperscript{51} The organ-like effects of some doublings in Ravel’s \emph{Bolero} (e.g., the passage beginning in m. 149) are
perhaps even stronger examples of how planing chords can fuse to express timbres.
ideal repertoire to demonstrate its application. As mentioned at the beginning of this chapter, spectral music is a vivid and diverse repertoire in which parallels between timbral and harmonic perception are musically operationalized. Although the genre is well-known for its elevation of timbre to a formative role, its composers achieve this in different ways. In the next chapter, I will address conceptual differences between four prominent composers of spectral music as a prelude to analytical work attuned to the music’s unusually rich timbral-harmonic domain.
CHAPTER 2:
TIMBRE, HARMONY, AND SPECTRAL MUSIC

2.1: “Spectral” Music

The epistemological gulf between the word *spectral* and the confluent aesthetic motivations it represents is a preliminary obstacle to understanding the nature of *spectral music*. As a label for a compositional trend, *spectral* is misleading in that it implies an elevation of *spectrum* from pre-compositional resource to audible structure—a glimpse at the trees with no view of the forest.¹ As a way of transcending such a narrow perspective, noted spectral scholar and composer Joshua Fineberg recommends detailed exploration of the disparate “views” and “recurring themes and ideas” expressed by composers of spectral music to nurture a nuanced sense of “the overall trend.”² One such recurring theme is evident in how composers of spectral music conflate timbre and harmony—an aesthetic and epistemological preoccupation that makes analytical approaches attuned to both timbre and harmony uniquely relevant to the study of spectral music. To explore how spectral music can serve as a proving ground for such techniques, let us consider how timbral-harmonic conflation is manifested in compositional strategies of Tristan Murail, Gérard Grisey, Kaija Saariaho, and Jonathan Harvey—four prominent composers of spectral music.³

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³ The terms *spectral music* and *spectral work* are useful, but I prefer to avoid the expression *spectral composer*. Tristan Murail and Gérard Grisey might be prototypically *spectral* composers because they pioneered the trend. But the idea that there are *spectral* composers is problematic. Spectral music, as Murail famously asserts, is an attitude toward composition rather than an adherence to a more unified compositional method [Tristan Murail, “Target Practice,” trans. J. Cody, *Contemporary Music Review* 24/2-3 (2005): 152]. Indeed, Grisey’s distaste
Attempts to cultivate an understanding of how spectral works conflate timbre and harmony give one the uncomfortable feeling of trying to hit a moving target. It is difficult to discuss conflations of timbre and harmony when it is unclear how to comprehensively define either phenomenon (especially independent of the other). As I will show in this chapter, writings by influential composers of spectral music reveal a significant amount of disagreement on this very issue. To set the stage for analytical perspectives sufficiently attuned to the timbral-harmonic forces at work in spectral music, let us consider how composers of spectral music idiosyncratically exploit what Gérard Grisey has identified as a “liminal zone” between their respective natures.4

2.1.1: Listening to Spectral Music

As in the source-filter model mentioned in the previous chapter, our senses mediate our experience and facilitate the emergence of multiple possible percepts.5 Accordingly, Figure 2.1 sketches out two ways of perceiving the iconic opening sonority of Grisey’s “Partiels” (1975) in phenomenological terms: either as a chord with distinct pitches forming something akin to a “dominant ninth sonority” or a fused sonority that evokes the timbral

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character of a trombone. A preference for one perception over the other is influenced by how one tends to hear pitch relationships and how appropriate this tendency is to the nature of the music in question.

Figure 2.1: A phenomenological representation of the opening gesture of Grisey’s “Partiels”

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6 In figure 2.1, I describe this as “almost, but not quite, entirely unlike a trombone” to echo a scene from Douglas Adams’ *The Hitchhiker's Guide to the Galaxy*. Arthur Dent tries in vain to describe a good cup of English tea to a machine that synthesizes a cup of liquid “almost, but not quite, entirely unlike tea”—an entertainingly appropriate analogue for the imprecise nature of instrumental synthesis.

7 Although “Partiels” is often performed on its own, it is one work in a cycle entitled *Les Espaces Acoustique*. 
Pierre Boulez, who may default to atomistic perceptions given his association with serialism, made his opinion on such instrumental synthesis rather clear, writing:

“What is reproduced is certainly not the phenomenon itself, but an abstract relationship which leaves aside the fluctuations of the component parts with respect to each other. In the most rudimentary cases, you end up with dominant seventh and ninth chords which, even when they are incomplete, involve very strong stylistic connotations, and divert our attention towards the notion of style and the appropriateness of this style to harmonic functions which govern the work.”

Although Boulez limits his criticism to “the most rudimentary cases,” it remains possible that listeners with similar pitch-oriented priorities may hear the “Partiels” sonority as a dominant-ninth chord whose stylistic connotations can be difficult to ignore. In contrast, a listener aware of Grisey’s attitude toward composition may be more open to a holistic perception of the “Partiels” sonority.

These two modes of listening are the extremes of a perceptual continuum. Stephen McAdams proposes the terms analytic and synthetic for these extremes that, though serviceable and technically correct, contain connotations that I find troublesome when applied to music as opposed to psychoacoustics. Synthetic has often been used as a euphemism for artificial. Though this label is certainly apt when considering electronic means (or even acoustic ones in the case of the instrumental additive synthesis of many

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In deference to this, I will use quotation marks instead of italics when referring to the cycle’s component works.


composers of spectral music) by which novel sounds are engineered, it falls short of evoking more transcendent, and less technical, qualities of our perception—our natural tendency, for example, to perceive a “complex sound as a whole rather than as many parts.” Analytic simply strikes my ear as too dry a term for the perception of and musical engagement with a sound’s component features. Even with these connotations, however, I admit I prefer the somewhat more poetic terms atomistic and holistic mostly because they reflect something attractively ineffable about how we experience music.11

2.1.2: Reading About Spectral Music

Some influential composers of spectral music have shared their thoughts about harmony and timbre in ways that suggest holistic and atomistic modes of listening appropriate to the nature of their music. By referring back to each composer’s understanding of these overlapping concepts, we can compare how composers conflate harmony and timbre to develop a more nuanced understanding of their music, and the practice of spectral music in general. Such an inquiry seems straightforward, but the nature of the sources in question presents three significant challenges.

First, the motivations of those writing about their own music can differ from those of more theoretically focused discussions. Even those who confidently situate their music within larger trends understandably prioritize the idiosyncrasies of their contribution to a

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10 Ibid., 280.

11 This terminology is not without its own unfortunate connotations. It is probably not advisable to use the term holistic around a medical professional. To be clear, I am using holistic simply in reference to perceiving many parts as a whole, and atomistic in reference to perceiving those parts separately. I am not suggesting any link to “new age” trends.
shared musical practice over the nature of the practice as seen from a more objective perspective.

Second, some composers have written more extensively about their compositional priorities than others. As a result, one is faced with the task of comparing ideas that are not equivalently unpacked.

Third, the language used in this literature is not standardized. Though certain conventions are apparent (e.g., harmonicity vs. inharmonicity as roughly analogous to a gestalt sense of consonance vs. dissonance), core concepts can be obscured by how composers choose to express their ideas in writing. Kaija Saariaho, for one, refers to this problem directly by confessing that the language she uses to discuss her music is “subjective and unconventional” and has “nothing in common with the usual psychoacoustic terminology.” One should evaluate the precise meaning of terms used in this literature with care.

Given these challenges, I should be explicit about the purpose of the conceptual comparisons laid out in this chapter. I will discuss diverse aesthetic opinions and priorities concerning the practice of spectral music, and demonstrate how critical understanding of this diversity can deepen one’s appreciation of spectral music’s essential qualities. These discussions will provide context for analytical studies of spectral music, in this chapter and later chapters, that are distinct from studies of their compositional genesis. Although I will discuss my work as it relates to existing analytical studies (e.g., those of Robert Hasegawa, Jeffrey Hennessy, and François Rose) the body of analytical literature that confronts spectral

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music is minimal in comparison to more thoroughly studied repertoires. I will compensate for this dearth by exploring aesthetic preoccupations of influential composers of spectral music. These preoccupations will complement existing analytical resources by suggesting how one might listen to spectral music and understand it as an “overall trend” rather than a singular compositional style.

2.2: Tristan Murail

Tristan Murail, a pioneer of spectral music who has written extensively about his compositional ethos, conflates harmony and timbre by referring to perceptions linked to specific pitch relationships.\(^\text{13}\) By atomizing sounds into their component frequencies, translating frequencies into pitches, and reassembling sounds as chords, Murail dramatizes an intriguing perceptual dichotomy: our deep-rooted ability to focus our hearing to perceive a sound’s constituent frequencies as individual sounds, and to perceive groups of frequencies as fused.\(^\text{14}\) Murail demonstrates such perceptual plasticity using as an example the sound of a cello—an instrument whose spectral content (number and relative intensity of prominent overtones) is particularly rich:

“A cellist plays a ‘beautiful’ sound, with nice vibrato, and the listener represents it mentally as a beautiful cello sound with vibrato. Nonetheless, if you listen to a sound in a certain way, if you focus your ear so as to dissect its contents, you can distinguish different harmonics of this sound quite well and thereby understand that it is made up of a group of components—all of which have their own lives. We are accustomed to considering this group of components as a single object, and calling it the ‘sound,’ but it is equally possible to dissociate them: allowing unitary timbre to burst into multi-dimensional harmony.”\(^\text{15}\)

\(^{13}\) Murail, “After-thoughts,” 272.


Psychoacoustic studies of the cognitive faculties behind our experience of timbre as unitary identify ensembles of contributing factors.\textsuperscript{16} Singular references to harmony (e.g., “a chord,” “a sonority”) confuse the issue in a similar way.\textsuperscript{17} Though such terms are often used as shorthands, their prevalence seems inconsistent with “multidimensional” harmony and highlights the lack of clarity inherent to broad categorical distinctions such as Murail’s. But such an accessible distinction is part of what makes Murail’s example of the “beautiful cello sound” so compelling. One can immediately grasp the essence of what Murail means to convey because he evokes two contrasting perceptions of a familiar sound.

Murail does not maintain such a stark contrast in practice. He is critical of equal temperament—a practice he decries as forcing “acoustical reality […] through inexorable sieves”—and this sheds light on how timbre and harmony coexist within his music.\textsuperscript{18} Many

\begin{itemize}
\item \textsuperscript{16} Stephen McAdams and Bruno L. Giordano, “The Perception of Musical Timbre,” in \textit{The Oxford Handbook of Music Psychology}, ed. Susan Hallam, Ian Cross, and Michael Thaut (Oxford: Oxford University Press, 2009), 78. McAdams and Giordano generalize a link between the unified perception of timbre and the spectral content of a sound as a “combination of perceptual dimensions” that “often have quantifiable acoustic correlates.”
\item \textsuperscript{18} Tristan Murail, “The Revolution of Complex Sounds,” trans. Joshua Cody, \textit{Contemporary Music Review} 24,
of Murail’s works “are built on structures that are not direct spectral observations,” instead relying on “harmonies conceived outside the domain of equal temperament […] placing us in a domain where harmony and timbre are more or less the same thing.”\textsuperscript{19} Although Murail seems to be suggesting that a composer’s notation of micro-intervals is sufficient to erode the boundaries between timbral and harmonic perception, he makes it clear that there is more to his “frequential harmony” than a logical basis for the deployment of micro-intervals.\textsuperscript{20} The micro-intervals of spectral music amplify the emergence of chimerical perceptions of timbre by facilitating more convincing approximations of certain frequency proportions. For Murail, the affective power of “spectral structures” is rooted in a “plasticity” that allows them to “endure various treatments or tortures with their identities intact.” Micro-intervals allow pitch approximation and spectral structure to come into closer alignment and help preserve a compelling impression of a spectral structure’s inherent holistic timbre. Although this may be an overstatement, one could sum up Murail’s aesthetic as an engagement with an array of incomplete yet compelling impressions of timbre—impressions that inform and enrich the harmonic domain in his music.\textsuperscript{21}

2.2.1: Microtonal Approximation in the Opening of \textit{Désintégrations}

As instructive as a conception of a continuum between “unitary” timbre and “multidimensional” harmony may be to discussions of Murail’s sonorities, it does not reflect how they interact in his music. To demonstrate how Murail dramatically enriches timbral-

\textsuperscript{19} Murail, “Afterthoughts,” 272.

\textsuperscript{20} Ibid., 272; Murail, “Villeneuve,” 196.

\textsuperscript{21} Murail, “Target Practice,” 151.
harmonic “plasticity” through the interaction of “spectral structures” over time, let us consider the opening of Désintégrations (1982-83)—a work for electronics and large chamber ensemble that is arguably one of Murail’s most well-known. The opening of Désintégrations features timbre-harmonies that each approximate a spectral structure—a subset of overtones from a harmonic spectrum—by rounding to the nearest equal-tempered quarter-tone (24-TET). Such approximations recall the psychoacoustic relevance of our tolerance for mistuning as discussed in the previous chapter. While 24-TET is an equal division of the octave just as arbitrary as equal-tempered semitones (12-TET), the finer divisions of 24-TET provide a means for enhancing timbral-harmonic fusion.

Given the “plasticity” of his “spectral structures,” Murail balances the practical needs of communicating through notation with a desire for the high microtonal resolution that facilitates timbral-harmonic fusion. In general, given the limitations of instruments and performers, he defaults to 24-TET and reserves finer divisions of the octave for contexts that allow for such precision (e.g., music for a soloist or small ensemble, and electronic works). But this is neither as limiting nor as precise as it seems when considering notational compromises. Murail conceives of a “homothetic relationship between the perceived music, the performed music, and the written score without hoping for an exact equivalence” and relies on the “ear’s mechanism of auto-correction, whether physiological or cultural.”

Such a fluid correspondence between notated and sounding music is evident in an interaction that reportedly took place during a rehearsal of one of Murail’s works. Joshua Fineberg, a student of Murail’s, tells of a time when Murail “discovered in rehearsal that for

22 Ibid., 196.

23 Murail, “Target Practice,” 160.
the bass to sound in tune it had to play nearly a quarter-tone sharp. It was so natural to hear it this way that it turned out the instrumentalist had been partially correcting the intonation by ear already.”  

In a sense, this phenomenon is commonplace. Musicians, consciously or not, adjust their intonation slightly in deference to their role in the ensemble as a whole, or to suit the nature of the music. Notation, in this sense, is suggestive rather than prescriptive— “use this pitch as a reference point” instead of “reproduce this pitch.”

In light of the detailed calculations and unusually precise microtonal notation Murail cites as necessary to his compositional process, such flexible intonation in performance of his music seems out of place. But the incongruity evaporates when one considers why it was so “natural” for the bass player to have interpreted a notational typo in this way. The detailed calculations of “frequentational harmony” are the means through which Murail stimulates the psychoacoustic tendencies of listeners and performers alike and these tendencies transcend the need for absolute precision in the correspondence between pitch interval and frequency proportion.

2.2.2: Derivation of Timbre-Harmonies in the Opening of Désintégrations

In the opening of Désintégrations, Murail deploys two concurrent series of timbre-harmonies. One of these series is populated by timbre-harmonies with pitches drawn from a harmonic spectrum with an A#0 fundamental, while the other is made up of timbre-harmonies whose pitch content is similarly derived from a C#2 harmonic spectrum.  

Open noteheads in the first and third systems of fig. 2.2 highlight pitches from each spectrum used in the excerpt. Diagonal lists of numbers (lower left to upper right = bottom to top) in square


brackets above timbre-harmonies in the second and fourth systems show the overtone ranks of the members of each timbre-harmony within their parent harmonic spectrum.

**Figure 2.2:** Two series of timbre-harmonies from the opening of *Désintégrations* and their relation to harmonic spectra

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Although fig. 2.2 does not show how these series form a musical gesture, the identity of each series as a musically significant unit hinges on the plasticity of our perception. Quarter-tone approximations of each harmonic spectrum are imprecise realizations of a timbral archetype, but, as discussed above, spectral structures “endure various treatments or tortures with their identities intact.” These identities—emergent perceptions reliant on the
preservation of some timbral characteristics when overtones are imprecisely translated into pitches—are central to one’s experience of this music, as I will show below.

One might sense a parallel between Murail’s use of two harmonic series as timbral-harmonic reservoirs and the general notion of “harmonic fields” associated with the music of Berio and others of his contemporaries. But Murail’s use of harmonic series as de facto harmonic fields is unusually supple because of our ability to perceive virtual fundamentals—an ability rooted in an automatic cognitive mechanism that allows us to hear groups of frequencies as fused unitary sounds. By extension, this deep-rooted capacity facilitates the cohesion of groups of pitches according to how they map onto harmonic frequency proportions—especially in harmonic fields whose components map onto the more “resolved” frequency proportions expressed by overtones closer to the fundamental.

But our instinctive sensitivity to these proportions does not sufficiently explain our ability to perceive differences in timbre. Fineberg writes that “pitched sounds are often formed by combinations of sonic components [overtones] which belong to a single harmonic series whose fundamental is heard as the pitch. The relative amplitudes of these various partials—at a given moment and as they change in time—determine the color or timbre of the sounds.” Our ability to perceive a virtual fundamental, given a preponderance of

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26 For a recent example of this analytical perspective see Richard Hermann, “Berio’s Harmonic Fields and Counterpoint in the Sequenzas with Special Attention to that of the Violin” (paper presented at the annual meeting for the Rocky Mountain Society for Music Theory, Albuquerque, New Mexico, April 22-23, 2016).

27 Murail, “Target Practice,” 156.

overtones supporting such a perception, allows us to experience diverse elements as a single perceptual object. But an explanation for such fusion based on frequency proportions is incomplete. It accounts for a unifying harmonic sense but does not fully address factors shaping our perception of timbre.

Although how accurately referential intervals are expressed in a given timbre-harmony affects our perceptions of its timbre, timbral perception is shaped further by relative amplitudes of the overtones—a characteristic of sound more difficult to discuss as quantifiably related to our perceptions. The operative term, however, is “relative”—the amplitude of an overtone is of little perceptual significance until it is compared to amplitudes of other overtones in the spectrum. In an idealized spectrum (e.g., a “sawtooth” wave) amplitudes of overtones in the spectrum are proportional to the amplitude of the fundamental.  

29 In naturally occurring sounds, however, amplitude proportions are complicated by “formants”—regions of the spectrum that are relatively louder than the surrounding partials.  

30 “When physical bodies vibrate,” writes Fineberg, “they act, to a certain degree as filters, emphasizing certain bands of frequencies and attenuating others […] formants are one of the main clues that allow us to hear that the high notes and low notes of an instrument come from the same source.”  

31 In other words, the fixed construction of an instrument lends it an identifiable timbre that is audibly consistent regardless of pitch by

http://www.indiana.edu/~emusic/etext/synthesis/chapter4_waveforms.shtml. The amplitude of a specific overtone in a sawtooth wave = one over the overtone’s rank.

29 “Chapter 4: Synthesis,” Indiana University, accessed December 1, 2016


affecting the relative amplitude of overtones in a predictable way. How a bassoon filters the harmonic spectrum allows us to identify it as a bassoon even when playing the same pitch as, say, a viola.

With the influence of virtual fundamentals and formants in mind, let us reconsider Murail’s derivation of timbre-harmonies from the opening of *Désintégrations*. Murail cites two features of his analysis of a low note played on the piano as important to his conception of harmony in the work.32 First, since there is no partial that corresponds to the fundamental in the analysis, the perception of it as the pitch of this low note is virtual. When we hear pitches in combination, we may—to reiterate Murail’s cello example—focus on the perception of individual chord members or on the perception of a gestalt identity for the sonority as a whole. Theoretically, such an identity can be expressed by a variety of specific pitch combinations if they are drawn from the same harmonic field. These sorts of relationships are more easily perceived if the harmonic field itself conveys a unifying harmonic sense to which each combination is audibly related.

As an extension of our ability to hear virtual fundamentals, subsets of an A#0 harmonic spectrum convey different flavors of “A#0-ness” whether or not the fundamental frequency is present. For subsets from which a perceptible A#0 does not emerge, the remaining vestiges of the overall unifying harmonic sense can nevertheless be summarized as this common denominator. Compare, for example, the first and fourth timbre-harmony in the A#0 series (see fig. 2.2). The first timbre-harmony is made up of pitches that correspond to A#0*[7, 11, 13, 21, 29, 36] while the fourth is made up of pitches that correspond to A#0*[6, 7, 11, 13, 19]. Since both timbre-harmonies are made up exclusively of pitches that

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correspond to overtones from an A#0 harmonic series, they are audibly related as contrasting manifestations of the same gestalt harmonic sense—the “A#0-ness” that unifies the series.

The second curious feature of Murail’s analysis of a low note played on a piano is the presence of identifiable “formantic zones”—some encompassing a wider band of frequencies than others—that include following groups of overtones: F*[2 - 7], [9 - 13], [15], [17 - 23], [27 - 30], [35 - 38], and [42 - 43]. In other words, the piano acts as a filter that emphasizes these overtones while attenuating others {e.g., F*[8, 14, 16]}. Since formants are an important factor in our perception of instrumental timbre, an emphasis on the overtones listed above preserves some shadow of “piano-ness.” With this in mind, consider that these formantic zones constrain the components of all timbre-harmonies in the opening of Désintégrations. The only exceptions to this constraint come at the end of each series when a pitch corresponding to the fundamental confirms its unifying harmonic sense.

Timbre-harmonies from the opening of Désintégrations express different shades of a pianistic timbre, while manifesting one of two prevailing gestalt pitch identities—A#0 and C#2. These pitch identities, as Murail attests, were chosen for their likelihood to merge and evoke the sensation of an occidental bell sound—a sound shaped by a quasi-evolutionary process of aesthetic preference to include an inharmonic element approximately a minor-tenth above the fundamental of an otherwise harmonic spectrum.33 The equal-tempered pitch interval between the two fundamentals used in this passage is approximately consistent with

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33 Ibid., 200-201, 214. The stipulation that a “bell” spectrum features a “minor-tenth above the fundamental” oversimplifies a complex web of perceptual cues that inform our perceptions. But, the interpolation of a minor-tenth within an otherwise harmonic spectrum is an important cue for the perception of “bell-ness”—an identity that remains remarkably intact despite the absence of other perceptual cues.
this salient feature of Western bell sounds, and this unusually provocative spectral feature seems to have been the primary guiding factor in Murail’s choice of fundamentals. But the “bell-ness” of these spectra in combination is unusually striking. A “minor-tenth” explanation falls short of accounting for the lush nature of the effect. Additional support for the exhilarating bell-like timbre of these spectra in combination is apparent when compared to a spectral structure characteristic of Western bell sounds, and a spectral structure derived from a sound emitted by a specific Western bell.

Figure 2.3: Correspondences between A#0 bell spectra and the A#0 and C#2 harmonic spectra from the opening of Désintégrations

Figure 2.3 shows two bell spectra rounded to the nearest quarter-tone with an A#0 bourdon. One is a schematic spectrum that Murail has presumably compiled from a variety

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34 Ibid., 201. Murail uses the term bourdon, presumably borrowed from the preferred terminology of bell-makers, to reflect the slight inharmonicity of bell spectra. If one reserves the term fundamental for use in regard to the perception of harmonic spectra, then bourdon provides a useful alternative when referring to spectra that
of observations. The other is a bell spectrum Jonathan Harvey derived from his analysis of a bell at Winchester Cathedral, and used as the basis for Mortuos plango, vivos voco—an electroacoustic spectral work Murail describes as a “classic.” 35 I will discuss this seminal spectral work in more detail later in this chapter. Correspondences between these bell spectra and A#0 and C#0 harmonic series demonstrate how combinations of overtones from both series can form hybrid spectra that compellingly engender a bell-like timbre.

The stems in figure 2.3 represent correspondences between bell spectra and the two harmonic spectra featured in the opening of Désintégrations. Upward stems show correspondences between bell spectra and an A#0 harmonic spectrum. Downward stems show correspondences between bell spectra and a C#2 harmonic spectrum. 36 Solid stems indicate pitches from the excerpt, and dashed stems indicate pitches that are not present. These pitches are not explicitly present but may be perceived, in some sense, nonetheless. Our cognitive pattern-matching tendency, as discussed previously, makes it possible that the influence of these overtones will be felt despite their absence. Unstemmed notes indicate pitches that do not correspond to overtones in either harmonic spectrum.

35 Ibid., 200 and 203. I have transposed the bell spectra presented by Murail to align with the fundamentals used in the opening of Désintégrations.

36 cf. Murail, “Target Practice,” 156. “We would have little chance, for example, to find identical frequencies in two spectra—in other words, identical values in two lists of data calculated by a function. If we want to establish such types of comparisons, we must resort to approximations, consider effects of ‘critical bandwidth’, and exploit our charmingly imprecise faculties of perception.”
2.2.3: Time and Process in the Opening of Désintégrations

Figure 2.3 shows how an aggregation of A#0 and C#0 harmonic spectra exhibits spectral properties characteristic of western bell sounds. A blend of harmonies derived from these two harmonic spectra in particular expresses a unified, tintinnabulous timbre—a quality that serves as a timbral-harmonic goal in the opening of Désintégrations. Spectral properties on their own, however, do not explain the palpably dramatic sense of arrival at this goal in the music. Figure 2.4 shows a graph of Murail’s plan for a temporal process realized in the opening of Désintégrations. Timbre-harmony onset time is on the x-axis, the interonset duration between successive timbre-harmony onsets is on the y-axis, and the two series of timbre-harmonies—A#0 in blue, C#2 in red—form what Murail calls “rallentando curves” over the course of which the interonset duration between successive timbre-harmonies in each series increases.

Four significant features of the process are apparent when represented in this way. First, the initial timbre-harmony in the A#0 series does not conform to the process of increasing durations in the A#0 series. This timbre-harmony signals the true beginning of the work after a ten-second electronic introduction and technically precedes the beginning of the temporal process in question. But since it establishes a boundary between the introduction and the first directed process of the piece—especially by highlighting the entrance of acoustic instruments—it seems inappropriate to exclude it completely from consideration. Second, onsets of chords in both series do not coincide until each series reaches a fourteen-second durational goal. Third, onset density decreases over the course of the process.

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37 Murail, “Villeneuve,” 215. I have based figure 2.4 on the composer’s handwritten graph.

38 Murail’s account of the process begins seven seconds later with the onset of the first C#0 timbre-harmony.
Although some of the onsets are quite close to one another, there are fewer onsets per second at the end of the process at the beginning. Fourth, after around the 38 second mark, onsets on the C#2 curve follow more and more closely after onsets on the A#0 curve, asymptotically approaching the simultaneous attack that links the two series. These properties support the experience of an overall rallentando leading to a timbral-harmonic goal—an effect realized through the deployment of two convergent rallentando curves that facilitate the gradual blending of two harmonic spectra.

Figure 2.4: A graph of Murail’s precompositional plan for “rallentando curves” in the opening gesture of Désintégrations

Given the adherence to two harmonic spectra throughout this passage, it is notable that Murail highlights the ambiguity of their nature in his preface to the score. Although Murail is clearly referring to the work as a whole when he writes that spectra “only serve as a model for the construction of timbres or harmonies (in any case I make little distinction
between these two notions), and even for the construction of musical form,” this statement seems especially appropriate to the opening of Désintégrations.39 Each timbre-harmony expresses both a unifying harmonic sense and a gestalt timbre, and evocations of this duality are important to Murail’s idiosyncratic conflation of timbre and harmony.

The unifying harmonic sense of each timbre-harmony, which emerges from correlations between intervalllic content and harmonic frequency proportions, can be summarized as a virtual fundamental. Each timbre-harmony in the opening of Désintégrations expresses one of two virtual fundamentals that anchor the distinct identities of two series of timbre-harmonies. The various shades of timbre expressed by the timbre-harmonies ambiguate these unifying harmonic senses, and Murail leans into this effect by using formantic zones identified in his analysis of a piano sound to constrain the timbre-harmonies. In this way, they are limited to pitches corresponding to certain overtones—those in the formantic zones that support nebulous perceptions of pianistic timbre. Since a number of different subsets of overtones within the formantic zones form timbre-harmonies in the opening, the timbral palettes expressed by each series are erratic but relatable to a basic piano-ness that the series share.

The harmonic senses of intervals in each timbre-harmony support perceptual organization of timbre-harmonies into two distinct streams. But the timbral qualities expressed by these intervals elide this distinction by engendering imperfect manifestations of the same overall timbre. Although these two forces pull against one another in some sense, they mutually support a larger dramatic process of fusion. The two series of timbre-harmonies express a variety of pianistic timbres that obscure the harmonic distinction

between them. Such timbral elisions foreshadow and motivate an arrival at a unified bell-like timbre-harmony that subsumes the piano-ness characteristic of both series.

Temporal and timbral-harmonic structures deployed in the opening of *Désintégrations* are somewhat removed from Murail’s conception of sound as an ensemble of forces that coalesce into a unified perception.\(^{40}\) Murail’s pitch structures are based on observations of sound that are quite general. The harmonic series, the contribution of formants to our perception of timbre, and the very general observation that bell sounds feature an inharmonic element roughly equivalent to a minor-tenth above the bourdon are patterns that have been extracted from the study of sound but do not completely reflect its nature. Temporally, Murail’s departure from an ensemblist conception of sound is more distinct. Though he cites the practice of performers as the reason for his deployment of rallentando curves instead of rallentando lines, the process has nevertheless been conceived as separate from sound’s inherent properties.\(^{41}\)

A temporal aspect of the opening of *Désintégrations* that I have yet to discuss, however, defers to sound in a more “natural” way. Although interonset durations between timbre-harmonies are strictly regulated, no timbre-harmony is held for the entire time. Instead, timbre-harmonies begin to decay soon after their onset, fading from foreground to background. The decays of timbre-harmonies overlap to varying degrees over the course of the opening gesture and further foreshadow the eventual blending of both series of timbre-harmonies into a unified bell-like sonority at the end of the process. Furthermore, the envelope of each timbre-harmony features a sharp attack followed by a gradual decay,

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\(^{40}\) Murail, “Target Practice,” 153.

emphasizing a general similarity between bells and piano notes. The temporal process that governs the opening of *Désintégrations* is based on a compositional abstraction, but local-level temporal effects are audibly related to the behavior of specific sounds—bells, piano notes, and (at least at this level of generalization) any sound that features a sharp attack followed by a gradual decay. With this distinction in mind, let us now consider Murail’s spectralism in relation to the aesthetic priorities of another spectral pioneer.

### 2.3: Gérard Grisey

Gérard Grisey writes that “spectral music offered a formal organization and sonic material that came directly from the physics of sound, as discovered through science and microphonic access.”\(^{42}\) Although this broad claim seems consistent with Murail’s derivations of “formal organization and sonic material” for the opening of *Désintégrations*, there is a key difference: for Grisey, such features come “directly from the physics of sound.” Murail deploys timbre-harmonies that reflect salient spectral structures of a piano sound and a temporal process that defers to the “natural” tendencies of musicians’ realizations of rallentandos, but these derivations are relatively abstract and indirect. Such gaps between sound and compositional procedure suggest significant logistical hurdles to be overcome in pursuit of a more direct relationship.

While spectra and their use as reservoirs tend to dominate discussions of spectral music, Grisey’s writings and music reveal an important conceptual departure from Murail’s spectralism: Grisey privileges temporal aspects of timbral perception over those of pitch. For example, Grisey artfully exploits temporal cues to tip the scales towards the perception of a more-or-less unitary timbre in the opening of “Partiels.” Unlike Murail’s timbre-harmonies in

\(^{42}\) Grisey, “Did You Say Spectral?,” 1.
the opening of *Désintégrations*, the discrete members of the timbre-harmony from the opening of “Partiels” do not all sound at the moment of attack. Instead, they are gradually introduced and each proceeds along its own dynamic path.

This feature resonates with Murail’s assertion that “each sound has a specific dynamic evolution along with attack and extinction transients; and, in fact, each of the sound’s components has its own, independent dynamic evolution.” However, Murail and Grisey engage with this aspect of sound with opposite ends in mind. Murail’s acknowledgement of such evolutions as “independent” reflect his opinion that the paths traversed by the components of a sound support a perceptual “dissociation” of sound into its elementary components—the perception of “unitary timbre” gives way to the perception of “multidimensional harmony.” In contrast, Grisey’s staggered temporal deployment of the opening sonority of “Partiels,” strengthens associations between its components, facilitating emergent perceptions of an imprecise, yet compelling, instrumental synthesis. In essence, while Murail conceives of the temporality of spectral flux (i.e., how the spectral content of a sound changes over time) as a feature that may undermine spectral fusion, Grisey considers this same temporality a perceptual cue essential to the emergence of fused timbral percepts.

**2.3.1: “Partiels”**

Joshua Fineberg has recreated Grisey’s derivation of the opening sonority of “Partiels” (1975) by relating the pitch content and temporal gesture to a sonogram of a trombone. Aware of the availability of different—and presumably more advanced—technological resources at the time of his writing, Fineberg acknowledges the likelihood that


his analysis of the trombone’s sound is quite different from Grisey’s. Nevertheless, he is able to highlight two very general, but perceptually significant, features of the sound as represented in his sonogram—features likely to have been similarly evident in Grisey’s analysis despite any technological disparities. First, “the [overtones] enter one after the other with lower [overtones] entering earlier and higher [overtones] appearing later.”\(^{45}\) Second, the amplitude of the overtones is neither equivalent nor evenly distributed over the entire spectrum. Fineberg identifies formants that correspond to \(F^*[5, 9]\).\(^{46}\) Even though these do not align exactly with Grisey’s stratification of dynamics as notated in the opening gesture of “Partiels,” they significantly influence the emergent “trombone-esque” timbre of the opening sonority.\(^{47}\) Although these observations are not very specific—the identification of formants, for example, is apparently flexible according to the capabilities of particular analytical equipment—they are indispensable to the effect Grisey achieves in the opening of “Partiels.”\(^{48}\)

Instruments have distinctive spectral features linked with perceptions of some of their signature timbral characteristics. For example, Fineberg cites a contextual emphasis on \(F^*[7, 9]\) in a “fortissimo brass sound” as formants that contribute to emergent perceptions of

\(^{45}\) Ibid., 116.


\(^{47}\) Grisey’s realization suggests that he observed significant formants at \(F^*[7, 11]\) in addition to the \(F^*[5, 9]\) as identified by Fineberg. See fig. 2.1 and compare to Fineberg, “Musical Examples,” 116-117.

\(^{48}\) For a more detailed discussion of correspondences between Grisey’s compositional procedures and his exposure to principles of acoustics, see François-Xavier Féron, “Gérard Grisey: première section de Partiels (1975),” *Genesis* 31 (2010): 78-83.
“brassy” timbre.49 Although it is curious that Fineberg does not identify F*5 as a formant as in his reproduction of Grisey’s analysis of a trombone sound, he establishes—though not always explicitly—two links between spectral features and timbral perception that are important to the effect of the opening of “Partiels.” First, formants are perceptual cues that facilitate expressions of timbre. Second, the spectral content of a sound varies with the sound’s overall intensity. A quiet trombone, for example, does not exhibit the same “brassiness” as a loud trombone.

The generality of Fineberg’s observations suggests that timbres are preserved, to some compelling extent, even when such spectral features are only roughly reflected in orchestration. To summarize in relation to the opening gesture of “Partiels,” it is important that a) the pitches corresponding to overtones enter one after the other and that b) the music reflects, in some way, perceptually significant features of the spectrum (e.g., the contextually emphasized formants). Grisey’s fluid engagement with timbre according to such nebulous correlations between sound and perception lies at the heart of this hauntingly ambiguous gesture.

An account that only relates the opening of “Partiels” to Grisey’s synthesis of a trombone sound, however, does little to highlight the musical significance of the gesture. Instrumental synthesis, despite correspondence with specific frequency proportions and selection of overtones emphasized in the sounds of the instruments involved, is not likely to reproduce a specific timbre in a more than general sense.50 Fineberg, well aware of this

50 Nicolas Donin, “Sonic Imprints: Instrumental Resynthesis in Contemporary Composition,” in *Musical
aspect of spectral music, provides a compelling characterization of the musical quality of the opening gesture of “Partiels”:

“At the very start of the piece one hears the trombone attack forte with the double bass repeating the attacking gesture with less and less determination. This allows the sound of the sustained trombone to gradually emerge. Just as this happens the sustained note which has been performing a decrescendo begins to give way—through a cross-fade—to an instrumentally synthesized version of itself. This instrumental timbre does not seek to present an indistinguishable copy of the original, but rather to generate an amplification and transfiguration of the trombone note. The listener can still sense the underlying trombone color of the sound while at the same time a doorway is opened up to a vast new domain of sound found within the original sound.”

Fineberg’s rather elegant account points toward an analysis in which the opening gesture of “Partiels” is, despite its compPELLINGLY ephemeral qualities, not an end in itself. Instead, it is the beginning of a larger timbral-harmonic process. The “amplification and transfiguration” of the trombone’s sound reveals “a vast new domain of sound” that forms the basis for what Murail would likely agree is a “progressive decomposition from timbre to harmony.”

Subsequent gestures comprise steps in a process during which the effects of fusion so audible in the opening are gradually undermined. “Unitary” perceptions of timbre give way to “multidimensional” perceptions of harmony as inharmonic partials clash with and eventually...

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*Listening in the Age of Technological Reproducibility*, ed. Gianmario Borio (Farnham/Aldershot: Ashgate, 2014), 327. “A concern for combination and coherence, much more than a drive towards mimesis and ‘phonorealism,’ oriented Grisey’s evolution.”


52 Murail, “Complex Sounds,” 127. “Properties of spectra […] support harmonic ideas and allow the fabrication of agglomerations that are neither harmonies nor timbres, but rather progressions within the domain of timbre-harmony—for example, progressive decompositions from timbre to harmony.”
supplant the overtones that previously allowed one to perceive the sonority as fused.53

Once again, we encounter a procedural tendency that shows an affinity with Murail’s attitude toward composition, specifically with regard to “progressive decompositions from timbre to harmony.” Ironically, Murail has established a progression towards fusion while Grisey has established a progression towards dissociation—a feature that suggests Murail’s title may be more appropriate to the particulars of Grisey’s piece. Such apparent irony, however, only applies to short excerpts from each work. Besides, Murail cites a “progressive decomposition from timbre to harmony” as but one example of the ways in which “properties of spectra” might “support harmonic ideas.”

The opening gesture of “Partiels” expresses a temporal curve that is an imprecise reflection of temporal cues evident in an analysis of the source sound. While Grisey’s use of proportional rhythmic notation makes discussions of exact temporal proportions difficult, we can use the metered portion of the gesture—two measures of triple-meter during which Grisey specifies the onset of each overtone—to represent the shape of the opening gesture graphically. Time, measured according to the notated beats of the metered portion of the gesture, is on the x-axis in fig. 2.5, and overtone rank is on the y-axis. Given that each overtone continues after its entrance, fig. 2.5 shows the points at which a new overtone enriches the prevailing timbre-harmony and contributes to an emergent experience of increasing timbral depth.

53 In chapter 4, I will discuss this process in more detail in light of François Rose’s account in “Introduction to the Pitch Organization of French Spectral Music,” Perspectives of New Music 34/2 (1996): 8-11.
Although the curve plotted by the entrance of component overtones in the opening of “Partiels” is not very smooth, it does reflect the gradual emergence of a trombone-esque timbre-harmony. After the entrance of the most prominent overtones—E2*[2, 3, 5, 7, 9, 11] whose onsets are plotted in fig. 2.5—the first violinist extends the upward curve by quietly oscillating between 5 pitches that correspond to E2*[13, 15, 17, 19, 21]. In other words, a set of overtones Grisey deemed the most prominent enter one after the other and a second set of less prominent overtones enter only after the more perceptually significant elements of the emergent chord is represented by its lowest pitch instantiation. Also, each of these pitches generate their own harmonic series, including most prominently its octave replicates, which fill in many of the chord’s “missing” even overtones.

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54 Grisey only uses odd overtones in this instrumental synthesis. This means that each pitch class in the
spectrum have begun to exert their influence. The first violinist’s quietly oscillating pitches bolster the evocation of a unified timbre and, perhaps most compellingly, arouse an illusory sensation of immersion among those inner realities of “sound at the very threshold before its transformation into representation.”

Grisey asserts that “What is radically different in spectral music is the attitude of the composer faced with the cluster of forces that make up sounds and faced with the time needed for their emergence.” The idea that a certain amount of time is necessary to allow a sound’s “cluster of forces” to exert themselves is also evident in his characterization of spectral music as exhibiting “hypnotic power of slowness” and an “extremely dilated time.”

Although the surface of spectral works can be quite active, the processes that govern transitions between zones of activity tend to progress at a relatively slow rate. Composers of spectral music often derive their developmental strategies—and, in turn, their formal architecture—by mapping, however approximately, the temporal qualities of sound onto a stretch of musical time of such length as to sustain the evolution of the music at a deeper temporal level. In Grisey’s words, time is magnified and integrated as “the very object of form.”

Direct translation of a sound’s temporal qualities into a formal process, however, presents some significant challenges. If all spectral music proceeded from nothing more than

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57 Grisey, “Did You Say Spectral?,” 1-2.
58 Ibid., 1-2.
59 Ibid., 2.
orchestration of a sound’s spectral qualities (i.e., frequency, dynamic, and temporal proportions), then spectral repertoire could sound quite similar. Murail, for one, sidesteps this issue in Désintégrations by establishing a temporal process that—although conceived in deference to the “natural” tendencies of performing musicians—does not reflect the characteristic temporal qualities of a specific sound or even class of sounds. Nevertheless, the notion of process and its relation to formal structure is paramount.  

2.3.2: “Prologue”

There many types of process and, in an attempt to cope with such variety in the temporal domain, Grisey has proposed a classification of temporal processes according to their effect on our perceptions. Grisey also explores non-spectral bases for temporality in some of his work. This practice suggests that despite his engagement with the nature of musical time as it relates to spectral features, he is not averse to seeking alternatives for temporal and formal structure in his music. Another work from his Les Espaces Acoustique cycle— “Prologue” for solo viola (1976)—is a particularly compelling example of one of these alternatives.

Jeffrey Hennessy, in his analysis of “Prologue,” refers to the opening two gestures of the work as comprising an “initial gestalt unit”—a “periodic referent for subsequent iterations of similar events.” My analysis, though proceeding from similar foundations,

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60 Grisey, “Did You Say Spectral?,” 2-3; Murail, “Afterthoughts,” 270.
departs from Hennessy’s in three significant respects. First, while I agree that there is an identifiable germ of form in “Prologue,” I find it difficult to fully embrace the term “initial gestalt unit.” This term evokes a presumption of holism that obscures the temporality central to the emergence of such “periodic referents.” The opening gestures obtain their identity as a formal unit primarily by presenting the first, and least embellished, iteration of a cycle of formal functions analogous to a cycle of biological actions considered components of the respiration process. In deference to this epistemological distinction, I will hereafter use BFC (basic functional cycle) instead of IGU (“initial gestalt unit”) unless referring to Hennessy’s analysis.

Second, Hennessy's IGU comprises just the first two gestures: a series of five pitches he conceives as “respiratory” and a repeated B2 he conceives as “cardiac.” I propose, instead, a BFC that encompasses not only the sounds of the passages, but also the silences. In my interpretation, I have identified two types of “respiratory” gesture, maintained the “cardiac” gesture, and included a third element—“rest”—manifested by the silences. I maintain a terminological distinction between types of respiratory gesture in deference to the motivic similarity that could undermine their ability to fulfill separate, but complementary functions—a progressive dynamic analogous to inhalation or a recessive dynamic analogous to exhalation. The orientation of each respiratory gesture within the BFC supports such a functional distinction between otherwise similar gestures.

Finally, unlike Hennessy, I have conceived the quadripartite BFC central to my

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analysis of “Prologue” in light of Grisey’s use of a similar BFC in “Périodes” (1974)—the piece that, though composed earlier, comes after “Prologue” in the Les Espaces Acoustique cycle. In his preface to the published score of “Périodes,” Grisey explicitly outlines a respiratory BFC that “presents a constant cycle of three part periods which are analogous to the respiratory rhythm: inhalation, exhalation, and rest”—everything but the heartbeat.64 Although my analytical comments here are limited to the emergence of form in “Prologue,” such similarities suggest that a more detailed analytical study of formal connections between the component pieces of Grisey’s Les Espaces Acoustique cycle is worth pursuing.

I have preserved the composer’s beaming in figure 2.6, while parsing different manifestations of the BFC, whose essential components are summarized in the first line. An inhalation figure—labelled “I”—is followed by a cardiac figure—labelled “C.” This is followed by a brief period of rest before the entrance of an exhalation figure—labelled “E”—that, in turn, is followed by a slightly longer period of rest. The physical process that this conception suggests is that of an intake of breath—an accumulation of tension—held through both a heartbeat and slight pause—either a maintenance of tension or an increase in tension caused by a brief postponement of an expected resolution—before being answered by an exhalation—a release of tension. After a longer period of rest, the process repeats in a slightly different form.

It is the respiratory figures—inhalation and exhalation—and the silences—the moments of repose—that are the most flexible in their deployment. Although the cardiac element of the BFC remains fairly static throughout the passage—presumably expressing the ubiquitous presence of one’s heartbeat—consider that in one’s own breathing, exhalation

64 Gérard Grisey, “Périodes” (Milan: Ricordi, 1974), ii.
may follow inhalation with or without a period of rest. Furthermore, exhalation and inhalation are not necessarily equivalent gestures. Sometimes one breathes in quickly then breathes out more slowly, and vice versa. Such phenomenological flexibility allows the music to concatenate into larger respiratory gestures articulated by silences.

Figure 2.6: An analytical account of the opening of “Prologue”

The dramatic nature of this roughly cyclic structure is supported in the pitch domain. All pitches in the first three lines of Figure 2.6 are drawn from a single harmonic series with an E1 fundamental. Integers above each pitch indicate overtone ranks within this spectrum. In the first line, the highest pitch is F#4 (≈ E1*9), in the second line, the highest pitch is G#4 (≈ E1*10), and in the third line, the highest pitch is B4 (≈ E1*12). This gradual extension of an upper overtone limit and concomitant increase in the number of pitches unifies the first three lines of fig. 2.6 by establishing an expository process that transcends the fuzzy
boundaries between multiple iterations of a roughly cyclical process.\textsuperscript{65} In the fourth line of Figure 2.6—a gesture Hennessy aptly describes as a “sonic jolt”—harmonic relationships degrade as pitches corresponding to E1*[6, 8, 11] drift down a semitone in four eighth-tone steps.\textsuperscript{66} Even though the tandem descent of the pitches preserves an expression of the same proportional relationships—frequentially speaking—among E1*[6, 8, 11], they no longer express a harmonic relationship to the prevailing spectral structure. The pitches remain locally harmonic but become inharmonic in a global sense. This gradual progression through eighth-tone steps is reflected in the fourth line of fig. 2.6 by an identification of E1*[6, 8, 11] followed by dashed horizontal lines that show their gradual “detuning” by, ultimately, a semitone. Grisey’s instruction to move from a relatively staid “alto sul tasto” (AST) to a noisy “sul ponticello” (SP) reinforces the experience of such an entropic slide into inharmonicity. In light of the prevailing harmonicity of the excerpt, this incongruous “jolt” of inharmonicity motivates emergent expectations of a return to harmonicity—a timbral-harmonic goal whose establishment enriches temporal expectations engendered by the prevailing respiratory pattern.

Grisey’s treatment of pitch in “Prologue” is significant to his conflations of timbre and harmony in two ways. First, he evokes a hierarchy of timbral “brightness” through his deployment of the harmonic series. Although the analogy of “brightness” is not a perfect fit,

\textsuperscript{65} I have chosen the word “fuzzy” to evoke Grisey’s use of “fuzzy periodicity” as a term for “periodic processes which fluctuate slightly around a constant.” Just as we are able to tolerate a certain amount of “mistuning” in relation to a referential set of just intervals, it seems we are able to perceive periodicity within tolerable limits (Grisey, “Tempus ex Machina,” 245-247).

\textsuperscript{66} Hennessy, “Beneath the Skin of Time,” 44.
it follows from an observation that *sul tast*o playing (i.e., bowing closer to the fingerboard) attenuates higher overtones, resulting in a relatively darker tone, while *sul ponticello* playing (i.e., bowing closer to the bridge) emphasizes them, resulting in a brighter sound. The highest pitch of each of gesture rises over the course of the first three gestures, suggesting a correlation between pitch structure and the timbral distinction associated with these two extremes of playing technique. This aspect of Grisey’s treatment of pitch in “Prologue” resonates with timbral differences between components of the BFC—the respiratory gestures are “alto *sul tast*o” (AST) while the cardiac gestures feature a more normative tone (ORD)—and the brighter “*sul ponticello*” (SP) that amplifies the disruptive effect of the “sonic jolt.”

Second, Grisey establishes a collection of pitches—close approximations of overtones from a single harmonic series—as a timbral-harmonic referent. In the first three lines of Fig, 2.6, E1*4—an overtone that, when translated into a pitch, is the same pitch class as the “missing” fundamental and E1*2—is featured in every respiratory gesture. E1*5 is similarly featured in all but one of the respiratory gestures (see the second inhalation gesture in the third line of fig. 2.6). The inclusion of octave-equivalent E1*10, however, undermines the salience of this exception. E1*[7, 9] are featured in most of the respiratory gestures, but their occasional absence is not similarly mitigated by an octave equivalent pitch. E1*3 is repeatedly emphasized as the sole frequency/pitch component of the cardiac gestures.

These overtones support an emergent sense of timbral-harmonic unity in the excerpt since they are all members of the same harmonic spectrum. But it is important to note that the simple frequency proportions reflected by their relatively low overtone ranks—especially E1*[3, 4, 5]—are likely to evoke a more salient perception of an underlying harmonicity than more complex relationships. Also, octave equivalence of overtones related by a factor of 2—
a property of the harmonic series discussed in the previous chapter—suggests a broader relevance of certain overtones in establishing a group of overtone classes as timbral-harmonic referent.

From this perspective, the spectral content of the first three lines of fig. 2.6—E1*[3, 4, 5, 6, 7, 8, 9, 10, 11, 12]—features two members of E1*I—E1*[4, 8]. This overtone class includes the fundamental and thus supports its virtual perception most strongly. The spectral content of the first three lines also features three members of E1*3—E1*[3, 6, 12]—two members of E1*5—E1*[5, 10]—and one member each of E1*(7, 9, 11). The less frequent occurrence of E1*[7, 9, 11] in the passage, along with their overtone class isolation, suggest a secondary role in the establishment of their parent harmonic series as a timbral-harmonic referent. But unlike E1*[7, 9], E1*11 acquires an increased dramatic significance since it is absent until the third line of fig. 2.6. Its subsequent inclusion with E1*6 and E1*8 (members of E1*I and E1*3) as one of the “detuned” elements in the fourth line of fig. 2.6 suggest a hearing in which it serves as a catalyst for the “sonic jolt.”

The timbral-harmonic referent—an E1 harmonic series—remains in play throughout, and the “detuning” of the “sonic jolt” engenders an expectation that such distortion will

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67 As discussed in the previous chapter, I will label individual overtones as F*n, wherein F is a fundamental frequency and n is an integer multiple of this frequency (e.g., F*13). The labels for overtones of specific fundamentals approximate a pitch for F with a letter name followed by a number indicating octave location (e.g., C2*13). When referring to overtone classes, the primes can represent the overtone class as a whole. To distinguish between the prime overtone and the overtone class it represents, the labels for overtone classes will be in italics (e.g., F*5 is the prime of F*5). In reference to groups of overtones, I will use square brackets as in F*[2, 3, 7, 18]. When referring to groups of overtone classes, I will use italics and parentheses as in—to translate the group of overtones from above—F*(1, 3, 7, 9).
eventually be resolved. Although the linearity of “Prologue” does not support virtual fundamental perception as directly as the discrete timbre-harmonies of Désintégrations, a timbral-harmonic referent aligned with the ingrained set of referential just intervals discussed earlier increases the urgency of such expectations. Even though it is unlikely that one will consciously perceive a virtual fundamental as an audible drone well beneath the viola’s range in “Prologue,” the unifying influence of the prevailing E1 harmonic series will nevertheless shape our expectations to some extent. Our cognitive pattern-matching tendencies, as discussed earlier, allow us to differentiate between the unifying effect of a referential collection whose members correspond to overtones from an E1 harmonic series and the distortion manifested by the outliers of the “sonic jolt.” Grisey deploys a timbral-harmonic structure in “Prologue” whose unifying harmonic sense (i.e., the fundamental of a harmonic series), and gestalt timbre (i.e., a prevailing and cohering sense of harmonicity) support a dramatic timbral-harmonic effect (i.e., a resolution of the “jolting” distortion of said timbral-harmonic structure).

Differences in how Murail and Grisey engage with timbre-harmony and musical time highlight a broader distinction between the composers’ idiosyncratic spectral attitudes toward composition. Murail, faced with the “cluster of forces that make up sounds,” translates rather precise sets of calculations into musical gestures. Even though Murail factors in the imprecision of such translations into his compositional process, an overall pressure toward high precision emerges that encourages performers to defer to his notation in a detail-oriented way. In contrast, Grisey engages with performers, and, by extension, listeners, in an arguably more visceral sense. The opening of “Partiels” presents an interpretation of a flexible musical environment—an interpretation that depends on musicians “feeling,” in a
not-necessarily-conscious way, how the music should evolve in relation to the ambiguity of
the notation. Similarly, “Prologue” presents a BFC that evokes an intuitive, flexible, and
even intimate embodiment of musical time supported by a gradual expansion into the upper
regions of a single harmonic series.68

Differences aside, Murail and Grisey both explore a “liminal zone” between timbre
and harmony by modeling timbre as something external and preliminary to the music itself.
With this in mind, let us consider Kaija Saariaho—an influential composer of spectral music
whose views on timbre, harmony, and their musical applications represent a significant
conceptual departure from the spectralism of Murail and Grisey.

2.4: Kaija Saariaho

Although not generally considered a founder of spectral music, Kaija Saariaho’s
music conflates timbre and harmony in ways that are so influential that she has emerged,
intellectually and aesthetically, as an artist central to the trend. Moreover, her idiosyncratic
conceptions of timbre and harmony inform a compositional attitude that, despite some
similarities, is distinct from those of Murail and Grisey. Consider her assertion that,

68 Many composers of spectral music share the idea that ineffable qualities of “sensation” (Murail, “Target
Practice,” 149), “ambiguity” (Harvey, “Spectralism,” 13-14), and even “eroticism” (Grisey, “Did You Say
Spectral?,” 2) are expressed through structural idiosyncrasies. Due to the complexity and richness of acoustic
data, analyses of spectral music can become so inundated with minutia that it is easy to lose sight (hearing?) of
more ephemeral expressive qualities. Analytically speaking, the ultimate significance of such data lies in how
they relate to the “enigmatic” (Harvey, “Spectralism,” 11, 14, quoting Kristeva) nature of aesthetic experience.
Of course, whether an individual listener’s sensations are erotic or merely ambiguous is a matter of very
personal taste.
traditionally, “harmony […] provides the impetus for movement, whilst timbre constitutes the matter which follows this movement.”69 In this sense, timbre is the substance of the music and harmony is the structural logic that facilitates its coherent musical deployment. But, by stipulating that “when timbre is used to create musical form it is precisely the timbre which takes the place of harmony as the progressive element,” she suggests it is possible to reverse this traditional paired relation. Furthermore, by establishing extremes that prioritize either timbre or harmony, she raises the possibility that the roles of timbre and harmony can be elided in some sense.70 Ultimately, the most important aspect of Saariaho’s brief description of roles fulfilled by timbre and harmony is an implication—intuited as a feature of the liminal zone suggested by the extremes she presents—that timbre and harmony are mutually contingent.

Traditionally (at least in the West), a harmony establishes expectations for how it may progress to another harmony and thus may be related to an abstract continuum of tension.71 In tonal music, the tonic harmony—especially when realized in root position—expresses little, if any, harmonic tension, while harmonies further removed from the tonic create differentially intense expectations that they will eventually resolve to this focal point. In order to appreciate how timbre can assume a role commensurate with that traditionally fulfilled by harmony, it is necessary to establish a similar continuum according to which timbres may be heard to express a sense of progression.

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69 Saariaho, “Timbre and Harmony,” 94.

70 Ibid., 94.

To this end, Saariaho proposes a “sound/noise axis”—a continuum of tension expressed by “smooth, clear” textures at one extreme and “rough, noisy” textures at the other.\footnote{Saariaho, “Timbre and Harmony,” 94.} In the works discussed above, Murail and Grisey derive timbral-harmonic progressions, at least in part, from spectral structures. Saariaho’s “sound/noise” axis shows a more abstract qualitative engagement with timbre—an engagement more intuitively applied according to evaluations of gestalt timbres individual sounds, and by extension, their accumulation into qualitatively distinct musical textures. In this way, Saariaho establishes a continuum that “in an abstract and atonal sense […] may be substituted for the notion of consonance and dissonance.”\footnote{Ibid., 94.}

As straightforward as the conception of a sound/noise axis may seem, Saariaho avoids suggesting that its “substitution” for culturally well-established sensations of consonance and dissonance implies equivalence. With the possible exception of music in which the harmony remains essentially static, the simple fact that different pitch structures are sequentially represented is likely to give rise to a sense of harmonic progression. With an ear toward how timbre may be heard to “take the place” of harmony according to the conception of a “sound/noise axis,” let us examine the first of Saariaho’s Sept Papillons for cello (2000) and try to understand how timbre and harmony may be heard to express its form.

### 2.4.1: Harmonics in “Papillon I”

“Papillon I” is almost entirely made up of harmonics—in the sense of the playing technique rather than spectral content—and although these sounds are quite common in string music, their ephemeral qualities are incompletely understood. Orchestration texts tend
not to fully address how and why harmonics are not qualitatively equivalent. This sounds like a weakness, but, in their defense, it is probable that a more complete characterization is not a priority. Many differences between harmonics are almost inaudible in an orchestral context.\footnote{e.g., Samuel Adler, *The Study of Orchestration*, 2nd Ed. (New York: W.W. Norton and Co., 1989), 48. Adler characterizes the “touch M6” harmonic as somewhat unsuitable for use in orchestral contexts, while the “touch M3” harmonic that produces the same pitch is more “secure.”}

Based in large part on my experiences as a guitarist and fiddle player, I propose that the stability and clarity of the pitch produced at a particular harmonic node on a string instrument is inversely correlated with its overtone rank—a correlation commensurate with the tendency of overtones to be weaker the further they are from the fundamental.\footnote{“Further” in the sense of the harmonic series as a single dimension. If one prefers, for example, the notion that sounds with more harmonics have more timbral “depth” or “richness,” then a conception of the harmonic series as a dimension along these lines could be useful. The issue, however, is problematic. Since a sine wave theoretically has no overtones, it is “closest” to the fundamental, but also, speaking in more qualitative terms, the “shallowest” and “poorest” of timbres.} Noisy artifacts—more prominent in more distant harmonics—further ambiguat\footnote{Alfred Blatter, *Instrumentation and Orchestration* (Boston: Schirmer, 1997), 34. “Depending on the skill of the performer and quality of the string and bow, the acoustical properties of the instrument, and the sound environment in the room of performance, it is possible to produce harmonics through the seventh, eighth, and even ninth [overtones]. In situations where it is necessary to produce a specific, audible pitch, it is wise to limit the natural harmonic to, at most, the fifth [overtone]. When purely coloristic, filigree types of effects are desired, natural harmonics through the eighth [overtone] may be called for.”}e the resultant pitch.\footnote{}

In light of these observations, I have plotted six commonly used natural harmonics on an A string as points along an axis of “purity” shown in the lower staff of fig. 2.7. The number over each round notehead identifies the type of a particular harmonic. In addition to...
harmonic type, these integers show the resultant pitches’ overtone ranks. These ranks stem from a fundamental corresponding to the pitch of open string used to produce the harmonic.

Figure 2.7: Harmonics as points along an axis of “purity”

Harmonics produced in the same way are of the same harmonic type, and they feature similarly prominent inharmonic artifacts and produce similarly stable and clear pitches. “Artificial” harmonics—touching nodes above stopped notes—are of the harmonic type wherein the node/stopped note proportion is equal to the node/open string proportion in a natural harmonic. Although the left-hand stretch required to produce artificial harmonics is a significant practical issue, qualitative differences between artificial and natural harmonics of the same harmonic type are negligible.77 Taken together, these observations inform an

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77 Patricia and Allen Strange, *The Contemporary Violin: Extended Performance Techniques*, (Berkeley: University of California Press, 2001), 113-121. The authors propose “stopped vs. open” as a more accurate
analytical perspective in which harmonic types are—at least in the context of a solo work like “Papillon I” that is made up almost entirely of harmonics—functionally equivalent in some sense.

2.4.2: Toward a Timbral-Harmonic Analysis of “Papillon I”

Table 2.1: Symbols used in figure 2.8

<table>
<thead>
<tr>
<th>6, 4, 3</th>
<th>Harmonic type/overtone rank in relation to the pitch of the open or stopped string.</th>
</tr>
</thead>
<tbody>
<tr>
<td>5a/b</td>
<td>Two types of notehead indicate a qualitative difference between nodes that produce the same pitch. Filled diamond noteheads reflect &quot;5a&quot; (touch M3) harmonics, and unfilled diamond noteheads reflect &quot;5b&quot; (touch M6) harmonics.</td>
</tr>
<tr>
<td>i</td>
<td>Stopped notes in this piece (i.e., notes that are not harmonics) are fundamentals.</td>
</tr>
<tr>
<td>RH</td>
<td>&quot;Right hand&quot; - Round noteheads show the pitch of the open string used to produce each sound.</td>
</tr>
<tr>
<td></td>
<td>In each gesture, solid boxes show strong focalness, wavy boxes show focalness attenuated by a fingered tremolo, and dashed boxes show ambiguous focalness otherwise undetermined.</td>
</tr>
<tr>
<td></td>
<td>Solid lines indicate that a sound continues. Dashed lines indicate that a sound continues, but is intermittent (e.g., tremolo).</td>
</tr>
<tr>
<td></td>
<td>Fingered tremolo vs. bowed tremolo.</td>
</tr>
<tr>
<td>S.T., N, S.P.</td>
<td>&quot;Sul Tasto,&quot; &quot;Normale,&quot; and &quot;Sul Ponticello;&quot; Arrows indicate a continuous change from one technique to another.</td>
</tr>
<tr>
<td></td>
<td>Brackets in the right hand staff highlight bowing patterns. Dashed arrows indicate continuations of these patterns.</td>
</tr>
<tr>
<td>... _gliss.</td>
<td>The intermediate sounds of harmonic glissandos are unpredictable as the finger moves through different harmonic nodes. A wavy line distinguishes this type of glissando from a glissando between stopped notes.</td>
</tr>
</tbody>
</table>

“Papillon I” features five distinct zones of activity I will refer to as the component gestures of the work. Given the frequent disconnect between the notation of harmonics and their sounding pitches, I have renotated these gestures in figure 2.8 for use as an analytical guide that faithfully reflects sounding pitch, while highlighting an effervescent qualitative diversity of harmonic type. Using this guide, I would like to briefly consider which sounds are most focal over the course of the work. Table 2.1 provides brief explanations of other symbols used in figure 2.8.

alternative to “artificial vs. natural.” Since a “stopped” harmonic essentially creates a shorter string, there is no qualitative difference between its sound and that of an “open” harmonic.
Focal sounds, identified in figure 2.8 with three different kinds of boxes, are almost all harmonic type 4—a harmonic type with a relatively clear pitch. The exception to this tendency comes near the end of gesture 4 where a type 5a B4 draws the ear’s focus before a harmonic glissando facilitates a transition to an ambiguous emphasis on a type 4 D5. A fingered tremolo with a relatively “purer” type 3 A4 weakens what I will call the focalness of
this type 4 D5. Although one could hear the type 3 A4 or the type 5a B4 as the most focal sound in measure 11, I instinctively defer to an interpretation in which the type 4 D5 is most focal due to its focalness in the preceding gestures. Regardless of one’s specific interpretation of this ambiguous moment in the music, the type5a B4 and type 3 A4 in the fourth gesture introduce a dramatic amount of ambiguity just before the incorporation of more spectrally complex stopped notes in gesture 5 and the “resolution” of D to C# in measure 14.

I use the term “resolution” here with some trepidation. While I do feel that the piece eventually settles on C#, I am left wondering how to interpret such a sensation in relation to Saariaho’s preoccupation with the conceptual and perceptual gray area between timbre and harmony. As a way to explore this sensation, I pursued two different analytical perspectives—the results of which are summarized in figure 2.9—that reflect how I hear this music. The first is a rather traditional “tonal” interpretation that reads a strong I-IV-I-V across the piece. This seems out of place given Saariaho’s stated opinion that tonality is “outdated” and “a thing of the past.” But since Saariaho, as discussed earlier, identifies the traditional roles fulfilled by timbre and harmony as a backdrop to her efforts to upend their paired relation, it is enlightening to consider her music in these traditional terms.

The second interpretation rests on a holistic conception of these sounds as an imperfect microcosm of a larger organizing principle. Using an analytical perspective similar to Robert Hasegawa’s “tone representation,” sounds in “Papillon I” can be heard as overtones

78 I prefer this neologism over focality because the connotation of the -ity suffix (expressing state or condition) seems less appropriate to this analysis than that of the -ness suffix (denoting state or quality).

79 Saariaho, “Timbre and harmony,” 94 and 132.
whose relationships are summarized according to a bass line of virtual fundamentals.\textsuperscript{80} For each “measure” of the second interpretation in figure 2.9, the bottom staff shows a low pitch whose overtones best match the sounding pitches. Such a virtual bass line is, psychoacoustically speaking, not quite appropriate since it mixes harmonic and timbral metaphors. But a conception of a series of virtual fundamentals as reflections of timbral-harmonic progression resonates with Saariaho’s liminal preoccupations and can—just like the Roman numerals of the “tonal” interpretation—be an enlightening analytical fiction when considering how timbre and harmony coexist in Saariaho’s music.

![Figure 2.9: Two Interpretations of “Papillon I”](image)

The two interpretations are, unsurprisingly, similar since they adopt overlapping protocols for imputing roots/fundamentals to tone combinations. After all, major triads all are analogous to prominent features of any harmonic spectrum. Such correlations are probably why, at least in part, the move from a D fundamental to a G fundamental and back again over

the course of the first three gestures mirrors an interpretation of this passage as a tonic expansion—a move to and from a subdominant harmony. But the dramatically ambiguous fourth gesture assumes a different character in a tone-representative hearing. The B4 of measure 9, rather than drawing the ear’s focus as the root of a supertonic harmony, colors an underlying D fundamental.81

In her 1987 essay, Saariaho poses an intriguing question—one that is particularly significant in light of differences between the two interpretations in figure 2.9: “how [in the absence of a tonal basis for modulation] can a chord or a pitch suddenly assume a new function and thus give rise to utterly different relationships amongst the same, previously known factors?”82 An answer to her question, in very general terms, might be that changes of context induce corresponding changes of function. But this truism overlooks how her query suggests her desire for refreshment of the underlying logic through which pitches and chords

81 My interpretation of B4 in gesture 4 as D1*13 (see fig. 2.9) is an interpretive choice. D1*13 is, technically, closest to B♭4 but this correspondence is off by nearly a quarter-tone (41c). In truth, D1*13 nearly splits the difference between B4 and B♭4. Given the prevailing D fundamentals to this point in the piece (i.e., gesture 1, initially in gesture 2, and all but the opening of gesture 3) and the particular ambiguity of how this overtone maps onto 12TET, the interpretation of B4 as D1*13 rather than D♯1*13 aligns with my hearing better than a move to a globally incongruous fundamental in gesture 4. Similar reasoning guided my ear when interpreting E4 as G0*13 in the first part of gesture 3. Deliège has a particularly intriguing way of deferring to the rough correspondence between F*13 and 12TET. In pitch class terms, the minor sixth above the fundamental is F*13-, and the major sixth is F*13+. See Célestin Deliège, “Atonal Harmony: From Set to Scale,” in Contemporary Music: Theoretical and Philosophical Perspectives, ed. Max Paddison and Irène Deliège (Farnham: Ashgate, 2010), 57.

acquire their functions. The hearings reflected in figure 2.9 demonstrate how—at least in harmonically ambiguous works like “Papillon I”—a deferral to the harmonic series can show how traditional perceptions of harmony are enlivened, transfigured, or overshadowed in the broader interplay of psychoacoustic factors.

Given Saariaho’s apparent rejection of tonality, in general, I assume that the tone-representative analysis is the more appropriate of the two interpretations. But I can’t completely ignore the influence of my immersion in a musical culture dominated by Western tonal harmony. Even though I like to think of my personal listening habits as unusually diverse in this sense, the roots of most of the music I hear burrow deep into specifically Western tonal soil. With these competing influences in mind, I will reconsider these two analyses in chapter 4 and address whether the atomistic traditional harmonic structure I hear in this music is best described as enlivened, transfigured, or overshadowed in a more holistic hearing.

### 2.4.3: A Subjective Account of Form in “Papillon I”

Although the interpretations of figure 2.9 describe different but not necessarily contradictory modes of listening to this music, I cannot say if either reflects considerations essential to Saariaho’s compositional process. Perhaps a more general expository timbral narrative—a characterization of “form and content” as “organically contained” within an “idea” of overall form—would be more consistent with that process.\(^3\) Saariaho, not alone among composers influenced by the aesthetics of spectral music, alludes to inherent features of sound—features she refers to as “microphenomena”—as especially provocative models

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\(^3\) Ibid., 105.
for her conception of musical form.\textsuperscript{84}

Imagine that the idea of overall form in “Papillon I” is the emergence of the cello as a sonorous sound object. A move from airy harmonics to the full-bodied sound of stopped pitches is consistent with a gradual exposition of the cello’s full timbral palette—an enrichment that peaks in mm. 13-14 with a noisy increase in bow pressure. From this perspective, interpretations such as those detailed in figure 2.9 emerge organically as a consequence of the composer’s exploration of a more general formal idea. Although I cannot say for sure what guided Saariaho’s ear in composing this piece, an expository timbral narrative of emergent “cello-ness” resonates with her affinity for the ideas of Kandinsky—specifically that “form is the external manifestation of inner meaning.”\textsuperscript{85}

A conception of form in relation to such a subjective experience suggests the affective possibilities of Saariaho’s sound/noise axis. Sound—the “purer” harmonics from the beginning of the work—becomes noise—the increased bow pressure in mm. 13-14—before the piece settles on a more normative cello tone somewhere in between these two timbral extremes. In this way, timbre is a guiding factor in one’s experience of form in “Papillon I” and, at least partially, takes on the progressive role traditionally fulfilled by harmony. Although the substitution is incomplete, Saariaho has, at the very least, disrupted the traditional pairing of timbre and harmony in a musically dramatic way.

Direct deferrals to the physics of sound are not the only ways to musically conflate timbre and harmony. While Murail and Grisey plumb the depths of timbre-harmony in a way

\textsuperscript{84} Ibid., 130.

\textsuperscript{85} Ibid., 93; Saariaho is quoting here from Kandinsky's \textit{Concerning the Spiritual in Art} (1912/1969).
relatable to features “discovered through science and microphonic access,” Saariaho evokes a similar liminality through a more subjective conceptual foundation. This is not to say that Murail and Grisey are less sensitive to the subjective nature of timbre. It is presumably an increased sensitivity to timbre that led them to seek the guidance of observed and at least somewhat quantifiable acoustic correlates.

Saariaho’s less objective engagement with timbre reveals a compositional aesthetic wherein a sensitivity to timbre is, arguably, more deeply embedded. There is a greater parallel between Saariaho’s intuitive engagement with timbre and Murail’s and Grisey’s intuitive engagements with musical time. Murail’s rallentando curves in *Désintégrations* are calculated in relation to his subjective observation that rallentandos tend to be unevenly realized by musicians. Grisey turns to the embodied experience of biological rhythms as a basis for form in “Prologue.” Despite their adherence to the physics of sound, these features are externally conceived and subjectively evaluated according to the composers’ idiosyncratic perceptions. Similarly, Saariaho sidesteps relatively quantifiable aspects of a sound such as harmonicity/inharmonicity and substitutes a subjective evaluation of “purity/noisiness.” With such subjective evaluations of timbre in mind, let us turn to the music and writing of Jonathan Harvey—a composer whose engagement with timbre and harmony proceeds from yet another distinct foundation.

### 2.5: Jonathan Harvey

Harvey’s conception of timbre and harmony is rooted in the idea that harmony (to him, combinations of notes) is “symbolic,” while timbre (to him, the fusion of notes into a single gestalt perception) is “semiotic.” Harvey’s use of these terms is somewhat

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86 Grisey, “Did You Say Spectral?,” 1.
unconventional and reliant on an analogous relationship to a conception of language as a “limiting symbolic system” unable to completely account for the ephemeral nature of “syntax.” In qualifying this analogy further, Harvey refers to Stéphane Mallarmé’s “mysterious rhythm”—an aspect of poetry that evokes pre-conscious “semiotic” impressions of infants—instinctive perceptual responses established prior to the internalization of a mediating “symbolic” system. Although Harvey’s terminology is problematic, I will continue to refer to “semiotic” and “symbolic” as extremes on a continuum between, to use Harvey’s words, “spectral fusion and microtonal polyphony.”

According to Harvey’s dichotomy, segmentation of the continuous domain of frequency into discrete musical pitches is symbolic, while the extent to which symbolic combinations evoke unified gestalt perceptions is evidence of the influence of pre-conscious semiotic sensations. Harvey’s sensitivity to symbolic and semiotic aspects of aural perception is essential to the dramatic nature of his music and it is enlightening to examine his music in these terms. Consider, for example, Harvey’s account of a passage from his One Evening for two singers, instruments and electronics (1993-94):

“The first movement is constructed intervallically—on the principle of symmetrical

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87 Harvey, “Spectralism,” 11. Harvey’s citation of Julia Kristeva suggests that her usage of these terms is the nearest philosophical correlate. For Kristeva, “symbolic” reflects how language expresses “orderly meaning,” while “semiotic” reflects how language evokes a “feeling, desire, or unconscious drive.” [Noëlle McAfee, Julia Kristeva (New York: Routledge, 2004),14-18]. For Harvey, harmony refers to the “symbolic” ways in sounds can be organized to express “orderly meaning.” Considering our deep-rooted sensitivity to timbral differences, timbral perception is “semiotic” in that it is more of a “feeling.”


89 Ibid., 14.
inversion round an axis. This principle gives a poised, floating stillness to the
harmony, which changes but yet remains still around a central point. The music is
then repeated with the addition of very deep, soft notes on a synthesizer. In these
pitches I found the most plausible fundamentals for a reading of the harmony as
partials, i.e., spectrally. So, the floating harmonies acquire a ghostly hierarchisation:
intervallicism seen in a spectral light, the symbolic world seen in the larger
perspective of the semiotic one.”

Recasting “intervallicism” in light of the harmonic series provides an alternative perceptual
window onto the music. The “central point” that provides a symbolic referent for the
“floating stillness” of the harmony gives way to a semiotically informed “ghostly
hierarchisation” of gestalt timbre. With an ear towards the semiotic (i.e., timbral) qualities of
symbolic representations (i.e., pitches), let us consider Mortuos Plango, Vivos Voco (1980)—
an electronic work that is one of Harvey’s more influential contributions to the spectral
repertoire.

2.5.1: Mortuos Plango, Vivos Voco

A bell spectrum Harvey gleaned from his analysis of the great tenor bell at
Winchester Cathedral informs timbral-harmonic structures in Mortuos Plango, Vivos Voco. Figure 2.10a shows this bell spectrum quantized to the eighth-tone—an unusually fine 48-
TET microtonal approximation enabled by the greater pitch/frequency precision of electronic
media. The bourdon of this bell is C3 and, not surprisingly given the nature of bell spectra
discussed earlier, the spectrum features an inharmonic partial a minor-tenth (E♭4) above the
bourdon (C2). Harvey has added an F4 (parenthesized in figure 2.10a) to reflect the

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90 Ibid., 14.

91 It is interesting to note that, despite the finer 48-TET resolution of Mortuos Plango, Vivos Voco, the
approximate minor-tenth so characteristic of bell sounds is most accurately reproduced as a 12-TET pitch
presence of partials that are overtones of a subordinate F3 fundamental. Open noteheads in figure 2.10a highlight these partials and a number above the staff indicates their overtone rank within an F3 harmonic series.

Figure 2.10b shows a subset of the bell spectrum’s partials—including the added F4—that Harvey has identified as the most prominent. These serve as “ pivots” for each of the eight sections of the work. Numbers above each pivot partial reflect the proportional relationship between its frequency and that of the bourdon. Since bell spectra are slightly inharmonic, the pivot partials are not all integer multiples of the bourdon frequency. The invariance of these pivot pitches in each section are stable points for transformations tied to the interval content of the bell spectrum—a practice that reflects Harvey’s attachment to “intervallicism seen in a spectral light.”

Numbers above the staff and between the noteheads in figure 2.10c–d reflect eighth-tone pitch intervals. Figure 2.10c demonstrates what Harvey refers to as a “degree 3 change”—an initial transformational step in which five partials from the bell spectrum are replaced with partials three steps further from the bourdon. Since higher partials in the spectrum tend to be closer to one another, the intervals contract. Figure 2.10d shows the next step in the transformation: transpose the “changed” pitch collection so that the pivot pitch—

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interval. Perhaps this unusually robust 12-TET correspondence is part of the reason this particular spectral feature is so strongly correlated with a specific timbre.

92 Whole numbers = semitones: 1 = semitone, 1.25 = semitone + eighth-tone, 1.5 = semitone + quarter-tone, and so on.

in this case an eighth-tone lower than A5—remains in the position it occupied prior to the “change.” Although transposed, the intervallic content of the resultant sonority corresponds to a set of frequency proportions particular to a subset of the spectrum. Consistent expressions of such frequency proportions imbue the music with a unifying “bell-ness” despite their realization at different pitch levels.

Figure 2.10: Timbral-harmonic derivation from a bell spectrum in *Mortuos Plango, Vivos Voco*

Harvey defers to proportional relationships between each pivot pitch and the bourdon to further establish the sectional design of the work. Different “pulsation speeds”—subtle periodicities related to the frequency proportion expressed by each pivot pitch in relation to
the bourdon—rhythmically activate each section, and Harvey uses a similar method to determine each section’s duration (see figure 2.10e). Overall, Harvey defers to the bell spectrum’s frequency proportions as the basis for pitch structures, formal proportions, and section-specific periodicities. An emergent semiotic “bell-ness”—a consequence of structural peculiarities of the bell spectrum—unifies Harvey’s symbolic derivation of pitch and temporal structures for use in Mortuos Plango, Vivos Voco.

By using a timbral structure—the bell spectrum—to constrain intervallicism, Harvey establishes a deeper level context—a “mysterious rhythm” à la Mallarmé—for his symbolic deployment of pitches in Mortuos Plango, Vivos Voco. Despite the contempt expressed by Murail for the intervallic machinations of serialism, Harvey has found a way to incorporate transformational (in the intervallic sense) procedures into spectral music. Harvey’s assertion that “harmony can be subsumed into timbre. Intervallicism can come in and out of spectralism, and it is in the ambiguity that much of the richness lies” beautifully summarizes the rapprochement between intervallicism and spectralism he achieves in Mortuos Plango, Vivos Voco.

The “ambiguity” cited by Harvey as the most powerful aspect of his spectral compositional attitude arises from his idiosyncratic engagement with the liminal zone

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95 For a more detailed—and fascinatingly “interactive”—account of how everything from local level details to global architecture correlate to features of the work’s source spectrum, see Michael Clarke, “Jonathan Harvey’s Mortuos Plango, Vivos Voco,” in Analytical methods of electroacoustic music, ed. Mary Simoni (New York: Routledge, 2006), 116 – 141.

96 Murail, “Afterthoughts,” 270.

between timbre and harmony—a perceptual environment composers of spectral music access through individualized conflations of timbre and harmony. Murail accesses this liminal zone primarily through pitch relationships that evoke imperfect timbral sensations and Grisey prioritizes temporal aspects of timbral perception. Saariaho prioritizes subjective evaluations of timbre as the root of a flexible timbral hierarchy—her “sound/noise” axis—and Harvey uses timbral structures to constrain intervallic transformations, derive rhythmic features, and calculate formal proportions.

Of course, composers cannot be categorized quite so neatly. The evolution of spectral envelope from that of a “bell-type” sound to that of a “brass-type” sound in Murail’s Gondwana, for example, relies on the gradual transformation of a temporal gesture—a feature that aligns more with my characterization of Grisey’s spectralism than Murail’s.98 But the extent to which my characterizations of each composer’s conceptual foundations ring true reveals “recurring themes and ideas” particular to the “overall trend” of spectral music. These conceptual contrasts serve as a backdrop against which I will discuss analytical approaches to spectral repertoire. Each of the foregoing discussions went beyond classification of pitch/timbre to consider the temporal aspects of the compositions and this focus will be maintained in the theory to come.

As useful as conceptual comparisons might be as an analytical guide, there is a significant gap to account for: the need for analytical techniques that can address hierarchical relationships among discrete timbre-harmonies. Figure 2.2 includes dynamics taken directly from the score of Désintégrations, but I have yet to consider the logic behind Murail’s choices. Even if Murail’s assignment of these dynamics is purely intuitive, it may be possible

to provide evidence suggesting that timbral-harmonic factors guided his ear. But hierarchical comparisons of timbre-harmonies can be complicated. Before delving into this issue, let us first consider how theorists have coped with similar challenges in both the distant and recent past.
CHAPTER 3:
THINKING ABOUT TIMBRE AND HARMONY

Our ability to perceive “virtual fundamentals” suggests that certain psychoacoustic principles underlie our emergent perceptions of timbre and harmony. But the epistemological gray areas discussed in the previous chapter stand as evidence that the musical relevance of these principles is variable. Although there seems to be a general consensus among composers of spectral music that perceptual and aesthetic correlations between timbre and harmony exist, there is less agreement on what these correlations might be or how they might be prioritized in support of specific expressive ends. Such ambiguity suggests that overly precise definitions of the relationship between timbre and harmony inappropriately fossilize sensations whose phenomenological flexibility is essential to spectral music. Musically compelling manifestations of this flexibility arise, in part, from spectral music’s timbral-harmonic liminality—a characteristic that distinguishes spectral *timbre-harmony* from more superficial attempts to imbue timbre with form-bearing salience.¹ In this chapter, I will lay a foundation for analytical engagements with the phenomenological limbo of spectral *timbre-harmony* by discussing timbre and harmony as separate, but overlapping and contingent, multidimensional musical domains. But first, a brief digression on practices of orchestration will provide some useful context for the more abstract speculations to come.

3.1: Timbre, Harmony, and Orchestration

3.1.1: Functional Uses of Timbral Relationships

To shed some light on how orchestration relates to timbre and harmony, let us briefly

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consider a quixotic attempt from the 1950s to incorporate timbre into total serialism through systematized instrumentation. Pierre Boulez contrived a serial method of pairing instrumental timbres in *Polyphonie X*, a work by for mixed instrumental ensemble, but ultimately he withdrew the work, citing the method as a feature that drove him “back to the keyboard” in search of greater “neutrality.”\(^2\) One assumes that “neutrality” here is a euphemism for timbral homogeny, and the prevalence of integral serial works for piano(s) (e.g., Boulez’s *Structures Ia*, Messiaen’s *Mode de valeurs et d’intensités*, Babbitt’s *Three Compositions for Piano*) suggests that the serialization of timbre was troublesome and worth avoiding. Pitch can be ordered from low to high and durations can be quantified in relation to a fundamental pulse—as demonstrated rather beautifully in Stockhausen’s *Kreuzspiel*. But there is no self-evident basis for the ordering of timbres and thus no self-evident basis for their serial treatment. Ad hoc deferrals to *instrumentation* sidestep the issue by systematically deploying instrumental sounds—the material of orchestration—without directly *orchestrating* their interactions.

Alfred Schnittke has characterized a common result of such attempts to bring timbre under serial control as “timbral pointillism.” While such diffuse and haphazard engagements with timbre successfully reflect a Webernian “tendency…to dissociate and differentiate,” he writes, they underemphasize the aesthetically arresting effect of “timbral affinities”—timbres that blend well and/or exhibit similar characteristics.\(^3\) In light of this untapped expressive

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\(^3\) Alfred Schnittke, “Timbral Relationships and Their Functional Use,” in *Orchestration: An Anthology of Writings*, ed. Paul Mathews (New York: Routledge, 2006), 167. While examples of such timbral nuance in
resource, Schnittke proposes an approach to orchestration that elevates timbral affinity to a primary compositional concern.

Proceeding from a distinction between timbral “consonance” and “dissonance”—the relative degree to which individual timbres can be aurally distinguished when combined with others—he uses familiar harmonic terms to discuss how timbral affinity attains a functional, rather than ornamental, significance. For example, Schnittke describes a dovetailing of the oboe and clarinet in the second movement of Brahms’ Symphony No. 1 as a timbral “modulation.” Shortly before the end of the oboe’s melody, the clarinet enters “taking off from the oboe as if it were what was left of the oboe’s sound. After the clarinet enters, the oboe loses its thematic independence, its part now merely figuration in the pulsing chords of the strings.” Such effects are not uncommon, but Schnittke’s account is particularly compelling in that he highlights how an evolving timbral blend deepens the sense of elision arising from overlapping melodic lines and enriches the emergent effect of the clarinet waxing as the oboe wanes. The transient and compelling timbral ambiguity of the tipping

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Webern’s music are plentiful, his elegantly parsimonious Op. 10 orchestral pieces spring readily to mind. Schnittke cites one of these as an example and I enthusiastically reaffirm his choice by suggesting that a more visceral appreciation of “timbral affinity” is attainable through immersion into Op. 10 in its entirety.

4 Ibid., 164.

5 Such “timbral modulation” is especially prevalent in jazz as one improvising soloist hands off to another. Many tracks on Miles Davis’ seminal Kind of Blue album (esp. “So What?”) are notably elegant in this way. Perhaps the most memorable timbral modulation I have ever experienced was in a performance by the Jumbo Shrimp Creole Band—an unsigned Dixieland group that frequently performs in New Orleans. At one point, the banjo player ended a solo on an extended C3 tremolo—the banjo’s lowest pitch in traditional four-string Dixieland tuning. This sustained tremolo expressed the banjo player’s struggle against the banjo’s lack of
point—the moment when the oboe timbre seems to merge with emerging clarinet timbre as it fades to the background—resembles the harmonic effect of a pivot modulation between tonal centers.⁶

Such harmonic analogies highlight how timbral relationships can function to articulate musical form. But Schnittke eschews more direct parallels between timbre and harmony because he aims to demonstrate that timbre can, through clever orchestration, emerge as an expressive domain independent of harmony. To this end, presumably, he tends to cite excerpts that are either harmonically almost static (e.g., Stravinsky’s *Symphony of Psalms*) or undermine harmony through other aspects of compositional technique (e.g., Stockhausen’s *Kontrapunkte*). Ultimately, despite the promising implications of a continuum of timbral consonance and dissonance, one comes away from Schnittke’s writing with a sense that timbre can only be formative if it connects events that have little else in common or if it affords a sense of progression within otherwise undifferentiated harmonic fields.

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⁶ cf., Ibid., 165-170. The shift in focus from oboe to clarinet that Schnittke cites aligns generally with “modulation” in the sense of shifts between tonal centers. Elsewhere, however, his use of the term reflects a more generalized sort of change over time. For example, he describes “timbral modulation within a single timbre” (e.g., moving from *sul tasto* to *sul ponticello* on a string instrument). Although one is tempted to default to the more generalized meaning of “modulation,” Schnittke’s assertion that both timbre and pitch can be organized into a “functional system” [emphasis added] with a scale of nuances and gradual modulations” encourages one to interpret “modulation” in a more specific sense when appropriate.
Schnittke’s functional uses of timbral relationships suggest an elevation of timbre within the “hierarchy of expressive resources.” But their mostly surface-level significance does not demonstrate how deeper level structural connections can emerge along similar lines. Ironically, then, Schnittke’s functional uses highlight rather than transcend the traditionally “subordinate role” of timbral relationships. Nevertheless, it is tempting to view them as seeds from which practical theories concerning the structural role of timbre might be cultivated. But such theories are unlikely to evolve directly from the foundation he provides because he shies away from explaining how specific properties of sound contribute to emergent perceptions of timbral consonance and dissonance. His suggestion of a perceptible “timbral scale,” based on the truism that some timbres differ more than others, does little to shed light on the issue.

3.1.2: Holistic and Atomistic Orchestration

Although Schnittke’s approach to orchestration highlights timbre as an expressive

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7 cf. Ibid., 162.

8 The familiar and seemingly tautological description of the sound of brass instruments as “brassy” is an example of a similar epistemological deficit. Admittedly, “brassy” refers to a shared timbral quality of brass instruments and is significant in that it suggests a parallel between a type of instrument and a quality of sound. The discourse around timbre, especially with regard to the study of orchestration, is likely to improve with the adoption of terminology that at least partly reflects why sounds express characteristic timbral qualities. Fineberg references a specific spectral property of brass instruments as related to an emergent perception of “brassiness” [Joshua Fineberg, “Guide to the Basic Concepts and Techniques of Spectral Music,” Contemporary Music Review 19/2 (2000): 87]. Although this is not the whole story, it does suggest we can attain a deeper awareness of factors that influence our perceptions of qualitative similarity among a group of physically similar stimuli.

resource in a general way, Tristan Murail demonstrates, through occasional references to orchestration as means to timbral-harmonic ends, that timbre can be woven into a dramatic musical discourse with greater phenomenological nuance. In relating orchestrational logic to the emergence of timbral-harmonic effects in his work, Murail cites both the spectral structure of sonorities and the spectral qualities of individual instruments or groups of similar instruments. One example is in a lengthy conference lecture he gave that included compositional details about the first section of his *Gondwana* (1980). The opening of this orchestral work features a series of timbre-harmonies meant to evoke the perception of a series of bell-like timbres. Each timbre-harmony—conceived as a spectrum comprised of differentially salient harmonic overtones and inharmonic partials—is approximately realized as a chord with differentially salient pitches. Murail chose unmuted brass instruments to play the strongest components in each timbre-harmony. He justifies this choice by pointing out that “the sound of the brass, without mutes is somewhat concentrated on the first harmonics, and thus stays rather clear.”

The nuance of this orchestrational decision becomes evident when viewed as a logical extension of his compositional strategy. After determining the component pitches and their relative salience within each timbre-harmony, Murail confronted the problem of orchestration. He conflated amplitude, experienced as loudness, with “clarity” and assigned the loudest partials in each spectrum to instruments capable of being similarly “clear” when mixed with other instruments in the ensemble. It is difficult to say precisely which feature(s)

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11 Ibid., 209.
of brass instruments’ sounds are reflected in Murail’s description of their “clarity.” But one can make some intriguing assumptions given his holistic orchestrational logic. The brass pitches realize intervals that correspond to frequency proportions strongly correlated with evocations of bell-like timbre. Given the importance of these particular intervals as the seeds of especially redolent timbral cues, it is not surprising that Murail chose a group of instruments known for their ability to play loudly and express an unusually focused pitch.12 To be sure, tapping the brass section for this purpose in an orchestral work requires little justification. But the factor Murail cites to support his orchestrational decision—a property of brass spectra that explains their unusually focused pitch—reveals an important departure from Schnittke’s thinking about timbre.

The crux of the issue lies not in how timbre supplants or subsumes other expressive resources, but rather in how timbre participates as a more or less equal partner with harmony, melody, etc. in a musical discourse. The chords from the opening of Gondwana differ from each other in that they do not share the same pitch structure. But their spectral pedigree ensures each chord will express a bell-like timbre to some extent. Murail deploys instrumental resources to maintain and highlight this shared timbre—a quality that, in part, unifies a series of diverse harmonies. Most importantly, the passage can also be described from a perspective that prioritizes timbre over discrete harmonies: a diverse progression of harmonies activates a relatively stable expression of timbre. Personally, I can’t say which

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12 While Murail’s identification of this characteristic of a class of instrumental sounds is correct, generally speaking, the spectral feature he correlates with this observation is but a small part of the story. The acoustic factors that correlate to our perception of brass instruments’ notably clear pitches are much more complicated [Thomas Rossing, The Science of Sound, 2nd edition (New York: Addison-Wesley, 1990), 217-234].
conceptual stance I prefer, but I consider the possibility of two equally valid perspectives to be a positive consequence of spectral conflations of timbre and harmony.

Such coordination complicates discussions of timbre and harmony as separate musical domains and suggests broader conceptions of sound predicated on perceptual cues that support both atomistic and holistic aspects of musical experience. As discussed in chapter 2, Saariaho draws parallels between holistic perceptions of musical texture and the “purity/noisiness” of individual sounds.13 Harvey cites his timbre-harmony conflation as useful for facilitating the fusion of structures subjected to atomistically conceived intervallic transformations.14 Murail and Grisey both employ metaphors that express a conception of musical sound as an emergent but singular group identity rather than a looser semantic association of independent parameters. Murail characterizes sound as a “field of forces” in which each force “pursu[es] its own particular evolution.”15 In other words, the properties of each independent “force” contribute to the gestalt identity of a unified “field.” Grisey expresses a similar, if somewhat more poetic, perspective by celebrating spectral music’s “more ‘ecological’ approach to timbres, noises, and intervals.”16 Although Grisey does not

16 Gérard Grisey, 2000, “Did You Say Spectral?,” trans. Joshua Fineberg, Contemporary Music Review 19, no. 3 (2000): 2. The scare quotes around the word “ecological” suggest a broad mimetic interpretation of its meaning. Independent elements—organisms ≈ “forces”—interact with each other and their environment—habitat ≈ time—to engender holistic perceptions that transcend or obscure one’s perception of their
fully flesh out this metaphor, he does refer to sound as a “cluster of forces” that need time to have a perceptual impact.17

The notion of what constitutes a “force” remains ambiguous and I will return to it at the end of this chapter. For now, the key point is that composers of spectral music—of which the composers mentioned above are prominent and influential examples—promote a holistic conception of music. Schnittke’s functional uses of timbral relationships reflect an atomistic assumption that musical parameters—pitch, rhythm, timbre, harmony, etc.—are characters on a stage, vying for the spotlight. Composers of spectral music advocate similar parameterization for practical reasons, but with a different end in mind. A listener who is “faced,” as Grisey puts it, “with the cluster of forces that make up sound” and “the time needed for their emergence” will require, at the very least, an awareness of the nature of each “force” and a basic understanding of its interactions with other “forces.”18 Despite this superficial similarity, composers of spectral music avoid parameterization like that promoted by Schnittke. For them, the aesthetic significance of each parameter is tied to its role in the creation of a desired holistic effect rather than how it expresses its independence.

3.1.3: From Practical to Speculative

To this point, I have focused on timbre and harmony from a group of compositional perspectives for which spectral music serves as an aesthetic locus. But it is difficult to fully appreciate the unique musical consequences of spectral conflations of timbre and harmony without taking into consideration more speculative attempts to deal with related issues.

17 Ibid., 1-2.

18 Ibid., 1-2.
Before proceeding, I would like to briefly establish a corresponding locus of theoretical concern that similarly confronts hazy phenomenological distinctions between timbre and harmony.

Many spectral works feature series of discrete timbre-harmonies—chords that evoke unusually rich sensations of timbral fusion. Murail’s *Désintégrations* and *Gondwana*, along with Grisey’s “Partiels,” are prominent examples of this recurring characteristic of spectral works. Although such cleanly articulated timbral-harmonic progressions are not the only mechanism through which composers of spectral music conflate timbre and harmony, such textures are ideal for considering an important question: What exactly are the roles of timbre and harmony in facilitating the experience of a given *series* of discrete timbre-harmonies as a temporally-directed timbral-harmonic *progression*?

To address this question, I will begin by discussing Heinrich Schenker’s critique of Jean-Philippe Rameau’s “verticalization” of music theory, to understand how temporal progression could be conceived for an earlier harmonic music. Then, I will discuss how perceptible correlations between timbre and harmony can be understood according to two different psychoacoustically oriented theoretical perspectives: Ernst Terhardt’s discussions of psychoacoustic consonance and dissonance, and Robert Hasegawa’s theory of tone representation. Finally, I will revisit the notion of “force,” as mentioned above, and consider its meaning and relevance in light of the speculative discussions in this chapter.

### 3.2: Heinrich Schenker

In his 1930 essay “Rameau or Beethoven?: Creeping Paralysis or Spiritual Potency in Music?,” Schenker accuses Rameau of sowing “seeds of death” that infiltrated music theory
and subsequently infected composition with a pernicious phenomenological stance.\textsuperscript{19} Essentially, Schenker sees Rameau’s theory as placing undue emphasis on the vertical “superimposition of notes” in light of the more musically significant “flux of horizontal voice-leading.”\textsuperscript{20} Although Schenker’s antagonistic tone in this essay is distracting, peering through the more histrionic aspects of his polemic can be enlightening.\textsuperscript{21} Specifically, his exaltation of the horizontal over the vertical highlights a seemingly basic difference between facets of musical experience—a difference ambiguated in conflations of timbre and harmony such as those described in chapter 2.

3.2.1: “Seeds of Death”

At the heart of Schenker’s umbrage is a disagreement over the musical relevance of scale degree. For Schenker, Rameau’s concept of scale degree is “too limited” because it is tied to his vertical concept of “fundamental bass” at the expense of a more rigorous exploration of the “true laws according to which scale degrees move.”\textsuperscript{22} Given such


\textsuperscript{20} Ibid., 2.

\textsuperscript{21} Although Schenker often criticized Rameau’s theories, he did not always couch his criticisms in such xenophbic vitriol (e.g., frequent references to “French mediocrity,” Ibid., 3). Harald Krebs provides an enlightening survey of the political and musical factors that contributed to the evolution of Schenker’s increasingly vehement distaste for Rameau’s work [Harald Krebs, “Schenker’s Changing View of Rameau: A Comparison of Remarks in \textit{Harmony, Counterpoint}, and ‘Rameau or Beethoven?,” \textit{Theoria} 3 (1988): passim].

deference to the vertical, Schenker sees the horizontal inappropriately minimized in Rameau’s theory as “mere counterpoint to the vertical,” so he upends this relationship by associating scale degree with “the composing-out of the fundamental chord.”23 In this way, Schenker reveals how a prototypical sonority can have a deeper significance as scaffolding that facilitates temporal motion.

Although the tone of Schenker’s indictment of Rameau is unwarranted, the idea that the latter’s focus on the “vertical superimposition of notes” obscures musical forces that motivate horizontal motion is not.24 Schenker’s more abstract concept of scale degree as linked to the composing-out of a fundamental chord highlights profound structural features and expressive qualities that might not be revealed as compellingly through a more Rameauvian approach. For example, Schenker’s analysis of the C-minor fugue from the first book of Bach’s Well-Tempered Clavier shows how the composing-out of a fundamental chord serves as the basis for an elegantly unified account of the work’s structure, and, most importantly, transcends motivically-focused analytical accounts.25 Since Rameau’s theories lack a similarly comprehensive mechanism for explaining the significance of horizontal motion at deep structural levels, it is unlikely to reveal unifying musical forces that are similarly all-encompassing.

But Schenker’s are not the only “laws” according to which music moves.26 Recall

23 Schenker, “Rameau or Beethoven,” 3.
24 Ibid., 2-3.
26 Schenker, Counterpoint I, xxix.
Saariaho’s characterization of harmony as the “impetus for movement” and timbre as “the matter which follows this movement.”\textsuperscript{27} Although Saariaho’s subsequent assertion that the “matter/impetus” roles of timbre and harmony can be reversed does not contradict Schenker’s preference for the horizontal, it does suggest that the engine of horizontal motion in music can be powered by forces other than “the paths scale-degrees must traverse.”\textsuperscript{28} For example, it would be difficult, if not impossible, to hear similar “paths” in the openings of Murail’s \textit{Désintégrations} and Grisey’s “Partiels.” The progressions of discrete timbre-harmonies in both works realize processes primarily reliant on the holistic timbre expressed by each chord. These progressions are unified, in part, because they express timbres that are either audibly relatable to an overall unifying timbre (\textit{Désintégrations}) or plot out steps in a process of timbral-harmonic decomposition (“Partiels”).\textsuperscript{29} In light of this holism, the contributions of each note to the gestalt timbre of their parent chord overshadows the structural significance of connections between individual tones in successive chords.

In the openings of \textit{Désintégrations} and “Partiels” the chords are “matter” that flows according to “impetuses” that emerge from interactions between the gestalt timbres they

\textsuperscript{27} Saariaho, “Timbre and Harmony,” 94.

\textsuperscript{28} Schenker, \textit{Counterpoint I}, xxix.

\textsuperscript{29} Leonard Meyer’s distinction between “syntactical” and “statistical” parameters of music is relevant here. The timbral-harmonic progressions mentioned above cohere in general and express a general sense of timbral-harmonic motion. But, even though the move toward inharmonicity in the opening section of “Partiels” expresses timbral-harmonic motion in a single “statistical” direction, neither progression projects a predictable endpoint or goal. In contrast, the typically expected “syntactical” continuations of many tonal progressions facilitate a sense of harmonic motion towards predictable points of closure. See Leonard B. Meyer, \textit{Style and Music} (Chicago: University of Chicago Press, 1989), 14-16.
express. These interactions are organized into timbral processes that facilitate perception of a directed timbral-harmonic progressions. Although the timbral impetus for horizontal motion can be explained in part by the motive force of the unifying process, it is less clear how local interactions between timbre-harmonies contribute to the effect. This gap in accounting for how local interactions support larger timbral-harmonic processes is a serious analytical deficit and addressing this deficit will be a motivating factor in the analysis to come in later chapters.

3.2.2: “Any and Every Piling-Up of Notes”

Along with his more acerbic comments, Schenker raises a vital issue by expressing exasperation with a disorganized conception of harmony in which “on the pretext of the higher partials of the overtone series, any and every piling-up of notes, no matter how it may have come about, is indiscriminately taken for a chord.” Indeed, he asserts that parallels between chord structure and more distant regions of the harmonic series are ominous symptoms of a “creeping paralysis” in which listeners become desensitized to the nuance of intricate horizontal connections. The harmonic series is theoretically infinite, and thus contains the frequency analogues of all possible pitch intervals, which are also theoretically infinite. Since this infinity of parallels exceeds our decidedly finite perceptual capacities, it is also true that any pitch interval we are capable of perceiving can be explained according to

30 For now, the preliminary discussions of these processes in chapter 2 are sufficient support for a general demonstration of the timbral-harmonic matter/impetus reversal under discussion. I will discuss both of these processes in more detail in chapter 4 and flesh out this timbral-harmonic generalization in less diametric terms.

31 Schenker, “Rameau or Beethoven?,” 5.

32 Ibid., 5-6.
its approximate correlation with a finite set of harmonic frequency proportions. This imbalance between finite and infinite sets of information is awkward. Since the harmonic series can explain everything in an abstract sense, it might not, in a musical sense, explain anything. Given this troubling paradox, implies Schenker, why are correlations between pitch interval and harmonic frequency proportion relevant to our experience of music?

Since Rameau does not touch on distant overtones in his work, it is likely that Schenker’s reference to them is rhetorical hyperbole. After all, the European repertoire Schenker focused on in his work—primarily 18th and early 19th century—features relatively few extensions of the prevailing harmonic language of Rameau’s time. In contrast, the enriched harmonic vocabulary of late 19th and early 20th century chromatic harmony (e.g., Debussy, Strauss, Wolf, Mahler) lent urgency to the issue of how upper regions of the harmonic spectrum might come into play.

Given this pressure to understand new harmonic resources, it is not surprising that Schoenberg—a composer at the forefront of developments in chromatic harmony—casts the same issue in a more positive light in his theoretical work.

“Generally, with chords of six or more tones, there will appear the tendency to soften the dissonances through the wide spacing of the individual chord tones. That such is a softening is obvious. For the image of what the dissonances actually are, more remote overtones, is imitated in a satisfying way.”

Schenker suggests that a dilution of musical sensibility has arisen from an attention to vertical relationships that are not only increasingly diverse, but also increasingly ephemeral. Schoenberg, in contrast, cites an “obvious” vertical “softening” that shows there is much to

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be gained from continued exploration of how our perceptions are affected by pitch relationships analogous to frequency proportions further removed from the fundamental.

The distant overtones referenced by both scholars are likely to express relationships whose direct perception is beyond the capabilities of most humans. But Schoenberg’s assertion that these same relationships are indirectly related to the emergence of an easily-perceived global quality circumvents this apparent obstacle by showing how details of distant overtone relationships can be subsumed by the emergent qualities they evoke. Furthermore, the absorptions of individual pitches into holistic expressions of quality demonstrate the inadequacy of Schenker’s elevation of “voice”—manifested “in art” as “a succession, not a superimposition, of notes”—to “the very concept of music.”

**3.3: Psychoacoustic and Proportional Consonance**

How “horizontal” successions of tones engender a sense of connection is rooted in both their successive presentation and an ability to plot each tone along a single dimension (pitch). Even if the exact interval between pitches is not accurately perceived, the ease with which two tones may be perceived as higher, lower, or the same supports an emergent sense of connection between them. In contrast, the identities of concurrent tones are undermined if their relationships express a fused sonority into which each tone is subsumed. When complexes of concurrent tones (i.e., chords) sound successively, the ways in which they support horizontal connection are more difficult to pin down. Although there is bound to be some sense of connection that arises from their successive presentation, comparisons between chords are more complicated than comparisons between independently sounded tones. To more fully understand how vertical relationships can affect our perceptions of

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34 Schenker, “Rameau or Beethoven?,” 2.
music’s horizontal flow, let us consider how a given chord’s gestalt qualities are engendered by identifiable aspects of its vertical structure.

3.3.1: Beating and Roughness

Hermann von Helmholtz famously described a link between auditory beats, experienced as “roughness,” and our perception of consonance. The novelty of his conception of consonance is reflected in his classification of interval types, wherein he considers not only the ratio between fundamentals, but also the beats between proximate upper overtones. But the path from acoustic phenomenon (beating) through sensation (roughness) and ultimately to the emergent perception of a gestalt quality with musical implications (consonance/dissonance) is not as straightforward as Helmholtz’s observations imply.

Consider, for example, a comparison between the following pairs of sine tones: (P5) from A1 to E2 and a tritone (TT) between A4 and D#5. One well-versed in traditional music theory would predict the P5 will sound more consonant than the TT. But upon hearing these intervals the distinction is unlikely to be perceived as clearly as one might expect. Although A4/D#5 is the smaller interval in pitch space, the frequency difference between these two midrange tones is greater than the frequency difference between the low register A1/E2, an apparent paradox that arises from the logarithmic relationship between frequency


36 These sine tones are idealized and meant to facilitate the abstract discussion of “critical band” to come. In reality, even sine tones (i.e., frequencies without additional partials) would produce partials arising from the environment in which they are sounded. These partials would interact with each other and enrich the timbre expressed by the sine tones on their own.
and pitch. Frequency difference affects the amount of beating and the emergent sensation of roughness that affects our perception of consonance.

“When two pure tones [i.e., sine waves] of differing frequency are added [i.e., sounded together] the resulting waveform fluctuates in amplitude at a rate corresponding to the difference of the two frequencies.”\(^{37}\) Such amplitude fluctuation is perceived differently according to the frequency difference between the tones.\(^{38}\) If the frequency difference between two tones is less than around 10 Hz, then the two tones are difficult to perceive separately and the resultant amplitude fluctuation is literally perceived as “beating”—an audible pulse. Beyond this range, the rate of the amplitude fluctuation increases to the point that our perception of separate “beats” gives way to the more unified quality of “roughness.”\(^{39}\) As the frequency difference between two tones increases, it becomes easier to perceive two separate tones, but a “rough” quality persists. Eventually, when the frequency distance between two tones is great enough, roughness disappears, and one can easily perceive two distinct tones.

Despite the roughening effect of beating, a culturally shaped sense for pitch relationships may win out. For one steeped in Western tonal music, A1/E2 sounds like a perfect fifth, but a muddy one, and A4/D#5 sounds like a run-of-the-mill midrange tritone—a dissonance whose resolution is a quasi-grammatical expectation. There is also the curious fact of how the beating frequency relates to the frequency analogues of the pitches in


\(^{38}\) Ibid. 21-22; Rossing, The Science of Sound, 147-148.

\(^{39}\) Helmholtz, On the Sensations of Tone, 184.
question. Assuming 12TET with a standard pitch of A4 = 440Hz, the beating frequency between A1/E2 is approximately A0 (E2 – A1 ≈ 82.41Hz – 55Hz = 27.41 ≈ A0). Since A0 is approximately equivalent to the fundamental that generates both pitches, one might assume that such an emergent subordinate vibration could only bolster one’s sense of the interval’s consonance. In contrast, the beating frequency between A4/D#5 is approximately F#3 (D#5 – A4 ≅ 622.25 - 440Hz = 182.25 ≅ F#3)—an emergent imperfect consonance in relation to both pitches in the parent interval that binds them together in a subtle manifestation of a comparatively dissonant diminished triad.

But the psychoacoustic influence and musical relevance of beating frequency do not quite map onto our sense of pitch so directly. Psychoacoustic research shows that perceptions of roughness peak at beating frequencies of around 70Hz. Moreover, we increasingly filter out beating frequencies starting around 100Hz and, instead of hearing a rough interval we represent each pitch separately in our peripheral auditory system. Even though the 27.41 beating frequency of A1/E2 will not produce the strongest sensation of roughness, its effect

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40 I am defaulting to 12-TET, here, for two reasons. 1) When discussing the tendencies of pitch perception, I find it useful to assume 12-TET—a prevailing pitch system in use today—so that my observations are more easily testable and communicable. Despite the slightly distorted spectra of piano sounds and the illusory nature of some of its lowest notes [cf., Murail, “Villeneuve,” 190-193, 228], one can experience the effect(s) under discussion here by playing intervals at the keyboard. 2) The approximate relationship between pitch and frequency, and how this affects our perceptions is a recurring theme of this project. A 12TET example fleshes out such abstract correlations in familiar and practical terms, and shines a light on how they affect our everyday musical perceptions.

is not filtered out. In contrast, 182.25 beating frequency of A4/D#5 will have little audible effect because it is well beyond the point at which our peripheral auditory system starts filtering out its roughening influence. In other words, we only hear tones interact to produce beating within a certain range.

The preceding discussion of beating and roughness highlights psychoacoustic factors at play in even the most basic combinations of sounds. But to gain a sense for how beating and roughness contribute to emergent holistic perceptions of complex sounds and chords—and ultimately help motivate the music’s horizontal flow—let us consider their cumulative effect on perceived consonance in terms of critical band.

3.3.2: Critical Band

The bandwidth around the frequency of a tone within which beating/roughness will result if disturbed by a second tone is known as the critical band. Calculating the critical band is complicated and variable according to context, but we can draw on some very general assumptions to highlight an important distinction: psychoacoustic consonance (the absence of beating/roughness) is not equivalent to proportional consonance (conceived as simple harmonic frequency proportions). In terms of approximate correlation with harmonic

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43 Although not directly relevant to this discussion here, it is worth noting that the existence of this frequency region arises from how sounds stimulate regions of the basilar membrane. (Rossing, *The Science of Sound*, 74).

44 Ernst Terhardt, “Pitch, consonance, and harmony,” *The Journal of the Acoustical Society of America* 55 (1974): 1062. Terhardt’s “musical” consonance is tied to harmonic frequency proportions and is equivalent to what I am calling “proportional” consonance. This slight terminological adjustment is more suited to music
By taking into account the critical bands of each frequency, we can see how psychoacoustic dissonance can erode proportional consonance. For higher frequencies, the critical band is about 11% of the frequency of the tone under consideration, and levels off to around 25Hz at lower frequencies. The critical band around a 55 Hz tone (≈40Hz – ≈70Hz) overlaps the critical band of an 82.41 Hz tone (≈66Hz – ≈99 Hz), while the critical band around a 440 Hz tone (≈404Hz – ≈476Hz) does not overlap the critical band of a 622.25 Hz tone (≈576Hz – ≈668Hz). The psychoacoustically dissonant roughness that results from the overlapping critical bands of A1 and E2 tarnishes the proportional consonance engendered by their relatively simple frequency ratio. Conversely, a psychoacoustically consonant lack of roughness mitigates the proportional dissonance of the A4/D#5 tritone.

Although psychoacoustic and proportional consonance seem to arise from different sorts of acoustic stimuli, both sensations contribute to our perception of a chord’s gestalt.

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theory in that it leaves room for how culture also shapes our musical perceptions of consonance.

45B. C. J. Moore and B. R. Glasberg, “A Revision of Zwicker’s Loudness Model,” *Acta Acustica* 82 (1996): 336. Critical bandwidth, in relation to the relatively young field of psychoacoustics, is a venerable concept. Moore and Glasberg update the prevailing conceptions concerning critical bandwidth and incorporate it into a more nuanced conception of “equivalent rectangular bandwidth.” “At moderate sound levels, the equivalent rectangular bandwidth (ERB) of the auditory filter, which is assumed to be closely related to the critical bandwidth (CB), is described by: ERB = 24.7(4.37F + 1), where the ERB is in Hz, and the centre frequency F is in kHz.” I will use this simple formula to estimate critical band in the discussion above.

46 Terhardt, “Pitch, consonance, and harmony,” 1062.
qualities and, through these qualities, influence our perception of chords’ roles in facilitating horizontal musical motion. An appreciation of this combined effect requires some understanding of how we unconsciously cope with complex sounds. Ernst Terhardt points out that although roughness is demonstrably related to our sensations of psychoacoustic consonance, our “sense for music intervals and harmony”—an extension of our sense for “[proportional] consonance”—is more difficult to relate to quantifiable acoustic correlates. He hypothesizes, however, that our ability to divine a virtual fundamental implies that our predisposition to harmonic frequency proportions may help explain our sense for interval and harmony.47

Terhardt’s hypothesis recalls James Tenney’s assertion that, as discussed in chapter 1, the harmonic series is an ingrained referential structure.48 But the imprecision with which frequency proportions inherent to this structure are preserved when sounded by instruments as discrete pitches remains a problem—especially since each instrument realizes each pitch as a complex of additional overtones. Our tolerance for mistuned intervals and a distinction between harmonic sense and timbral quality go some distance toward addressing the issue. But the nature of what Murail refers to as our “charmingly imprecise faculties of perception” with regard to the harmonic series is worth considering in greater detail.49

3.4: Tone Representation

In two relatively recent essays, Robert Hasegawa draws a parallel between a

47 Ibid., 1063.

48 For a summary of some psychoacoustic research supporting Tenney’s assertion, see Thompson, “Intervals and Scales,” 112-113.

Riemannian notion—the physical reality of sound is not necessarily equivalent to our evaluation of its musical significance—and Tenney’s deferral to the harmonic series as an ingrained template central to our ability to “make sense of incoming auditory data” and perceive harmonic sense and timbral quality. This juxtaposition of theoretical perspectives is compelling—especially in the sense that intervals can be experienced as qualitative sonic phenomena with or without a direct awareness of an exact pitch distance. By bracketing out qualitative experience in this way, Hasegawa echoes Tenney by implicitly aligning chord quality and timbre as homologous manifestations of the same general percept. This implication also resonates with Wayne Slawson’s intriguing definition of “sound color” briefly discussed in chapter 1—and Alfred Cramer’s assertion that a “musical chord [...] is perceived at least partly as a single timbral unit, but its fusion is incomplete—its tones are perceptually separate.”

Hasegawa’s observation that in “music which rounds off microtonal just intervals to a semitone grid, it is necessary to accept larger degrees of tolerance than in music rounded to a quarter-tone grid,” attributes two important characteristics to our auditory cognition. First, there is some flexibility and agency in our perceptual response(s). Second, there are

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53 Hasegawa, “Tone Representation and Just Intervals,” 272.
boundaries on our perceptual abilities, but it is unclear what those boundaries are. On the one hand, it is unlikely that perceptible connections to the harmonic series will be expressed in music where pitches are rounded off according to a whole-tone, rather than semitone, grid. On the other, since equal temperament is the most common expression of pitch, rounding off to a microtonal grid may strain the capabilities, or tastes, of many listeners. Given such cognitive constraints, Hasegawa adapts the term “tone representation” (borrowed from Hugo Riemann) to reflect how listeners subconsciously reference the harmonic series to cognitively process the pitch content of a sonority, and suggests that accessing this ability “can function as a sort of listening ‘grammar.’”54 The possibility that tone representation may serve as a listening “grammar” is analytically provocative and sets Hasegawa’s work apart from the theorists mentioned above who express similar perspectives on timbral-harmonic perception.

**3.4.1: Mistuning, Tolerance, and Preference Rules**

Although Hasegawa grounds much of his analytical approach in the ideas of Tenney, he notes that:

> “Tenney does not define what the tolerance range of a just interval might be, but he notes that the degree of tolerance tends to ‘vary inversely with the ratio complexity of the interval’; that is, simple intervals such as octaves and fifths are more likely to be recognized in spite of mistunings, while complex relationships, such as the 19:24 major third, are likely to lose their identity if mistuned by a comparable amount.”55

Such speculation seems to place tone representation on shaky conceptual ground. Elsewhere, however, Hasegawa alludes to psychoacoustic research and, although he does not refer to specific psychoacoustic resources, his tone suggests that other scholars have established

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55 Ibid., 267.
concrete foundations for his reasoning. For example, Olli Väisälä—a scholar whose work explores a similar analytical approach to post-tonal sonorities—draws on specific psychoacoustic research in his assertion that “since virtual pitch [i.e., virtual fundamental] perception allows mistunings of harmonics up to at least a quarter-tone, the musical relevance of this phenomenon is in no way negated by the use of equal temperament.”

Hasegawa—not alone among scholars who evoke the harmonic series as a referential structure—effectively bypasses concerns about listeners’ tolerance range. By claiming our deep-rooted ability to evaluate the gestalt quality of a sonority in light of the harmonic series despite a significant amount of mistuning, he is able to focus on emergent qualitative perceptions and relate these to somewhat quantifiable aspects of the sonority’s structure. The practicality of his first preference rule— “Prefer interpretations in which the referential just intervals correspond as closely as possible to the actual intonation of the music”—is immediately apparent. The closer the pitches are to the “referential just intervals” the easier it will be to hear the chord as a fused “representation” of the virtual fundamental proposed by the analysis.

Hasegawa’s second preference rule, based on a subtler consideration, directs analysts

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toward the “simplest possible interpretation of a pitch collection”—in the sense that the pitches of the chord correspond to the simplest possible referential just intervals. “Simple intervals,” he writes, “have low integers in their frequency ratios when reduced [mathematically speaking] to lowest terms.” He additionally stipulates that—with regard to interpreting the tone representation of a pitch collection in the simplest way—the “presence of the fundamental (or one of its octave transpositions) tends to considerably strengthen the plausibility of a tone representation.”58 In chapter 1, I drew on this perspective to categorize overtones into overtone-classes—a structural feature that, as I will demonstrate analytically in later chapters, can streamline and facilitate qualitative comparisons between timbre-harmonies in some contexts.59

Hasegawa's final preference rule stipulates that in the interpretation of complex sonorities one should “use the smallest possible number of fundamentals” and “invoke multiple fundamentals only if they yield a significantly simpler interpretation than is possible with a single fundamental.”60 He derives this preference rule from the work of Albert Bregman, who posits the existence of an implicit “scene-analysis mechanism that is trying to group the partials into families of harmonics that are each based on a common fundamental.”61 One can imagine this mechanism supports our nearly automatic ability to hear more than one sound simultaneously and cognitively collate the morass of resultant partials appropriately. Since the complexity of this cognitive process is likely to increase in

58 Ibid., 357.
59 Hasegawa, “Tone Representation and Just Intervals,” 268.
61 Albert Bregman, Auditory Scene Analysis (Cambridge: MIT Press, 1990), 221.
relation to the number of sound sources, Hasegawa's third preference rule privileges the simplest possible interpretation of those pitch collections that cannot be characterized according to the referential just intervals of a single harmonic series.

3.4.2: Tone Representation and Analysis

Hasegawa provides an elegant demonstration of tone representation by applying it to a series of seven pitch collections of increasing cardinalities from mm. 11-19 of Ligeti's *Melodien*. His interpretation of these pitch collections reveals an intriguing virtual bass line in which “the shift in fundamentals from B to G mimics the shift from A to F at the beginning of the passage”—an observation that suggests coherence other than that revealed through analytical approaches that primarily address transformations in pitch space.  

Figure 3.1: Pitch collections from mm. 11-19 of Ligeti's *Melodien* interpreted as a series of “tone representations” (from Hasegawa 2006)

[Image of musical notation]

Capital letters in fig. 3.1 show the pitch class of the virtual fundamental each collection “represents.” Numbers indicate the correspondence between individual pitches and overtones from harmonic series built on these fundamentals. Note that the addition of an F# in measure 16 and a D in measure 19 each create situations in which two interpretations are similarly plausible. Although an interpretation of the virtual fundamental of the pitch

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62 Hasegawa, "Tone Representation and Just Intervals," 272.

63 Ibid., 271.
collection in measure 16 as B is simpler (i.e., pitches correspond to lower overtones in the harmonic series), an interpretation of the virtual fundamental as F includes an octave transposition of the fundamental—mitigating factors both included under Hasegawa's second preference rule. Since, in both instances, one interpretation aligns with the interpretation of the previous collection while the other aligns with the interpretation of the collection that follows, the ambiguity can be conceived as transitional. Moreover, the entrance of the first whiff of a B fundamental just before the inclusion of this pitch class, and again the first hint of a G fundamental just prior to the first G in the excerpt, supports such a transitional interpretation.

Hasegawa's analysis demonstrates that tone representation can analyze passages like the first 19 measures of Melodien as manifesting a series of shifting virtual fundamentals. Although the virtual bass line is not explicitly audible, it provides a guideline for listeners to organize implicit sensations evoked by pitch collections according to progressions of timbre-harmonies. Furthermore, such a guideline contributes to a deeper sense of timbral-harmonic progression by suggesting a holistic listening strategy that amplifies the salience of timbral/harmonic contrasts that, in turn, shape one’s experience of continuity in the excerpt.

Hasegawa's analysis of Melodien is a rather tidy analytical application of tone representation and one is left wondering how well the theory will apply to pitch collections that resist characterization according to an acceptably small number of fundamentals. Hasegawa writes that “In the bars following m. 19, Ligeti continues to add pitches more rapidly; our analysis can keep up with only a few more additions before the density of pitches overwhelms our capacity to discern a clear harmonic structure” and suggests that beyond “this point, a motivic or transformational analysis [...] could better describe the music's
progress.”

One can sense in these statements an implicit disconnect between the perceptually-oriented notion of a listener's “capacity to discern a clear harmonic structure” and the more arcane analytical goal of providing “better descri[ptions] of the music's progress.”

The issue of the “music’s progress” deserves special attention in light of Hasegawa’s work. For some scholars of spectral music, an emergent sense of progression is situated within a broader conception of process. Damien Pousset, for example, downplays the significance of discrete vertical structures in spectral music by characterizing “process” as “the unavoidable archetype of spectral organization” and observing that “the notion of process implies that of a path and especially of a temporal path.”

While process is certainly a component of a spectral aesthetic, broadly considered, Hasegawa’s work suggests that one can a) conceive of discrete timbre-harmonies in relation to the harmonic series, b) draw on knowledge of psychoacoustic tendencies to suggest correlations between the structure of each timbre-harmony and its more ephemeral holistic qualities, and, most importantly, c) compare and contrast discrete timbre-harmonies according to these holistic qualities.

3.5: “Forces”

Over the course of the preceding surveys of compositional and theoretical engagement with conflations of timbre and harmony, a broad analytical perspective, reminiscent of Grisey’s bodily analogies for our experiences of musical time, has come into

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64 Ibid., 272.

focus. Grisey characterizes duration as the “skeleton of time,” how pre-audibility shapes the experience of musical time as the “flesh,” and the more ineffable aspects of listeners’ experience of musical time as the “skin.”66 One could graft Grisey’s metaphor onto the timbral-harmonic domain and characterize harmonic sense (i.e., the quantifiable aspects of timbral-harmonic structure) as the “skeleton” of timbre-harmony, sensations of relative tension that create their own pre-audible expectations (i.e., a strong implication of eventual resolution) as the “flesh,” and emergent perceptions of timbre as the “skin.”

As mentioned at the beginning of this chapter, parameterization (in the sense of the independence of different musical domains) is phenomenologically problematic. Nevertheless, parameterization is a useful fiction that can facilitate composers’ efforts to shape holistic effects in their music. Anatomically speaking, a focus on any single body part is certainly enlightening but is nevertheless deeply connected to its role within the body as a whole. In this sense, Grisey’s bodily metaphor is particularly apt considering the nature of spectral music.

In light of this nature, it is worth briefly revisiting the notion of “forces” as expressed by Murail and Grisey. As discussed at the beginning of this chapter, both composers characterize sound as comprised of “forces” that are independent in some sense, but whose interactions contribute to the emergence of larger gestalt qualities. An emphasis on partials and spectra in discussions of spectral music—especially those focused on narratives of compositional process—might lead one to assume that “force” is yet another synonym for overtone, or partial. Granted, the term “force” suggests a temporal trajectory for an

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overtone—a shade of meaning reflected in Murail’s assertion that each force “pursu[es] its own evolution.” But, given both composers’ emphasis on the gestalt qualities that emerge from interactions of forces, a more nuanced definition of force would include not only the overtone, but also its influence on the emergent quality of the overall sound as it “evolves.”

I will use this broad concept of force as a guide in three analytical chapters that make up the second part of this project. In these chapters, I will revisit works discussed in chapter 2, and consider additional works not yet mentioned. By applying the analytical tools and concepts developed in the first part of this project, I will demonstrate how timbral-harmonic forces affect our experience of spectral music.

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68 cf. Gilles Deleuze, *Francis Bacon: The Logic of Sensation*, trans. Daniel W. Smith (London: Continuum, 2003), 56-64. “In art, and in painting as in music, it is not a matter of reproducing or inventing forms, but of capturing forces.” Thanks to Robert Hasegawa for suggesting this as a possible source of spectral composers’ conception of “forces.”
CHAPTER 4:
TIMBRAL-HARMONIC ANALYSIS I – INHARMONICITY

4.1: Introduction

In the first part of this project, I developed a method for using the harmonic series as an analytical referent, discussed how the conflation of timbre and harmony is a recurring theme of spectral music, and considered timbral-harmonic conflation from more speculative perspectives. In the second part of this project, I will apply these concepts analytically to specific spectral works. I will revisit Désintégrations, “Partiels,” “Papillon I,” and Mortuos plango, vivos voco and develop a more detailed account of the timbral-harmonic forces that shape listeners’ experience of them. In order to show that this analytical stance is applicable to a broader sampling of spectral music, I will also discuss spectral compositions not yet mentioned in this project—Claude Vivier’s Lonely Child, and Magnus Lindberg’s orchestral trilogy Kinetics, Marea, and Joy.

All these pieces fall in two broad categories: those that feature homophonic progressions of discrete timbre-harmonies, and those that feature polyphonic textures whose coherence is rooted in timbral-harmonic conflation. In Chapter 6, I will discuss such coherence as an affordance of timbral-harmonic forces in “Papillon I,” Mortuos plango, vivos voco, and the Lindberg trilogy. In chapters 4 and 5, I will explore productive ways of hearing progressions of discrete timbre-harmonies in Désintégrations, “Partiels,” and Lonely Child. In chapter 5, I will provide a timbral-harmonic account of an excerpt from Lonely Child that consists of complexes of overtones that form a progression of timbre-harmonies. I will show how ten unique timbre-harmonies, each with a different fundamental, express different shades of harmonicity, and that these shades affect how we hear timbral progression in the excerpt.
In this chapter, I will discuss excerpts from *Désintégrations* and “Partiels” that feature progressions of discrete timbre-harmonies different from those of *Lonely Child* in two important ways. They include inharmonic partials that disrupt *harmonicity*, and these expressions of *inharmonicity* are set against the backdrop of a prevailing fundamental. I will propose a measure of inharmonicity that will permit me to analyze tension and relaxation as formative forces in these passages. Given the focus on overtones as analytical referents in this project, it may seem odd that I am beginning with analyses focused on the timbral contributions of inharmonic partials. But recall from chapter 1 that, in my experiment with constructing timbres out of sine tones, I was able to appreciate the timbral contributions of overtones most through their absence. Similarly, the different shades of harmonicity as expressed by complexes of overtones are perhaps easiest to appreciate first through how the overtones maintain a prevailing harmonicity despite the influence of inharmonic partials. As a prelude to such accounts of the excerpts, let us revisit section I of *Désintégrations* and consider in more detail how two prevailing harmonicities blend into a bell-like timbre-harmony comprised of both overtones and inharmonic partials.¹

### 4.1.1: *Désintégrations*, Section I

In my analysis of this section at the end of chapter 2, I highlighted a gap worth

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¹ I will be discussing two excerpts from *Désintégrations* in this chapter—section I, which I previously referred to as the opening, and section VIII. These are Murail’s labels and seem to reflect the ambiguous role of each section in the work’s episodic structure. Tristan Murail, "Villeneuve-lès-Avignon Conferences, Centre Acanthes, 9-11 and 13 July 1992," trans. Aaron Berkowitz and Joshua Fineberg, *Contemporary Music Review* 24, no. 2/3 (2005): 211-232; Anthony Cornicello, “Timbral Organization in Tristan Murail’s *Désintégrations*” (PhD diss., Brandeis University, 2000), *passim*. 
exploring in more detail. I described a timbral basis for understanding timbre-harmonies in section I, but I have yet to account for the compositional logic and formative function of Murail’s dynamic markings, which are shown under the timbre harmonies in figure 2.2 (ch. 2, p. 45). Although it is tempting to assume that they contribute to timbral processes, they seem to have primarily a rhythmic effect.

Figure 4.1: Dynamic curves from the opening of *Désintégrations*

![Dynamic curves from the opening of *Désintégrations*](image)

Figure 4.1 shows how each of the two series of chords creates a dynamic wave, and that the contours of the two waves strongly covary. The waves, along with the rallentando curves discussed in chapter 2 (see fig. 2.4, pg. 54), converge on the simultaneous onset of the final timbre-harmony in both series. Together, these processes of duration and intensity afford the emergence of a broad push toward the same endpoint. The nature of this push is, almost paradoxically, enriched by the sense of gradual slowing that emerges from section I’s
rallentando curves: the listener expects that the next event will not happen quite as soon as its predecessor did, but also that it will nevertheless happen eventually. The overall effect resembles, if you will, how rivers slow into deltas on their way to the sea.

The timbral-harmonic forces contributing to this momentum are more difficult to pin down. The different timbres of the A#0 and C#2 sonorities blend into a more-or-less unified tintinnabulous timbre at the final, simultaneous onset—a moment of synthesis. But it is unclear whether there is a timbral-harmonic process pointing to this goal. As discussed in chapter 2, the overtone content of timbre-harmonies in the excerpt varies within boundaries defined by piano-derived formantic zones. When heard in succession, such diverse overtone content evokes sensations of kaleidoscopic timbral shifts that erode aural distinctions between the series as independent streams.

Nevertheless, if we represent this beautiful chaos as collections of overtone classes, as discussed in chapter 1, we can appreciate how the diverse gestalt timbres expressed by the discrete chords participate in a temporally directed process. To review: overtones related by powers of two are treated as members of the same overtone class, and also belong to the same pitch class. For example, the 3\textsuperscript{rd} overtone of a C2 harmonic series (C2*3) is G3, C2*6 is G4, C2*12 is G5, C2*24 is G6, and so on. Thus, every member of the overtone collection C2*[3, 6, 12, 24] manifests the same overtone class—C2*3. Each of them expresses “C2*3-ness,” but C2*3—the prime of this overtone class—expresses this quality most saliently. Overtone classes affect timbre in different ways. Overtones in lower, more “resolved” overtone classes contribute more to a unifying harmonic sense than overtones of higher, more “unresolved” classes, whose contribution is felt more as an influence on emergent timbre.

With this in mind, let us reconsider the overtone content of timbre-harmonies from
the opening of *Désintégrations*. Each column of table 4.1 represents the overtone collection of a timbre-harmony in the A#0 series (see fig. 2.2, p. 45) as a collection of overtone classes. Similarly, each column of table 4.2 represents the overtone collection of a timbre-harmony in the C#2 series as a collection of overtone classes. A black box in these tables signifies the presence of the prime itself (e.g., F#7 is the prime of F#7). The lighter-shaded boxes with integers denote overtone classes that are represented by higher, non-prime overtones corresponding to those integers. The further removed from the prime overtone, the lighter the box. For example, the “4” in the lightest box of the circled portion of table 4.1 corresponds to A#0*4—an overtone two powers of two removed from lowest member of A#0*1.

Table 4.1: Overtone class content of the A#0 series of timbre-harmonies from the opening of *Désintégrations*
Table 4.2: Overtone class content of the C#2 series of timbre-harmonies from the opening of Désintégrations

<table>
<thead>
<tr>
<th>Overtone class</th>
<th>21</th>
<th>19</th>
<th>17</th>
<th>15</th>
<th>13</th>
<th>11</th>
<th>9</th>
<th>7</th>
<th>5</th>
<th>3</th>
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</tr>
</tbody>
</table>

The completely black row labeled 7 in table 4.1 indicates that A#0*7 is present in every timbre-harmony in the A#0 series. The mostly black rows labeled 11 and 13 indicate that A#0*11 is present in all but three (one of which has a representative A#0*22 of overtone class A#0*11), and A#0*13 is present in all but one. These primes establish a core group of overtone classes—A#0*(7, 11, 13)—for the series.

The C#2 series (table 4.2) also features overtone classes 7, 11, and 13, but the prevalence of C#2*(5, 9), along with secondary emphases on C#2*15 and a weakened C#2*3, creates a larger and richer core group of overtone classes: C#2*(3, 5, 7, 9, 11, 13, 15). This richer nucleation with lower overtone classes helps explains why I consistently hear each timbre-harmony of the C#2 series as more fused than its adjacent timbre-harmonies from the A#0 series.

The core groups of overtone classes in the A#0 and C#2 series anchor the more ephemeral effects of overtone classes outside these groups, but do not themselves afford a
sense of progression. Instead, the stability of these core groups—which emerges from the ubiquity of certain overtone classes in each series—engenders an experience of two layers of effervescently diverse, yet non-progressive, timbral-harmonic stasis. However, at the end of both series, a progression can be heard, as shown by the circled cells in the tables. $F^*l$ becomes increasingly strong, starting with $F^*4$ then changing to $F^*2$, and finally, in the last timbre-harmony, $F^*1$ is presented explicitly. As discussed in chapter 2, Murail chose fundamentals for both series to approximate a spectral feature characteristic of western bell sounds—an inharmonic partial roughly a minor tenth above the fundamental. The progression solidifies this interval between their respective fundamentals in that they become more overt.

Since this interval is strongly associated with a bell-like timbre, its increasing salience amplifies the emergent tintinnabulous quality subtly expressed in the overlapping envelopes of previous timbre-harmonies. This amplification foreshadows the eventual timbral-harmonic blend of both series—an event that coincides with, and bolsters the sense of arrival at, the endpoint projected by processes of duration and intensity. Timbre’s emergence as a shaping force is delayed and contributes—despite the backpedaling effect of the progressively increasing durations of the rallentando curves—to an increasing sense of goal-directed urgency near the end of the opening gesture. What was initially a two-layered background sheen of effervescent, but unordered, timbre-harmonies coalesces into a timbral-harmonic

\[ \text{\textsuperscript{2} cf., Murail, "Villeneuve,” 214. Murail describes a move toward the fundamental as “progressive enrichment,” but does not fully unpack how a correlated sense of directed timbral-harmonic progression emerges at the end of each series.} \]
process that, in coordination with processes of duration and intensity, affords a sense of arrival at a moment of timbral-harmonic synthesis.

**4.2: “Partiels,” Opening Section**

Timbre’s role in section I of *Désintégrations* is secondary, but in other music timbre can emerge as a primary structuring agent. A good example is the opening section of Grisey’s “Partiels” (up to rehearsal number 12 in the score), in which a directed timbral-harmonic process is the engine that drives its overall effect. This process, though not alone in expressing the opening section’s dramatic arc, causes its otherwise disconnected gestures to cohere as a formal unit.

François Rose provides a compelling analytical account of this process by tracking “downward octave shifting” of overtones over the course of eleven varied restatements of the opening gesture. Essentially, harmonic partials are progressively transposed downward by octaves until they no longer reflect an integer multiple of the fundamental and become inharmonic. For example, when lowered by an octave, F*11—the prime of F*11—becomes an inharmonic partial whose frequency is 5.5 times that of the fundamental.

Rose’s account of the 11-chord progression makes it seem like the increasing number of inharmonic partials is a smooth process, but he overlooks two important factors. Some inharmonic partials affect timbre more than others. Also, given our tolerance for imprecise

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3 François Rose, “Introduction to the Pitch Organization of French Spectral Music,” *Perspectives of New Music* 34/2 (1996): 9. This downward octave shifting is similar to the successive downward octave shifts at the end of both series of timbre-harmonies in *Désintégrations*, as discussed above, that eventually settle on the fundamental. As we will see, however, Grisey’s downward octave shifts produce inharmonic partials because they do not stop at the primes of overtone classes.
translations of frequencies into pitches, theoretically inharmonic partials that approximate integer multiples of the fundamental can be heard as mistunings of overtones rather than inharmonic disturbances of a globally expressed harmonicity. In this case, the hearing can vary according to which pitch we hear as fundamental. For example, Rose identifies a D6 in the third timbre-harmony as the first introduction of an inharmonic partial, analyzing it as a downward octave displacement of a very distant E1*57.4 But I interpret the same pitch as a slightly mistuned E2*14, a relatively strong member of the indubitably harmonic overtone class E2*7. In my account, then, the third chord in the progression does not yet have inharmonicity.

Rose’s identification of E1 as the fundamental rather than E2 is problematic.5 Joshua Fineberg, a few years after Rose, clarified the issue.

“…the low bass which seems to be presenting the fundamental along with the trombone is, in fact, an octave too low. However, this note is in that octave for separate formal (the lower octave E1 has a pivotal role in the entire Les Espaces Acoustiques cycle of which “Partiels” is one part) and gestural reasons […] This note’s separation from the other pitches of the instrumental synthesis is reflected in its exclusion from the composer’s annotations of partial rankings for each of the other pitches.”6

The bass’s aggressive articulation of E1 during the attack phase of each gesture separates it from the prolonged varying blend of more stable sounds in the ensuing sustain and decay phases. Such a salient distinction between phases in each gesture resonates with Grisey’s celebration of the “hypnotic power of slowness,” and suggests that each gesture is a temporal

4 Ibid., 9-10.
5 Ibid., 8. Rose’s analysis took shape when access to spectral music resources was more limited. In light of this, my discussion should be taken more as update than critique.
magnification of briefer sonic events. These temporal zooms allow listeners ample time to perceive the gradual entrance of atomistic pitches that become like overtones as they fuse into the larger timbre-harmony, appreciate both their independence and their timbral contribution, and experience them as the seeds of timbral-harmonic forces that, in coordination, shape our holistic emergent perceptions.

Hasegawa’s second preference rule—prefer the “simplest possible interpretation of a pitch collection”—suggests a more straightforward consideration that further favors E2 over E1 as fundamental. Since Rose relates overtones to an E1 fundamental, they have correspondingly high overtone ranks. For example, Rose’s E1*22 is my E2*11, which is half as far from the fundamental and a stronger expression of $F^{*11}$-ness. Since overtones related by powers of two are members of the same class, one might assume discrepancies between octave-related fundamentals—a single power of two, frequentially speaking—are of limited functional significance. But, as I will show, an analysis which stems from an E2 fundamental leads to a different account of the opening process of “Partiels” than an analysis that stems

7 Gérard Grisey, “Did You Say Spectral?,” *Contemporary Music Review* 19/3 (2000): 2. As an example of such temporal magnification, let us consider the bass’s E1s in light of Grisey’s derivation of the opening gesture of “Partiels.” Since the spectral content of a trombone sound was Grisey’s model, it seems appropriate to hear the bass notes as functioning according to this model despite being somewhat incongruous. I hear the roughly periodic and aggressive attacks on an incongruent pitch in the bass as, spectrally, an attack transient—a manifestation, albeit much more slowly, of the rapid periodicity of the characteristic “buzz” of performers’ lips just prior to the emergence of a discernible pitch on a trombone.

from an E1 fundamental.

### 4.2.1: A Two-Stage Timbral-Harmonic Process

Taking into account both of these factors leads me to hear the 11-chord progression as uneven and composed of two distinct stages. Figure 4.2 shows the first of these stages as a progression between exclusively harmonic timbre-harmonies. The integer above each pitch indexes its overtone rank within an E2 harmonic series (following Fineberg, I exclude the prominent E1). The overtone class content of each timbre-harmony is summarized to the right of each staff. Open noteheads denote pitches I hear as mistunings of the indicated overtones. Overall, the figure can be read to express how the first stage features diverse expressions of timbre subordinate to a prevailing harmonicity—an experience reminiscent of qualitative shifts between harmonic timbre-harmonies in the opening of *Désintégrations*.

However, the progression is not static. For instance, the change $\begin{equation} \begin{array}{c} 1 \end{array} \end{equation} \Rightarrow \begin{equation} \begin{array}{c} 2 \end{array} \end{equation}$ from the first to the second timbre-harmony after the opening adds more members of three overtone classes, $E2^*(1, 3, 9)$,

- $E2^[1, 4, 8] \Rightarrow E2^[1, 2, 4, 16]$,
- $E2^[3] \Rightarrow E2^[3, 6]$, and
- $E2^[9] \Rightarrow E2^[9, 18]$,

and $E2^*23$ disappears. The next step, $\begin{equation} \begin{array}{c} 2 \end{array} \end{equation} \Rightarrow \begin{equation} \begin{array}{c} 3 \end{array} \end{equation}$, weakens the representation of $E2^*3$ by removing $E2^*6$, but it strengthens $E2^*7$ by adding $E2^*14$. So, each step in the progression introduces different degrees and qualities of change.
The sense of continuation evoked by progressions between such similar structures falls short of the continuity implied in Rose’s account. I do not hear the diverse, but similarly harmonic, timbres of the first stage as ordered along some salient perceptual dimension. In contrast, the gradual introduction starting from timbre-harmony of inharmonic partials (i.e., those I no longer hear as mistunings of overtones) does provide a basis for such hierarchical comparisons. As shown in figure 4.3, this procedure constitutes a distinct second stage of the overall process. The notation of this figure is that of figure 4.2 with the addition of exclamation points to highlight inharmonic partials. The numbers above these partials are
non-integer multiples that relate them to the prevailing E2 fundamental established in the first stage. Open noteheads without exclamation points continue to denote mistunings.

Figure 4.3: Spectral content of timbre-harmonies from the second stage of the opening section of “Partiels”

Rose’s characterization of increasing inharmonicity is more evident during this second stage. The number of overtone classes in each timbre-harmony—contributors to harmonicity—progressively decreases while the number of inharmonic partials in each timbre-harmony increases. However, I do not perceive the increase as proceeding linearly,

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9 My hearing is anchored to an E2 fundamental throughout the opening process because of its establishment in
in equal steps; the path traversed between these timbral-harmonic states sounds more complicated. Interonset durations between timbral-harmonic gestures are more or less equal, but increases in inharmonicity between successive timbre-harmonies are not.

Compare, for example, the G#3 in timbre-harmony 7 with the B♭2 of timbre-harmony 8. Though inharmonic, these partials do not disturb harmonicity to the same extent. G#3 disturbs less than B♭2 because of their different relation to the prevailing E2 fundamental of the opening section. If they were overtones, we could (as we have above) compare their contributions to timbre according to their distances from the primes of their overtone classes, considering also the relative “resolution” of those classes. But describing the timbral contributions of inharmonic partials is more complicated because their relationships to the fundamentals they disrupt are less direct. I will assume that the special power-of-two aural relationship that allows us to hear similarities among overtones of a class is also relevant to how we hear the various disruptive effects of inharmonic partials.

Accordingly, to characterize the timbral contribution of an inharmonic partial, I propose that we consider how many powers of two it is from the lowest possible overtone.

the first stage. As a result, the analysis I present in this section prioritizes how inharmonic partials disrupt this fundamental. However, one could also depart from this foundation, and interpret the second stage as shifting the fundamental rather than introducing inharmonic partials. For example, the E2*[2.5, 3.5, 8.5] in timbre-harmony 7 could instead be overtones of a fundamental one octave lower: E1*[5, 7, 17]. The remaining overtones of timbre-harmony 7 would then be the next highest member of their overtone class (e.g., E2*[7, 9] => E1*[14, 18]). Such an analysis would reflect a hearing of the opening section as reaching ever higher into the harmonic series of ever lower fundamentals instead of as a progression toward inharmonicity realized as the gradual dissolution of the memorably gleaming harmonicity of the opening gesture.
With regard to the partials from above, for example,

\[ G\#3 \approx E2^{*}2.5 \] is a single power of two from \( E2^{*}5 \), because 5 is 2 times 2.5, and

\[ Bb2 \approx E2^{*}1.44 \] is four powers of two from \( E2^{*}23 \), because 23 is 1.44 times 16.

In overtone class terms, \( G\#3 \) is only one octave from a harmonic (i.e., one power of two away from \( E2^{*}5 \)), and is thus closer to a harmonic than \( Bb2 \), which is four octaves removed from its nearest power-of-two related overtone.\(^{10}\)

This description of inharmonic partials comports with Rose’s analysis of them as “downward octave shifts” (hereafter “DOSs”) of prime overtones, and links them, through that prime’s class, to the fundamental they disrupt.\(^{11}\) Members of an overtone class, as discussed in chapter 1, are instances of a type of timbral contribution. The special power-of-two aural relationship that ties an inharmonic partial to an overtone class also ties its disruptive effect to the type of timbral contribution associated with that class. In other words, the things being “disrupted” by an inharmonic partial are, specifically, the timbral contributions attributable to overtones of the nearest class in power-of-two terms.

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\(^{10}\) The inharmonicity of these partials is qualitatively different. While the notion that \( G\#3 \)—one DOS from \( E2^{*}5 \)—is audibly related to an E2 fundamental in this way makes intuitive sense, the much more distant relationship of \( Bb2 \)—four DOSs from \( E2^{*}23 \)—to the E2 fundamental that anchors the opening is questionable. Out of context, such a distant derivation is so abstract that the nature of the inharmonicity expressed by \( G\#3 \) and \( Bb2 \) are probably incomparable because it would be nearly impossible to perceive such a link in the latter case. In the context of the opening section of “Partiels,” however, such abstract descriptions of inharmonic partials allow us to consider how inharmonic partials specifically erode the strong foundation provided in the first stage.

Table 4.3: Frequency proportions produced by dividing $F^*(1\text{-}31)$’s primes by powers of 2

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<td>0.78</td>
<td>0.84</td>
<td>0.91</td>
<td>0.97</td>
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</table>

A summary of the inharmonic partials available by downward octave shifting of harmonics is offered in table 4.3, which shows the frequency proportions that result from up to five power-of-two divisions of the primes of $F^*(1\text{-}31)$. In the cell at the intersection of each column and row is the non-integer multiple (rounded to the nearest hundredth) that results from dividing the overtone labeling that column by the power of two labeling that row. The circled cells are the frequency proportions of the two inharmonic partials from timbre-harmonies 7 and 8—G♯3 and B♭2—discussed above.

Cells shaded light grey denote inharmonic partials below the fundamental. These are partials in the sense that they are component frequencies, but considering them as such seems odd since one assumes the fundamental is the lowest frequency in sounds that express a discernible pitch. But, in the context of the opening section of “Partiels,” wherein a prevailing fundamental is established and then increasingly disrupted, each partial’s contribution arises from its proportional relationship to this reference frequency. Thus, the \{A1, B1, C2, C#2\} of timbre-harmonies 10 and 11 (see fig. 4.7) may be heard as E2*[.66, .75, .78, .84] despite being lower than the fundamental to which they are linked.

In “Partiels,” the effects of DOSs between successive timbre-harmonies resemble, at times, those of common tones in tonal voice leading. For example, three new inharmonic partials emerge in timbre-harmony 7: \{G♯3, D4, F5\} ≈ E2*[2.5, 3.5, 8.5]. Each of these
partials is a single DOS removed from its respective nearest prime. In other words, their nearest overtone counterparts are one octave higher. As shown by the red arrows in figure 4.3, these primes are present in timbre-harmony $\text{G\#4 (E2*5), D5 (a slight mistuning of E2*7), and F6 (E2*17).}$ The juxtaposition of G#4 and D5 with their DOS cousins in timbre-harmony softens the already subtle distinction between timbre-harmonies and and reinforces the experience of their difference as relatively small. Such “common tone” connections maintain the E2 harmonic series as a consistently discernible, timbral-harmonic referent even as the inharmonicity increases.

4.2.2: Inharmonicity Value

A link between inharmonic partials and overtone classes via DOSs suggests useful dimensions of comparison. Although it does not explain how inharmonic partials arise, a conception of inharmonic partials in DOS terms provides a means of approximating a proportional link between an inharmonic partials and overtones. According to this approximate proportional link, the relative inharmonicity of inharmonic partials can be evaluated in light of their relation to a prevailing fundamental via their relations to its overtone classes. Inharmonic partials linked to overtone classes with primes more distant from the fundamental, hence more “unresolved,” have a commensurately more distant indirect relationship to the fundamental and disrupt overall harmonicity to a greater degree. But such a straightforward comparison does not map onto my experience of inharmonicity in the opening process of “Partiels” until modulated by a conception of inharmonic partials according to their distance—conceived as a number of DOSs—from their nearest overtones. Partials that are fewer DOSs removed from the primes of their parent overtone classes have a less disruptive effect on harmonicity because they express frequency proportions that are

143
closer—again, in DOS terms—to harmonic.

Multiplying these dimensions for a given inharmonic partial— (the integer denoting the prime of the overtone class to which the partial is related by integer multiple) * (number of DOSs necessary to change the partial into that prime)—produces a number that I will call its inharmonicity value (hereafter “InV”) with respect to a given fundamental. InV is a rough measure of the disruptive effect on harmonicity exerted by an approximated inharmonic partial. The InV of G#3 with respect to the fundamental E2 is 5 (the integer multiple of the nearest overtone prime in terms of DOS, which also indicates overtone class) times 1 (the number of DOSs it takes to change the prime of that class into G#3), which equals 5. The InV of B♭2 with respect to the fundamental E2 is 23 (overtone class) times 4 (DOSs), which equals 92.

12 Inharmonicity Value is similar to James Tenney’s notion of “harmonic distance” in that both explain inharmonic partials in terms of the harmonic series. However, Tenney arranges just intervals (i.e., pitch analogues for harmonic frequency proportions) into multidimensional lattices that allow for relationships other than powers of two to come into play [James Tenney, “John Cage and the Theory of Harmony,” in From Scratch: Writings in Music Theory, ed. Larry Polansky, Lauren Pratt, Robert Wannamaker, and Michael Winter (Urbana: University of Illinois Press, 2015) 294-300]. Similarly, Clarence Barlow’s “harmonicity” measure reflects a difference between overtones that are odd-numbered and prime, as in F*23, and overtones that odd-numbered and products of simpler primes, as in F*25 = F*(5*5) [Clarence Barlow, “Two Essays on Theory,” Computer Music Journal 11 (1987): 44-55]. The correspondence between octave relations in pitch space and frequencies related by powers of two is unusually robust. My acceptance of powers of two as an analytical guide in this project, and rejection of others (e.g., powers of three) reflects this strong pitch/frequency parallel.

13 Since the pitches-cum-overtones of “Partiels” include sixth-tones as notated, I assume this as a mistuning limit. E2*23 is slightly less than a sixth-tone above B♭6 [E2 = 82.407Hz, E2*23 = 1895.361Hz = (B♭6 + 28c)].
Table 4.4 shows the InVs of the partials that express the frequency proportions shown in table 4.3. The divisors on the left side of table 4.3 (2, 4, 8, 16, 32) are translated into DOS terms according to the powers of two that produce them in table 4.4. For example, 16 = 2^4 so 16 corresponds to 4 DOSs. The cells at the intersection of each column and row, as products of DOS and overtone class, are the InVs of specific inharmonic partials. As in table 4.3, the circled cells are the InVs of the G#3 and B♭2 we are using as recurrent examples.

Table 4.4: InV produced by DOSs of F*(I-31)’s primes

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InV is a facile measurement of such a nebulous emergent quality, but it enables a quantifiable, two-dimensional comparison between approximated inharmonic partials. Even if we are unsure what InV means in absolute terms, we get some sense of its meaning when comparing the InVs of inharmonic partials. G#3 (E₂*2.5) is a single DOS from E₂*5, while B♭2 (E₂*1.44) is four DOSs from E₂*23. These differences are quite pronounced (E₂*5 < E₂*23, 1 < 4) and the InV quotient of these partials—(23*4)/(5*1) = 92/5 = 18.4—is quite large. In other words, B♭2 is 18.4 times more inharmonic than G#3 with regard to the fundamental E₂.

In contrast E₂*11 is close to B♭5 [E₂*11 = 906.477Hz = (B♭5 – 49c)], but nearly a quarter-tone mistuned. With this mistuning limit as a guide, I chose to approximate a B♭2 inharmonic partial by linking it via DOSs to E₂*23, rather than E₂*11.
InV quotients are smaller when comparing inharmonic partials whose differences are less pronounced in terms of DOS and overtone class. For example, let us compare ≈F*1.38, an inharmonic partial approximated by three DOSs below the prime of F*11, with ≈F*3.25, an inharmonic partial approximated by two DOSs below from the prime of F*13. The difference between these two partials is much less pronounced in terms of overtone-class prime (F*11 < F*13) and DOS (3 > 2) than the G♯3 and B♭2 discussed above. Accordingly, their InV quotient is smaller—(11*3)/(13*2) = 33/26 ≈ 1.27. Also, unlike G♯3 and B♭2 in relation to an E2 fundamental, ≈F*1.38 and ≈F*3.75 are lesser and greater than each other in opposite dimensions. The higher InV for ≈F*1.38, despite its relation to a lower overtone class than ≈F*3.75, suggests that an additional DOS reflects a greater disruption of harmonicity than a corresponding single step between adjacent overtone classes.

Table 4.5: Calculating InV of timbre-harmony 8 from the opening section of “Partiels”

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<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

Adding together the InVs of inharmonic partials in a timbre-harmony—provided there are sufficient perceptual cues to establish a prevailing fundamental—produces a cumulative InV for the timbre-harmony as a whole. Since InV reflects one’s hearing of a given component of a timbre-harmony as a contribution to an overall gestalt identity, this means that even one particularly inharmonic partial can greatly affect a timbre-harmony’s total InV. Table 4.5 shows the basis for calculating the cumulative InV of timbre-harmony 8 from the opening section of “Partiels.” The dark grey boxes in the top row (the row that we
also use to label the overtone classes) highlight overtones present in timbre-harmony $E^2*[1, 3, 5, 7, 9, 11, 13, 19, 21]$. Dark grey boxes in other locations highlight the InVs of timbre-harmony $I_8$'s four inharmonic partials—$E^2*[\approx 1.44, \approx 3.5, \approx 4.75, \approx 7.5]$. The InVs of each of these inharmonic partials are 92, 7, 38, and 15, and these add up to an InV of 152 for timbre-harmony $I_8$. Repeating this procedure with each timbre-harmony in the second stage—the stage during which inharmonic partials are gradually introduced—provides a basis for considering how their progression contributes to the dramatic arc of the passage.

**4.2.3: Inharmonicity in the Second Stage**

For example, InV can serve as a rough comparative measure of timbral-harmonic tension in progressions whose timbre-harmonies contain enough inharmonic partials to make their emergent effects a formative concern. Figure 4.4 plots InVs for each timbre-harmony in the second stage over time. The curve described by these pillars shows a rather straightforward progression toward inharmonicity—an increasing disruption of the initially prevailing harmonicity that maps onto my hearing of this excerpt rather well. Specifically, the varying sizes of the steps in this climb reflect what I hear as its not-entirely-predictable nature.

The InV quotients (InVQ) of timbre-harmonies $I_6$ and $I_7$ (29/25 = 1.16) and $I_8$ and $I_9$ (213/152 = 1.4) are minimal when compared to the significantly greater InVQs of the pairs that follow ($I_7$ vs. $I_8$ = 5.24, $I_9$ vs. $I_{10}$ = 2.28). The dramatic increases in inharmonicity after timbre-harmonies $I_7$ and $I_9$ create local senses of notably large steps toward inharmonicity. Together, large and small steps toward inharmonicity create ebbing and flowing timbral-harmonic motion—an effect made especially salient in light of the more-or-less equal interonset duration between timbral-harmonic gestures.
In summary: the concepts I have just developed permit a more thoroughgoing and nuanced account of the opening section of “Partiels.” It consists of a roughly periodic sequence of 14 similar gestures that feature a harsh attack articulated by the bass, a gradual accumulation of pitches into a brief sustain phase, and a decay shaped by these pitches as they fade away (see fig. 2.1, p. 38). The opening gesture repeats three times before the opening process begins to unfold. The next five gestures activate timbre-harmonies that, like the opening timbre-harmony, are exclusively made up of overtones. These gestures atomize the relatively fused timbre established in the opening gesture but do not disrupt the prevailing fundamental (see fig. 4.2). A single inharmonic partial in the next gesture (timbre-harmony

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signals the beginning of a second, more directed stage—a series of increasingly inharmonic timbral-harmonic gestures (see fig. 4.3) whose unpredictable contour features juxtapositions of relatively minimal increases in inharmonicity with noticeably larger steps towards inharmonicity (see fig. 4.4). The timbral harmonic goal for the passage—a completely inharmonic timbre-harmony—marks the beginning of the next section of the work.

This account helps us appreciate how the relatively strident instrumental techniques that Grisey specifies—the irregular vibrato, increased bow pressure, and extreme sul ponticello that increasingly saturate the texture—amplify the inharmonicity expressed by timbre-harmonies in coordination with the overall progression toward inharmonicity. An irregular vibrato—introduced by the viola in timbre-harmony 4, continued by the viola in timbre-harmony 5, echoed by the horn in timbre-harmony 6, and expressed by both instruments in timbre-harmony 7—stands out as an orchestrational device that is particularly effective in this way. The viola’s unstable vibrato unsettles the already-imperfect harmonicity of timbre-harmonies 4 and 5—the end of the first stage—and foreshadows the entrance of inharmonic partials in the second stage. Continuation of such chaotic vibrato in timbre-harmonies 6 and 7—the beginning of the second stage—further supports elision of the stages and solidifies their roles as components of a larger timbral-harmonic process.

4.2.4: Tree Structures

To the extent that we associate harmonicity with stability and inharmonicity with instability or tension, we could characterize the second stage of the opening section of “Partiels,” just discussed, as a steady increase in timbral-harmonic tension. In progressions that do not realize such linear timbral-harmonic processes, it will be necessary to represent a
more varied trajectory of timbral-harmonic tension. To facilitate this, I have borrowed an analytical tool from Fred Lerdahl commonly known as “tree structures,” the most important aspects of which are summarized in figure 4.5.\textsuperscript{15} The lower end of each line segment represents a musical event. A right branching tree—one in which the second event is subsidiary to the first, such as in the top row of the figure—indicates a “tensing motion” from a more stable event to a less stable (i.e., more tense) event. A left branching tree—one in which the first event is subsidiary to the second, as on the bottom row—indicates a “relaxing” motion from a less stable event to a more stable (i.e., less tense) event.

Figure 4.5: “Tree Structures” (from Lerdahl 1987)

Three different types of connectors indicate the way in which events are related: an empty circle reflects repetition or recurrence, a filled circle reflects a move between transformationally-related structures, and the absence of a circle indicates a move between

unrelated structures. Although these progressions are classified in a systematic way, the hierarchy itself has a qualitative basis, as it represents differences in tension and stability that are based on temporal and dynamic cues (e.g., one event is in a stronger metrical position, one event is played louder than the other, etc.).

The question of how to conceive of middleground hierarchies is a difficult one. In this project I am developing a nascent theory of how to quantify certain aspects of the cognition of timbre-harmonies. Given these quantifications, such as InV, it seems appropriate to conceive of connections between, say, two pairs of timbre-harmonies, according to the sum or average of the analytical quantity in question. But, given the approximate nature of such quantifications and the ephemeral nature of the perceptions they reflect, I have trouble hearing them either accumulate or hover around some average value. Instead, my hearings, which I will describe in detail throughout the remainder of this project, align more with the conventions that each level of a hierarchy consists of events, and that a two-event progression is represented at the next higher level of the hierarchy by the more relaxed of the two events. For example, consider a succession of two pairs of events—A and C and D and B—in which tension increases with alphabetical order. In the first pair, C is subordinate to (more tense than) A, and in the second pair, D is subordinate to B. So, at the next level of the hierarchy, A represents A - C and B represents D - B. The second pair is subordinate to the first because B is subordinate to A, so at the highest level of the hierarchy, A represents the entire four-event succession A - C - D - B.

Using a similar perspective, we can consider temporal and dynamic cues alongside waxing and waning timbral-harmonic tension. The facets of our perception discussed in this project (especially psychoacoustic vs. proportional consonance and our tolerance for
mistuning)—shape our emergent gestalt experience of timbral-harmonic tension. Every move from one timbre-harmony to the next is a (relative) tensing or relaxing motion. Taken together, such motions can inform layered hierarchical accounts of timbral-harmonic progression—accounts that reflect, to some extent, a projection of vertical structure onto a sense of horizontal progress.

4.3: Désintégrations, Section VIII

As an additional analytical application of InV, let us consider section VIII of Désintégrations. As Grisey did in the opening section of “Partiels,” Murail establishes a harmonic timbre-harmony as a referent and constructs a series of timbre-harmonies that are “progressive distortions” of this referent. Given the progression toward inharmonicity in the second stage of the opening section of “Partiels,” “progressive distortion” seems an apt descriptor for excerpts from both works—a possible “recurring theme” of spectral music. But unlike Grisey, Murail does not deploy his timbre-harmonies in order of their “progressive distortion,” nor does he assign them more or less equal durations. Also, he uses successive transpositions, by different pitch intervals, of two of the referent’s pitches to guide his progressive distortions and he “molds” the “ambits” (i.e., the distance between registral extremes) of each timbre-harmony “to create an accordion effect.”

To appreciate how these compositional procedures relate to how we hear section VIII of Désintégrations, let us use InV to analytically consider Murail’s derivation, reordering, and alteration of its constituent timbre-harmonies. With InV as a rough measure of timbral-

17 Ibid., 164.
harmonic tension, we can discuss how we can hear timbre-harmony interacting with duration and registral constraints to shape the excerpt.

4.3.1: Derivation

Figure 4.6 summarizes Murail’s description of his derivation of section VIII’s timbre-harmonies. Throughout our discussion of section VIII, I will refer to specific timbre-harmonies using the derivation numbers boxed to the left of each staff in figure 4.6. Timbre-harmony 1 is the starting point for a process of intervallic compression guided by the incremental transposition of two of its pitches. Open noteheads in figure 4.6 highlight these pitches and their successive transpositions. Numbers above the staff indicate the multiple that relates each pitch, when conceived as a partial, to the C#1 fundamental that anchors timbre-harmony 1. Over the course of six steps, G#2 (C#1*3) moves up a tritone by semitones while F¼#5 (C#1*21) moves half that distance in quarter-tone increments. This imbalance compresses the interval between these two pitches by a quarter-tone with each step and this

18 Ibid., 163-165.

19 In the analyses to come, I maintain timbre-harmony 1 as a memorably relaxed timbral-harmonic referent. But this is not the only way to hear this progression. Indeed, my reliance on timbre-harmony 1 may be guiding my ear more than is appropriate. I came to Désintégrations first through Murail’s writing about his compositional procedures. Primed as I was to hear section VIII as featuring “progressive distortion,” my perceptions have continued to be anchored in the harmonicity of timbre-harmony 1 even as my hearing evolved to incorporate Murail’s reordering of the progression. An alternative perspective—less tainted by poietic considerations—would be to map every timbre-harmony onto its own fundamental. For example, timbre-harmony 2, though quite inharmonic when related to the C#1 fundamental of timbre-harmony 1, would be much less inharmonic if one were to calculate the best fitting fundamental for these pitches alone.
interval serves as a guide. The remaining pitches move up in increments that approximately, according to Murail’s adherence to 24TET, compress the remaining intervals to scale in relation to this guide.\textsuperscript{20}

Figure 4.6: Timbre-harmonies from section VIII of \textit{Désintégrations}

Although the component intervals of each timbre-harmony get smaller, the frequency proportions they reflect do not necessarily become more inharmonic in relation to the

\textsuperscript{20} Ibid., 163.
referential fundamental of timbre-harmony. Figure 4.7 analyzes how each member of the seven timbre-harmonies relates to an overtone of a C#1 fundamental. To more clearly indicate which pitches are primes, which are integer multiples of primes, and which are inharmonic, it uses a more arithmetical notation. The odd integer above each pitch, whether alone or in an arithmetical expression, denotes overtone class. A multiplier indicates that an overtone is not the prime of its overtone class. For example, “11*2” shows that the F♯/♯5 in timbre-harmony 3 is C#1*22—a member of C#1*11 twice the frequency of its prime.

Figure 4.7: Inharmonicity values of timbre-harmonies from section VIII of Désintégrations
For inharmonic partials, their identity as power-of-two divisions of prime overtones is expressed in figure 4.7 with fractions. The numerator indicates an inharmonic partial’s parent overtone class, and the denominator is the powers of two corresponding to the number of DOSs from the prime of that class. For example, the label “7/2” over the A#1 in timbre-harmony 3 shows that the pitch is one octave lower than the prime of class C#1*7. Since the purpose of these labels is to enable a discussion of the progression according to relative disruptions of a prevailing harmonicity, I will consider only the fractions, disregarding the integers that indicate harmonic overtones. Rather than disrupting the prevailing harmonicity, these overtones support the maintenance of C#1 as a referential fundamental for the progression.

Inharmonic partials disrupt the unifying influence of this fundamental to different extents reflected in their InVs. For example, the InV of G4—C#1*(45/4)—in timbre-harmony 4 is 90—the product of its number of DOSs (the power of two that produces the denominator, as in 4 = 2² = 2 DOSs) and the integer multiple of its nearest prime (the numerator). The overall InV for each timbre-harmony—boxed to the right of each staff in figure 4.7—is the sum of the InVs of its inharmonic partials. For example, timbre-harmony 4’s InV is the sum of the InVs of C#1*[57/16, 23/4, 45/4, 33/2, 39/2, 45/2]. A divisor of 16 means 4 DOSs, a divisor of 4 means 2 DOSs, and a divisor of 2 means a single DOS. Thus, 57*4 + 23*2 + 45*2 + 33*1 + 39*1 + 45*1 = 481, the InV of timbre-harmony 4.

Using InV rather than intervallic compression as a guide, we can appreciate how these timbre-harmonies, when heard in order of their precompositional derivation, do not afford an experience of progressively increasing distortion. Instead, tensing and relaxing motions between timbre-harmonies realize an uneven trajectory of timbral harmonic tension.
and express the hierarchical structure shown in figure 4.8. Timbre-harmony 1, as the only timbre harmony with no inharmonic partials, has the lowest InV and expresses the least timbral-harmonic tension. Thus, every other timbre-harmony is ultimately subordinate to 1 as the least tense event in the progression. Relaxing motions between adjacent timbre-harmonies locally reverse this trend and provide perceptual cues that facilitate the formation of groups beneath the level of the entire progression. Square brackets beneath the timbre-harmony numbers in figure 4.8 show these groups. Unlike the relaxing motions of timbre-harmonies 2 – 3, and 4 – 5, the relaxing motion of 5 – 6 does not cue a group beginning because it is not preceded by a tensing motion and thus does not provide enough local contrast. Instead, 5 – 6 is a continuation of the larger relaxing motion of 4 – 5 – 6. The 4 – 5 relaxing motion cues a group beginning, and 5 – 6 continues on to 6—the least tense timbre-harmony within its local group.

Figure 4.8: A hierarchical representation of timbre-harmonies from section VIII of Désintégrations, in order of their derivation and according to InV

Surprisingly, Murail deploys these timbre-harmonies in an order different from the way he derived them. So, the hierarchical analysis of figure 4.8 does not reflect the actual
music. (We will examine that ordering shortly.) However, the analysis in Figure 4.8 does raise some questions about Murail’s motivations. He said that he reordered the timbre-harmonies to lend “unpredictability” to the sequence while preserving its general direction. But, given the unpredictable ways that intervallic compression maps onto an experience of increasing timbral-harmonic tension, there is little—other than perhaps the upward trend of pitches from one timbre-harmony to the next—that is “predictable” in the progression. From a spectral point of view, Murail shuffles the progression to address a non-existent problem. Nevertheless, using InV, we can appreciate the hierarchical structure that emerges as a result of the shuffling.

4.3.2: Reordering and Alteration

The reordering of the timbre-harmonies that actually appears in Section VIII still begins with timbre-harmony 〈 (InV = 0), thus maintaining its role as a memorably relaxed timbral-harmonic referent. As in the precompositional version, motions between it and other timbre-harmonies in the progression are tensing motions and all the other timbre-harmonies are subordinate to it. The first change is a tensing to the much more inharmonic timbre-harmony 〈 (InV = 481). It features only two C#1 overtones and, were it to appear in isolation, its six inharmonic partials would almost completely obscure their link to this fundamental. But the establishment of a C#1 as a referential fundamental at the outset encourages judgments of inharmonicity specifically as disruptions of C#1 harmonicity, and thus the link between these overtones and their fundamental is strengthened by context.

Figure 4.9 shows the hierarchical structure expressed in Murail’s reordering. At a

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21 Ibid., 164.
glance it seems, somewhat ironically, to be almost identical to the structure expressed by the timbre-harmonies in their original order (compare with fig. 4.8), but there are two important differences. First, although the grouping structure is the same, the final group now begins with its most relaxed timbre-harmony. In terms of classical prosody, an amphibrach (\(\sim\sim\)) has become a dactyl (\(\sim\)). Moreover, the progression’s local relaxing motions—\(\boxed{4} \rightarrow \boxed{5} \rightarrow \boxed{6}\)—both establish group beginnings, solidifying relaxing motions’ roles as perceptual cues that facilitate group formation. Second, the tensest event—timbre-harmony \(\boxed{2}\) (InV = 523)—is now in a more central position. Its relocation to the halfway point in the series delays a timbral-harmonic climax and avoids the front-heavy dramatic arc of the original progression.

Figure 4.9: A hierarchical representation of timbre-harmonies from section VIII of *Désintégrations*, in order of their deployment and according to InV

There is one further twist in the journey from precompositional conception to actual score. While Murail deploys the timbre-harmonies of section in the reshuffled order shown in figure 4.9, he also alters their pitch/partial content. It is impossible to say whether his alterations reflect a wish to amplify the differences between the hierarchical structures of the original series and its reordering (evident in the differences between figures 4.8 and 4.9), or
simply to move even further away from the supposed predictability of the progression as originally derived. But, as above, we can use InV to appreciate how Murail’s seven “progressively distorted” timbre-harmonies evolved into the formative roles they ultimately fulfill in section VIII.

Murail explains his alterations as a filtering of the timbre-harmonies according to his definition of registral extremes for each one. This process, summarized in figure 4.10, resembles the use of band-pass filters in electronic music to mold a sound’s spectral content. He applied a “low-pass” filter to the upper end of each timbre-harmony to remove notes above a certain point, and a “high-pass” filter to the lower end to remove notes below a certain point.

Figure 4.10: Filtering of timbre-harmonies according to their “ambits”

The first system of figure 4.10 shows the timbre-harmonies as originally derived, in order of their actual deployment. The second system shows the altered versions of these timbre-harmonies. Red lines in the second system of figure 4.10 connect the registral extremes of each timbre-harmony and show the visual “accordion” effect of alternating registral
compression and expansion. Open round noteheads (e.g., the G6 of timbre-harmony) highlight pitches added to achieve registral expansion, and open diamond noteheads (e.g., the B2 of timbre-harmony) highlight pitches removed as a result of registral compression.

The pitches added and removed at the registral extremes of each timbre-harmony are not the only differences between the derived and altered timbre-harmonies. Murail also added and removed pitches from the middle of each timbre-harmony. He cites a desire to maintain a “similar density” for each timbre-harmony as the motivation behind his “filter[ing of] certain components” (i.e., removing pitches) and “fill[ing] in certain spectral zones” (i.e., adding pitches). Murail’s wording here implies that these changes were tied directly to his initial derivations of the timbre-harmonies in some way. But he does not specify this link, and, at this point in our discussion, details of compositional procedure are less important than how they affect the timbral-harmonic structure expressed in the excerpt. Accordingly, let us recalculate the InV of each timbre-harmony in light of Murail’s addition and removal of pitches.

Figure 4.11 summarizes how Murail’s alterations affect the overall InV for each timbre-harmony. Overall, the notation is that of figure 4.7 with a few new features. Filled round noteheads denote pitches present in both the derived and altered versions of their...
parent timbre-harmony. Open round noteheads denote pitches that are absent from a timbre-harmony’s derivation, but present in its altered version. Parenthesized open round noteheads denote pitches present in a timbre-harmony’s derivation, but absent from its altered version, and the numbers showing their links to a C#1 fundamental are crossed out.

Figure 4.11: The effect of Murail’s addition and removal of pitches on the InV of timbre-harmonies from section VIII of *Désintégrations*

On the right side of figure 4.11, two values are given for the cumulative InV for each timbre-harmony. The first of these is the InV of its original version, and the second is the InV
of its altered version. For example, the InV of timbre-harmony 2, originally 523, becomes 619, reflecting an increase in timbral-harmonic tension that results from the removal of one overtone and two inharmonic partials, and the addition of three new inharmonic partials. In terms of the InVs of the altered versions of the timbre-harmonies, the timbral-harmonic structure they express in progression becomes that of figure 4.12 (compare to fig. 4.9).

Figure 4.12: A hierarchical representation of timbre-harmonies from section VIII of Désintégrations, in order of their deployment, as altered, and according to InV

The timbral-harmonic structure expressed by altered versions of the timbre-harmonies of section VIII is mostly similar to that expressed by their derived versions, but there is an important difference. The reduced InV of timbre-harmony 4 (481 => 267) and the increased InV of timbre-harmony 5 (154 => 329) reflect how Murail’s alterations upend the hierarchical relationship between them. This eliminates a relaxing motion that cued a group beginning, and two groups of two become an uninterrupted group of four timbre-harmonies that inexorably progress toward greater timbral-harmonic tension. Having tracked the poietic evolution of this timbral-harmonic progression, let us consider how its emergent timbral-harmonic structure—as summarized in figure 4.12—contributes to one’s hearing of section
VIII through its interaction with hierarchical structures that emerge simultaneously according to other perceptual cues.

4.3.3: Deployment

Unlike the timbre-harmonies in the opening section of “Partiels,” those in section VIII of *Désintégrations* are not deployed equivalently. In “Partiels,” timbre-harmonies’ ambits are not constrained, and they are deployed in discrete events that last so long it is hard to hear their durations as dissimilar even though they are not exactly the same. In contrast, durations in section VIII are comparatively brief and their differences are easily appreciable. Also, the “accordion” effect produced by Murail’s constraints on the ambits of his timbre-harmonies generates its own formative perceptual cues.

Let us first consider how the hierarchical structure that emerges from durational cues in section VIII interacts with the timbral-harmonic structure discussed above. Figure 4.13 juxtaposes these two structures and allows us to consider their interaction. The lower tree shows timbral-harmonic structure (as in figure 4.12) and the upper tree shows a hierarchical structure that emerges when one hears longer durations as more stable, and hears moves from longer durations to shorter ones as tensing motions to less stable events. Since timbre-harmony [1] has the longest duration and lowest InV, it is maximally stable in both durational and timbral-harmonic terms. But, aside from this consistency, the two structures seem to contradict one another. The 4+3 grouping structure cued by the progression’s only timbral-harmonic relaxing motion is essentially the reverse of the 3+(2+2) grouping cued—with one exception—by tensing motions to shorter durations. Moreover, the comparatively long duration of timbre-harmony [2] establishes it as durationally, but not timbrally-harmonically, the most stable point in the latter half of the progression.
I do not hear the progression from the longer timbre-harmony 1 to the shorter timbre-harmony 4 as cueing a group beginning like other progressions to shorter durations in section VIII. Instead, I hear timbre-harmony 4 as durationally subordinate to timbre-harmony 1 indirectly via its subordination to timbre-harmony 5. The iambic foot (−−) created by the progression from the shorter timbre-harmony 4 to the longer timbre-harmony 5 sets up an expectation that leads me to interpret 2 – 6 and 3 – 7 as iambic as well. Although the last four timbre-harmonies are durationally subordinate to timbre-harmony 7, the iambic expectation established by 4 – 5 leads me to hear this group of four as two groups of two.

Figure 4.13: A juxtaposition of hierarchical structures of duration and timbral-harmonic tension expressed in section VIII of *Désintégrations*

The iambic expectation established by durational cues goes against the grouping cued by differences in timbral-harmonic tension because it leads one to hear timbre-harmony 2 as
a group beginning. But this difference in grouping does not mean that these forces cancel each other out. Instead, it allows us to consider their formative influence in more nuanced terms according to their interaction. The durational cues that establish timbre-harmony 2 as a group beginning do not override its timbral-harmonic subordination to timbre-harmony 1 via its subordination to timbre-harmony 5. But they do ambiguously the only timbral-harmonic group division and lead one to consider an alternative hearing in which timbre-harmony 2 is subordinate to timbre-harmony 1 via timbre-harmony 6. Figure 4.13 shows this alternative as a dashed line connecting timbre-harmony 2 to 6. The climactic timbral-harmonic tension expressed by timbre-harmony 2, along with the ambiguity of its formative role in the progression, affords a sensation that timbre-harmony 2 serves as a keystone supporting the dramatic arc of the progression.

Another hierarchical structure emerges from perceptual cues created in the alternating registral compression and expansion of the timbre-harmonies. Figure 4.14 juxtaposes this structure with the progression’s timbral-harmonic structure, including, as in figure 4.13, the dashed-line alternative arising from interactions between timbral-harmonic and durational cues. The upper tree shows a hierarchical structure that emerges when one hears larger ambits as more stable. Thus, the registral crunch of a move from a larger ambit to a smaller one is a tensing motion to a less stable event. The shaded polygon in which the upper tree is “rooted” abstractly represents the changing ambits of the timbre-harmonies (compare to the shape outlined by red lines connecting registral extremes in figure 4.10).

At a glance the structures seem quite different, but they are actually quite similar. Contrary to the timbral-harmonic and durational structure, timbre-harmony 1 is not the most
stable point in terms of its ambit because it is smaller than the ambit of timbre-harmony 7. As a result, timbre-harmony 1 is ultimately subordinate to timbre-harmony 7. This seems like a fairly basic difference until one considers the context. Timbre-harmony 1 is still the second most stable point in the progression in terms of its ambit, and such a privileged temporal position strengthens its formative role significantly. Although timbre-harmony 1 is technically subordinate to timbre-harmony 7 in terms of its ambit, the subordination of timbre-harmony 7 to timbre-harmony 1 in terms of duration and timbral-harmonic tension overshadow this comparatively subtle distinction.

Figure 4.14: A juxtaposition of hierarchical structures of ambit and timbral-harmonic tension expressed in section VIII of Désintégrations

With the exception of the incongruous hierarchical reversal of timbre-harmonies 1 and 7, hierarchical structures that emerge according to ambit and timbral-harmonic tension
are in rather close agreement because they express similar grouping structures—4+3 vs. (2+2)+3. The internal hierarchy of the final group—timbre-harmonies 4, 5, and 7—is different because timbre-harmony 4 is subordinate to timbre-harmony 7 in the ambit structure. This final group—a dactyl (−−−) in timbral-harmonic terms—becomes, in terms of ambit, a cretic (−−) wherein the first “syllable” is less stressed than the last. Although timbre-harmony 7 is far too inharmonic for me to hear it as a stable point in the progression, its stability in terms of ambit seems to explain how, despite its inherent timbral-harmonic tension, I experience a subtle sense of arrival at the end of the progression. Durationally, timbre-harmony 7 is the second longest and this also supports my experience of timbre-harmony 7 as an unstable, but salient goal for the progression—a formative role cemented by the ensuing change in texture at the onset of section IX.

As in the timbral-harmonic structure, the first four timbre-harmonies cohere as a group. But the registral compression and expansion of the timbre-harmonies supports an even division of this group into two subgroups. Ironically, this echoes the duple grouping that would have been engendered if the timbre-harmonies were deployed without alteration. Despite the disappearance of this internal group boundary after Murail altered the timbre-harmonies, the ambit structure provides strong cues that divide the first four harmonies into two subgroups of two. Indeed, this parsing effect is so strong that I have included dashed brackets in the lower tree of figure 4.14 to show how it enriches my experience of timbral-harmonic tension in section VIII. Together with the dashed line reflecting a durationally-informed alternative hearing of timbre-harmony 2’s formative role, the ambit-informed dashed brackets of figure 4.14 show how a hearing of section VIII focused on its expressions
of timbral-harmonic tension can be shaped by other facets of musical experience.

This chapter has concentrated on inharmonicity, showing how to use it as a measure of timbral-harmonic tension that can generate a sense of progression and grouping structure. This approach is appropriate for works such as “Partiels” and Désintégrations wherein the harmonicity-disrupting effect of inharmonic partials is the primary source of perceived differences in timbral-harmonic tension. But it sets up harmonicity as a more singular perception than it actually is. In the next chapter, I will explore how timbre-harmonies without any inharmonic partials express different shades of harmonicity, and through these different shades engender formative differences in timbral-harmonic tension.
CHAPTER 5:
TIMBRAL-HARMONIC ANALYSIS II – HARMONICITY

5.1: Introduction

In the last chapter, we discussed music in which inharmonic partials disrupt a prevailing harmonicity that unifies entire sections. These disruptions informed analyses rooted in discrete timbre-harmonies’ levels of timbral-harmonic tension. But, unlike the excerpts discussed in the last chapter, some works do not feature inharmonic partials, and thus their constituent timbre-harmonies express, at least in terms of inharmonicity, the same timbral-harmonic tension (InV = 0). As I will demonstrate in this chapter, the absence of inharmonic partials’ disruptive effects allows subtler timbral-harmonic factors to emerge into the foreground and assume an observable formative role.

Harmonicity—the fused quality that complexes of overtones express—is not a singular phenomenon. To appreciate how there can be different harmonicities, consider that many orchestral instruments (e.g., violin, oboe, trombone, etc.), when played in the usual fashion, produce sounds that express different timbres. When playing the same pitch, such instruments produce different subsets of its harmonic series, and with different intensities for each partial. As a result, the harmonicity expressed in these subsets is different for each instrument, and may also vary across the pitch range of the instrument.

In this chapter, I will again confront our “charmingly imprecise faculties of perception” by using the harmonic series as an analytical referent.¹ I will propose a measure of timbral enrichment that will permit me to analyze tension and relaxation as formative forces in an excerpt from Claude Vivier’s Lonely Child.

Although some consider Vivier to be a peripheral figure in spectral music, his compositional ethos aligns quite well with the flexible spectral “attitude” Murail celebrates as essential to the practice of spectral music. For example, he celebrates the combination of “even two sounds” as “terribly complex” and “fascinating” because of the myriad interactions among their constituent partials. Such perceptions show that, like other composers of spectral music, he is focused on how the interactions of partials—the component frequencies of sounds I metaphorically discussed as “subatomic” in chapter 1—can inform the interactions of pitches. With Vivier’s “fascination” in mind, let us consider the details of how he generates the pitches-cum-partialis that populate timbre-harmonies in one of his best-known compositions.

5.2: Combination Tones and “Les Couleurs”

The timbre-harmonies of mm. 24-41 of Lonely Child feature what Vivier refers to as “les couleurs.” Essentially, these “colors” are pitches that approximate a type of combination tone. Psychoacoustically speaking, combination tones are curious. We perceive

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them even though they are not present in the sound. Instead, they emerge in our perceptions as psychoacoustic artifacts of how we cognitively process sounds.\textsuperscript{5} Musically, combination tones were something of an instrumental curiosity (e.g., Tartini’s “terzo tuono”) until the latter half of the nineteenth century when Helmholtz related the phenomenon to auditory beats and, more importantly, to perceptions of consonance and dissonance.\textsuperscript{6} Helmholtz’s perspective on the aural effect of combination tones influenced Hindemith’s theory of harmony in the 1940s but the relationship between combination tones and musical perception remained mostly theoretical.\textsuperscript{7} It was not until the 1960s that combination tones became associated with modulations of electronic signals and were shown to affect timbral perception.\textsuperscript{8} Hindemith notwithstanding, it seems reasonable to assume that until the relationship between combination tones and timbre was made explicit with the rise of modulation-based synthesis in electronic music, the influence of combination tones on timbral perception was poorly understood, even if some expert orchestrators may already

\textsuperscript{5} Thomas Rossing, \textit{The Science of Sound}, 2\textsuperscript{nd} edition (New York: Addison-Wesley, 1990), 151-154.


\textsuperscript{8} Though modulation techniques were theorized in the nineteenth century, applications of these techniques to music were limited until technological obstacles highlighted a need for computationally efficient ways to produce certain effects [John M. Chowning, “The Synthesis of Complex Audio Spectra by Means of Frequency Modulation,” \textit{Journal of the Audio Engineering Society} 21 (1973): 526-534].
have (consciously or unconsciously) exploited intuitive or experiential understanding of combination tones in their orchestral writing.

Measures 24-41 of Lonely Child is a particularly beautiful example of combination tones in acoustic music. The excerpt features a homorhythmic chordal texture in which diaphanous timbre-harmonies, comprised of sounding pitches that realize combination tones, harmonize and qualitatively enrich the interaction between two main melodic lines. Since the details of Vivier’s “les couleurs” technique—the compositional logic behind the derivation of these sonorities—have been well documented, a brief summary of its most important aspects will suffice.

Figure 5.1: Derivation of a timbre-harmony from Lonely Child

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9 A later section of “Partiels” also features combination tones. Grisey’s procedure is similar to Vivier’s in that he generates combination tones according to the interaction of two melodic voices. Unlike Vivier, Grisey generates a polyphonic rather than homophonic texture [Joshua Fineberg, “Musical Examples,” Contemporary Music Review 19/2 (2000): 129-131].

Although combination tones in general include both sum and difference tones, Vivier uses only sum tones in *Lonely Child*.\(^\text{11}\) To generate these sum tones, Vivier uses pairs of simultaneously sounding pitches—hereafter “generator” pitches—from the two melodic lines—hereafter melody (X) and bass (Y). Vivier conceives of each generator as a complex sound, each with a full complement of overtones. In light of this idealized timbral richness, he calculates sum tones not only by adding the generators’ fundamental frequencies, but also by adding the frequencies of some of their overtones (i.e., the overtone multiples of X and Y generators’ fundamentals, as in 2X+3Y). Bryan Christian has productively seized upon this feature of Vivier’s technique to compile “combination-tone classes” (CTCs)—matrices of possible sum tones derived from generator frequencies and their integer multiples.\(^\text{12}\)

Figure 5.1 demonstrates Vivier’s method for constructing timbre-harmonies in the excerpt. Simultaneously sounding melody (X) and bass (Y) pitches, respectively A4 (440Hz) and G3 (196Hz), generate a CTC matrix (not shown). Then, five sum tones are selected—(X+Y), (X+2Y), (2X+Y), (2X+3Y), and (3X+3Y)—and approximated to the nearest quarter-tone. For each of these quarter-tone approximations, a mistuning value (in cents) shows the imprecision of the frequency-to-pitch conversion. In some cases, the mistuning is negligible. For example, (X+2Y) is only three cents higher than G#5—an imperceptibly slight discrepancy.\(^\text{13}\) In others, the mistuning is more significant. For example, (2X+3Y) is a more

\(^\text{11}\) Sum tones are frequencies derived from the addition of one frequency to another (e.g., 440Hz+110Hz = 550Hz), while difference tones are frequencies derived from the subtraction of one frequency from another (440Hz-110Hz = 330Hz).


\(^\text{13}\) Though many factors contribute to our ability to detect differences in pitch, the average “just noticeable
salient fourteen cents lower than F#6.14

Figure 5.2: Annotated reduction of mm. 24-41 of Lonely Child

The “nickel’s worth” rule (“Just Noticeable Difference in Pitch,” Georgia State University Department of Physics and Astronomy, accessed June 27, 2017, http://hyperphysics.phy-astr.gsu.edu/hbase/music/cents.html#c4) seems sufficient and I will discount differences in frequency below 5 cents as not perceptually salient.

Figure 5.2 is a reduction of mm. 24-41 of *Lonely Child* to which I will refer throughout this chapter. Octave and unison doublings reinforce both of the generating voices (lower staff) and 5 violinists realize aggregates of gossamer sum tones (upper staff). Each sum tone aggregate is derived, as in figure 5.1, from a pair of pitches that sound simultaneously in the generating voices. Vivier deploys a different collection of sum tones for each pair, and whenever a given pair recurs, he deploys the same collection. Thus, since there are ten unique generator pairs in the excerpt, there are ten unique sum tone collections. In combination, the generators and sum tones form ten unique timbre-harmonies, and these are circled in figure 5.2. Roman numerals assigned to these timbre-harmonies are neutral labels that reflect only order of appearance in the excerpt, and I will reference specific timbre-harmonies using these labels.

5.3: Timbre-Harmonies of mm. 24-41 of *Lonely Child* as Complexes of Overtones

Although we now have some sense of these timbre-harmonies’ provenance, it is unclear how this relates to timbral-harmonic perception. In an effort to look beyond compositional concerns, let us characterize each timbre-harmony as a complex of overtones, and, as such, an approximation of harmonic frequency proportions that informs our perceptions of its gestalt identity. Figure 5.3 shows the pitches of timbre-harmony and boxed numbers above each pitch show how they map onto overtones of a G0 harmonic

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15 The odd parsing of the measures into four unequal lines in figure 5.2 reflects an analytical grouping that I will discuss later in this chapter. For now, note that each line has its own bass generator (B)—G3 for the first line, F#3 for the second, E3 for the third, and F3 for the fourth. For an analysis that shows how this excerpt fits into the structure of the overall work, see Jacques Tremblay, “L’écriture à haute voix: *Lonely Child* de Claude Vivier.” *Circuit: musique contemporaines* 11/1 (2000): 45-67.
In conceiving chords comprised of pitches as complexes of overtones, one might assume it is sufficient to identify the overtones closest to the notated pitches. But strict adherence to this guideline belies the nature of ensemble playing. Rather than adhering precisely to notated pitches, musicians tune to one another and shape their sound according to expressive demands of the music. In light of such flexibility, a preference for more resolved (i.e., lower) overtone classes tempers my analysis. This preference is expressed in the table at the bottom of figure 5.3, in which each of the highest three pitches is given two possible interpretations, one of which I reject. For example, a red X on the table shows that I have rejected an interpretation of F6 as G0\*57—the prime of a very distant and unresolved class. Despite the near equivalence of this pitch and overtone, I have instead identified F6 as an approximation of G0\*56—a few octaves removed from the prime of the much more resolved G0\*7. Since G0\*57 is only 31 cents higher than G0\*56 (i.e., slightly less than a
sixth-tone), a performer’s desire to blend—especially given the homorhythmic texture—may motivate a slight flattening to accomplish the stronger sort of fusion associated with a more resolved frequency proportion.

Such intonational flexibility is common but only appropriate as an analytical assumption in some contexts. It is not so appropriate for the opening process of “Partiels” since the primary agent affording a sense of timbral-harmonic progression is a gradual disruption of harmonicity through the incorporation of inharmonic partials. In contrast, my hearing of mm. 24-41 of *Lonely Child* rests on a reading of every timbre-harmony as a complex of overtones, so that they all express harmonicity, but each in a different way. In the absence of inharmonic partials, differences in harmonicity—as expressed by ten unique timbre-harmonies—attain a formative salience and encourage the listener to defer to frequency proportions that most convincingly support the fundamental that anchors each timbre-harmony’s expression of harmonicity.

Four pieces of information to the right of the staff in figure 5.3 summarize the overtone content and cumulative mistuning of timbre-harmony [4]. The first is the set of G0 overtones that correspond to the pitches from timbre-harmony [4]. The second is the set of G0 overtone classes of which timbre-harmony [4]’s overtones are members. The third highlights the overtone classes that include X and Y, the more strongly emphasized generator pitches, which in this timbre-harmony are A4 and G3.

The final piece of information to the right of the staff in figure 5.3 is a cumulative mistuning for timbre-harmony [4] that reflects the qualitative effect of inexact parallels between pitch and frequency on our perceptions. Though conceived as harmonic, timbre-harmony [4] is not purely so because some of its pitches are perceptibly mistuned. Our
tolerance for mistuning allows us to hear these as expressing qualitatively tarnished approximations of harmonic frequency proportions. Each of these approximations contributes to a tarnishing effect on the timbre-harmony as a whole—an effect summarized as its cumulative mistuning, which is the sum of the absolute values of the mistuning of each mistuned pitch. For timbre-harmony \( \text{I} \), the mistunings of five mistuned pitches—9c, 5c, 29c, 31c, 41c—add up to a cumulative mistuning of 88c.

Table 5.1: Overtone content of timbre-harmonies from mm. 24-41 of *Lonely Child*

<table>
<thead>
<tr>
<th>Timbre-harmony</th>
<th>F*</th>
<th>Overtones</th>
<th>Overtone Classes</th>
<th>X</th>
<th>Y</th>
<th>cumulative mistuning</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>G0*</td>
<td>[4, 8, 9, 18, 26, 34, 42, 56, 80]</td>
<td>(1, 5, 7, 9, 13, 17, 21)</td>
<td>9</td>
<td>1</td>
<td>88c</td>
</tr>
<tr>
<td>II</td>
<td>E♭0*</td>
<td>[5, 10, 12, 24, 34, 46, 58, 78, 104]</td>
<td>(3, 5, 13, 17, 23, 29, 39)</td>
<td>3</td>
<td>5</td>
<td>128c</td>
</tr>
<tr>
<td>III</td>
<td>F♯1*</td>
<td>[2, 4, 5, 10, 14, 18, 24, 32, 42]</td>
<td>(1, 3, 5, 7, 9, 21)</td>
<td>5</td>
<td>1</td>
<td>166c</td>
</tr>
<tr>
<td>IV</td>
<td>B(-1)*</td>
<td>[6, 12, 17, 34, 46, 58, 78, 114, 140]</td>
<td>(3, 17, 23, 29, 35, 39, 57)</td>
<td>17</td>
<td>3</td>
<td>66c</td>
</tr>
<tr>
<td>V</td>
<td>F♯2*</td>
<td>[1, 2, 3, 6, 8, 10, 14, 17, 24]</td>
<td>(1, 3, 5, 7, 17)</td>
<td>3</td>
<td>1</td>
<td>78c</td>
</tr>
<tr>
<td>VI</td>
<td>C0*</td>
<td>[5, 10, 18, 36, 46, 56, 84, 98, 148]</td>
<td>(5, 7, 9, 21, 23, 37, 49)</td>
<td>9</td>
<td>5</td>
<td>103c</td>
</tr>
<tr>
<td>VII</td>
<td>F0*</td>
<td>[4, 8, 15, 30, 36, 46, 70, 82, 118]</td>
<td>(1, 9, 15, 23, 35, 41, 59)</td>
<td>15</td>
<td>1</td>
<td>124c</td>
</tr>
<tr>
<td>VIII</td>
<td>B♭(-1)*</td>
<td>[6, 12, 17, 34, 46, 58, 78, 104, 140]</td>
<td>(3, 13, 17, 23, 29, 35, 39)</td>
<td>17</td>
<td>3</td>
<td>72c</td>
</tr>
<tr>
<td>IX</td>
<td>F1*</td>
<td>[2, 4, 5, 10, 14, 18, 24, 32, 42]</td>
<td>(1, 3, 5, 7, 9, 21)</td>
<td>5</td>
<td>1</td>
<td>166c</td>
</tr>
<tr>
<td>X</td>
<td>D♭0*</td>
<td>[5, 10, 18, 36, 44, 56, 94, 98, 148]</td>
<td>(5, 7, 9, 11, 37, 47, 49)</td>
<td>9</td>
<td>5</td>
<td>74c</td>
</tr>
</tbody>
</table>

In the next two sections of this chapter, I will propose a rough measure of timbral-harmonic tension in the excerpt based on the overtone content of its constituent timbre-harmonies. I will use this measure as a primary factor in accounting for the formative roles of discrete timbre-harmonies in the excerpt, and I will use cumulative mistuning as a secondary factor in evaluating differences in timbral-harmonic tension. To inform the analytical discussions to come, table 5.1 summarizes the overtone content and cumulative mistuning of all ten unique timbre-harmonies in the excerpt.
5.4: Enrichment Value

As discussed in chapter 1, sounds comprised mostly of overtones of a single fundamental express harmonicity, and overtones contribute to emergent harmonicity in different ways. Overtones of more resolved classes—those closer to the fundamental—provide the strongest support for our perception of the fundamental as the sound’s overall pitch. Overtones of less resolved classes provide less support for the fundamental, and are increasingly experienced as timbral enrichment further from the fundamental. Accordingly, even though every timbre-harmony in mm. 24-41 of Lonely Child consists entirely of overtones, they do not express harmonicity in the same way, because the timbral contributions of their overtones are different. These differences can be a source of timbral-harmonic tension that creates progression and hierarchy, as inharmonicity does for the works discussed in chapter 4.

As with our analysis of inharmonicity, it will be analytically useful to quantify in some way the differences in harmonicity expressed by each timbre-harmony. The measure will need to reflect that lower overtone classes support our perception of a sound’s pitch while higher classes engender our emergent perceptions of a sound’s timbral enrichment. For example, consider two harmonic sounds, one of which consists of $F^*(1, 3, 7)$ while the other consists of $F^*(1, 5, 17)$. Both sounds express harmonicity, but the harmonicity of $F^*(1, 5, 17)$ is more timbrally enriched, especially due to the particularly enriching contribution of the comparatively unresolved $F^*17$. In this section I will demonstrate how this contribution can be roughly quantified as an enrichment value (hereafter EV) according to an overtone’s class and distance from the prime of its class. Like InV, a timbre-harmony’s overall EV is the sum of the EVs of every sounding pitch in relation to the timbre-harmony’s fundamental.
Using the information in table 5.1, we can calculate an EV for each timbre-harmony, and use it as we used InV in the last chapter—as a rough measure of each timbre-harmony’s expression of timbral-harmonic tension. This measure arises, as does InV, from a two-dimensional consideration of spectral components. Each pitch approximates an overtone of the fundamental of its parent timbre-harmony. These overtones are members of classes whose distance from the fundamental is correlated with the extent of their contribution to timbral enrichment. The effect of $F^*5$, for example, is less enriching than $F^*9$. $F^*1$—the class that includes the fundamental—is the seat of our perception of the sound’s overall pitch. As such, $F^*1$ overtones contribute to timbral enrichment the least, and EV is partly a measure of increasing timbral enrichment according to incremental moves away from the fundamental in terms of overtone classes.

But overtones within classes are only similar, and their contributions are not equivalent. To account for the similar, but not equivalent, contributions of overtones of the same class, I assign each overtone a salience multiplier (δ) that—in line with the weakening of overtones further from the fundamental—reflects its diminished salience as a function of its distance from the prime of its class. Since the timbre-harmonies in the excerpt are comprised of overtones no further removed from their primes than five powers of two, I use six integers as salience multipliers, reducing the integer value with each successive octave level. Although these multipliers are somewhat arbitrary, they make intuitive sense in that the prime of an overtone class expresses the type of timbral contribution associated with that class most strongly and thus has the highest salience multiplier. For the six lowest overtones of $F^*3$, for example, $F^*3$, δ = 6; $F^*6$, δ = 5; $F^*12$, δ = 4; $F^*24$, δ = 3; $F^*48$, δ = 2; and $F^*96$, δ = 1. The EV of an overtone is the product of its class and salience multiplier, and the
EV for a timbre-harmony is the sum of the EVs of its constituent overtones. The higher numbers of higher overtone classes will result in higher enrichment values for members of that class than commensurate members of lower overtone classes. These higher enrichment values reflect the broad difference in timbral contribution between resolved and unresolved overtone classes, as discussed in chapter 1. Within each class the enrichment values decrease further from the prime of that class.

Figure 5.4 demonstrates EV calculation using timbre-harmony I, whose constituent overtone classes are listed in the top row of the table. The column of boxes below each overtone class shows its power-of-two multiples, thus representing five overtones—the prime and four others—within each of timbre-harmony I’s seven overtone classes. The salience multipliers (8) of these overtones are listed separately to the left side of the table. Shaded boxes highlight overtones that map onto the pitches from timbre-harmony I. The EV of each overtone is the product of the top cell in its column—its overtone class—and the salience multiplier that aligns with its row. As shown on the right side of figure 5.4, the cumulative EV for a given timbre-harmony is the sum of the EVs of its constituent overtones and, as such, is a rough estimate of the overall timbral-harmonic tension to which they contribute. My choice of multipliers, and even the multiplication of overtones, is only one of many options, but it seems to reflect my intuitions. Another option I tried—a Fibonacci series of

16 Only five overtones—the prime and four others—from each class are shown in figure 5.4 because the highest non-prime overtone in timbre-harmony I—G0*80 = G0*[5*16]—is only four powers-of-two away from its prime. As mentioned above, the timbre-harmonies in the excerpt are comprised of overtones no further removed from their primes than five powers of two.
multipliers—produced different EVs for each timbre-harmony, but reflected similar relative tensions for the excerpt’s ten timbre-harmonies.

Figure 5.4: EV calculation for timbre-harmony

![EV Calculation Diagram]

Calculating a cumulative EV for each of the excerpt’s ten unique timbre-harmonies begins to bring into focus a timbral-harmonic hierarchy. Figure 5.5 shows this hierarchy as an ordering of the timbre-harmonies from lowest EV (least tense) to highest (most tense). Each timbre-harmony is represented by its fundamental (F). Numbers above these fundamentals show the cumulative EV for each timbre-harmony. By this measure, the EV values for some timbre-harmonies are equal or very nearly so. Additional information in figure 5.5 about each timbre-harmony provides the basis for three heuristics for determining relative tension in such cases. First, the register of a timbre-harmony’s fundamental is correlated, generally, with its place in the preliminary hierarchy. Recall the comparison from chapter 3 of a low register P5 to a midrange TT in light of their respective critical bandwidths. The frequency difference between adjacent overtones is equal to the fundamental frequency. Smaller frequency differences between overtones of lower frequency fundamentals increase the likelihood that critical bands will overlap to produce
psychoacoustically dissonant sensations of roughness and/or beating. Therefore, when the hierarchical distinction between two timbre-harmonies is otherwise unclear, I will consider the one with the higher fundamental as less tense.

**Figure 5.5: Preliminary hierarchy of timbre-harmonies from mm. 24-41 of Lonely Child**

Second, in otherwise ambiguous situations, I will regard the timbre-harmony with lower mistunings as less tense, since these reflect how much pitch approximations of frequency proportions qualitatively tarnish our perceptions of harmonicity. Third, unison and octave doublings emphasize generator pitches in the excerpt (see figure 5.2 and 5.3). Given such increased salience and a general correlation between lower X and Y overtone classes and lower EV, I will regard the timbre-harmony with lower X and Y overtone classes as less tense when other distinctions are unclear. In the next section of this chapter, I will consider these three heuristics in coordination with EV and perceptual cues in other domains to support hierarchical accounts of timbral-harmonic progression in mm. 24-41 of Lonely Child.

**5.5: Timbral-Harmonic Progression in mm. 24-41 of Lonely Child**

A large “rin” or “singing bowl” (see figure 5.2) articulates the excerpt into groups aligned with changes in the bass generator pitch (Y). Thus, each group features only those

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17 The reduction in Figure 5.2, as mentioned above, is formatted so that the groups summarized in figure 5.6 are
timbre-harmonies that share a bass generator. In light of this musical cue, figure 5.6 abstractly summarizes this grouping, thus revealing which timbre-harmonies will be involved in the local level comparisons that will inform our hierarchical accounts of timbral-harmonic progression in the excerpt. The groups are separated in the figure by spaces, and for each timbre-harmony are shown its EV, mistuning, and (in italicized integers) the overtone classes of its generator pitches.

Figure 5.6: Abstract summary of mm. 24-41 of Lonely Child

<table>
<thead>
<tr>
<th>EV</th>
<th>F</th>
<th>392</th>
<th>655</th>
<th>259</th>
<th>1094</th>
<th>218</th>
<th>680</th>
<th>998</th>
<th>848</th>
<th>259</th>
<th>829</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timbre-harmony</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mistuning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X</td>
<td>9</td>
<td>3</td>
<td>5</td>
<td>1</td>
<td>17</td>
<td>3</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Y</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The rin (indicated by asterisks on the top layer of Figure 5.6) articulates the beginning of the first three groups and the ends of the second and fourth groups. Although the rin does not initiate the fourth group, increased rhythmic activity in m. 37 establishes a contrast that signals the beginning of the fourth group and isolates timbre-harmony [VI] within its own group. Since this group is comprised entirely of repetitions of timbre-harmony [VI] its internal progression is fairly straightforward, and it is perhaps best appreciated as a pivotal passage of the excerpt. To appreciate this special role, let us consider the form of the excerpt’s remaining timbre-harmonies by first analyzing the within-group timbral-harmonic structures they express in their progression, and then describing how these contribute to the timbral-harmonic structure of the entire excerpt.

on separate lines.
5.5.1: mm. 24-27

Figure 5.7 shows a hierarchical account of timbral-harmonic progression in mm. 24-27, the first group of the excerpt as identified in figure 5.6. The music is again reduced to two staves as in figure 5.2. The top staff sounds an octave higher than written and shows the five violins’ “couleurs” (sum tones). The bottom staff, sounding as written, shows the generator pitches. The first group of the excerpt features only two timbre-harmonies. Timbre-harmony I has a lower EV (392) and mistuning (88c) than timbre-harmony II (EV = 655, mistuning = 128c). Also, timbre-harmony I’s Y overtone class is G0*1—a class that includes the fundamental and whose members strongly support pitch-engendering fusion without contributing much to timbral enrichment. Such emphasis on this class in timbre-harmony I and its absence in timbre-harmony II supports a hearing of timbre-harmony II as less stable than, and thus subordinate to, timbre-harmony I.

Figure 5.7: Hierarchical account of timbral-harmonic progression in mm. 24-27

An exception comes in m. 25 where timbre-harmony I—briefly sounded between statements of timbre-harmony II, the second of which is durationally accented—serves a
neighbor function that locally overshadows differences in timbral-harmonic tension. The first occurrence of timbre-harmony II is on the first beat of a notated measure, and a quarter-note beat is maintained in the preceding introduction (mm. 1-23). But the changing meter of both the introduction and the excerpt make it difficult to audibly parse the excerpt into measures, and thus make it difficult to hear any quarter note beat as expressing the metrical accent associated with initiating a new measure. In the absences of regular meter, my hearing of measure 25 is informed by the prosodic accents of the soprano’s text—“bel enfant”—as shown in beneath the staves of figure 5.7.

Ultimately, timbre-harmonies in mm. 24-27 are subordinate to the first occurrence of timbre-harmony II in m. 24. This timbre-harmony’s long duration and strong metrical position bolster its expression of timbral-harmonic stability in relation to both timbre-harmony II and subsequent recurrences of timbre-harmony I. Vivier’s breath marks, included in the lower staff of figure 5.7, cue the performers to parse mm. 24-27 into subgroups as shown by brackets above the upper staff. My hearing of the brief timbre-harmony II that initiates the second of these subgroups as not subordinate to the durationally accented timbre-harmony I that follows, reflects my interpretation of this subgroup as a neighbor figure that prolongs timbre-harmony II—a hearing supported in part by repetitions of the verb “dors” (sleep). A rearticulation of the bass generator emphasizes the audible division between subgroups in measure 26, and affirms my hearing of timbre-harmony II on beat 3 of the measure as a more stable point in the progression than its brief duration implies.

5.5.2: mm. 28-34

Figure 5.8 shows a hierarchical account of timbral harmonic progression in the second group of the excerpt, mm. 28-34. Of the three timbre-harmonies in this group, III, IV,
and $\text{V}$, the last is the most stable as it expresses the least timbral-harmonic tension. It has a lower EV (218) than both timbre-harmony $\text{II}$ (EV = 259) and $\text{V}$ (EV = 1094), its X and Y overtone classes $[F#2*(1, 3)]$ feature the two lowest overtone classes, and it is less mistuned (78c) than timbre-harmony $\text{II}$ (mistuning = 166c)—the second most stable harmony in the group. Timbre-harmony $\text{V}$ is the least stable of the group. It is less mistuned (66c) than timbre-harmonies $\text{II}$ and $\text{V}$ but its high EV (1094) reflects the tensing influence of more distant, and more unresolved overtone classes.

Figure 5.8: Hierarchical account of timbral-harmonic progression in mm. 28-34

Unlike in the neighbor figure in m. 25 of the previous group, local interactions do not overshadow differences in timbral-harmonic tension as a formative cue in mm. 28-34. As reflected in their different EVs, timbre-harmony $\text{II}$ is subordinate to timbre-harmony $\text{V}$, and timbre-harmony $\text{V}$ is subordinate to timbre-harmony $\text{II}$ and/or $\text{V}$. The EVs of timbre-harmonies $\text{II}$ (EV = 259) and $\text{V}$ (EV = 218) are quite close, and their relative expressions of timbral-harmonic tension could easily be overridden by contradictory cues in other domains. In this excerpt, however, there are no instances where such cues suggest upending the
hierarchical relationship reflected in this comparatively subtle difference in EV. For example, there are only two immediate juxtapositions of timbre-harmonies $\text{II}$ and $\text{V}$—the notated downbeats of mm. 31 and 33. In both places, timbre-harmony $\text{V}$ aligns with the quarter-note beat consistently maintained to this point in the piece, and timbre-harmony $\text{II}$ is durationally accented off the beat. My interpretation of timbre-harmony $\text{II}$ as subordinate to timbre-harmony $\text{V}$ in these cases defers to the prevailing quarter note pulse, and to the fact that timbre-harmony $\text{V}$ initiates subgroups that, as in the first group (mm. 24-27), emerge according to the breath marks in the score.

The dashed portion of the bracket over the first subgroup (mm. 28-30) reflects the curiously ambiguous effect of the breath mark at the end of m. 28. This breath mark follows a metrically and durationally accented timbre-harmony $\text{II}$ that signals the beginning of a new group. Since timbre-harmony $\text{II}$ is more stable than timbre-harmonies in the first group, however, m. 28 also provides a point of stability toward which the first group relaxes. Such prospective and retroactive duality, along with the repetition of timbre-harmony $\text{II}$ in m. 29, undermines the articulating effect of the breath mark at the end of m. 28 and unifies mm. 28-30 as a coherent subgroup.

Although timbre-harmony $\text{II}$ provides relative stability following the tenser timbre-harmonies of the first group, it ultimately relaxes into timbre-harmony $\text{V}$ in m. 30. This occurrence of timbre-harmony $\text{V}$ is ultimately subordinate to the timbre-harmony $\text{V}$ on the downbeat of m. 32—the most stable point in mm. 28-34. At this point, the brief timbre-harmony $\text{V}$ that initiates the second subgroup relaxes into a much longer occurrence of timbre-harmony $\text{V}$. Subordinate intervening tensing motions to timbre-harmonies $\text{II}$ and $\text{V}$, establishing mm. 31-32 as a rather stable two-measure prolongation of timbre-harmony $\text{V}$.
Indeed, as we shall see, this notably stable moment anchors the entire excerpt.

5.5.3: mm. 37-41

As discussed above, the third group (mm. 35-36) contains only timbre-harmony VI and the significance of its straightforward internal hierarchy—motion between repetitions—is almost completely overshadowed by its pivotal role within the excerpt as a whole. Before zooming out to such a broad perspective, let us consider the hierarchical structure of the excerpt’s fourth and final group (mm. 37-41) according to the account shown in figure 5.9.

Figure 5.9: Hierarchical account of timbral-harmonic progression in mm. 37-41

Of the group’s four constituent timbre-harmonies, timbre-harmony X is the most stable. Despite being more mistuned (166c) than timbre-harmonies VII (124c), VIII (72c), and X (74c), its EV (259) is much lower and its X and Y overtone classes are the lowest and most resolved [F(1, 5)]. Timbre-harmony VII is the least stable since it is more mistuned than timbre-harmonies VII and X and has the highest EV (998) in its group.

There is less contrast between timbre-harmonies VII and X. Timbre-harmony VII
has a slightly higher EV (848 vs. 829), a lower fundamental [Bb(-1) vs. Db0], and its X overtone class is the comparatively unresolved B♭(-1)*I7. On the other hand, timbre-harmony X is slightly more mistuned (74c vs. 72c) and its Y overtone class—D♭*5—is less resolved than B♭(-1)*3—the Y overtone class of timbre-harmony VII. On balance, I am inclined to hear VII as expressing greater timbral-harmonic tension than X. But the comparatively subtle differences between them could be easily overshadowed by cues in other domains. There is only one place—m. 40—that features timbre-harmonies VII and X in direct succession. However, since this succession crosses a subgroup boundary their roles in the progression are separate. Timbre-harmony X is subordinate to the timbre-harmony IX that initiates its subgroup, and timbre-harmony VII relaxes into the timbre-harmony IX that follows.

Ultimately, timbre-harmonies in mm. 37-41 are subordinate to the second occurrence of timbre-harmony IX in m. 37. The opening iambic rhythm of m. 37 relaxes into the second dotted-quarter beat of the measure with the arrival of timbre-harmony IX. This occurrence of timbre-harmony IX then relaxes, via a neighboring timbre-harmony VII, to the durationally accented timbre-harmony IX that ends the measure. Although the only occurrence of timbre-harmony IX in m. 38 is in a weak metrical position as notated, it is in a strong metrical position with respect to a projective compound meter, analyzed beneath mm. 37-38 in figure 5.9: attacks of IX realize dotted-quarter and dotted-half durations.¹⁸ The stabilizing effect of

¹⁸ Christopher Hasty, Meter as Rhythm (Oxford: Oxford University Press, 1997), 84-91. The notation I have used to show the dotted-quarter and dotted-half projections in figure 5.9 are similar to those used by Hasty.
this realized metrical projection overrides the weak notated metrical position of timbre-harmony $[IX]$ in m. 38, supports its role as the most stable point in the measure, and contributes to the coherence of the first two measures as a unified group.

A breath mark, as before, establishes a boundary between groups, the second of which is further parsed into four smaller subgroups according to Vivier’s phrase markings as shown in the bottom staff. The timbre-harmonies in the first of these subgroups are subordinate to the second occurrence of timbre-harmony $[IX]$ in the subgroup. The subgroup begins with timbre-harmony $[VIII]$ relaxing into timbre-harmony $[IX]$, and this relaxing motion repeats with longer durations. Due to these longer durations, the second relaxing motion from $[VIII] - [IX]$ is more stable, and the first timbre-harmony $[IX]$ is subordinate to the second. Alternatively, the durational accent on the timbre-harmony $[VIII]$ that begins the subgroup could be interpreted as overriding the sense that it relaxes into the brief occurrence of timbre-harmony $[IX]$ that follows. But I hear timbre-harmony $[VIII]$ as consistently subordinate to timbre-harmony $[IX]$ in this excerpt because they express very different levels of timbral-harmonic tension. The EV of timbre-harmony $[IX]$ (EV = 259) is much lower than that of timbre-harmony $[VIII]$ (EV = 848). The sense of lessening timbral-harmonic tension in progressions from timbre-harmony $[VIII] - [IX]$ is significant and not easily overridden by contradictory cues in other domains.

The second timbre-harmony $[IX]$ in the first subgroup (m. 39) is the most stable point in the four subgroups of mm. 39-41. As such, it is the most stable point in its group, but subordinate to the more stable timbre-harmony $[IX]$ in the previous group—the second occurrence of timbre-harmony $[IX]$ in m. 37. The second subgroup (first part of m. 40) is a tensing motion from $[IX] - [X]$ via an intermediate tensing and relaxing to and from timbre-
The third subgroup (second part of m. 40) are two $\text{VII} \rightarrow \text{IX}$ relaxing motions, the second of which is subordinate to the first. The fourth and final subgroup is a relaxing motion from $\text{VII} \rightarrow \text{X}$ that is subordinate to the preceding timbre-harmony $\text{IX}$.

**5.5.4: mm. 24-41**

Given the above discussions of hierarchical structure within the excerpt’s four component groups, let us consider the pivotal role of timbre-harmony $\text{VI}$ in the context of mm. 24-41 in its entirety. Figure 5.10 shows a hierarchical interpretation of mm. 24-41. To avoid the notational clutter which could arise from such a broadening of perspective, I have replaced the reductions of figures 5.7-5.9 with a list of the timbre-harmonies in the order they occur, and I have excluded immediate repetitions. For example, timbre-harmony $\text{VI}$ is only listed once, but is sounded three times in succession in mm. 35-36.

Figure 5.10: Hierarchical account of timbral-harmonic progression in mm. 24-41

The timbre-harmony $\text{I}$ on the downbeat of m. 24 is the most stable point in the first of the excerpt’s four main groups. This relaxes into the timbre-harmony $\text{I}$ that initiates the second group, and ultimately into the timbre-harmony $\text{V}$ of m. 32—the most stable point in the second group and the excerpt as a whole. The most stable timbre-harmony $\text{IX}$ in the
fourth group occurs on the penultimate quarter-note beat of m. 39, and is ultimately subordinate to the timbre-harmony $V$ of m. 32. Timbre-harmony $VI$, isolated in the third group, serves as a high-level fulcrum for the excerpt. Situated between more active groups, the third group can be heard as subordinate to either the previous or subsequent group. Such deep level duality may have guided Vivier’s choice to intensify the third group’s three repetitions of timbre-harmony $VI$ by instructing the strings to tremolo near the bridge. Also, the highest member of each timbre-harmony is played as a harmonic rather than as a stopped pitch after m. 35. Although such a subtle distinction is nearly inaudible in this lush context, it may reflect Vivier’s sensitivity to the pivotal formative role of timbre-harmony $VI$ in the progression.

In chapters 4 and 5 we have explored how the harmonic series can serve as an analytical referent when considering the relative timbral-harmonic tension expressed by discrete timbre-harmonies. In the opening section of “Partiels,” the primary agent of timbral-harmonic progression is a gradual incorporation of inharmonic partials that engenders a sense of timbral-harmonic entropy. My division of this entropic process into two stages suggests that EV could be useful in characterizing the first stage, which is entirely harmonic, but the flow of the opening process as a whole contradicts such an approach. The timbre-harmonies in the opening process of “Partiels” are deployed as a more-or-less periodic sequence of gestures. Each gesture is temporally subordinate to the initial gesture as a repetition of a functionally equivalent duration. This subordination is echoed in the timbral-harmonic domain according to a gradual dissolution of the harmonicity expressed in the first gesture.

Such coordination between temporal and timbral-harmonic cues drives the directed flow of the process as a whole and overshadows subtler distinctions between harmonic
timbre-harmonies. These distinctions assume a secondary role as unordered colorations orbiting the initial gesture in the first stage. As such, they help establish the opening gesture as a timbral-harmonic referent, but their differences are not salient enough to support an emergent timbral-harmonic hierarchy. In Lonely Child, cues like those which impel the opening process of “Partiels” toward inharmonicity are not present and distinctions between harmonic timbre-harmonies—distinctions roughly quantified as differences in EV—assume a more salient formative role.

Our deep-rooted sensitivity to harmonic frequency proportions can also explain the coherence of more polyphonic textures according to how correlations between pitches and overtones facilitate timbral-harmonic cohesion. For example, as discussed at the beginning of chapter 4, consider that two prevailing harmonicities—A#0 and C#2—anchor the two streams of timbre-harmonies in section I of Désintégrations. In chapter 6 we will explore additional applications of such timbral-harmonic cohesion by revisiting “Papillon I” and Mortuos plango, vivos voco, and then discussing the evolution of Magnus Lindberg’s “chaconne” technique over the course of a trilogy of orchestral works—Kinetics, Marea, and Joy.
CHAPTER 6:  
TIMBRAL-HARMONIC ANALYSIS III – COHESION

6.1: Cohesion and Coherence

In the last two chapters, we used the harmonic series as an analytical referent to explore how a conception of pitches as partials relates to our experience of timbral-harmonic progression. Although we accounted for how differences among the holistic identities of discrete timbre-harmonies facilitate a sense of timbral-harmonic progression, we have yet to discuss in any detail how parallels between pitches and partials relate to our experience of more polyphonic textures. In this chapter, I define and examine cohesion—a synchronic property of a sound’s component partials—and consider how it facilitates coherence—a diachronic property of musical texture that allows us to perceive different sounds as belonging to the same musical unit.

The meaning of cohesion as I define it here is broadly analogous to its scientific usage in discussions of the forces that cause molecules of the same substance to stick together. The component partials of a sound stick together, in a sense, when they are subsumed in the emergent identity of their parent sound. For sounds that feature overtones of a single fundamental almost exclusively, cohesion is strong because of the pitch-engendering and timbrally-enriching fusion we experience due to our deep-rooted sensitivity to harmonic frequency proportions. In sounds whose partials are not all overtones of a single fundamental, inharmonic disruptions of harmonicity weaken the cohesion of their component partials.\(^1\)

The distinction between cohesion and coherence rests on a distinction between aspects of our auditory cognition that are discussed by Albert Bregman. “Sequential integration” is how we hear sounds in succession as being part of a coherent musical unit (e.g., successive notes in a melody). “Simultaneous integration” is how we hear concurrent sounds combine to express a cohesive gestalt identity. In “special cases,” writes Bregman, simultaneous integration is more aptly labelled “spectral integration” since our deep-rooted sensitivity to harmonic frequency proportions is central to the way we hear sounds in combination.² Bregman relates sequential and simultaneous integration to the musical notion of “horizontal” and “vertical” dimensions. Sequential integration allows us to hear “horizontal” groupings across time (e.g., melodies, phrases, sections, etc.). Simultaneous integration, in contrast, allows us to hear “vertical” chords as singular musical events.³

The last two chapters were focused on how the spectral integration of pitches/partials in timbre-harmonies—a specific sort of simultaneous integration—allowed us to sequentially integrate them into hearings of timbral-harmonic structure. Many of the examples we considered—especially Lonely Child and Désintégrations—fit well with this analytical demonstration of the musical relevance of such cohesion. Specifically, he raises the intriguing issue of how we group, or fail to group, inharmonic partials in ways that are tied to our deep-rooted sensitivity to harmonic frequency proportions. Unlike a composite of two harmonic spectra, a composite “of two inharmonic spectra is not easily resolved into two distinct sources and often results in vague or ambiguous sense of pitch, or sometimes the chimerical perception of more than two illusory sound sources.” (Ibid., 367).

³ Ibid., 31. We encountered a similar musical distinction between “horizontal” and “vertical” in our discussion of Schenker’s criticism of Rameau in chapter 3.
strategy because of their mostly homophonic texture.

The Grisey examples—“Prologue” in chapter 2 and “Partiels” in chapters 2 and 4—do not fit so well because they are not homophonic. I did interpret the opening section of “Partiels” homophonically because the boundaries between its component timbre-harmonic gestures are clearly articulated, and the gestures are quite similar in terms of texture and duration. Unlike “Partiels,” however, “Prologue” lacks musical cues that would allow us to parse it into discrete timbre-harmonies. Instead, my discussion of “Prologue” focused on the articulation of events whose coherence—the perception that they belong to the same musical unit—rested on two important factors: our sequential integration of a flexibly realized cycle of events, and how the overtones of a single harmonic series caused a series of successive iterations of the cycle to cohere as components of a musical section. In other words, the cohesion of overtones amplifies the coherence of discrete gestures in “Prologue.” The “vertical” organizing force of spectral integration reinforces the “horizontal” organizing force of sequential integration, and supports a hearing of the gestures as components of a cycle. Furthermore, our capacity for spectral integration allows multiple iterations of this cycle to cohere at a deeper level because each iteration exclusively features overtones of the same harmonic series.

In this chapter, let us explore further how spectral integration can contribute to the “horizontal” coherence of music. Instead of focusing on discrete timbre-harmonies, as in previous chapters, we will discuss how the cohesion among partials in timbral-harmonic fields is a primary agent of coherence in some spectral music. We will begin by reconsidering two works from chapter 2—“Papillon I” and Mortuos Plango, Vivos Voco—in terms of how our “horizontal” capacity for spectral integration relates to a coherent reading
of the works’ structures. Then, we will consider how Magnus Lindberg developed his “chaconne” technique to take advantage of spectral integration, and bolster the fragile coherence of *Kinetics, Marea*, and *Joy*—works whose supple resonance, at times, soothes the chaos of densely woven polyphonic textures.

**6.2: “Papillon I”**

“Papillon I,” as we discussed in chapter 2, features five distinct zones of activity, and we referred to these as the work’s five component gestures. In light of Saariaho’s thoughts on the traditional roles of timbre and harmony, we considered two different hearings of the work—tonal and timbral-harmonic—but stopped short of considering their relative merits. Let us resume this discussion by considering how we can interpret the discrete events of each gesture as cohering into both a series of harmonies in a tonal hearing, and—with the cohesion of overtones in mind—a series of timbre-harmonies in a timbral-harmonic hearing. Then, let us discuss how hierarchical structures expressed in both hearings—individually and in tandem—may affect one’s experience of “Papillon I.”

**6.2.1: A Tonal Hearing of “Papillon I”**

Figure 6.1 shows how a hearing that privileges triadic tonal relationships informs an interpretation of the piece as, overall, a tensing motion from gesture 1 to gesture 5 engendered by a shift in tonal center from D to A. Although there is no return to D, A may be heard as subordinate to it if one defers to traditions of tonal harmony and perceives the first tonal center as “home.” Gestures 1 and 2 establish a [C#, D, E] trichord with D realized as

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4 Given our discussions of timbral-harmonic structure since chapter 2, I will use “timbral-harmonic” instead of “tone-representative” to describe the alternative to the tonal hearing of “Papillon I” in this chapter.
the lowest pitch. F# replaces D in the third measure of gesture 2 and (in the context of Gesture 1) suggests an incomplete triadic structure: Dmaj9—a tonic harmony missing a fifth. In the fourth measure of gesture 2, a tremolo on G and B signals a tensing motion to Gmaj7—a subdominant harmony with respect to the opening D major, also missing a fifth. Gesture 3 opens with a combination of pitch-classes from the opening harmony but settles on a tremolo between G and B with a stable D filling in the previously missing fifth of the subdominant harmony. A tremolo between C# and E eventually replaces the tremolo between G and B, while D sounds steadily throughout. By the end of gesture 3, the incomplete Dmaj9 from the opening is all that remains.

Figure 6.1: Hierarchical interpretation of a tonal hearing of “Papillon I”

The return of the opening harmony completes a neighbor figure and the intervening subdominant sonority can be heard as subordinate to either the opening sonority or its return—a perceptual duality reflected by a dashed line in figure 6.1. Personally, I find the local relaxing motion from subdominant to tonic in gesture 3 less salient than the influence of
tensing motion at two levels over the course of the first three gestures. Locally, a tonic chord progresses to a subdominant. At a deeper level, the tonic chord recurs and is subordinate to the opening in that it confirms, but does not initiate, tonic function.

Gesture 4 begins with the opening harmony, but by the end of its first measure B and F# replace E and C# and suggest a pivot toward A as a new tonal center—a pivot ultimately confirmed by the introduction of G# in gesture 5. The F# soon drops out and a harmonic glissando leads to an A below an incomplete Bm triad—a voicing that evokes a common third inversion of the supertonic seventh chord, which would in turn create expectation for a first inversion dominant sonority. Indeed, a tremolo then highlights the perfect fourth between A and D in this voicing, suggesting a 4-3 suspension (A-G#) over the implied root of an incompletely realized dominant harmony, and foreshadowing the eventual confirmation of A as the new tonal center with the resolution of D to C#.

Gesture 5 opens with a restatement of the opening trichord. Resolutions foreshadowed by the end of gesture 4—A-G# and D-C#—are then realized in unexpected ways. After E drops out of the opening trichord, D and C# remain. A fingered tremolo on the first string produces an airy fluctuation between C# and G# while a glissando on the adjacent string drags D down to C#. Despite its location in a distant upper register, the entrance of G# confirms A as a new tonal center and, along with the glissando from D to C#, fulfills, to some extent, tonal harmonic expectations established in gesture 4. The noisy timbre of increased bow pressure amplifies the ambiguity of these resolutions. Though distorted, a sense that the resolutions of gesture 5 follow logically from the harmonic implications of gesture 4 support a perception of C#—heard on its own in three octaves at the end of the piece—as a mediant rather than a tonal center in its own right. Moreover, the hearing of this
resolution to C# as a mediant of A rather than a new tonal center is confirmed by the repeated A3s that follow immediately and initiate the subsequent movement of the work.

Hierarchically, the tonal shift initiated in gesture 4, and confirmed in gesture 5 and the opening of “Papillon II,” is a series of relaxing motions toward a new tonal center. The tonic chord at the beginning of gesture 4—a continuation of the harmony that ends gesture 3—serves as a pivot because subsequent motion away from the prevailing tonal center triggers a reevaluation of its hierarchical role. A dashed line in fig. 6.1 shows the result of this reevaluation: a subdominant subordinate to the subsequent supertonic and, ultimately, the new tonic.

6.2.2: An Alternative Timbral-Harmonic Hearing of “Papillon I”

An alternative hierarchical interpretation arises from a timbral-harmonic hearing of pitches as overtones of fundamentals. Although the fundamentals are physically absent, they provide anchors that allow us to discuss the cohesion of pitches/partials in the work. Despite salient triadic sonorities, the prevalence of harmonics and ephemeral artifacts of tremolos strongly supports the coherence of sounds within zones of activity—the five component gestures of “Papillon I.” The overtone content of the gestures, along with temporal cues that suggest further parsing of timbre-harmonies within gestures, contribute to the emergence of a timbral-harmonic hierarchy based on the relative timbral enrichment—roughly measured as enrichment values (EVs) as in the previous chapter—of timbre-harmonies that realize a

5 Despite the tonal link described here, I hear the main formative cues in “Papillon II” as rhythmic rather than timbral-harmonic. My analysis of “Papillon II” is given in the following article: Christopher Gainey, “Three Approaches to Modularity in Contemporary Music,” Perspectives of New Music 55/2 (2017): 153-158.

succession of fundamentals that supports, in contrast to the tonal hierarchy, an overall relaxing motion, as shown in Figure 6.2.\(^7\)

Figure 6.2: Hierarchical interpretation of a timbral-harmonic hearing of “Papillon I”

Gesture 1 features three overtones of a D2 fundamental—D2\(^*[8, 15, 18]\)—and these are members of three different overtone classes—D2\(^*[1, 9, 15]\). The opening of gesture 2 features the same overtone classes, but the fundamental is one octave lower and additional overtones contribute to a higher EV. Though gesture 1 and the opening of gesture 2 share pitches, the inclusion of E4—an overtone of D1 (D1\(^*9\)) but not of D2 (D2\(^*4.5\))—triggers a

\(^7\) The procedure used to calculate EVs for the timbre-harmonies in “Papillon I” is nearly identical to the method used to calculate EVs for Lonely Child’s timbre-harmonies in chapter 5. The only difference is in the number of salience multipliers. Since the timbre-harmonies of “Papillon” are comprised of overtones no further removed from their primes than four powers of two, I used five integers as salience multipliers, reducing the integer value with each successive octave level. For Lonely Child, I used six multipliers because the excerpt included overtones removed from their primes by five powers of two.
commensurate reevaluation of the remaining overtones. The C#6 and E6 of gesture 1—D2*(15, 18)—become higher multiples—D1*(30, 36) of their respective overtone classes in gesture 2 as a result, and thus manifest the contributions of their overtone classes more weakly.

Gesture 2 settles on a timbre-harmony whose overtone class content—G1*(1, 5, 15)—suggests greater stability than the opening timbre-harmony [D2*(1, 9, 15)] in that G1*5 replaces the less resolved D2*9 of gesture 1. Indeed, G1*[8, 10, 15] with EV = 97 is less enriched than the opening D2*[8, 15, 18], whose EV = 113. Two factors, however, override this timbral distinction. First, G1*8 is a relatively distant member of G1*I so does not stabilize the timbre-harmony very much. The same is true of the D2*8 in gesture 1. But, unlike the D2*8 in gesture 1, a tremolo at the end of gesture 2 that includes G1*8 undermines its relatively weak stabilizing effect so much that it counters the stabilizing effect of G1*5 in relation to D2*9. Second, the eventual return of the opening timbre-harmony at the end of gesture 3, which I will discuss below, causes me to hear the first three gestures as prolonging the opening timbre-harmony.

In light of these two factors, I hear gesture 1 and 2 to realize a tensing motion instead of a relaxing motion as implied by their difference in EV. An intervening evocation of a D1 fundamental—realized rather briefly as an initiating flurry of activity in gesture 2—is locally subordinate as an anacrusis to the subsequent timbre-harmony with a G1 fundamental.

An alternative hearing of this E4 could be as an inharmonic partial, thus allowing the prevailing fundamental to remain the same from gesture 1 through the beginning of gesture 2. To my ear, the ephemeral nature of string harmonics encourages a holistic hearing that privileges spectral integration. As a result, I chose to analytically integrate every pitch in the work as an overtone of some fundamental.
Similarities to the timbre-harmony of the opening—same overtone class content, octave-related fundamental—create a subsidiary sense of retrospective connection rooted in the perception of the opening of gesture 2 as a timbral-harmonic enrichment of gesture 1. Dashed lines with filled-circle connectors show such subsidiary connections between related timbre-harmonies in figure 6.2.

Like gesture 2, gesture 3 opens with an enrichment of the timbre-harmony that ends the preceding gesture. This anacrustic flurry of pitches pushes towards a recurrence of the opening timbre-harmony and so completes a larger tensing motion that involves the entire piece to this point. This coincides with the recurrence of the “tonic” that serves as a harmonic pivot in the tonal interpretation discussed above (see fig. 6.1) and the music after this point in both interpretations is a series of tensing motions subordinate to the ending. Unlike gestures 2 and 3, gesture 4 is not broken down into two-timbre-harmonies because all its constituent pitches approximate overtones of the same fundamental. Gesture 5 is broken down into three timbre-harmonies that progressively relax. The overtone class content of the first of these timbre-harmonies—$D1^\#(1,9,15)$—is slightly more resolved than the second—$D2^\#(1,11,15)$. Moreover, the second timbre-harmony in gesture 5 has a higher EV (121 vs. 108). But the entrance of the first stopped pitch of the work in the second timbre-harmony, along with a preference for higher fundamentals as in the previous chapter, causes me to hear the second timbre-harmony of gesture 5 as less tense than the first. My hearing of the second timbre-harmony of gesture 5 as relaxing into the third is rooted in more resolved overtone classes—$C#4^\#1$ as compared to $D2^\#(1,11,15)$—a much higher fundamental, and an intervening noisy increase and clarifying decrease in bow pressure.
6.2.3: Integrating Timbral-Harmonic and Tonal Hearings of “Papillon I”

There are many similarities between these tonal and timbral-harmonic hearings of “Papillon I” but there is one substantial difference that raises questions about how the hearings are compatible. In a tonal hearing, the C# at the end of the piece is a mediant that confirms A as the new tonal center. In a tone-representative hearing, this C# is the most stable point in the work, because it contains only members of C#4*1. The opening is subordinate to it; it is not a “mediant” of anything. Such a contradiction suggests that listening strategies founded on tonal vs. tone-representative hearings of “Papillon I” may be mutually exclusive, at least with respect to interpretation of some events. (The two perspectives may align quite well for other events.) Just as in our discussion of section VIII of Désintégrations, however, the different hierarchical interpretations of figures 6.1 and 6.2 can be integrated as coordinated accounts of a field of forces that act on perception in more than one way.

As a setting for this coordination, recall the more subjective account of form in “Papillon I” discussed in chapter 2—an expository narrative in which ephemeral harmonics coalesce into the more stable sound of bowed notes. This narrative aligns with the timbral-harmonic reading of a relaxing motion and suggests that it is more appropriate than a tonal hearing. Nevertheless, tonal implications affect one’s experience of this relaxing motion in a curious way. Both hearings identify fundamental/root motion from D to G but only a tonal hearing shows this motion counterbalanced in pc-space by a subsequent move from D to A. Although the focus on C# in three octaves at the end of the piece creates timbral stability through its emphasis on C#4*1, one is left with the harmonically unstable impression that these C#s are subordinate to an A implied at a deep structural level—a perception and
commensurate sense of arrival audibly confirmed by the repeated A3s that initiate the subsequent movement of the work.

The cohesion of partials allows us to hear five zones of activity in “Papillon” as five coherent timbral-harmonic gestures. Indeed, the gestures are so clearly articulated that one could imagine that they would be immediately distinguishable even without such cohesive reinforcement. But the cohesion of partials allows each gesture to take on more specific formative roles. Our spectral integration of each gesture serves as the basis for our sequential integration of them into a hearing of overall structure.

6.3: Mortuos Plango, Vivos Voco

Our capacity for spectral integration relates to how we experience Jonathan Harvey’s Mortuos Plango, Vivos Voco in a more dispersed sense. To appreciate this subtle relation, let us reconsider how Harvey used a bell spectrum as a compositional resource. As shown in figure 6.3—a reproduction of figure 2.10—Harvey calculates characteristics of each of the work’s eight sections according to frequency proportions expressed by eight “pivot” partials (fig. 6.3b) drawn from a bell spectrum (fig. 6.3a).

Harvey’s use of the bell spectrum as a transformational guide (see fig. 6.3c) limits the work’s pitch intervals (as reflected by numbers above the staff in figs. 6.3c and 6.3d) to those that approximate the bell spectrum’s constituent frequency proportions. A set of eight fixed pitches—each an approximation of a pivot partial (fig. 6.3b)—anchor the transformations (compare figs. 6.3c and 6.3d), and establish an audible reference point particular to each section. In other words, a spectral intervallic constraint on the work as a whole supports a hearing of eight separate sections as components of a coherent whole —each of which hovers around a different point in pitch space.
For Harvey, referring to a bell spectrum for the derivation of both background structural proportions and surface events dramatizes the interplay of “semiotic” and “symbolic” aspects of aural perception. “Symbolic” pitch structures interact and evoke “semiotic” timbral sensations associated with the particular mix of inharmonic and harmonic frequency proportions in a bell spectrum. Harvey similarly refers to the bell spectrum to

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calculate pulsation speeds and section durations. These “symbolic” background features are not as salient as foreground events. Although pulsation speed and section duration are proportional to features of the source spectrum, it is difficult, if not impossible, to consciously appreciate this link.

Longer sections allow more time for listeners to settle into “symbolic” interactions of pitch structures tied to an invariant pitch. Within sections, slower pulsation speeds create a less active background texture than faster pulsation speeds. In light of these observations, let us posit that, just as lower overtone classes are more resolved, longer sections and slower pulsation speeds are more stable. Since frequency proportions further from the bourdon create shorter sections and faster pulsation speeds, the relationship between each pivot partial and the bourdon can be used as a rough measure of each section’s role in establishing a background hierarchical structure.10

Harvey’s use of “semiotic” and “symbolic” is problematic. His citation of Julia Kristeva suggests that her usage of these terms is the nearest philosophical correlate. For Kristeva, “symbolic” reflects how language expresses “orderly meaning,” while “semiotic” reflects how language evokes a “feeling, desire, or unconscious drive.” [Noëlle McAfee, Julia Kristeva (New York: Routledge, 2004),14-18]. For Harvey, harmony refers to the “symbolic” ways in sounds can be organized to express “orderly meaning.” Given the comparative ease with which we are able to perceive timbral differences, timbral perception is more of a “feeling.” But the parallel falls short in one important respect. Our timbral perceptions, especially in works like Mortuos Plango, Vivos Voco whose formative coherence (i.e., its expression of orderly meaning) relies on conflations of timbre and harmony, function “symbolically” according to Kristeva’s use of the term. With regard to Mortuos Plango, Vivos Voco, the church bell spectrum that serves as the work’s foundation imbues the piece with a “symbolic” bell-ness, that may, for example, evoke “semiotic” spiritual sensations in some listeners.

10 As discussed in chapter 2, **bourdon** is a useful alternative to **fundamental** when discussing perceptibly
As shown in figure 6.4, the background structure of *Mortuos Plango, Vivos Voco* is a relaxing motion between its two most stable sections. Section I, whose pivot is twice the frequency of the bourdon, relaxes to the more stable section VIII, whose pivot is equal to the bourdon. Six intermediate sections—all less stable than sections I and VIII—compose out this deep level motion toward stability. The local stability of sections I and III suggests a grouping of the first four sections into a pair of tensing motions, the second of which (III – IV) is subordinate to the first (I – II). In contrast, successive tensing motions between V – VI, VI – VIII, and VII – VIII form a larger group. The peak instability of section V—a quality whose structural significance comes into focus with each subsequent relaxing inharmonic spectra that still express a more-or-less clear pitch.
motion—overshadows the local tensing motion from section [V] and establishes a climactic formal lynchpin that triggers an inexorable progression toward the peak stability of section [VIII].

Though this background structure is not the most salient feature of Mortuos Plango, Vivos Voco, it provides a useful perceptual scaffold—a “skeleton,” to again borrow a bodily metaphor from Grisey, that supports the “flesh” and “skin” of foreground events.\textsuperscript{11} Since the background structure arises according to the way Harvey mines the source spectrum, characteristics of the source spectrum seep, at least “symbolically,” into the work’s very foundations. These “symbolic” features—pulsation speed, section duration, invariant pivot pitch—distinguish each section and allow us to sequentially integrate them as components of the work.

Across sectional boundaries the music provides little in the way of perceptible associations between events (e.g., recurring motives), and yet the sections are not completely disconnected. As mentioned above, the interval content of the entire work is limited to intervals that approximate frequency proportions of the bell spectrum. The consistent adherence to these intervals—despite their realization at different pitch levels according to the invariant pivot pitches of each section—imbues every section with similar “semiotic” sensations of “bell-ness” that lend the work a compellingly organic coherence. This coherence is rooted in the cohesion of the bell spectrum’s partials. Certainly, their cohesion is weaker than that of overtones in purely harmonic spectra, due to their mix of harmonic and

inharmonic partials. Given the active textures in the piece, however, such loose cohesion seems particularly appropriate as a timbral-harmonic model. Bell sounds, like Mortuos Plango, Vivos Voco, express gestalt timbres (i.e., “bell-ness”) while also allowing one to hear out the interplay of their component partials with relative ease.

Although “Papillon I” does not feature discrete timbre-harmonies, it does feature five gestures whose clearly articulated boundaries allow us to treat them analytically much as we would if the texture were more homophonic. We spectrally integrate each gesture, and this affects how we sequentially integrate them as an expression of timbral-harmonic structure. In contrast, the more complicated foreground of Mortuos Plango, Vivos Voco makes it difficult to parse surface activity in a similarly straightforward manner. Our capacity for spectral integration nevertheless informs our hearing of the work’s structure. To appreciate this, we zoomed out to a broader analytical perspective. We considered how the work’s structure was compositionally derived from a bell spectrum, and how this compositional strategy operationalized the delicate cohesion of its partials in a way that provides a rather robust timbral-harmonic foundation for the work. Let us maintain this global perspective and explore how another composer’s compositional strategy has evolved to take advantage of the cohesion of partials as a formative timbral-harmonic force.

6.4: Magnus Lindberg’s Chaconne Technique

6.4.1: Twelve-Note Chords

Many of Magnus Lindberg’s works are founded on cycles of complex chords. Like Witold Lutoslawski, Lindberg often deploys chords in his music that include all twelve pitch
classes, differently distributed (hereafter “twelve-note” chords). Figure 6.5 provides examples of this correlation, and highlights an important difference in terms of intervallic structure. Figure 6.5b shows a twelve-note chord from Lutoslawski’s *Symphony No. 2* (1967), and figures 6.5a and 6.5c show two twelve-note chords from the chaconne cycle at the heart of Lindberg’s *Kinetics* (1988-89).

As figure 6.5 shows, Lutoslawski’s chord and both of Lindberg’s chords consist of complementary manifestations of the same hexachordal set class, symmetrically arranged around an axis point in pitch space. Letter names in a circle between the component hexachords of each twelve-note chord denote this axis point. The pitches of Lutoslawski’s chord, for example, are symmetrically arranged around an axis between E4 and F4. In terms of the intervals between adjacent pitches in the chords, however, Lutoslawski’s chord is more rigidly constrained than either of Lindberg’s chords. Although the chords are equally saturated with pitch classes, such a systematic arrangement allows them to express an emphasis on some interval classes over others. Lutoslawski’s chord (fig. 6.5b) constrains the intervals between adjacent chord tones to two, five, and seven semitones, emphasizing just two interval classes—ic2 and ic5. The eleventh chord from the chaconne cycle of *Kinetics* (fig. 6.5c) is quite similar to Lutoslawski’s since it features a complementary pair of hexachords from the same set class, but Lindberg’s voicing emphasizes an additional interval class (ic3).

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Interval class emphasis is even more evenly distributed in the seventh chord from *Kinetics* (fig. 6.5a), whose adjacent chord members manifest all but one (ic4) of the six possible 12TET interval classes.

For Lutoslawski, the intervallically constrained construction of his chords creates appreciable contrast. One is more able to aurally distinguish between complex twelve-note

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chords when their interval structures are differently constrained.\textsuperscript{14} Indeed, the combinatorial hexachordal symmetry of the chord in figure 6.5b may be a symptom of Lutoslawski’s intervallic control rather than a procedural preference, because many symmetrical twelve-note chords can be generated according to such intervallic constraints. Lindberg, on the other hand, seems to prefer hexachordal symmetry over the contrast-enhancing effect of intervallic constraints.\textsuperscript{15} As a result, Lindberg’s twelve-note chords often, as in figure 6.5a, exhibit a more varied interval class emphasis than Lutoslawski’s, and this interval-class saturation can make it difficult to hear the differences between his twelve-note chords. Instead of a kaleidoscopic interaction of distinct colors, if you will, one is faced with an effervescent but essentially homogenous sheen.

6.4.2: Hearing Twelve-Note Harmonic Fields

Lindberg uses his chaconne cycles as compositional blueprints for his cyclic deployment of harmonic fields (unordered pitch sets). This is a relatively straightforward and quite useful compositional strategy because, as in other systematic means by which composers organize pitches, fixing the pitch content allows Lindberg to concentrate on the expressive possibilities and structural salience of other parameters. Lindberg’s consistent use of active polyphonic textures, however, can make it difficult to perceive his chaconne principle at work because it is difficult to hear boundaries between complex harmonic fields among such an abundance of surface activity, especially when consecutive fields share pitches. For example, Kraft (1985)—an outsized orchestral work—is impressive in scope but

\textsuperscript{14} Ibid., 63.

\textsuperscript{15} Martin, “Harmonic Progression in the Music of Magnus Lindberg,” 8-9.
can be an overwhelming experience. The struggle to gain perceptual traction amid the work’s layers of noisy percussion and jagged instrumental lines is not entirely unpleasant. Indeed, it allows one to focus on Lindberg’s particularly supple and idiosyncratic orchestration. Despite arresting moments of instrumental and textural blend, however, it is difficult, if not impossible, to perceive the work as perceptibly organized by a foundational chaconne cycle.

Figure 6.6: Deployment of chaconne cycle in mm. 1-11 of Twine (from Martin 2005)

A similar lack of perceptual cues makes it difficult to parse Twine (1988)—a more

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economical application of Lindberg’s chaconne principle for solo piano. Figure 6.6 reproduces Edward Martin’s segmentation of the first eleven measures of the piece and shows how a foundational cycle of eight symmetrical twelve-note harmonic fields is first realized in the work. Some of the harmonic fields overlap (e.g., chords 4 and 5) and even those that do not (e.g., chords 1 and 2) provide few perceptual cues (e.g., stark textural contrast) that could support one’s perception of a boundary between them. With repeated listening one is able to hear nebulous zones of greater surface activity that roughly map onto the succession of harmonic fields. For example, the lower attack density of measure two in relation to measures one and three highlights, though not very specifically, a boundary region between chords 1 and 2. Unlike “Papillon I,” wherein zones of surface activity are clearly articulated, the boundaries between zones of activity in Twine are quite ambiguous, as is the formative salience of the links between these zones and the work’s foundational chaconne cycle.

Though a lack of perceptible boundaries between harmonic fields makes it difficult to hear the chaconne cycle as formative, repetitions of the cycle engender a somewhat predictable trajectory according to differences in the axes and registral extremes of the symmetrical twelve-note chords. Figure 6.7 shows the contour traced by these axes and registral extremes across the cycle. The reiteration of the contour takes on a formative role in a work with few other salient formative cues. The axes of the harmonic fields form a curve that maps onto my hearing of Twine quite well, at least in terms of a rather faint sense of the

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music inhabiting regions of registral space in a roughly cyclical pattern. But the pitch and interval class saturation of these harmonic fields undermines my ability to distinguish them. Instead, I hear a chromatically saturated and essentially undifferentiable river of pitches flowing between the banks of changing registral extremes.

Figure 6.7: Contour of axes and registral extremes of the chaconne cycle from *Twine*

Although the experience is thrilling, subsequent developments in Lindberg’s harmonic language suggest that he was searching for a way to establish more perceptible distinctions between harmonic fields in his music, while still indulging his apparent predilection for frenetic polyphonic textures. Let us explore how his subsequent incorporation of “overtone chords” into his harmonic vocabulary in a trilogy of works written just after *Twine* (1988)—*Kinetics* (1988-89), *Marea* (1989-90), and *Joy* (1990)—provides a means for hearing events, structured cohesively like harmonic series, cohere into distinct complex harmonic fields.

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19 Ibid., 2.

20 Peter Szendy, “Interview with Magnus Lindberg,” in *Magnus Lindberg*, ed. Risto Nieminen, trans. Nick LeQueux (Paris: Editions IRCAM, 1993), 17. “…my works are like islands grouped around a major project…another archipelago would be formed by the orchestral triptych *Kinetics, Marea, and Joy.*” I find the
Lindberg, though not considered a typical composer of spectral music, was exposed to the trend via his studies with Grisey. It may have been this connection that led him to rein in his twelve-note harmonic vocabulary by conceiving harmonic fields as comprised not just of pitches, but also of overtones. Kinetics, the first-composed work in the trilogy, features a chaconne cycle of twelve symmetrical twelve-note chords (two of these are shown above as fig. 6.4a and 6.4c) that are deployed together with overtone chords whose pitches correlate to overtones of a single fundamental. Lindberg deploys twelve-tone chords and overtone chords as, essentially, foreground and background textural layers. Although the overtone chords are not all subsets of the same harmonic series (i.e., comprised of overtones of the same fundamental), the cohesion of overtones in the overtone chords creates a resonant timbral background as twelve-tone symmetrical harmonic fields writhe in the foreground. Lindberg enhances the cohesion of the overtone chords’ pitches by mapping overtones onto the nearest quarter-tone, rather than semitone, thus producing closer approximations of

connotation of “triptych” a bit uncomfortable since I associate the term with three-paneled paintings meant to be viewed together. Since I enjoy these works on their own as well as in succession, I prefer Julian Anderson’s somewhat looser description of these three works as a “trilogy” (Anderson, “The Spectral Sounds of Magnus Lindberg,” 566).


22 Ibid.


24 In addition to their audible distinctions, the overtone and twelve-note layers of Kinetics are distinct in a more nominal sense that demonstrates their separate roles in the work. The twelve-note chords are, as one might expect, comprised of 12TET pitches, and the overtone chords are quantized to the nearest quarter-tone (24TET).
harmonic frequency proportions.

Although the dense chromatic pitch content of both layers causes them to blend intermittently, the twelve-note harmonic fields are orchestrated more prominently, and are more rhythmically active. These factors create an audible distinction between overtone and twelve-note layers in a general sense, but their separate roles are maintained at an even deeper structural level. The twelve-note chords of the foreground chaconne cycle are not paired with specific fundamentals. Instead, harmonic series conceived separately from the foreground twelve-note harmonic fields form reservoirs of pitches from which Lindberg draws the overtones that populate the overtone chords of the background.

In the next work, Marea, overtone and twelve-note chords coexist in a different way. Unlike Kinetics, wherein the twelve-note foreground is conceived and deployed separately from the overtone background, eight harmonic series—now approximated to the nearest semitone rather than quarter-tone for practical reasons—are linked respectively to each of the eight twelve-note chords in Marea’s foundational chaconne cycle. Moreover, each of the eight harmonic series is chosen so that its overtones map onto just the upper hexachord of its associated twelve-note harmonic field. Although this seems to rein in the possibilities for variation as compared to the separate overtone and twelve-note layers in Kinetics, an added benefit is that, at times, Lindberg is able to use an overtone chord in place of the twelve-note harmonic field because the consistent pairing supports the substitution. Conversely, Lindberg

26 Ibid., 62.
27 Ibid., 18, 30.
28 Ibid., 32.
occasionally omits overtones altogether, metaphorically presenting the skeleton without the flesh and creating the potential for enhanced timbral-harmonic contrast between chords with and without the added cohesion of overtones.

Although Lindberg does not maintain a sense of foreground and background in _Marea_ by treating overtones and twelve-tone harmonic fields separately, as in _Kinetics_, the lower hexachord maps onto inharmonic partials that disrupt harmonicity, even when many overtones are present to add their cohesive influence. This disruption weakens the cohesion of overtones and undermines the sense in which successive harmonic fields cohere as components of the work’s timbral harmonic foundation.

For _Joy_, the final work in the trilogy, Lindberg loosens his technique considerably. As in _Kinetics_ and _Marea_, he uses collections of pitches that approximate overtones from a single harmonic series. In _Kinetics_ these overtone harmonic fields are separate and provide a resonant background sheen. In _Marea_, twelve-note and overtone harmonic fields are partially combined. In contrast, the foundational chaconne cycle of _Joy_ is a series of harmonic series, which can be summarized as a series of fundamentals \{C1, E1, B♭0, F♯1, B1, A1, D1, E♭1\}, and does not include the twelve-note harmonic fields of _Kinetics_ and _Marea_. As I will show, however, the exclusive use of harmonic series in _Joy_ is not incompatible with Lindberg’s predilection for twelve-note chords. Furthermore, I will show how the adherence to a series of harmonic series in _Joy_ exploits the cohesion of overtones in a way that allows its foundational timbral-harmonic cycle to be the most coherent of the trilogy.

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Figure 6.8 shows a slightly condensed notation of the string parts from mm. 51-55 of *Joy*. This excerpt features the beginning of the first complete presentation of the work’s foundational chaconne cycle.\(^{30}\) The strings at this point in the piece provide a resonant background layer that, as in *Kinetics*, sets a stage for more active foreground events. But the coherence of different harmonic fields in this background lend the passage a palpable sense

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\(^{30}\) Ibid., 52. Szendy describes mm. 1-60 as an introduction that establishes C1—the fundamental of the first harmonic series of *Joy*’s foundational chaconne cycle—as a “key formal landmark.” My hearing aligns mostly with this assessment. There is a stark textural contrast at m. 60 that supports a perception that a new musical unit is beginning. Also, this rather abrupt change in texture aligns with the key formal landmark that signals the beginning of the foundational chaconne cycle—a C1 harmonic series. But the salient realization of the chaconne cycle in mm. 51-59—especially after the comparatively ambiguous timbral-harmonic structure expressed in mm. 1-50—causes me to hear a formal division at this earlier point. Ultimately, I have come to prefer a compromise. I hear the piece coalesce into a coherent timbral-harmonic cycle at m. 51, coming into sharper focus just prior to embarking on the next phase of the piece.
of timbral-harmonic progression that sets *Joy* apart from its companion works. A move from one harmonic field (i.e., harmonic series) to the next is cued by the basses who play low pitches that map onto members of \( F^*1 \) within their respective harmonic series. The first two of the basses’ pitches in mm. 51-55—C1 and E1—correspond to fundamentals (F*1), while the next two—B♭1 and F♯2—are both F*2, an octave higher than their fundamentals. The rest of the pitches in the excerpt are labelled with numbers that show their overtone ranks accordingly.

In addition to signaling moves between harmonic fields, the \( F^*1 \) overtones of the bass trigger a reevaluation of overtones held over these timbral-harmonic boundaries. This reevaluation is shown in figure 6.8 as dashed lines connecting overtone ranks across boundaries. In many cases, this reevaluation is fairly straightforward. For example, the B minor triad in the violins in m. 51 is C1*[9, 11, 15], but becomes E1*[7, 9, 12] after the bass triggers a change in harmonic field on the second quarter-note beat of m. 52. Occasionally, such “suspensions,” if you will, introduce a measure of inharmonic disruption. For example, the B♭2 of the cellos in m. 51 is C1*7, but becomes an inharmonic partial 5.5 times an E1 fundamental as it is held through m. 52, eventually “resolving” to a B2—E1*6—in m. 53. In addition to such “suspensions,” an overtone from the next harmonic field in the cycle will enter early as an “anticipation.” For example, the B♭2 of the cellos in m. 54 is E1*5.5, an inharmonic partial. When the bass initiates the next harmonic field later in the measure, this inharmonic partial becomes an overtone—B♭0*8.

The background mélange of overtones provided by the strings in mm. 51-55 can be audibly parsed as a progression of distinct harmonic fields because the use of harmonic series as harmonic fields exploits our capacity for spectral integration. But, unlike other works in
which Lindberg creates a clear division between foreground and background textures, the cohesion of overtones also enhances the coherence of surface activity. As an example of this, let us consider how foreground activity in the keyboards and winds in mm. 51-52 relate to the harmonic fields established in the background. Figure 6.9 shows these gestures against a very condensed representation of the background texture established mostly by the strings.

**Figure 6.9: Background Harmonic Fields and Foreground Activity in mm. 51-52 of Joy**

As in figure 6.8, numbers above the staff in figure 6.9 show each pitch’s correlated overtone rank within the prevailing harmonic series. Dashed lines show how these ranks are reevaluated when held over the boundary between harmonic fields. The winds in m. 51 (excluding the oboe) are part of the background in mm. 51, and their eventual emergence into the foreground in m. 52 is triggered by a brief and comparatively energetic burst in the keyboards. Indeed, the final pitch in the keyboard gesture—D5—is the first pitch in the winds’ gesture in m. 52, establishing an explicit link between them.

Not only does the D5 of m. 52 link the keyboard and wind gestures, it also has a
deeper significance in light of Magnus Lindberg’s preference for symmetrical pitch structures. The first staff of figure 6.10 shows a symmetrical structure around D5 that includes the pitches from the keyboard gesture of m. 51. The second staff shows how this structure manifests in the music. The pitches in the keyboard gesture partially realize this symmetrical structure, and pitches from the background fill in the gaps. Two pitches are not included in either the background or foreground. The first of these is C#4—the only pitch in this symmetrical structure that does not map onto a C1 overtone—and the second of these is C6, possibly omitted because it is the same pitch class as the prevailing fundamental.

The global perspective we have adopted in this discussion of one aspect of Lindberg’s compositional method does not afford us a very comprehensive view of the forces that govern the effervescent, and occasionally overwhelming, nature of Kraft, Twine, Kinetics, Marea, and Joy. It does, however, allow us to appreciate the development of Lindberg’s chaconne principle as an evolution toward greater timbral-harmonic cohesion, and the greater

sense of timbral-harmonic coherence this cohesion can support. While all these works feature complex and energetic polyphonic textures, the overtone chords of Kinetics create a fused background layer that provides a stable backdrop for foreground events. In Marea, Lindberg defers to our inherent tolerance for mistuning by abandoning the use of quarter-tones. He also takes more advantage of overtone cohesion by linking twelve-note harmonic fields to specific fundamentals. This allows the cohesion of overtones to contribute more directly to the coherence of the work’s harmonic fields, but the inharmonic partials included in these fields (i.e., the lower hexachord of each twelve-note chord) weaken this cohesion and ambiguating the coherence they help engender.

It is not until Joy that Lindberg achieves a more balanced comingling of twelve-note and overtone harmonic vocabularies. When approximating harmonic series to the nearest semitone, the result pitch collection is chromatically saturated above F*14. This means that if the lower intervals are carefully controlled to realize the more resolved components of each harmonic series then Lindberg is free, as evident in the excerpt discussed above, to indulge his penchant for symmetrical pitch structures above a certain point. Given his choice of low fundamentals, this freedom encompasses large swaths of the pitch domain in his music. Far from undermining a sense of timbral-harmonic coherence, the freedom of Lindberg’s chromatically saturated polyphonic layers in Joy is anchored by a foundational cycle of fundamentals. Our capacity for spectral integration allows us to hear Joy as more timbrally-harmonically coherent than earlier works even though its harmonic fields are deployed according to fewer constraints.

While the above discussion of Lindberg’s chaconne principle highlights important developments in his compositional strategy, it glosses over an important point: the chaconne
cycles are not always deployed in the same way. This is worth further study, specifically in light of a conception of how the cohesion of overtones facilitates timbral-harmonic coherence. In this project, we have used the harmonic series as an analytical referent to reveal and explain how spectral works express a coherent timbral-harmonic structure. Although we have focused primarily on how perceived differences between fused vertical structures create the horizontal momentum essential to an experience of timbral-harmonic progression, similar strategies can and should be developed to discuss in greater detail how our ingrained sensitivity to harmonic frequency proportions informs the horizontal coherence of polyphonic textures, and engenders similarly hierarchical experiences of timbral-harmonic progression.
CHAPTER 7: EPILOGUE – MUSIC COGNITION, THEORY, AND ANALYSIS

Murail has lamented that although the harmonic series has “often been invoked to justify this or that theory of music, a systematic study and conscious use of [its] characteristics is a recent development.”1 While my use of the harmonic series as an analytical referent is not the only way to explain musical perceptions, it does go some way toward addressing Murail’s concern and highlights the different ways that composers of spectral music conflate timbre and harmony, and suggests how one might listen to spectral music on its own terms.

The analyses in this project draw on shared aspects of human auditory cognition to identify factors that affect how one hears a number of spectral works. Although the analyses align with my own hearing, the complex nature of auditory cognition makes it unlikely that such analyses will predict another’s hearing of this music in a more than general sense. Precise predictions of others’ perceptions, however, are not a goal for this type of inquiry. Instead, the aim is to describe hearings attuned to the nature of phenomenologically ambiguous works and thus provide a backdrop against which other listeners might consider and enrich their perceptions.

A significant portion of our perceptions are unconscious in that they emerge from automatic cognitive processes, and our conscious perceptions are subject to our will to some extent. The recent good-natured fervor over an ambiguous audio clip—heard as “laurel” by some listeners and “yanny” by others—stands as compelling evidence of the influence of

both conscious and unconscious perceptions since they are different perceptions of the same stimulus.\(^2\) Although those who hear “laurel” can seem mystified by those who hear “yanny,” and vice versa, few doubt the relevance or existence of a perception other than their own. Some are more able than others to focus in a way that allows them some access to the opposite percept, but none, to my knowledge, have heard anything other than “laurel” or “yanny”—a dichotomy that says more about our shared cognitive capacities than our perceptual idiosyncrasies.

Some aspects of cognition are characteristic of our species (e.g., our ability to perceive a complex of overtones as a unified pitch) and these contribute to our emergent perceptions. Consider, for example, pareidolia: the perception of significant information in response to ambiguous or random stimuli.\(^3\) This phenomenon is most often experienced as a tendency to see faces (e.g., the man in the moon, deities on toast, etc.) and it is important to note that it is not a hallucination, but rather a misperception. Hallucinations, though perceived as external, do not reflect external stimuli and are symptoms of cognitive disorder.\(^4\) In contrast, misperceptions are erroneous interpretations of external stimuli—anomalous artifacts of healthy cognition that become detrimental only when we attach undue


\(^4\) With the exception of purposefully induced hallucination, as with psilocybin. Usually, this would not be worth mentioning, but recent efforts to adapt powerful psychedelics for therapeutic purposes suggests that temporary cognitive disorder may be beneficial to some.
significance or reality status to them. Rorschach tests, for example, which assess unconscious fixations in a therapeutic setting, capitalize on the universal ability to perceive patterns in random stimuli.

One’s experience of music “reflects the operation of a rich and multifaceted cognitive system.” Some of these facets, such as our ability to sense the unifying influence of a virtual fundamental, are capacities related to our more-or-less automatic processing of sound. Others, such as our ability to hear hierarchical relationships among musical events, are capacities related to our intellectual engagement with sounds and reflect the influence of “learned structural norms.” Robert Hasegawa, whose work has heavily influenced my analytical stance in this project, seizes on this dichotomy as an analytical strength. He invites his readers to appreciate their perceptions in light of those of a fellow human by sharing his perceptions—perceptions shaped by his own learned norms—through the inclusive lens of how deep-rooted “mechanisms of aural perception make sense of musical sound.”

Although Hasegawa does not prioritize his perceptions over those of his readers, an important question arises from his “pragmatic” approach. If an analysis is validated in some sense by how well it aligns with the analyst’s hearing, how does the analyst know that others are likely to hear this music in similar ways? What if, for example, the analyst is distracted

6 Ibid., 648.
8 Ibid.
from more musically significant features of a work by some sort of auditory pareidolia? I personally discarded a number of diverting misperceptions while studying the works cited in this project. Part of the strength of Hasegawa’s approach, however, is that he mitigates such ambiguities by expressing his perceptions in terms of shared perceptions emerging from universal cognitive tendencies.

Hasegawa’s pragmatic analytical stance resonates with Richard Parncutt’s assertion that music theory operates at a lower “level of precision” than more objective modes of inquiry. Given the vagaries of musical perception, such a distinction rings true but “lower level of precision” puts a rather negative spin on the comparison. In contrast, consider how an expression of the same distinction as “greater flexibility” favors music theory. Such connotations stimulate some reflections on some of the motivations, challenges, and benefits characteristic of rapprochements between music psychology and music theory.9

Musicians have long aspired to the rigor of scientific pursuits. Rameau considered music a “science which should have definite rules.”10 Grisey, centuries later, references a

9 “Music psychology” is a recurring label in some of the literature, as are “psychoacoustics” and “music cognition.” Although I have yet to find a resource that makes the distinctions clear, my understanding is that psychoacoustics is a discipline focused almost exclusively on the study of the link between acoustics and aural perception and is a sub-field of music cognition—a broader label encompassing the mental processing (implicit and explicit) of all aspects of musical sound. Music cognition is, in turn, a sub-field of music psychology which, in addition to psychoacoustic and cognitive issues, explores correlations between more traditional psychological concerns (e.g., emotion, personality, psychopathology, etc.) and participants’ responses to music. This Russian doll characterization is a little too tidy to be accurate, but I find it useful as a guideline in situations where the labels seem interchangeable.

“utopic desire for a musical language articulated on scientific facts.” Implicit in this “utopic desire” is a deferral to nature in the sense of those aspects of the physical world that transcend individual experience. What we are perceiving is natural, as are biological limitations on our perceptions, but acquired psychological predispositions—perhaps nurtured through cultural influence or specialized training—affect and diversify how individuals of our species attach meaning to it.\(^\text{12}\)

In a sense, the quantifiable aspects of sound are but shadows enlivened and substantiated by our qualitative experience of them. The recent passing of Pauline Oliveros invites renewed consideration of her life’s work in this sense. Although a comprehensive discussion of her ideas is beyond the scope of this project, it is worth noting that she advocates awareness of and sensitivity to the distinction between our ability to automatically gather information via the normal operation of our auditory system, and the subset of this information of which we are consciously aware.\(^\text{13}\) Incorporating such knowledge into the act of listening enriches our capacity for aural experience by encouraging us to not only attend to our perceptions but also appreciate the unconscious reactions which support them.

An interest in links between unconscious reactions and quantifiable features of sound is a recurring theme of psychoacoustic research and compelling correspondences have been


\(^{12}\) cf. Patel et al, “Experimental Evidence for Synchronization,” 827. One might assume such psychological predispositions arising from social interaction to be uniquely human. Interestingly, though, the ability to synchronize movements with a musical beat may be unique to “vocal learning species”—a group which includes seals, cetaceans, and some birds in addition to humans, but not nonhuman primates.

\(^{13}\) Pauline Oliveros, *Deep Listening: A Composer’s Sound Practice* (Lincoln: iUniverse, 2005), xxi.
found. For example, spectral centroid—a measure of “the relative weights of high and low frequencies” of sounds is strongly correlated with our perception of “brightness or nasality.”\textsuperscript{14} Such correlations, considered as coordinated timbral dimensions, reveal multidimensional “timbre spaces” whose complexity makes them difficult to apply to the practicalities of making and enjoying music.\textsuperscript{15} In this sense, intricate psychoacoustic models of timbre space highlight an epistemological difference between music theory and music psychology. Music psychologists’ efforts to factor in as much of the available data as possible does exhibit a greater “level of precision” than music theory, but such rigorous attention to detail often exceeds our capacity for conscious perception and makes it difficult to appreciate our agency as listeners. In contrast, analyses which describe the analyst’s aural experience according to universal tendencies of human auditory cognition assume this agency as fundamental to one’s appreciation of music.

Epistemological differences between music theory and music psychology highlight challenges inherent to reaching across this particular aisle. Robert Gjerdingen compellingly and entertainingly summarizes one of these challenges by drawing a parallel between music and the Wizard of Oz—a “living blend of art and artifice, of enthralling magic and cornball trickery.”\textsuperscript{16} The “continuing challenge for new research,” writes Gjerdingen, “will be to avoid oversimplifying the magic, to avoid reducing it to just a ‘man behind the curtain’

\textsuperscript{15} Ibid., 36-45.
pulling levers.”\textsuperscript{17} This challenge is daunting. The unconscious factors which influence our emergent perceptions of sound are so complex that study of them may postpone and/or overshadow intellectual considerations of their aesthetic effect.

Another challenge arises from efforts to study how universal tendencies of human auditory cognition map onto musical experience. Aniruddh Patel writes that “theories and research findings based solely on a single culture’s music are severely limited in their ability to tell us about music cognition as a global human attribute.”\textsuperscript{18} For example, it is tempting to assume that the major triad formed by $F^*$[4, 5, 6] explains the prevalence of major triads in Western music. However, “just a few hundred years ago,” writes Gjerdingen, “[the C major triad] could only be found in Europe.”\textsuperscript{19} If the major triad were as universal as its manifestation at the lower end of the harmonic series implies, then presumably it would be more common.

Studies geared toward explaining “music cognition as a global human attribute” are fascinating, but problematic. Efforts to control for the influence of cultural predisposition, musical training, and other complicating factors place stringent limitations on experimental methods. Carol Krumhansl asserts that “the methods necessarily interrupt the musical experience, so generalizations to more typical listening conditions must be made with caution.”\textsuperscript{20} If anything, “caution” understates the issue. If an aural stimulus designed for

\begin{itemize}
\item \textsuperscript{17} Ibid., 702.
\item \textsuperscript{18} Patel and Demorest, “Comparative Music Cognition: Cross-Species and Cross-Cultural Studies,” 648.
\item \textsuperscript{19} Ibid., 702.
\end{itemize}
experimental purposes is not aesthetically appreciable as music, then in what sense are reactions to it “musical?”

Music theorists have much to offer music psychologists in this area. Krumhansl writes that music theories “oriented toward psychological issues and informed by the experimental literature are valuable resources for the psychological study of music. In exchange, the experimental results can serve to refine theoretical proposals, offer complementary techniques, and explicate the psychological foundations underlying musical structure.” In other words, experimenters zero-in on testable claims, and music theorists—less constrained by objective scientific rigor—are uniquely situated to generate testable claims relevant to nebulous questions of musical experience.

Results from experiments designed to test such claims could inform refinements of analytical technology like the qualitative estimates of timbral-harmonic tension—InV and EV—developed and applied in chapters 4 and 5. Subsequent analyses could demonstrate the musical significance of such refinements, and, in doing so, generate more testable claims. In this way, music theorists and music psychologists can explore not only universal tendencies of human auditory cognition but also the diverse ways in which we convey musical meaning according to these fundamental similarities.

In addition to being of potential benefit to empirical research, the analyses in this project reflect an enriched aural experience relevant to music making. In this project, I considered musical ramifications of analytical observations through repeated focused listening to the analyzed works. Through these efforts, I became increasingly aware of how

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21 Ibid., 79.
unconscious mechanisms supporting timbral perception supported ineffable artifacts of my conscious efforts to hear out formative timbral-harmonic relationships.

For example, in chapter 4 I identified a core group of overtone classes in the C#2 series of timbre-harmonies from section I of Désintégrations and observed that it was richer than the core group from the A#0 series. Although this perception can be explained according to the interaction of overtones, its salience and formative influence demonstrates that Murail was able to translate, as Damien Pousset writes “one mode of sensory reception into another, going from the objectivation [sic] of a sensorial reality to notation.

Composition, inasmuch as it synthesizes and coordinates, implies its own readjustment of the different imperatives of coherence.”22 Murail exploits our “charmingly imprecise faculties of perception” and evokes imperatives of timbral coherence that enrich the sense of timbral-harmonic progression in the excerpt.23

Pousset’s description of composition is, perhaps, too reliant on physical sensation. Compare, for example, Roger Scruton’s argument that “sounds heard as music are heard in abstraction from their physical causes and effects, and assembled in another way, as individuals in a figurative space of their own.”24 Though these perspectives seem to be at odds, they resonate with the idea that a mental template corresponding to an acoustic phenomenon—the harmonic series—provides a cognitively efficient normative pattern against which we evaluate auditory information. Pousset’s “readjustment of the different


23 Murail, “Target Practice,” 156.

imperatives of coherence” and Scruton’s “figurative space” point to imperfect parallels between the physical world and the way we hear it—parallels anchored in ingrained cognitive tendencies such as our sensitivity to harmonic frequencial proportions.

Robert Hasegawa proposes a broad redefinition of timbre as “an emergent property of composite events” and the same could be said, even more broadly, of music in general. An increased understanding of what the components of composite events are and how we perceive their interactions is especially relevant to spectral music. The analyses in this project highlight “imperatives of coherence” particular to spectral works and can bring the picture of the “overall trend” of spectral music into sharper focus. Furthermore, analytical approaches similarly “oriented toward psychological issues and informed by the experimental literature” can inform practical developments useful to musicians.

The flexible analytical stance I have developed in this project is well suited to mediate between different modes of inquiry regarding questions of timbral-harmonic coherence and the expressions of hierarchical structure this coherence supports. Although my hearings of the analyzed works are unlikely to be identical to anyone else’s, they have emerged from a liminal zone between psychological and musical concerns. As such, my hearings highlight speculative and practical benefits of an increased sensitivity to the diverse interactions between conscious and unconscious factors that shape our perceptions and facilitate our ability to experience sound as music.

BIBLIOGRAPHY


