THE COMPOSITION OF TIMBRE:

A MULTIDIMENSIONAL APPROACH

IVONNE MICHELE ABONDANO FLÓREZ

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ABSTRACT

This study on timbre as a principal compositional resource in acoustic music seeks to develop a coherent approach to timbral complexity and its multiple dimensions. First, I work on a notion of timbre that responds to the process of interaction between the parameters of sound, their features, distribution, and development over time. Such interaction may be organised by physical and semantic associations that emerge out of the perception of particular timbral qualities. Furthermore, in this compositional approach, the piece itself is thought of as a percept, from a philosophical perspective: the final objective of the concept through which the timbral experience is modulated. Exploratory sessions with performers are the starting point for developing instrumental techniques. These are spectrally analysed to reveal how timbral components, such as loudness, dynamic envelope, pitch register, inharmonicity, or spectral centroid, are correlated to specific descriptors for the perception of timbre in terms of the three semantic dimensions proposed by Asteris Zacharakis, Konstantinos Pastiadis, and Joshua D. Reiss: luminance, mass, and texture. Through cross-modal perceptual associations with vision and touch these are the categories by which timbre is usually described. The adjectives for each dimension function as structural points according to the conceptual and metaphorical meanings attributed to each composition. This multidimensional approach accounts for diverse perspectives through studying the physicality, psychoacoustics, and semantics of timbre, leading to even more philosophical reflexions; these further enable a wider understanding of the timbral experience and contribute to the development of particular strategies and techniques for timbral composition.

KEYWORDS: *composition*, *timbre*, *luminance*, *mass*, *texture*, *multidimensionality of timbre*, *semantics of timbre*, *physicality of timbre*, *philosophy of timbre*.

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INTRODUCTION

From an etymological perspective, there seems to exist a long-standing confusion around whether timbre means the source of sound, the mechanism by which sound is produced, or the perceptual experience of sound itself.[1] Consequently, research on timbre as a resource for the composition of acoustic music has led me to deepen its meaning, constitution, behaviour, and perceptual associations. Influenced by composers and researchers from the fields of psychoacoustics and philosophy, I have worked on the construction of a notion of timbre that accounts for such complexity and allows me to develop a compositional approach in which each piece can be perceived as a particular timbral experience in itself.

It is important to clarify that in this research I propose a 'conversation' between different perspectives on timbre, from which it is possible to trace the development of a compositional approach that accounts for the correlations between semantics (metaphorical or conceptual lineaments), physicality (parameters and values), and philosophical aspects of timbre. The particular associations that emerge from these, apparently distant, readings allow me to move between them throughout the thesis to present an extended exploration and understanding of timbre as a compositional resource.

In the first chapter, I present timbre in a more philosophical mode as a percept, in an attempt to approach it as a *process* of interaction between the parameters of sound, perceived as a multidimensional and dynamic experience, which can be imagined, then created, developed, and modulated through the compositional approach. Therefore, I work from the correlations between descriptors for timbre and the acoustic conditions that determine its characteristics and physicality. Thus, each composition is developed through the study of *luminance*, *mass*, and *texture*, the three semantic dimensions of timbre proposed by Asteris Zacharakis, Konstantinos Pastiadis, and Joshua D. Reiss, who recognise them as the main categories in which timbre seems to be generally 'thought', described, and understood, which will be argued from literature in diverse fields. This psychoacoustic perspective is taken as the starting point for developing my own technical and conceptual compositional strategies. Therefore, the methodology involves a first stage of exploratory sessions with performers in order to discover new timbral possibilities from particular techniques and preparations with different kind of objects and materials. The recordings of

[1] Pierre Schaeffer approaches the transformation of these associations in the etymology of timbre in 'Playing an Instrument', in *Treatise on Musical Objects. An Essay across Disciplines*, trans. by Christine North and John Dack (Oakland: University of California Press, 2017), 31–45 (p. 34).

these explorations are analysed with specialised software to identify how the level of loudness and inharmonicity, the presence of upper partials, the pitch register, or the fluctuations of the spectral centroid can influence the perception of timbre according to each semantic dimension. This information is the basis for a classification of the instrumental techniques and development of specific structures that respond to a particular meaning attributed through metaphorical or conceptual associations.

The second chapter corresponds to the study of luminance through the compositional process of three pieces: *and it comes like a piece of light through the dust* (2018–20), for solo bass clarinet; *The Shimmer Beneath: A Scattering Attempt* (2019), for cello duo; and *Distorted Pieces of Something. Study on Light (when it rains)* (2019), for soprano saxophone and viola. Luminance has been understood as the dimension that describes timbre in terms of how brilliant it is, a concept I outline more fully below. In exploring nuances in the experience of light, I developed a two-phase scale for the measurement of the *amount* and *intensity* of light perceived in timbre going from darkness to distortion (overexposure). Consequently, each piece is structured as a process of timbral transformation directly associated with specific visual experiences, where *dust* and *rain* act as filters, amplifiers, or means of refraction in the perception of light.

The third chapter is dedicated to the study of mass through the composition of a further three pieces: *A Weightlessness Process (… or how to become ethereal)* (2019–20), for solo cello; *Just An Attempt to Dissipate* (2019), for soprano voice, alto flute, bass clarinet, and guitar; and *We no longer sleep in the wind* (2020), for solo Paetzold double bass recorder. These compositions are based on the idea of the dissolution of mass, a desire for *disappearing*. The perception of mass in timbre is associated with the concept of *resistance*, which can be understood as the parameters of sound resisting change while interacting. Nonetheless, in order to understand the complexity of this timbral dimension, I also approach three related concepts: *weight*, developed as the perception of *force* that is applied explicitly from the instrumental technique or perceived as a consequence of the inner timbral interaction; *density*, which responds to the *distribution* of the timbral components in a spatio-temporal relation, mostly in terms of unity and segregation; and *volume*, which is related to the perception of *size* of matter, the space occupied by it. Since an approach to size in timbre results in too great an ambiguity, volume is addressed from the interrelation of other intrinsic dimensions—length, height, and width—to generate a new perspective on timbre, which is to say its

depth. Consequently, the experience of depth is developed as a perceptual consequence of space in terms of distance: proximity (clearness) and remoteness (concealment).

The fourth chapter focuses on texture and two pieces that have been composed as part of this study: *suelo seco* (2020), for amplified cello and piano; and *The Loneliness of the Rusted Things* (2020), for flute, oboe, clarinet, violin, viola, and cello. Texture responds to cross-modal associations between tactile and visual experiences that lead to a determination of the level of roughness-smoothness or hardness-softness perceived in timbre. From a technical perspective, texture is understood as the timbral result of a determined tactile experience or an intangible consequence in the perception of organisation and development of the components of timbre interacting between themselves. Therefore, the first composition explores texture from the experience of friction as generator and modulator of specific characteristics of *dryness*, while the second one responds to the modulation of the textural experience of *rust* from an image to timbre.

Finally, this research seeks to contribute to a broader understanding of timbral complexity, offering new perspectives on timbre as a main resource as well as a formal and aesthetic objective in composition from the study of its multidimensionality and dynamic condition. Since it is not the objective to prove the accuracy of the correlations between acoustic conditions of timbre and the actual perception of the timbral experience in the pieces, this is an exploration of timbre from the recognition of different compositional possibilities of semantic (metaphorical or conceptual) associations with the timbral instability, its fluctuating behaviour, and the transformation of its inner constitution and structure over time.

CHAPTER 1: TIMBRE AS A COMPOSITIONAL RESOURCE

Despite the multitude of approaches to timbre in musical practice, it remains difficult to define and to determine more specific strategies to approach it as a compositional resource. This may be a consequence of its complex nature and unstable behaviour. Isabella Van Elferen has argued for a recognition of what she calls the *timbral paradox*:

> Timbre undeniably has material as well as immaterial components […]. Its paradoxical im/materiality engenders a sublime aesthetic experience that can be described as the aporia of being drawn into a void which appears to be real but which—the closer you get to it—flickers in and out of earshot and comprehension.[2]

For Van Elferen, the fact that timbre's physicality can be scientifically measured is one of the reasons for the abundant study of this one of its facets. This is the case, too, for Philip Tagg's timbral approach:

> Timbre is defined by the spectral envelope: the attack, decay, sustain, and release of a given sound together comprise the individual timbre of that sound. Within this model, the pitch of a sound is determined by the shape, frequency, and harmonics of the sound waves. The frequency spectrum of a sound—that is the number of overtones it has and the moments at which these are audible in the timbral envelope—is a major factor in the timbre of that sound.[3]

From a similar perspective, my own interest in timbre was initially focused on its physicality, which led me to develop a preliminary conception that focused on a *process of interaction* between the parameters of sound:

> Timbre is a multidimensional and dynamic quality of sound that includes each of its parameters simultaneously: pitch and amplitude with their respective dynamic envelopes, harmonic and inharmonic content, space and time in which sound arises, grows and fades; all of them in a process of interaction that enables the mutual and continuous alteration of their characteristics.[4]

This is the result of my previous research on timbre from an approach to the fields of psychoacoustics, acoustics and composition, as well as my own experience as a composer/performer of experimental music. Here, I take it as a starting point for the exploration of new perspectives on the multidimensional and dynamic condition of timbre that may shed light on its complexity and contribute to the development of a compositional approach in which each piece can be perceived as a particular timbral experience in itself.

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[2] Isabella Van Elferen, 'Drastic Allure: Timbre Between the Sublime and the Grain', *Contemporary Music Review*, 36, 6 (2017), 614–32 (p. 616).
[3] Philip Tagg, *Music's Meanings: A Modern Musicology for Non-musos* (New York: Mass Media Music Scholars, 2013), cited in Van Elferen, p. 623.
[4] Ivonne Michele Abondano Flórez, 'El timbre: noción y experiencia creativa', *Ensayos: Historia y Teoría del Arte*, 21, 33 (2017), 87–103 (p. 87). My translation.

1.1. Perspectives on Timbre

Many studies on timbre have focused on understanding the components susceptible to *measurement*, which could be approached from a compositional perspective. Below, I present some of those which have most influenced my way of thinking about timbre.

Pierre Schaeffer is one of the composers who understands timbre as a quality, or even a value of sound, regardless of the source that produces it. His first, maybe indirect, approach to the timbral complexity is described by Beatriz Ferreyra as follows:

> At this time, when so much electronic music was employing serial techniques, I was deeply moved by Schaeffer's idea of the 'complex sound.' His idea was that recorded acoustic sounds, both pitched and unpitched, could be used as the basis for a new kind of music without reference to tonality or serial techniques. The pitch could still be present as a 'support,' but not the basis for organization.[5]

As such, Schaeffer reveals the difference between 'instrumental timbre' and what he calls 'harmonic timbre'.[6] Similarly, Gérard Grisey emphasises the contributions of spectral music to the understanding of timbre and harmony as a single, integrated entity.[7] This position is supported by Tristan Murail, who states: 'timbre can be defined as an addition of basic elements, pure frequencies, sometimes white noise bands; a harmony is created by adding timbres together, which is to say the addition of additions of basic sonic components'.[8]

Equally interested in the relation between timbre and harmony, Denis Smalley claims that 'timbre is an extension of harmony, or vice versa. The composer [of spectral music] uses spectral analysis as a basis for conceptualising the relationship between pitch and sound qualities, and attempts to negotiate fluent border crossings between the two'.[9] Hugues Dufourt also understands timbre to exist in essential relation with harmony and emphasises the importance of the interaction between sound paramameters:

> Traditional music separates pitch from timbre, thus making them incompatible. In serial music, they are competitors. Half way between two stabilized regimes of sound, texture is a combination. The understanding of this kind of intermediary situation makes possible to join the two fields of harmony and timbre, separate in the past but connected today, by specific forms of interaction […] pitch, timbre, dynamics and attack are mutually determined, and they combine in specific ways. The

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[5] Kim S. Courchene and Beatriz Ferreyra, 'A Conversation with Beatriz Ferreyra', *Computer Music Journal*, 25, 3 (2001), 14–21 (p. 15).
[6] Schaeffer, 'Theory of Homogeneous Sounds: Criterion of Mass', in *Treatise on Musical Objects. An Essay across Disciplines* (Berkeley: University of California Press, 2017), pp. 406–21 (p. 411).
[7] Gérard Grisey, 'Did You Say Spectral?', trans. by Joshua Fineberg, *Contemporary Music Review*, 19, 3 (2000), 1–3 (pp. 2–3).
[8] Tristan Murail, 'Spectra and Sprites', trans. by Tod Machover, *Contemporary Music Review*, 24, 2 (2005), 137–47 (p. 138).
[9] Denis Smalley, 'Defining Timbre–Refining Timbre', *Contemporary Music Review*, 10, 2 (1994), 35–48 (p. 36).

> law of coexistence and agreement between the different parameters makes it possible to manipulate sound.[10]

From a different perspective, Helmut Lachenmann's compositional approach shows an interest in the study of the correlations between the parameters of sound. He works toward a classification of sound material according to types of articulation of specific parameters, their characteristics, and their applications in composition:

> Pitch, timbre, dynamic, and duration are certainly indispensable to the definition of sound, and among those the timbre as sum and result of the various pitches and volumes of natural or artificial partials. But just as important as these four determinants is the differentiation between, on the one hand, sound as a state and, on the other hand, sound as a process. In other words, sound as a simultaneity of an arbitrary length whose duration is externally determined by its termination; and sound as a process that is temporally bounded by its distinctive qualities.[11]

Notwithstanding, Stephen Malloch suggests that it is the whole interaction which defines timbre:

> The quality of a musical sound depends almost entirely on our perception of its spectrum, which comprises its Fourier components—their frequencies, the way they are spaced (their differences in frequency), the way they change through time […] their amplitudes, and the way in which the components react with each other.[12]

In fact, an interest in the co-existence of all sound parameters has been recognised by Eldon Fayers as essential for the structural development of Iannis Xenakis's music:

> With mathematics as tool and guide, Xenakis intended to find an axiom that would allow the unification of all musical parameters. Broadly speaking, Xenakis' project is based upon Pythagorean ideals that would permit the unification of every element of the universe.[13]

From these perspectives, timbre can be approached as the perception of a *process* of interaction between the parameters of sound; the *simultaneity* in itself, its *result* and *consequence*. Nonetheless, the study of the complexity of timbre as an interaction inescapably points towards the analysis of the spatio-temporal development of timbre and the recognition of its multidimensionality and transformational stages. Below, I present various perspectives that show how these timbral aspects have been previously understood and addressed by composers and researchers.

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[10] Hugues Dufourt, 'The Principles of Music and the Rationalization of Theory', in *Contemporary Music. Theoretical and Philosophical Perspectives* (2010), pp. 19–50 (p. 43).
[11] Helmut Lachenmann, 'Sound Types of New Music' (1966), trans. by Peter Ivan Edwards, in *Peter Ivan Edwards Website*, [n.d.] <https://www.peterivanedwards.info/sound-types-new-music> [accessed 4 December 2020].
[12] Stephen Malloch, 'Timbre and Technology: An Analytical Partnership', *Contemporary Music Review*, 19, 2 (2000), 155–72 (p. 157).
[13] Eldon Fayers, 'Utopian Aesthetics: Philosophical Perspectives upon the Work of Iannis Xenakis', *Proceedings of the Xenakis International Symposium* (2011), 1–13 (p. 3).

1.2 A Multidimensional and Dynamic Experience

Pablo Araya explains multidimensionality in terms of the simultaneity of all the components of a piece, which are produced by specific instrumental techniques and executed at the same time:

> If it is a string quartet composition, it means that the following dimensions (instrumental techniques) could be considered: bow rhythm (right hand), pitch rhythm, pitches, dynamics, effects or colour changes on the instrument (*sul ponticello*, *sul tasto*, etc.), effects or colour changes with the bow (ordinario, *col legno*, ½ *legno tratt*.), etc.[14]

For Araya, each dimension is developed according to a scale of three levels of detail or refinement: macro, medium, micro. This multidimensional approach leads to the composition of non-linear experiences: that is, continuous activity within each dimension generates irregular and unstable movement(s) with immediate consequences in the timbral plane.[15] Proceeding from studies of the continuity between rhythm and sound, Julio Estrada presents the idea of a *macro-timbre*, which also exhibits an interesting relation to timbral multidimensionality:

> Imagine the global extension of musical material as a huge spectrum integrating an infinity of frequencies, from the lowest ones—which can be physically identified with the notion of rhythm and the sensation of time—to those whose higher speed lead to the notion of sound and the sensation of space. Inside such a global extension, rhythmic and sonic vibrations can be unified as a continuum, where the boundary between both is perceivable.[16]

For Estrada, the simultaneous illustration of all the macro-timbre components can be achieved by a three-dimensional representation of specific trajectories for *frequency* (x), *harmonic content* (y), and *amplitude* (z), while the rate of change is indicated by the distance between identical *time* units (i).[17] Furthermore, from this kind of chrono-graphical recording and transcription method, as he calls it, Estrada develops further, alternative applications like the *permutational variation*, applying the dynamic shape of one dimension to another one, and the *topological variation*, where the dynamic tendencies of the three dimensions are simultaneously transformed.[18]

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[14] Pablo Araya, 'Objetos sonoros de múltiples componentes y escalas con un comportamiento no-lineal', *Cuadernos de Análisis y Debate sobre Músicas Latinoamericanas Contemporáneas* 2 (2019), 1–18 (p. 4). My translation.
[15] Araya, p. 9. My translation.
[16] Julio Estrada, 'Focusing on Freedom and Movement in Music: Methods of Transcription Inside a Continuum of Rhythm and Sound', *Perspectives of New Music*, 40, 1 (2002), 70–91 (p. 72).
[17] Estrada, p. 78.
[18] Estrada, pp. 83–85.

At this point, it is important to address how the desire for a graphic representation of timbre for a better understanding of its inner qualities, its *substance*, has led to a widespread use of spectrograms for both analysis and composition as a tool to identify the content, structure, and behaviour of timbre in time and space. Notwithstanding its apparent precision, the information provided by such means can only be an estimate of timbral complexity, rather than its exact visual representation, as argued by Kailash Patil and others:

> Temporal features in a musical note include fast dynamics that reflect the quality of the sound (scratchy, whispered, or purely voiced), as well as slower modulations that carry nuances of musical timbre such as attack and decay times, subtle fluctuations of pitch (vibrato) or amplitude (shimmer). Some of these characteristics can be readily seen in the auditory spectrograms, but many are only implicitly represented.[19]

They insist: 'this conclusion is expected given the multidimensional nature of the timbre percept compared to the dense two-dimensional spectrogram; and is in agreement with other findings from the literature'.[20] In the light of this, I describe below further research that focus on the study of the physicality of timbre through spectral analysis.

Dufourt's perspective is important for understanding the dynamic condition of timbre, its process of transformation: '[t]imbre depends on the evolution of the frequency spectrum, on attack and decay, and on the respective and mutual development of the different harmonics or partials of the sound'.[21] Moreover, Dufourt recognises the importance of technology for the measurement and discrimination of timbral components:

> The computer is essential for the study of musical timbre. It makes it possible to work separately but jointly with the different elements of the sound; that is, the fundamental frequency, the distribution of partials and of energy throughout the spectrum, and the time envelopes as well as the micro-variations in amplitude and frequency, whether random or regular modulations.[22]

For his part, Stephen McAdams establishes four timbral dimensions that reflect the spatio-temporal evolution of timbre: attack time, spectral centroid, spectral smoothness, and spectral flux:

> Attack time is the time it takes to progress from a threshold energy level to the maximum in the rms amplitude envelope. Spectral centroid is the center of gravity of the long-term amplitude spectrum. Spectral smoothness is related to the degree of amplitude difference between adjacent partials in the

[19] Kailash Patil, and others, 'Music in Our Ears: The Biological Bases of Musical Timbre Perception', *PLOS Computational Biology*, 8, 11 (2012), 1–16 (pp. 4 and 11).
[20] Patil, and others, p. 11.
[21] Dufourt, pp. 28–29.
[22] Dufourt, p. 34.

> spectrum computed over the duration of the tone […] Spectral flux is a measure of the degree of variation of the spectrum over time.[23]

From a similar perspective, Malloch defines three timbral measures: timbral width, sharpness, and roughness:

> The total fraction of loudness that lies outside of the loudest 1/3 octave band (the spread of the loudness) […] results in the measure called *timbral width* (which ranges from *focused* to *diffuse*) […] sharpness measurement consists in locating the 1/3 octave band that corresponds with the loudness centroid (the centroid is the point on a graph where the areas below the graph, either side of the point, are equal in size) […] Roughness or acoustic dissonance, is defined here as the beating that occurs between simultaneously sounding partials.[24]

The dimensions proposed by McAdams and Malloch reflect specific timbral distribution and interaction within timbral development, which leads to the perception of particular qualities correlated to acoustic conditions. The way in which the estimation of these timbral dimensions can be addressed in a compositional process varies, of course, from one composer to another one, especially in terms of acoustic or electronic music. Smalley's approach is an example of how the multidimensionality and dynamics of timbre can play a role in the structure and development of a composition. He describes three linked temporal phases for the spectral history of sonic phenomena:

> The ideas of onset (how something starts), continuant (how it continues) and termination (how it ends) can be expanded into a list of terms, some of them technical, some more metaphorical, which can be used to interpret the function-significance of an event or context. These functions can be applied at both higher and lower levels of musical structure, referring, for example, to a note, an object, a gesture, a texture, or a type of motion or growth process, depending on our focus of attention.[25]

Therefore, Smalley presents three archetypes that he defines as: the attack alone, the attack-decay, and the graduated continuant as well as the variants that come from the manipulation of the duration and spectral energy of the three phases, which he calls the spectromorphological expectation.[26] Thus, this approach to spectral content and temporal shaping, as a tool for the analysis of the perceptual experience of the sonic phenomena, allows the development of structural relations in the compositions that respond to the way in which the behaviour of the sonic phenomena is heard from the transformation of the spectral energy of each phase.

The perspectives presented so far make it possible to think of timbre as the perceptual experience of a complex interaction of multiple components that mutually affect one

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[23] Stephen McAdams, 'Perspectives on the Contribution of Timbre to Musical Structure', *Computer Music Journal*, 23, 3 (1999), 85–102 (p. 90).
[24] Malloch, pp. 165–66.
[25] Smalley, 'Spectromorphology: Explaining Sound-shapes', *Organised Sound*, 2, 2 (1997), 107–26 (p. 115).
[26] Smalley, 'Spectromorphology', p. 113.

another and transform over time. However, deeper research is required into those aspects which, without being amenable to specific measurement or estimation, are equally determinate of the timbral experience.

1.3 Semantics of Timbre: Luminance, Mass, and Texture

The need to find the right words to describe timbre, the words that say *something* about it and help to understand what is it, or how it behaves, may correspond, in certain respects, to a more general urgency to name and classify *everything* to understand it. In his study of the semantics of timbre, Zachary Wallmark recognises how thinking of timbre in terms of analogies responds to the need to associate its abstraction to concrete matter in order to understand its nature:

> The prevalence of cross-modal adjectives in timbre description might be accounted for by way of conceptual metaphor theory […] we often make sense of abstract *target* domains through reference to concrete *source* domains (e.g., conceptualizing romantic relationships as journeys, as revealed in expressions such as 'it's been a long and bumpy road').[27]

The following excerpt from 'Solid Objects' by Virginia Woolf exemplifies how the use of specific words to emphasise qualities or conditions has a determining role in the experience of the story. I mark in bold those words that are also commonly used to describe or approach timbre:

> As he was choosing which of these things to make it, still working his fingers in the water, they curled round something **hard**—a full drop of solid matter—and gradually dislodged a large **irregular** lump, and brought it to the **surface**. When the sand coating was wiped off, a green tint appeared. It was a lump of glass, so **thick** as to be almost **opaque**; the **smoothing** of the sea had completely worn off any **edge** or **shape**, so that it was impossible to say whether it had been bottle, tumbler or window-pane; it was nothing but glass; it was almost a precious stone. […] John turned it in his hands; he held it to the light; he held it so that its irregular **mass** blotted out the body and extended right arm of his friend. The green **thinned** and **thickened** slightly as it was held against the sky or against the body. It pleased him; it puzzled him; it was so hard, so **concentrated**, so **definite** and object compared with the vague sea and the **hazy** shore. […] In truth, John had been that day to Barnes Common, and there under a furze bush had found a very remarkable piece of iron. It was almost identical with the glass in shape, **massy** and globular, but so **cold** and **heavy**, so black and **metallic**, that it was evidently alien to the earth and had its origin in one of the dead stars or was itself the cinder of a moon. It **weighed** his pocket down; it weighed the mantelpiece down; it **radiated** cold.[28]

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[27] Zackary Wallmark, 'A Corpus Analysis of Timbre Semantics in Orchestration Treatises', *Psychology of Music*, 47, 4 (2019), 585–605 (p. 601).
[28] Virginia Woolf, 'Solid Objects', in *The Complete Shorter Fiction of Virginia Woolf*, ed. by Susan Dick (Orlando: Harcourt, 1989), pp. 102–07 (pp. 103–06).

Moreover, the way in which Ferreyra describes her compositional approach demonstrates an interest in a multidimensional articulation of the parameters of sound. The use of conceptual markers like *waves*, *masses*, *dynamics*, *colour*, *movement*, or *thickness* makes evident that a semantic approach can be a productive basis for the understanding of sound in general, and timbre particularly, as does how she technically pursues specific qualities derived from these associations in structuring her works:

> Then I begin processing the sounds. I compose them in a very precise way. Then I begin to articulate short, medium, and long sounds in a particular way. With short sounds, I construct little complex structures […]. The moderate and long sounds, or weaves, are also treated as little structures, but in another time dimension. This way of composing gives me a rich assortment of possibilities in articulating sound masses, trajectories, polyphonic complexities, dynamics […] what is important in such structures is the color, the movement, the thickness of each sound bringing forward its characteristics to give its original form and movement to this particular structure. In other cases, we can recognize, more or less, each sound. It is the result that counts for me and how this result lives within a bigger structure.[29]

Since the semantic approach seems to be common to all kinds of perceptual process, the following reflection by Gilles Deleuze and Félix Guattari allows to recognise how similar the semantics of painting can be to the semantics of timbre. Again, I highlight in bold the common words between both:

> It could be said that Mondrian was a painter of **thickness**; and when Seurat defined painting as 'the art of ploughing a **surface**,' the only support he needs is the furrows and peaks of unglazed drawing paper. This is painting that no longer has any **background** because the 'underneath' comes through: the surface can be furrowed or the plane of composition can take on thickness insofar as the material rises up, independently of **depth** or perspective, independently of **shadows** and even of the chromatic order of **color** (the arbitrary colorist). One no longer covers over; one **raises**, **accumulates**, piles up, goes through, stirs up, folds. It is a promotion of the ground, and sculpture can become **flat** since the plane is stratified.[30]

Generally, the comparison by analogy allows the association of perceived timbral qualities with specific qualities of matter in terms of similarities or emulations ('it sounds like'). However, it also allows a source-relatedness process to identify the origin of timbre ('it is produced by'). Smalley proposes the term *source bonding* to explore the latter:

> Source bonding is the term I use to encapsulate the natural tendency to relate sounds to supposed sources and causes, and to relate sounds to each other because they appear to have shared or associated origins. All those attributes traditionally packaged under timbre—the nuancing and articulation of note-objects and phrase-shapes, and the control and variation of tone, including the roughness/smoothness of note-grain—could be traced to source-cause interactivity.[31]

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[29] Courchene and Ferreyra, pp. 20–21.
[30] Gilles Deleuze and Félix Guattari, 'Percept, Affect, and Concept', in *What Is Philosophy?,* trans. by Hugh Tomlinson and Graham Burchell (New York: Columbia University Press, 1994), pp. 163–199 (p. 194).
[31] Smalley, 'Defining Timbre', p. 37.

For Paul Rudy, the growing timbral practice and its analysis presents four key components, from which I especially emphasise the *source material* because it also approaches the two kind of associations discussed above. Following Albert Bregman's cognitive approach, Rudy discusses the distinction between primitive (innate) and schema (learned) strategies applied in the perception of source material of timbre which he exemplifies through a timbral description he makes of John Young's electroacoustic composition *Time, Motion and Memory* (1997, revised 2001):

> At 1:13 grating metal follows as a new, pitched motive. A low fluctuating explosion between these two statements fractures the flow, but spectrally connects to high frequency distant windy sounds through ascending filtered noise. This description alone betrays a conflict between schema-oriented strategy (identifying the source's associations to traditional music schemes), and a primitive impulse (the desire, however defeated, to identify the sound).[32]

Both 'similarities/emulations' and 'source-related' kinds of associations can be recognised in the seven *conceptual* categories in which Asteris Zacharakis organises the terms provided by the participants in his research: *properties of source* (wooden, glassy, synthetic, etc.); *temporal evolution* (static, energetic, constant, etc.); *emotional terms* (sinister, oppressive, suave, etc.); *technical terms* (spectral, phasey, sinewave, etc.); *sense of sight* (blurred, smoky, transparent, etc.); *sense of touch* (raspy, gentle, blunt, etc.); *size of object* (large, majestic, heavy, etc.).[33]

In a related context, Jan Štěpánek works on the perceptual experience of timbre through comparison of features of matter that are perceived by vision and touch: '[t]he verbal interpretation of perceptual spaces of sound contexts and perceptual space of verbal attributes are compared and the hypothesis of the four basic dimensions of timbre is formulated: 1. gloomy-clear, 2. harsh-delicate, 3. full-narrow, 4. noisy-?'.[34] Furthermore, Asteris Zacharakis, Konstantinos Pastiadis, and Joshua D. Reiss focus their research on the words most often used in Greek and English to describe timbre. In this context, they suggest three classifying factors: 'factor 1 could be: Depth-Brilliance for Greek and Brilliance/Sharpness for English, factor 2: Roundness-Harshness for Greek and Roughness/Harshness for English, and factor 3: Richness/Fullness for Greek and Thickness-Lightness for English'.[35] These three factors coincide with those presented by

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[32] Paul Rudy, 'Timbral Praxis: When a Tree Falls in the Forest Is It Music?', *Organised Sound*, 12, 1 (2007), 5–13 (pp. 6–7).
[33] Asterios Zacharakis, 'Musical Timbre: Bridging Perception with Semantics' (unpublished doctoral thesis, Queen Mary University of London, 2013), p. 94.
[34] Jan Štěpánek, 'Musical Sound Timbre: Verbal Description and Dimensions', *Proceedings of the 9th International Conference on Digital Audio Effects DAFx-06* (2006), 121–26 (p. 121). The question mark is in the original.
[35] Asteris Zacharakis, Konstantinos Pastiadis and Joshua D. Reiss, 'An Interlanguage Study of Musical Timbre Semantic Dimensions and Their Acoustic Correlates', *Music Perception: An Interdisciplinary Journal*, 31, 4 (2014), 339–58 (p. 344). On page 340, the authors explain that '-' indicates antonyms, and '/' synonyms.

Štěpánek, demonstrating the tendency to associate timbral qualities of sound with physical features of matter and perceptual experiences related to touch and vision. Below, I present the classification developed by Zacharakis, Pastiadis, and Reiss, from which they determine three semantic dimensions of timbre, which I have especially studied and extensively explored to develop my compositional approach through the eight pieces that are part of this research:

> The dimension that shows the strongest agreement between the two groups is the one that describes whether a sound is perceived as smooth-and-round or rough-and-harsh. As these adjectives originate from tactile quality description we suggest the label texture for this dimension. The first dimensions for both linguistic groups have the adjective brilliant in common. This is a metaphor that comes from the domain of vision, we therefore suggest the label luminance for the description of this dimension. Finally, the third dimensions in both groups describe whether a sound is perceived as thick-dense-rich-and-full or light. We suggest mass as an appropriate general semantic label for this dimension.[36]

Texture, *luminance*, and *mass* respond to the description of timbral characteristics traditionally used in musical practice. In fact, other researchers have worked in ways which accord, largely implicitly, with these three dimensions before (if not in the semantic labels, in the specific qualities that they attempt to describe). Such is the case of William H. Lichte, for whom timbral percepts are consistently described in terms of *brightness*, *roughness*, and *fullness*.[37] Likewise, Schaeffer enumerates the main analogies for the description of 'tonic sounds', where the association with texture, luminance and mass remains evident:

> When evaluating tonic sounds, musicians habitually describe them using the following analogies: 1. Their *volume*. Generally speaking, a high sound will seem less extensive than a low sound. But, again, a clarinet sound will appear 'narrower' than a flute sound of the same pitch […] 2. Their timbre, which will be *dark* or *light*. *Timbre* here denotes a quality of the notes and does not refer to the instrument […] 3. A musician will also say of a sound that it is *rich* or *poor*. These qualifiers will be applied equally to the timbre, with the same ambiguity as above. A singer can produce sounds that are hollow or full, with or without timbre. The flute has a poorer timbre than the clarinet. What does this mean, except that we can perceive a greater or lesser complexity, a fuller or less-full texture? 4. It may happen that even a rich timbre does not *come across*, is *muffled*, has no radiance, no *brilliance*. And so we say that a violin or a voice *comes* across to a greater or lesser extent, probably depending on whether the partials reinforce each other when the sound is produced or whether it strikes the ear that receives it in the registers where it is most sensitive.[38]

Wallmark, for his part, has also labelled seven basic categories of timbre descriptors: Affect, Matter, Cross-modal correspondence (CMC), Mimesis, Action, Acoustics, and Onomatopoeia. I quote from his description of matter and cross-modal correspondence to emphasise the relevance of the three semantic dimensions of timbre presented above:

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[36] Zacharakis, Pastiadis and Reiss, p. 348.
[37] William H. Lichte, 'Attributes of Complex Tones', *Journal of Experimental Psychology*, 28 (1941), 455–480, cited in Wallmark, p. 587.
[38] Schaeffer, 'Theory of Homogeneous Sounds', pp. 407–08.

> *Matter:* [w]ords that describe features of physical matter; *i.e.* objects or substances with weight, mass, shape, etc. Examples: *thin, round, hollow, liquid, sharp, blunt, heavy* […]"; "*CMC:* [w]ords borrowed cross-modally from other senses, encompassing an embodied conceptual transfer process by which an auditory target domain (timbre) is understood in reference to a non-auditory source domain (vision, touch, taste, smell) […]. This category can be further subdivided by sense modality. Examples: *bright, warm, sweet, smooth, dark, coarse, sparkling*.[39]

From the many approximations of timbre, *tone colour* could be identified as its most generalised description, as Van Elferen recognises it in Schoenberg's writings:

> In his *Harmonielehre* Schoenberg insists that timbre, which he consistently refers to as colour (*Farbe*), is the most important component of a tone, and that pitch is just one of its dimensions: 'after all, what is pitch but the collection of wave frequencies and harmonics generated by a specific timbre?'[40]

This concurrence is remarked on by Patricia Holmes in her construction of a line of 'evolution' in definitions of timbre:

> Timbre can also be regarded as synonymous with 'tone colour' or 'tone quality' […], yet these terms are equally vague and the latter could actually be perceived in judgemental rather than objective terms. Menon *et al.* include the words 'tonal color and *texture*' (my italics) when defining timbre […] which together with the concept of 'acoustic richness' […] begins to breathe life into description of timbre in a musical context.[41]

Colour is a property related to the perceptual experience of light, so it is possible to say (or at least to hypothesise) that timbre as tone colour refers more specifically to *luminance*, which opens up a space to identify the three semantic dimensions as a convenient way of approaching the study of timbre. In fact, their relevance can be seen in the way Chaya Czernowin explains one of her compositional strategies for electronics in the opera *Infinite Now* (2016), in which she works from the division of a band of noise according to a scale between two contrasting referent points, such as from *blandness* to *sharpness*.[42] Both terms can be related to the textural dimension of timbre although separately 'sharpness' can be associated with brilliance, too, which was recognised by Zacharakis, Pastiadis and Reiss as 'factor 1' in the classification of timbral descriptors mentioned above.

The relation between semantics and physicality of timbre has been amply explored in the researches and approaches presented above. However, the semantics of timbre also seem to point to other perspectives and strategies in this discussion. In regard to this, Clara Iannotta shares some reflections from her compositional experience:

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[39] Wallmark, p. 594.
[40] Arnold Schoenberg, *Harmonielehre. II. vermehrte und verbesserte Auflage* (Vienna: Universal-Edition, 1922), cited in Van Elferen, p. 619.
[41] Patricia Holmes, 'An Exploration of Musical Communication through Expressive Use of Timbre: The Performer's Perspective', *Psychology of Music*, 40, 3 (2011), 301–23 (p. 303).
[42] Chaya Czernowin, 'Analyse de Infinite Now', Lecture at ManiFeste, online video recording, IRCAM, 24 June 2017, <http://medias.ircam.fr/xfa50f4> [accessed 20 September 2019].

> Sound is an abstract world, and I constantly struggle to find the right words to describe it. In order to overcome this struggle, I normally try to find a concept or a metaphor that can help me navigate the abstract realm that sound is, and most of the time, relying on metaphors helps me not only to understand better my sonic material, but also hands me new, sometimes completely unexpected perspectives which lead me to sonic territories that I haven't explored before.[43]

Tim Rutherford-Johnson approaches the importance of the metaphorical association in Iannotta's music as follows:

> 'post-' refers to what comes after but, as bhabha notes, it also means to surpass what went before. to go beyond the pale. to infinity and beyond. clara iannotta composed *al di là del bianco* (2009) while she was still an undergraduate in milan, studying with alessandro solbiati, but its title—'beyond white'— provides a clue to one of the preoccupations of her highly refined output. her subsequent interest in decay—of sound in the resonance of bells, or of the body in the poetry of dorothy molloy—is directed not at the process of rotting or of disintegration, but at continuing and following an event or object into its afterlife. as a result her music has an almost spiritual quality that is surprising given its cutting edge, contemporary means.[44]

Indeed, for Zacharakis timbre also conveys aesthetic meaning, thus semantic descriptions are used to express perceptual concepts related to artistic intention.[45] Something related can be seen in how Araya explains the use of terms and concepts like *instability*, *turbulence*, *non-linearity*, *multidimensionality*, and *multiscale*, which he links to an origin in modern science (specifically, physics and mathematics) as indicating an intention to describe the behaviour of musical objects in which similarities (metaphors and analogies) are being established between domains of distant realities. Araya writes: 'what has drastically mutated in the current music […] is not only related to notation or the use of different sounds, on the contrary, *what has changed is the way to think, reason, and imagine music*'.[46]

One example of this kind of approach is found in Mark André's pieces. He has especially focused on the concept of *instability*, understood in terms of fragility, to make of it a method of composition developed from a parametric, morphological and sound-time typological organisation of the sound material. Therefore, the spectrogram as a representation of sound affords him an effective analysis, a measurement of the components of the spectrum and their behaviour, from which he proposes a 'deconcretisation'—a reference to the recording of a particular reality, the concrete sound—which is spectrally analysed to identify *impulse-response* relationships. He uses these

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[43] Clara Iannotta, 'Moulting Spaces', Lecture at Darmstädter Ferienkurse, online video recording, YouTube, 6 August 2021, <https://www.youtube.com/watch?v=XEHwkpaHylo> [accessed 9 August 2021].
[44] Tim Rutherford-Johnson, liner notes to Clara Iannotta, *a failed entertainment* (Edition RZ: Berlin, 2015), p. 14 [on CD]. Capitalisation follows the original.
[45] Zacharakis, 'Musical timbre', p. 3.
[46] Araya, p. 14.

values as compositional elements to create what he regards as metaphysical, transitional spaces, developed as traces of disappearance in his works.[47]

The semantic approaches presented above have strongly influenced my research and, at certain points and in certain ways, inspired my pieces. However, the desire to consider timbral experience in its fullest complexity has led me to extend the notion of timbre toward the concept of 'percept', understood from a more philosophical perspective, as an attempt to understand the specific meaning of timbre in my own music, and maybe unravel my deepest obsession with it as a composer and researcher.

1.4 Timbre as a Percept: A Philosophical Exploration

Daniel Villegas Vélez addresses the fact that parametric measurement of timbre, as well as its semantic approach, may not be enough to understand it or define it:

> There is always something else in sounds other than what we say about them—something that resists definitions and one-sided accounts. After accounting for pitch, duration, and intensity, a sound prompts us with something else: an instrument or body, a texture, a color, its reverberations, a reference, a memory, an affect. These belong to timbre as a kind of excess. Timbre easily discloses or hides its source, it confuses or tricks us, at times combining with other sounds, masking itself and masquerading as the sound of something else.[48]

From a similar perspective, Van Elferen recognises a paradox in how timbre has been historically understood: '[t]he Romantic aesthetics of tone colour exceeds the material, but Romantic idealism, with all its sublime desire, is unable to obliterate timbre's corporeality […] Matter and idea, object and Thing converge in timbre's paradoxical material sublime'.[49] With regard to this conflicting duality, Villegas Vélez adds:

> Timbre—as a remainder—is the 'and also' of any attempted description of sounds. In all cases, these aspects constitute the materiality of sound and timbre is the parameter by which we encounter this materiality […] Timbre is inexhaustible because it is not reducible to matter, although it is not purely ideal either'.[50]

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[47] Mark André, 'Portrait Lecture', *Synthetis International Course for Composers*, virtual event, 5 December 2020.
[48] Daniel Villegas Vélez, 'The Matter of Timbre: Listening, Genealogy, Sound', in *The Oxford Handbook of Timbre*, ed. by Emily Dolan and Alexander Rehding (Oxford University Press, 2018) <https://www.oxfordhandbooks.com/view/10.1093/oxfordhb/9780190637224.001.0001/oxfordhb-9780190637224> [accessed 16 December 2020].
[49] Van Elferen, p. 619.
[50] Villegas Vélez, pp. 5–6.

Although McAdams's approach to timbre seems to be based mainly on its physicality, he also agrees with the fact that the timbral multidimensional character is not limited to parameters of acoustic nature:

> Timbre is a misleadingly simple word that encompasses not only a very complex set of auditory attributes, but also a plethora of important psychological and musical issues […]. It covers many parameters of perception that are not accounted for by pitch, loudness, spatial position, and duration. It is thus, by definition, multidimensional.[51]

With regard to this reflection, Holmes opens the discussion toward a need to think timbre from different fields of knowledge that contribute to a wider understanding of its complexity:

> Perhaps it is its dynamic, ever shifting nature that makes it such an essential vehicle for the imagination. Scientific study of timbre continues to provide further definition of its dimensions. However, there is no reason why more philosophical debate should not be directed towards expanding our understanding of the more mystical, ineffable dimensions of timbre, particularly its significance to the human condition—as is implied by the findings of this study. A starting point might be that timbre is rooted in human evolution through speech.[52]

Taking timbre as the main compositional resource in this research has generated questions like: what is timbre? How does it behave? And how can its complexity be coherently addressed in compositional terms? This chapter has looked towards fundamental and diverse perspectives to present a specific context for my compositional objectives. In alignment with this review, I begin here a more philosophical usage of the concept 'percept' by proposing that, if timbre is understood as a process of interaction between the parameters of sound, which is *perceived* as a multidimensional and dynamic experience, then the timbral experience, in this research the piece itself, can be thought, in terms of Franklin Wolff, as 'a perceptually given existence', the final objective of the concept; its meaning or value. Nonetheless, following Wolff's discussion, *percept* can also be the instrumental in the awakening of a *conceptual* significance.[53]

From a similar perspective, Van Elferen recalls Emily Dolan's contention that 'timbre is nothing more and nothing less than the human experience of sound […] it is the concept to which we must turn to describe the immediacies of how sounds strike our ears, how they affect us'.[54] Even more, Deleuze and Guattari deepen understandings of percept by inviting the following reflection: '[i]s this not the definition of the percept itself to make

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[51] McAdams, p. 85.
[52] Holmes, pp. 317–18.
[53] Franklin F. Wolff, 'Concept, Percept, and Reality', *The Philosophical Review*, 48, 4 (1939), 398–414 (p. 398–99).
[54] Emily Dolan, *The Orchestral Revolution: Haydn and the Technologies of Timbre* (Cambridge: Cambridge University Press, 2013), cited in Van Elferen, p. 630.

perceptible the imperceptible forces that populate the world, affect us, and make us become?'.[55]

This particular emphasis on conceptual significance has posed questions of my approach to timbre and broadened my perspective on how to develop my pieces as multidimensional and dynamic processes of interaction. Therefore, the compositions of this research are based on particular experiences of luminance, mass, or texture, in intrinsic association with natural phenomena, metaphors, or concepts, such as dust, rain, disappearance, dryness, and rust. From these I work on fluctuating structures to explore, create, and conduct each timbral experience as an integral process. This unifying condition to the perception of timbre is addressed by Fales as follows:

> In theory, all the information needed to determine pitch and loudness for natural sounds is available before the sound has even left the inner ear; timbre must wait until signals from all elements reach the auditory cortex where they are grouped and subjected to the process of perceptual fusion into the unitary sensation of tone quality.[56]

Therefore, it is possible to argue that in this thesis the interaction between the parameters of sound, their conditions, and their distribution and development through time and space can be understood as a single percept with the semantics and the cross-modal associations that delineate the timbral experience. Timbre is *composed* through a specific conceptual or poetical approach that leads to an exploration of its light, matter, or texture; thus the piece as a timbral experience is the percept. Indeed, the following definition of a 'complex' by Walter B. Pitkin coherently connects all the facets of timbre that have been extensively studied in this chapter. A complex, Pitkin argues, 'may derive its specific character from either its individual elements or the relations into which these enter […]. If the complex does not get its peculiar nature from the elements, it must get it from their interrelations'.[57] Moreover, Pitkin recognises that 'in so far as the percept is a complex containing non-existents of the spatio-temporal order (past data, or memories, and future relations, or anticipations) it is a real assemblage'.[58]

Consequently, an understanding of timbre as percept allows the development of this compositional approach from the organisation of relations between its physicality, cross-modal perceptual associations, and semantics (conceptual delineation, poetical images, and

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[55] Deleuze and Guattari, p. 182.
[56] Cornelia Fales, 'The Paradox of Timbre', *Ethnomusicology*, 46, 1 (2002), 56–95 (p. 63).
[57] Walter B. Pitkin, 'Time and the Percept', *The Journal of Philosophy, Psychology and Scientific Methods*, 10, 12 (1913), 309–19 (p. 313).
[58] Pitkin, p. 318.

metaphors). Thus, each timbral experience, each piece, is composed according to a structure that responds to these particular relations, which results fundamentally from the compositional perspective and, in fact, may be the site of the *uniqueness* of this research.

1.5 Methodology: The Composition of Timbre

My compositional approach takes luminance, mass, and texture—the three semantic dimensions of timbre proposed by Zacharakis, Pastiadis, and Reiss—as starting points from which to develop my own technical, metaphorical, and conceptual strategies for the composition of eight chamber music pieces. That is, the experiments and estimations carried out by the researchers are not intended to be proved, or directly transcribed as values in my compositions. These dimensions, and their acoustic and semantic correlations, are the basis for the development of my own compositional approach, my own organisation of relations of the timbral percept according to specific conceptual delineations. Furthermore, it is necessary to clarify that these dimensions should not (indeed, cannot) be addressed as separate domains. The purpose of setting them apart in this research is exclusively creative, as a means to discover strategies to approaching and understanding timbre with specific compositional objectives.

It is important to clarify that the eight pieces that constitute this PhD portfolio have been composed as part of projects (commissions, workshops and festivals) with specific conditions of instrumentation and even duration, to which I adapted in order to achieve my research and creative objectives. It has not been therefore my intention to work exclusively in the field of chamber music pieces, nor to select these particular instruments. However, I have taken each instrumental condition as a research delineation, which has allowed me to transfer experiences and knowledge from one piece to another one. In most of the cases, this approach has guaranteed the work in collaboration with performers during the composition process as well as opportunities to have the pieces played in virtual or in-person concerts.

One of the biggest challenges of this research has been to address a conflict with the idea of 'representation' in the compositional approach. Trying to *avoid* any understanding of the semantics of timbre as a strategy of 'sonification' of images, poems, or nature phenomena

associated with the perceptual experience of luminance, mass, and texture, I found a useful and parallel study of Imagism, in which Langdon Hammer analyses Ezra Pound's 'A Few Don'ts by an Imagiste' (1913) to explain the difference between presentation and representation:

> Pound says: 'An "image" is that which presents an intellectual and emotional complex in an instant of time.' And when he uses that word 'complex' it has, perhaps, certain resonances from psychoanalysis and also, perhaps, from chemistry. 'It is a presentation of such a "complex" instantaneously which gives that sense of sudden liberation; that sense of freedom from time limits and space limits; that sense of sudden growth, which we experience in the presence of the greatest works of art.' […] It is important, again, that Pound emphasises 'presentation'. It is the presentation rather than representation of such a complex, as he describes it. How is presentation different from representation? For Pound the literary image is not a memory of a prior reality, a reflection; but it's rather something more like a new experience itself. Not an imitation of a thing but itself a kind of thing. Again, as Pound thinks about these things there is a drive specifically through technique to arrive to a kind of transparency beyond technique.[59]

Pound's statement amplifies the necessity of understanding each piece of this research as a new perceptual experience, not an *imitation* of another reality (from cross-modal association to the physicality of timbre), nor the sonic representation of a timbral metaphor, but the *presentation* of a new percept, a complex, dynamic and multidimensional experience of timbre. Consequently, there is no intention to *simulate* light, matter, or textural conditions; on the contrary, it is through the compositional approach that these particulars are engendered into a new 'energy', a new percept: the piece.

This said, the compositional process starts with the development of a conceptual idea or a poetical image which proceeds from the semantic dimension studied for each piece, following which there is an exploration of instrumental techniques that allow the production of the desired timbral conditions. While this stage can be undertaken on my own, by experimenting with objects and instruments, watching video tutorials, and analysing musical repertoire (scores and recordings, when available), in the best cases, it is a direct exploration with the performers (in person or virtually). The recordings from these instrumental explorations are spectrally analysed using the software Spear and Sonic Visualiser, which allow the identification of correlations between the semantics and physicality of timbre. It is important to clarify that this approach differs from other compositional practices in which spectral analysis is deployed to obtain specific values to determine different parameters of the piece or to be transcribed into musical notation. Instead, the perceptual experiences are developed as an integral exploration of the process

[59] Langdon Hammer, 'Imagism', Lecture at Yale University, online video recording, YouTube, 6 December 2012, <https://www.youtube.com/watch?v=2gU4F6ePhcM> [accessed 5 May 2020].

of interaction of all parameters, avoiding the creation of a hierarchical system that individuates or individualises the timbral components.

Consequently, I work on instrumental technique as the origin and the modulation 'device' by which to produce a timbral experience. How do timbral content and structure respond to the physical contact between performer and source of sound? How can timbre be creatively approached? How does timbre evolve from a single technique? To what extent can the spatio-temporal evolution of timbre be controlled or modulated from the technical execution? I attempt to address these questions in each composition by exploring timbre as a multidimensional and dynamic interaction, understanding the whole timbral experience as a single percept.

Part of this exploration includes experiments from unconventional techniques and preparation with objects that extend the timbral field of each sound source. The techniques are classified from a recognition of the acoustic correlates for each semantic dimension: that is, specific pitch registers, levels of loudness, inharmonicity, fluctuations of the spectral centroid, and dynamic envelope conditions are identified and organised according to the structural approach developed for each piece (the concept or metaphor associated with the exploration of luminance, mass, and texture). The composition of timbre has led me towards Gregory J. Sandell's three categories of timbral concurrency: timbral heterogeneity, timbral augmentation, and emergent timbre. My compositional approach particularly coincides with Sandell's ideas of *timbral augmentation*—where the timbre of a dominant sound is enhanced by the presence of another sound—and *emergent timbre*, the fusion of various timbral components into a novel percept. In both cases, the resulting overall timbre is a single percept.[60]

This technical approach to timbre as an integral expansion—a fusion—can be related to the idea of *form* in my compositional approach as the perception of the unique process of timbral transformation of each piece. This is also inspired by Edgar Varèse:

> Form is a result—the result of a process. Each of my works discovers its own form […]. There is an idea, the basis of an internal structure, expanded and split into different shapes or groups of sound constantly changing in shape, direction, and speed, attracted and repulsed by various forces. The form of the work is the consequence of this interaction.[61]

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[60] Gregory J. Sandell, 'Roles for Spectral Centroid and Other Factors in Determining 'Blended' Instrument Pairings in Orchestration', *Music Perception*, 13, 2 (1995), cited in Zacharakis, 'Musical Timbre', p. 39.
[61] Edgar Varèse and Chou Wen-Chung, 'The Liberation of Sound', *Perspectives on New Music*, 5, 1 (1966), 11–19 (p. 16).

Similarly, Agostino Di Scipio proposes that timbre as the qualitative emerging properties of the sonic structure can be conceived as *form* and therefore form can be described as a *process of timbre formation* through time. Di Scipio argues 'each local configuration of sonic units […] has its own morphological reality and brings forth emerging properties […] which reveal […] a higher level of existence and [can] be observed in terms of phase states of a dynamical process'.[62]

In fact, seeking coherence with the unstable and dynamic condition of timbre, the multidimensional interaction developed for and in each piece is highly susceptible to fluctuations and unpredictable behaviours of the timbral content and structure. This results in non-linear processes guided by particular metaphorical or conceptual associations with luminance, mass, and texture.

[62] Agostino Di Scipio, 'Formal Process of Timbre Composition. Challenging the Dualistic Paradigm of Computer Music', *Proceedings of the International Computer Music Conference* (1994), 202–08 (pp. 205–06).

CHAPTER 2: LUMINANCE

Luminance is an approach to timbre from the experience of light as a creative and technical strategy. For this research, I have worked on this concept from a variety of disciplines to develop a notion appropriate for musical composition.[63] First, I have taken a definition of luminance from a visual perspective:

> Luminance is a photometric measure of the luminous intensity per unit area of light travelling in a given direction. […] It describes the amount of light that passes through, is emitted or reflected from a particular area, and falls within a given solid angle. It also indicates how much luminous power can be perceived by the human eye.[64]

This definition works as a starting point to suggest that luminance as a dimension of timbre could be associated with the *amount* and *intensity* of *light* that is perceived in it. However, light is an ambiguous concept in music. Although qualities like *bright* and *dark* have been commonly expressed and pursued in musical practice, this research requires a better understanding of what light could mean in timbre and how the characteristics and behaviour of the parameters of sound could determine its perception. In order to answer these questions, I have approached different investigative and compositional perspectives, which will be presented below.

2.1 Perspectives on Luminance

Judy Lochhead has studied the experience of light in her analysis of *Lohn* (1996), for soprano and electronics, by Kaija Saariaho. Consequently, Lochhead approaches the concept of radiance as a formal property that emerges from the interaction of three types of musical phenomena that she calls moments of sonic luminance, moments of 'flickering', and moments of intensity. Thus, she describes luminance as 'a quality arising from pitch

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[63] An abbreviated version of this chapter appears in: Ivonne Michele Abondano Flórez, 'Distorted Pieces of Something: A Compositional Approach to Luminance as a Timbral Dimension', in *Proceedings of the 2nd International Conference on Timbre (Timbre 2020)*, ed. by Asteris Zacharakis, Charalampos Saitis, and Kai Siedenburg (2020), 125–28.

[64] 'Luminance vs. Illuminance', Konica Minolta, *Sensing Americas Website* <https://sensing.konicaminolta.us/blog/luminance-vs-illuminance/> [accessed 1 December 2018].

range, spectral attributes, and culturally derived timbral associations'.[65] Liza Lim has approached the experience of light from the concept of 'shimmer', inspired by a sacred painting technique called *bir'yun*, which was developed by the ancestral Yolngu culture in Australia:

> This [shimmer] is a visual effect created by fine cross-hatching drawn in high-contrast colours over the surface of sacred paintings. This technique projects a shimmering brightness that is seen as emanating from the ancestral creators of Yolngu mythology: bir'yun thus endows the paintings themselves with ancestral power. The shimmer of a painting is not only read as a representation of that power, but also felt as a direct manifestation of it.[66]

From another perspective, Murail's explanation of his own compositional approach allows the identification of an implicit relation with luminance through the use of words like *diffracting*, *light*, or *shade* to describe specific consequences of the spectral treatment:

> The tape was produced using additive synthesis, which involves the description of all dimensions of each partial. This seemed necessary to allow me to play with each spectrum with the precision that I wished. I had for a long time applied similar techniques to instrumental and orchestral works, and in *Désintégrations* the same processes are found in both orchestra and tape […]. The tape often exaggerates the character of the instruments, diffracting and disintegrating their timbre, or amplifying the orchestra […]. The piece is made up of 11 connected sections. It progresses from one section to the next by transition-transformation, or by passing a 'threshold'. Each section emphasizes one type of spectral treatment […] each section evolves from harmonic to inharmonic, or vice versa. This creates changes of light and shade accompanied by agitation, and by rhythmic order and disorder.[67]

These ideas of 'flickering', 'shimmer', and 'agitation' stress the importance of concepts like *movement* and *contrast* to understand that the perception of light in timbre is not a steady or fixed experience, but rather quivering, interrupted, or shifting. Regarding this, Lochhead determines that the recognition of timbral recurrence across sections in Saariaho's *Lohn* creates associations that generate intermittent moments of formal 'brightness' that lead to the emergence of formal flickering. Lochhead adds:

> Unique timbral events generate another dimension of formal flickering […]. The sense of uniqueness is, however, a comparative feature of timbral quality and hence it depends not on a particular quality as does luminance nor on the associational relations arising from timbral recurrence.[68]

Although Lochhead understands luminance, flickering, and intensity as three separate phenomena, I emphasise two dimensions of formal flickering from the sense of timbral *recurrence* (intermittent brightness), and *unique* timbral events, both compositional strategies

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[65] Judy Lochhead, *Reconceiving structure in contemporary music: New tools in music theory and analysis* (New York: Routledge, 2016), p. 111.
[66] Rutherford-Johnson, 'Patterns of Shimmer: Liza Lim's Compositional Ethnography', *Tempo*, 65, 258 (2011), 2–9 (p. 3).
[67] Murail, p. 141.
[68] Lochhead, p. 114.

that respond to the unstable behaviour of light. For Lim, flickering is a concept that refers to the contrast between *resistance* and *flow*, an interaction of different planes of tension that are developed from the technical approach to the instrument. Lim writes in the preface to the score of *Invisibility* (2009), for cello with two bows:

> The work is a study in flickering modulations between states of relative opacity/dullness and transparency/brightness, between resistance (noise, multiphonics and other distorted sounds) and ease of flow (harmonic clear sonorities). Striated, shimmer effects are created in the interaction between the competing planes of tension held in the retuned strings as they are affected by fingers and the varied playing surfaces of the two bows travelling at changing speeds, pressure and position.[69]

When talking about luminance, a general tendency to measure 'fidelity' or 'definition' in the perception of the timbral qualities can be seen. Musical descriptions for this timbral dimension are likely to rely on metaphors or poetical expressions that evidence the desire of distinguishing the identity of timbre clearly, a sort of effort to discover its *purity* or describe the obstacle to achieve it. This kind of association is found in the piece *eyam I (it takes an ocean not to)* (2009–13), for clarinet, in which Ann Cleare uses particular expressions to accompany instrumental techniques pursuing specific timbral results.

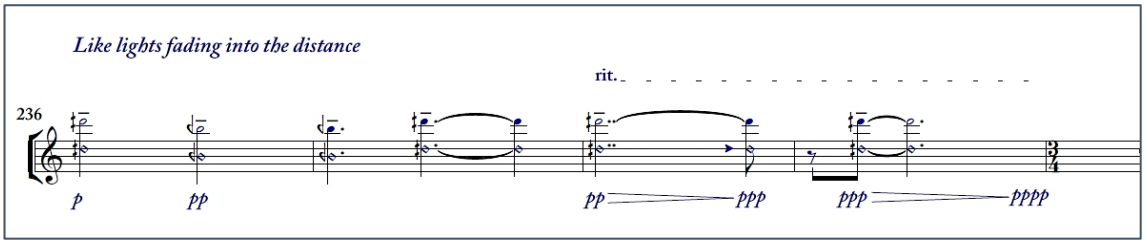

Figure 1. Score excerpt from *eyam I (it takes an ocean not to)* by Ann Cleare.[70]

The score excerpt in figure 1 is an example of how Cleare associates the experience of light with a technical approach to the clarinet. With a sequence of microtone harmonics in the high register, the composer creates a kind of instability and fragility, which can be attributed to the fading light. Indeed, the idea of disappearance, which is stated with the expression 'like lights fading into the distance', is reinforced by the use of very soft dynamics and a relatively slow change of pitches, emphasised with a *ritardando*.

These associations are central to explorations of nuances in the perception of light in timbre. Indeed, as Joseph A. Amato writes, 'in illuminating the desirable, lighting exposes

[69] Liza Lim, *Invisibility*, 2009, score (London: G. Ricordi & Co, 2009) cited in Rutherford-Johnson, p. 8.
[70] Ann Cleare, *eyam I (it takes an ocean not to)*, 2009–13, score. Reproduced by kind permission of the composer.

the undesirable'.[71] The experience of light could transgress the idealisation of a timbre; the presence of light could make evident conditions that were covered by other factors, but in excess it could exaggerate or distort some characteristics. From a visual perspective, the amount and intensity of light affects the shape, the size, the borderlines, and the colours of matter, which could be addressed in a composition as the possibility of perceiving the characteristics of the timbral parameters and their interaction through low levels of light to blur their features, or an extreme intensity to boost them until they lose their definition. In the middle of both experiences seems to exist a space for clearness, the exact amount and intensity necessary to 'perfectly' perceive a timbre. On the other side of the spectrum, the perception of darkness seems also uncertain. It could be related to quietness, or to the unseen. Amato compares it to the experience of dust:

> In this respect dust was like darkness: it formed a graduated and permeable screen between the realm of what was empirically known and the realm of the imagined. In it images appear and vanish, things are transformed and even generated. Dust formed a shadowy realm that harboured secret exchanges and sponsored unexpected transformations.[72]

Darkness in timbre, therefore, could be expressed as the impossibility of appreciating all its characteristics, as if there were such interference as the screen described by Amato, a layer of something that covers timbre and makes it confused, under-determined. This can be recognised in how Rutherford-Johnson approaches the notion of obscurity in Lim's music: '[w]hen listening, the ear is in fact drawn to these surface effects, rather than the underlying rhythmic ground, which indeed is so obscured as to be almost inaudible'.[73] The relationship between the obscure and the inaudible affords an emphasis on the need of light to make characteristics of timbre clear, thus the inaudible associated with the impossibility of listening could be the consequence of very low dynamics, but also an intended covering effect when timbre seems to be behind a screen that hides it. In *vermilion* (2003), for clarinet, electric guitar, and cello, Rebecca Saunders makes an association between the lack of sound and the experience of darkness.[74] She uses the following fragment from Samuel Beckett's *Company* (1980) as an epigraph for the score: 'By the voice a faint light is shed. Dark lightens while it sounds. Deepens when it ebbs. […] Is whole again when it ceases'.[75]

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[71] Joseph A. Amato, *Dust: a history of the small and the invisible* (London: University of California Press, 2000), p. 127.
[72] Amato, p. 20.
[73] Rutherford-Johnson, 'Patterns of Shimmer', p. 5.
[74] Michael Struck-Schloen, liner notes to Rebecca Saunders and musikFabrik, *Stirrings Still*, trans. by Steven Lindberg (Mainz: Wergo, 2008), p. 16 [on CD].
[75] Samuel Beckett, *Company* (London: John Calder, 1980), p. 25.

These relations between timbre and the perception of light are studied by Zacharakis, Pastiadis, and Reiss in proposing luminance as a semantic dimension of timbre: '[t]he first dimensions for both linguistic groups [English and Greek] have the adjective *brilliant* in common. This is a metaphor that comes from the domain of vision, we therefore suggest the label luminance for the description of this dimension'.[76] From their approach, it is possible to recognise *brightness* as a main factor for the understanding of luminance. Indeed, it can also be recalled from Lim's technical approach in *Invisibility*, where she works on flickering modulations between states of opacity/dullness and transparency/brightness. Although it seems to be common to understand brightness as a synonym of transparency or clearness, there may also be a place for subtle nuance in between. The experience of clearness could be related to the possibility of perceiving the qualities of timbre without any obstacle, transparently, while brightness could imply certain intensity of light and refraction affecting the perception of timbre. The following description of Di Scipio's piece *5 difference sensitive circular interactions* (1998), for string quartet with digital signal processing, expands the meaning of transparency in relation to timbre:

> Depending on the room's acoustical response to the music, the granular processing yields various sonic results, ranging from a complete 'vaporization' of the instrumental sound to more compact rhythmical gestures in some relationship to the quartet playing. The processing of noisy transient phenomena results in transparent, thin sonorities that I like to refer to sounds 'filled up with short silences'.[77]

The idea of 'vaporisation' as a process for eliminating the possibility of identifying the source of sound could be related to the perception of a barrier in the timbral perception of light. Di Scipio expresses this when the term 'transparent' is associated with silence as a sonority that has been 'cleaned' of noise, to which the composer adds: 'most of my own noise now appears to me as made of many sorts of sonorous powder'.[78]

The perspectives presented so far allow a recognition of how diverse the experience of light in timbre can be, an open space for multiple associations in my compositional approach. Nonetheless, it is also necessary to delimit the concept from the study of the acoustic correlations that seem to determine how timbre is conceived, from the perception of luminance, and how this information may contribute to the development of specific metaphorical associations that may be developed in each timbral experience.

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[76] Zacharakis, Pastiadis, and Reiss, 'An Interlanguage', p. 348.
[77] Di Scipio, 'Systems of Embers, Dust, and Clouds: Observations after Xenakis and Brün', *Computer Music Journal*, 26, 1 (2002), 22–32 (p. 26).
[78] Di Scipio, 'Systems of Embers', p. 31.

2.2 Compositional Approach: The Experience of Light

I like to dispense with the notion of time when appreciating the transformation of things through the experience of light. Shapes that appear delineated or perfectly defined suddenly became distorted, blurred, or diffused. The instability of light is fascinating; it makes it as powerful as it is fragile. Light defines and distorts. However, my eyes are very sensitive to light, which forces me to use polarised glasses that definitely alter my perception of things. It is not clear for me if this condition has been the root of my creative impulse to focus on the barrier, the interference, the 'something in between' that prevents light from passing through completely. Therefore, the means of diffraction, filtering, or covering, as unpredictable and dynamic entities, are the source of inspiration for the three pieces dedicated to the study of this semantic dimension of timbre.

In order to clarify the use of qualifiers for luminance in my own compositional process, I propose a scale of two phases that measures the *amount* of light going from dark to clear, as well as the *intensity* of light for qualities from clear to distorted (figure 1). The terms used to mark each level were taken from a list of thirty descriptors for timbre that Zacharakis preselected from the semantic literature review in his research, in which particular associations with light can be seen: for instance, *clear*, *shrill*, *distinct*, *bright*, and *dark*.[79] He additionally obtains a collection of free verbalizations from the listeners of his experiments, that includes other qualities such as *blurred* and *distorted*.[80] Other terms were selected from the analysis of instrumental repertoire, as well as my own experience and compositional criteria, like *incisive*, *veiled*, and *opaque*.[81]

[79] Zacharakis, 'Musical Timbre', p. 79.
[80] Zacharakis, 'Musical Timbre', p. 96.
[81] 'Incisive' could be understood as a synonym of 'piercing', which actually appears in Zacharakis, 'Musical Timbre', p. 96, and in Cleare, *eyam I (it takes an ocean not to)*. The same occurs with the adjective 'opaque', which could be a synonym of 'dull' as it is listed in Zacharakis, 'Musical Timbre', p. 79. My preference for the terms *incisive* and *opaque* may correspond to my experience as a Spanish native-speaker.

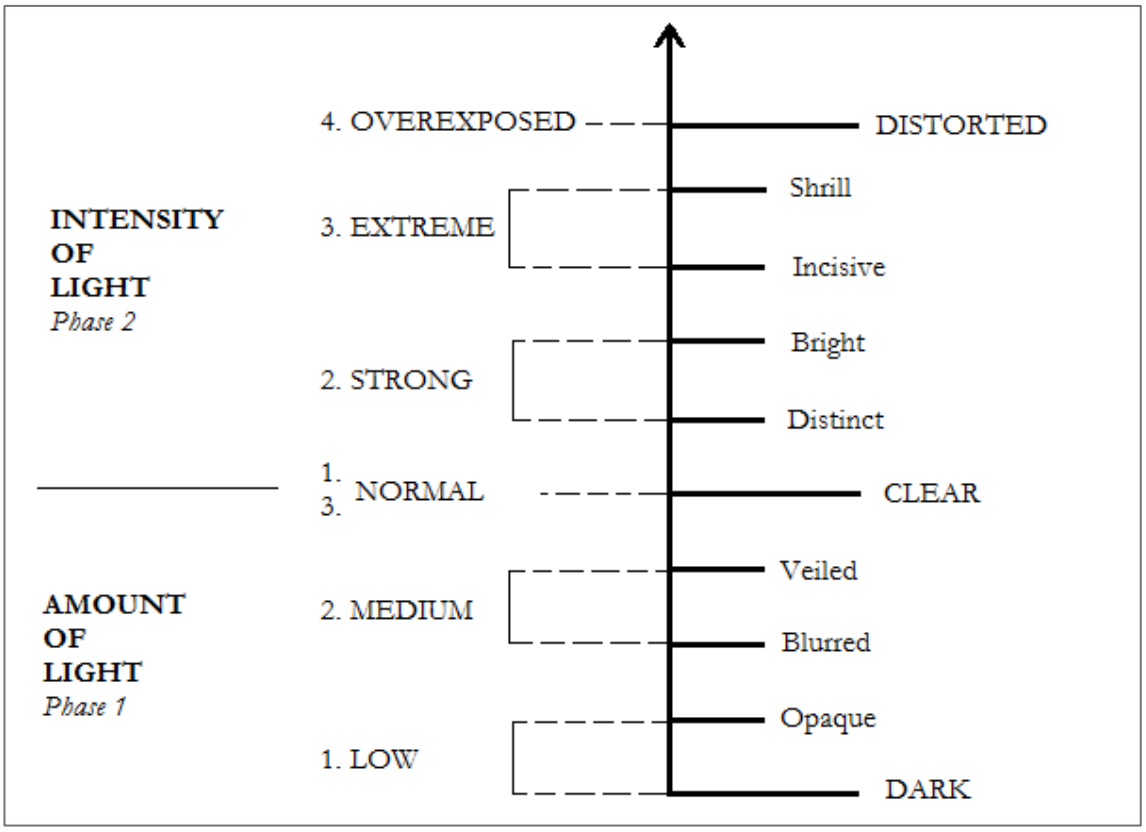

Figure 2. Two-phase luminance scale for the measurement of amount and intensity of light according to the correlations between the acoustic features and the semantics of timbre.

To deepen understanding of how the semantics of timbre in terms of light correlate to timbral physicality—that is, how timbre is constituted, structured, and developed, and how this information could be approached in the composition of the pieces—I turn to Zacharakis, Pastiadis, and Reiss:

> There is some evidence that the amount of inharmonicity influences auditory brilliance (i.e., more inharmonic sounds are perceived as less brilliant) in both groups [English and Greek]. Additionally, sounds with a stronger spectral centroid fluctuation are also more likely to be perceived as less brilliant. There is some evidence that fundamental frequency is positively correlated with brilliance in the Greek group.[82]

Additionally, Lochhead argues that the *events of luminance* include sounds with prominent upper partials, higher pitch, and a louder dynamic.[83] From these perspectives and through the spectral analysis of the instrumental techniques approached in the compositions, two features may be recognised as strongly influential on the perception of luminance: dynamic envelope (attack and development—sustain and release), and spectral content (pitch, spectral centroid, and inharmonicity) (table 1).

[82] Zacharakis, Pastiadis, and Reiss, 'An Interlanguage', p. 350.
[83] Lochhead, p. 111.

Phase 2	Distorted Shrill Incisive	Loud attack. Development: Large fluctuations of spectral centroid and loud dynamics. High fundamental frequency (pitch register). High inharmonicity and loud dynamics. High noisiness Strong presence of upper partials.
	Bright Distinct	Medium attack. Development: Low fluctuations of spectral centroid and medium dynamics. High-medium fundamental frequency (pitch register). Low inharmonicity. High presence of upper partials.
Centre	Clear	Medium attack. Development: Stable spectral centroid and medium dynamics. Middle fundamental frequency (pitch register). Low inharmonicity. Low presence of upper partials.
Phase 1	Veiled Blurred Opaque Dark	Soft attack. Development: Stable spectral centroid and soft dynamics. Low fundamental frequency (pitch register) and low presence of upper partials. High noisiness High inharmonicity and (very) soft dynamics.

Table 1. Luminance Scale Correlations: Acoustic conditions of timbre and the levels of the luminance scale.

From these general correlations, the categories of the luminance scale work as starting points for timbral transformation. However, in order to understand the creative applications of the scale, it is necessary to recognise how light could be approached compositionally. The nuances between each mark of the scale (descriptor) rely on contextual factors and the combination of specific conditions in the composition. Therefore, dust and rain act as metaphorical barriers in the pieces—imaginary layers that interfere in the experience of light in timbre. Furthermore, dust could evoke unpredictable movement, like its particles floating in the air, uncatchable tiny pieces scattering and refracting light, giving timbre an ambiguous power that is simultaneously both freedom and fragility. Rain, for its part, could affect the perception of light as a blocker according to the amount of water that falls, but could also be a means of dispersion like drops stuck on a window pane that have the power to refract light and distort any perceived form.

2.1.1 and it comes like a piece of light through the dust

and it comes like a piece of light through the dust (2018–20), for solo bass clarinet, presents the transitional process of timbre from being covered by a layer of dust to gradually revealing its essence as it is illuminated by different amounts and intensities of light. However, rather than timbre moving towards 'perfect' visibility, most of the time it is driven to total distortion as the consequence of a kind of 'overexposure effect'. Sometimes it remains covered while subtle transformations occur, because of rays of light that attempt to cross the dust but cannot.

For this composition, I started with a study of the clarinet repertoire to find references that allowed me to explore timbre from particular technical perspectives in association with the luminance scale. Although Martin Iddon's *Ptelea* (2014), for bass clarinet, was not composed under the premise of the experience of light; I found relevant metaphorical associations and technical concepts that contributed to the development of my own compositional approach. In this piece, the treatment of timbre seems to have an intrinsic relation to the title. Ptelea is a nymph who lives in a tree and inevitably dies when the tree dies: in a sense, the nymph is the tree. I make an association between the luminance experience and the level of intimacy that makes timbre be perceived as covered, not completely exposed to light, as an allusion to the liminal space between a mythological character who both *is* and *inhabits* the tree.

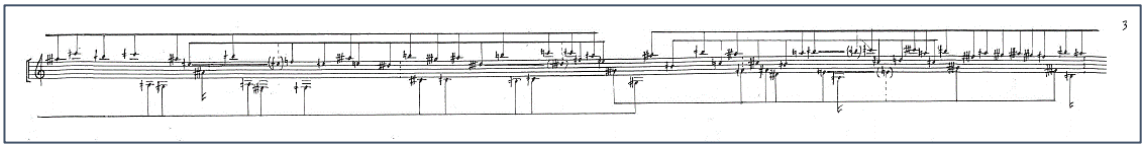

Figure 3. Score excerpt from *Ptelea* by Martin Iddon.[84]

The piece leads me to look for the 'interior' of timbre, maybe as an exploration of certain veiled closeness, like a secret that Iddon creates through two melodies that interact in a fascinating way from the impossibility of being played simultaneously. An excerpt showing this complex interaction can be seen in figure 3. One important instruction given by Iddon in the performance notes of the score is the relation between dynamics and techniques:

> There should be no differentiation of attack whatsoever, the piece having an essential flat, extremely quiet surface. Pitches grouped together by a beam should be linked by smooth *glissandi*. The first

[84] Martin Iddon, *Ptelea*, 2014, score. Reproduced by kind permission of the composer.

> note of each grouping should be slap tongued (at the lowest dynamic possible to make this effective).[85]

This instruction may coincide with the fact that a soft attack and general soft dynamics are associated with the perception of the first phase of the luminance scale, corresponding to a low amount of light. Additionally, I found an invaluable source of information about the clarinet, its notation, and its techniques in Heather Roche's website.[86]

After the analytical stage, I started the compositional process with material worked on over a two-session experimental laboratory with the clarinettist Amelia Richardson.[87] The purpose of this laboratory was to explore timbre and its susceptibility to alteration through subtle or even dramatic changes in execution, affecting the amount or intensity of light perceived in it. Being consequent with the general compositional idea of creating a barrier for light, I worked on techniques and preparations that led to the perception of an 'obstacle' in the inner workings of the clarinet mechanism to prevent the clarity of timbre.

Since Richardson is also a singer, her vocal skills inspired me to use the voice as an extension of the timbral possibilities of the instrument, not as an additional layer but as an element of internal disruption. The vocal exploration was later developed further in a workshop with the singer Jessica Aszodi, in which I could explore with my own voice the technical difficulties and the physical demands of techniques like growling, whistling, or vocal fry. Aszodi also approached specific notation which I adjusted to make it compatible with the clarinet transposition in my piece.[88]

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[85] Iddon, performance instructions.
[86] Heather Roche, 'Buzzing, noisy and distorted multiphonics for Bb clarinet', in *Heather Roche. Clarinettist Website*, 1 June 2018 <https://heatherroche.net/category/spectral-multiphonic/> [accessed 20 October 2018].
Roche, '…on double trills for Bb clarinet', in *Heather Roche. Clarinettist Website*, 11 May 2014 <https://heatherroche.net/category/double-trills/> [accessed 20 October 2018].
Roche, '…on close dyad multiphonics for bass clarinet', in *Heather Roche. Clarinettist Website*, 8 August 2014 <https://heatherroche.net/2014/08/08/on-close-dyad-multiphonics-for-bass-clarinet/> [accessed 20 October 2018].
[87] Each session of work with Amelia Richardson was two-hours long; they took place on 24 October and 3 December 2018 at the School of Music, University of Leeds.
[88] Jessica Aszodi's workshop was organised by the School of Music, University of Leeds, and took place on 29 April 2019.

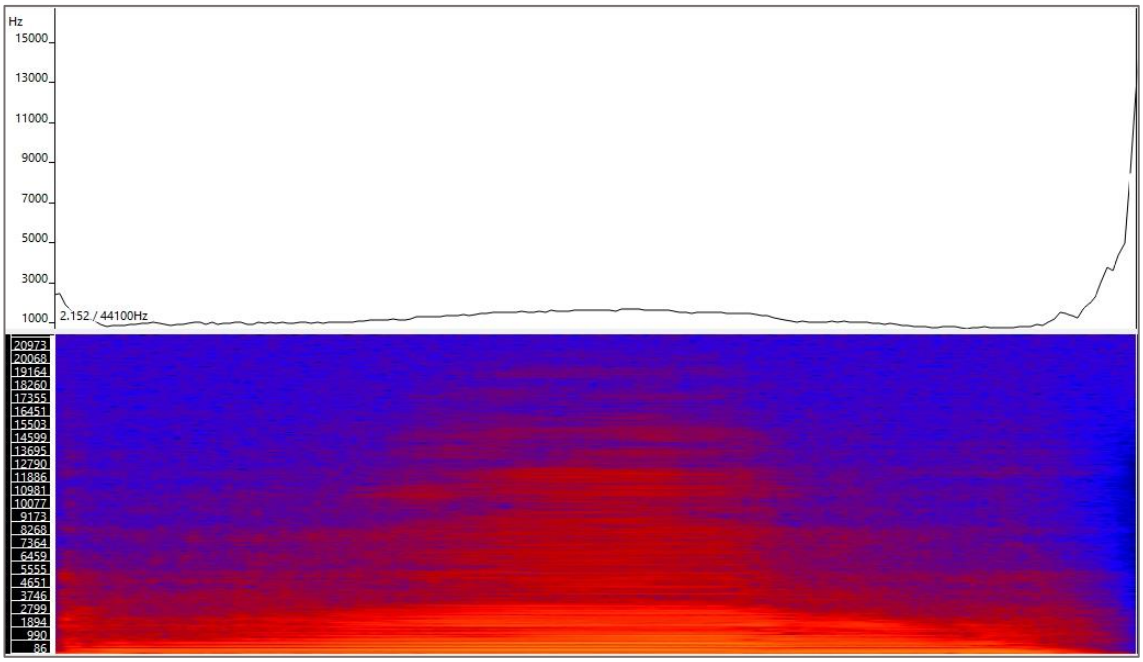

Figure 4. Spectral centroid and spectrogram of the bass clarinet middle C (sounding B flat 2: 116.54 Hz), *mezzo-piano* attack, then crescendo and decrescendo.[89]

A recording of the bass clarinet middle C was analysed with Sonic Visualiser (figure 4), from which it was possible to say that the timbre produced was *clear* as a consequence of the normal technique for the attack and the medium dynamics. A determinate pitch is discernible from the beginning (B flat 2: 116.54 Hz). However, the impact of the *crescendo* can be appreciated in the middle of the development, where upper partials are boosted and there is a slight fluctuation of the spectral centroid from around 1 KHz to 2 KHz. This condition is associated with the perception of a higher intensity of light (phase 2, level 2: *distinct*, *bright*), demonstrating the strong influence of dynamics on the temporal evolution of timbre.

[89] Audio recording of the exploratory laboratory with Amelia Richardson (Zoom H4n digital recorder, XY mic/stereo). The top image shows the estimation of the spectral centroid, and the bottom image corresponds to the spectrogram. In both cases, the left axis marks the frequencies in Hz while the level of loudness (dB) is represented with a red-orange-yellow colour scheme (lowest to highest) on a blue background. Although it is not properly marked, the 'x' axis represents the duration. The excerpt is 2.150 seconds long, which is indicated in the left bottom corner of the top image, adding the sample rate of the recording 44.100 Hz.

Technique 1. Singing or whispering (w/o mouthpiece)	Technique 2. Spectral multiphonics (mouthpiece)	Technique 3. Dyad multiphonics	Technique 4. Low pitch, soft dynamic
1.1 Change of covering (mouth position), change of dynamics. 1.2 Fingering trill/bottom C half pressed fingering. 1.3 Growling. 1.4 Air sound and flutter-tongue.	2.1 Add flutter-tongue. 2.2 Add cardboard mute. 2.3 Add singing voice. 2.4 Fry voice.	3.1 Going to air sound.	4.1 Double trill (producing dyad multiphonics). 4.2 Add flutter-tongue. 4.3 Add singing voice. 4.4 Add cardboard mute (preparation).

Table 2. Techniques in *and it comes like a piece of light through the dust*: luminance development of specific bass clarinet techniques.

The clarinet techniques that appear numbered in table 2 work as 'timbral stations', while their variations could be understood as 'round trip' points that contribute to the perception of the flickering experience of light. These techniques were similarly analysed, from which it was possible to structure the piece according to a process of filtration and dispersion of light through the dust. The piece is developed based on the correlations between the techniques and the descriptors for the resulting timbre (figure 5).

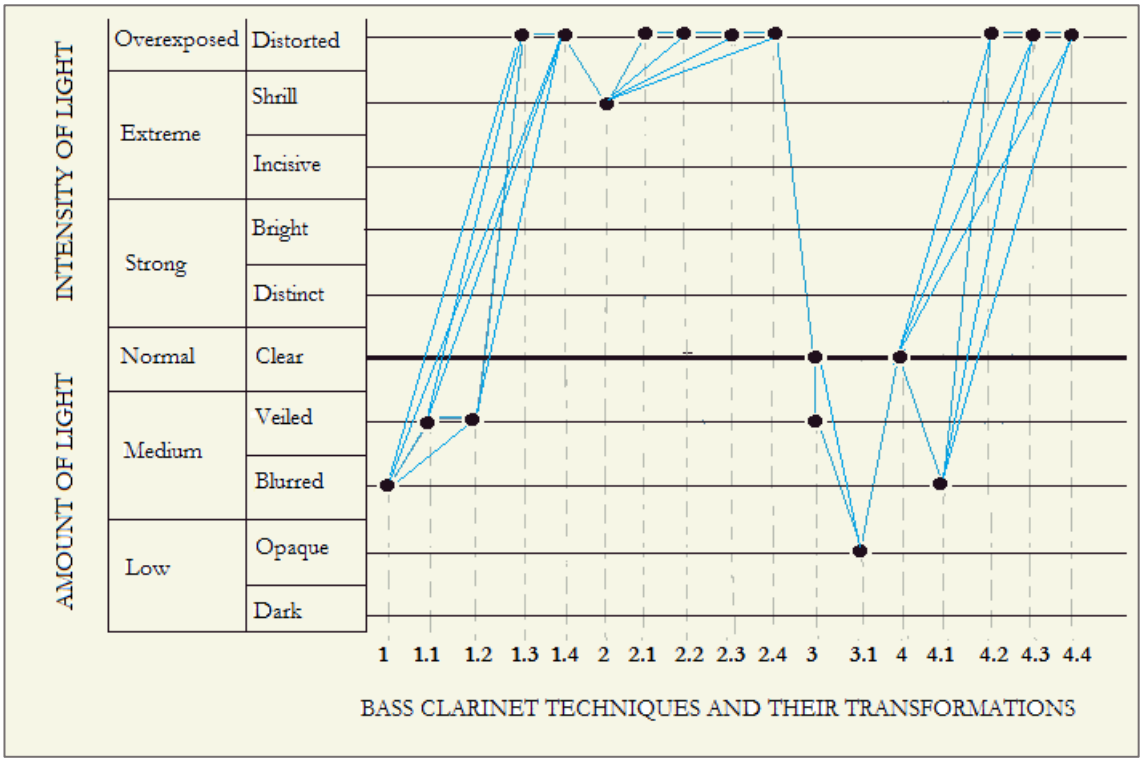

Figure 5. Luminance structure of *and it comes as a piece of light through the dust*.

A preliminary version of the piece was reviewed by the clarinettist Eduardo Spinelli, who made invaluable suggestions as a male performer, especially with regard to the vocal techniques. His comments also contributed to my understanding of the timbre resulting from dyad multiphonics with double trills applied from soprano to bass clarinet. Finally, we discussed the notation of spectral multiphonics, especially because the pitch of upper partials can fluctuate between one clarinettist and another.[90] Later, in a reading session of the new version with Heather Roche, I had the opportunity to listen to the whole piece for the first time. Since the work with Spinelli focused on the effectiveness of the individual techniques, the work with Roche was fundamental in recognising the limits of the compositional approach: that is, how the transitions between different light states had been articulated and where the conceptual objective had not been successfully achieved.[91] Further changes and final decisions were made after this experience, which allowed me to submit the piece to the Call for Scores organised by the new music collective Verdant Vibes, being selected to be premiered by Chuck Furlong in an online concert on 19 December 2020.

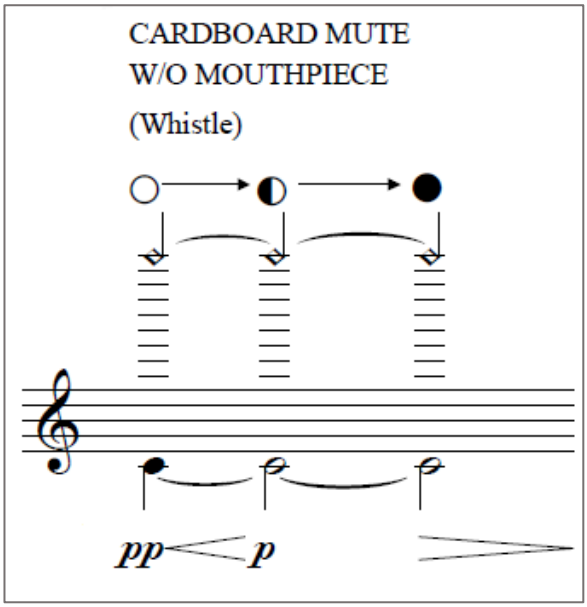

Figure 6. Score excerpt from *and it comes like a piece of light through the dust* (a) showing the mouth position towards the clarinet (without mouthpiece) while whistling: open (white circle), half covered (black and white circle), and complete covered (black circle).

[90] The communication with Eduardo Spinelli was carried out by e-mail, receiving an extensive written review of the piece on 20 December 2019.
[91] The reading session with Heather Roche was one-and-a-half hours long and took place at the School of Music, University of Leeds on 28 January 2020.

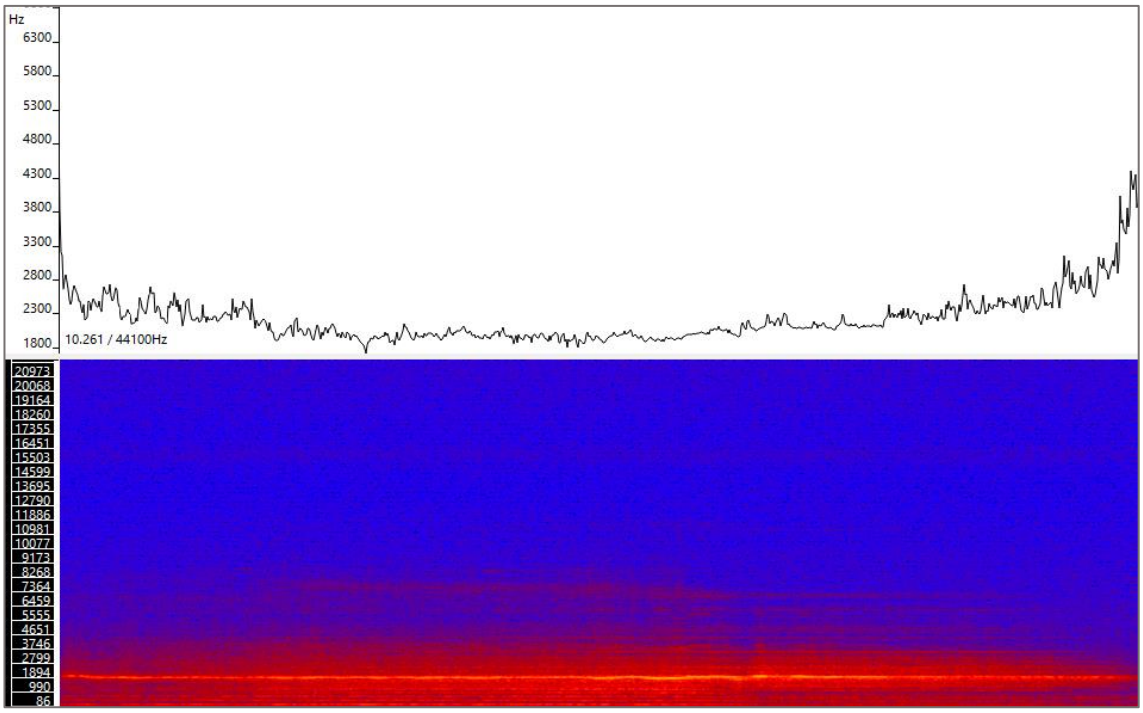

Figure 7. Spectral centroid and spectrogram of excerpt in figure 6.[92]

The score excerpt in figure 6 exemplifies how the concept of instability of light and the idea of dust being an interference that blocks or distorts the perceptual experience are compositionally approached by creating connections between subtle changes in the execution of a technique. Even though the pitch of the whistle is technically difficult to keep steady, the estimation of the spectral centroid (figure 7) shows very low fluctuations, especially in the middle part, owing to a subtle increase of loudness and close proximity between the mouth and the instrument. The low spectral centroid fluctuations and the high pitch of the whistle (sounding B flat 6, 1864.66 Hz) could be categorised as *bright* or even *incisive* in terms of the luminance scale; nonetheless, the general soft dynamics reduce the perception of the intensity of light. Moreover, moderate fluctuations of the spectral centroid appear at the end when the voice is directly resonating inside the instrument (complete covered), which generates a certain instability as a consequence of the interference produced by the fingering (middle C) altering the whistle vibratory flow. The inharmonicity of this technique is highly perceivable; moreover, the strong presence of air sound intrinsic in it acts as a layer of dust, which makes timbre flick to *veiled*.

'Timbral augmentation' through the incorporation of simultaneous techniques is a compositional strategy approached in this piece to reach different levels of luminance. These techniques include the preparation with a DIY cardboard mute developed through

[92] Audio recording of the premiere by Chuck Furlong.

an exploration with objects of different materials that could be introduced in the clarinet bell to create a barrier that served as a distortion rather than a muffling effect. The timbral result with a hard cardboard tube covered in plastic in one of the extremes might be associated with an electrical noise. However, this preparation only works as expected from the low C fingering because it requires all the holes to be closed. The sound that should flow through the bell is limited by the cardboard cylinder, which modifies the oscillations produced inside the instrument; while a part of the sound seeps through the borders of the mute inside the bell, most of the vibratory flow is 'trapped', which creates an oscillatory feedback because of the continuous reflection.

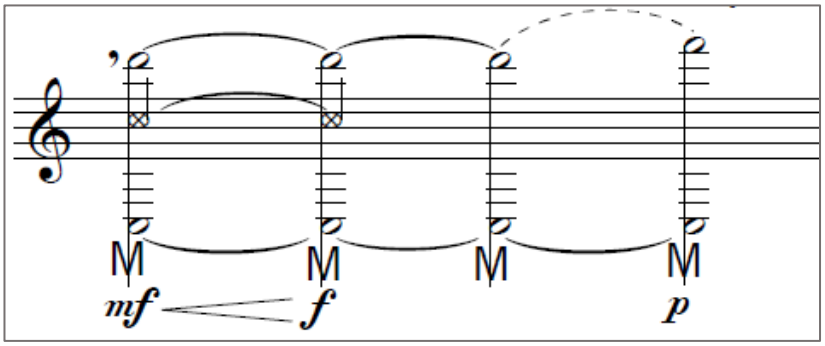

Figure 8. Score excerpt from *and it comes like a piece of light through the dust* (b) showing the overexposure effect in timbre.

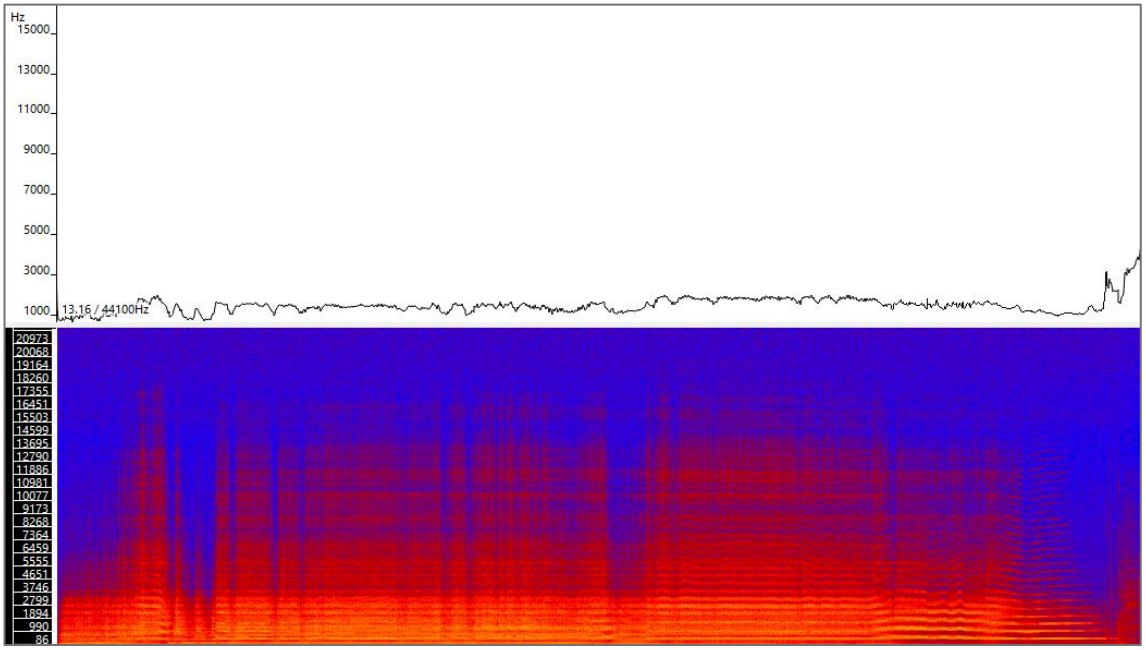

Figure 9. Spectral centroid and spectrogram of excerpt in figure 8.

Therefore, from the lowest C (sounding B flat 1: 58.27 Hz) a spectral multiphonic is constructed by successively filtering the 9th and 11th partials while the cardboard mute is used, with the voice adding the 4th partial—a 'stranger' to the spectrum (figure 8). The overexposure effect is a consequence of these techniques and the instrumental preparation working simultaneously. It is interesting to observe how the spectral centroid (figure 9) remains relatively stable around 2 KHz, as a consequence of the prominent upper partials emphasised by the cardboard mute. Nonetheless, there is an evident increase of *loudness* and *harmonic dissonance*, that is, the internal oscillations produced by the beating of close partials across the spectrum. This complex development contributes to the perception of a *distorted* timbre, the top of the luminance scale.

A section of dyad multiphonics with aeolian and air sounds serves as the apparent triumph of dust. The timbre presents low loudness and pitch instability, which allows an exploration of the first phase of the luminance scale. Finally, the timbral experience is guided through the oscillation of double trills that alternate with a low fundamental and vocal additions in a concatenation of *transitional events*, by direct transformation or by silences that act as time amalgams, giving rise to the perceptual experience of an irregular and unpredictable exposition of timbre to light.

2.1.2 The Shimmer Beneath: A Scattering Attempt

The Shimmer Beneath: A Scattering Attempt (2019), for cello duo, is inspired by an imaginary scene of light breaking through thick layers of dust with great difficulty. Dust has two different qualities in the piece. The first is the initial timbral experience in which it is perceived as an almost solid and visible cap over timbre. The second refers to the lightness and emptiness that allow it to drift. The shimmering beneath finds a way to escape in dust itself, scattering through the refracting power of its rising minute pieces. Although I was still attracted to the idea of *clearing* timbre *up* explored in the previous piece, in this composition, rather than approaching the process through exposure to light, it is timbre itself which 'contains' the light that tries to break free. Consequently, all the instrumental techniques were developed in order to study timbre from the 'inside' through the two phases of the luminance scale in a process of *dusting*.

The instrumental work started in an exploratory session with Scott McLaughlin to recognise the timbral qualities of cello multiphonics.[93] This technique resulted in a very interesting resource because of the unpredictable and unstable behaviour of the timbre produced. The technique is explained by Francesco Dillon as follows:

> The finger of the left hand that touches the string is played with light pressure exactly like an harmonic, but it is played a little slightly out of the right position so if this position is producing the seventh (partial) a little very like a 1 mm off the position will make the sound dirtier so it goes broken. But I think that the most important thing is the bow arm which is not too close to the ponticello because being directly to the bridge produces a cleaner sound. When you look for a difficult harmonic and you go here [very close to bridge] there is almost a selection of the sound that produces these high harmonics. So I go just a few centimetres off the bridge and really look for this, I will say again, resistance of the string this kind of, in Italian we would say it is a kind of force against, some kind of little tension on the string and I would say the bow has to be quite slow and a little deep […] the opposite to flautato.[94]

Dillon understands cello multiphonics as timbres mainly within the first phase of the luminance scale. This can be seen in the way he recommends not bowing too close to the bridge to avoid 'cleaning' the sound. The multiphonic notated in the following score excerpt (figure 10) could be classified as a blurred-veiled timbre, according to the luminance scale.

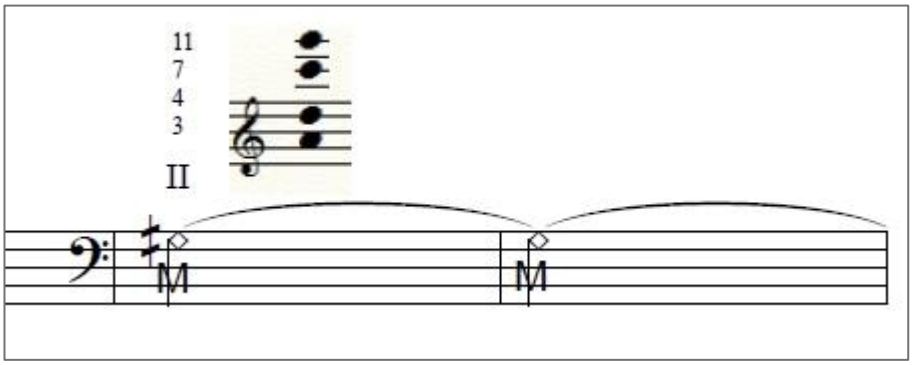

Figure 10. Score excerpt from *The Shimmer Beneath: A Scattering Attempt* (a) showing a multiphonic that could be classified as blurred-veiled.

[93] The exploratory session with Scott McLaughlin was one hour long and took place on 12 February 2019 at the School of Music, University of Leeds.
[94] Francesco Dillon, *Francesco Dillon parle sur les multiphoniques dans le quatuor n.9 de Salvatore Sciarrino*, online video recording, YouTube, 17 June 2014, <https://www.youtube.com/watch?v=lFpuv1N4frY> [accessed 10 February 2019].

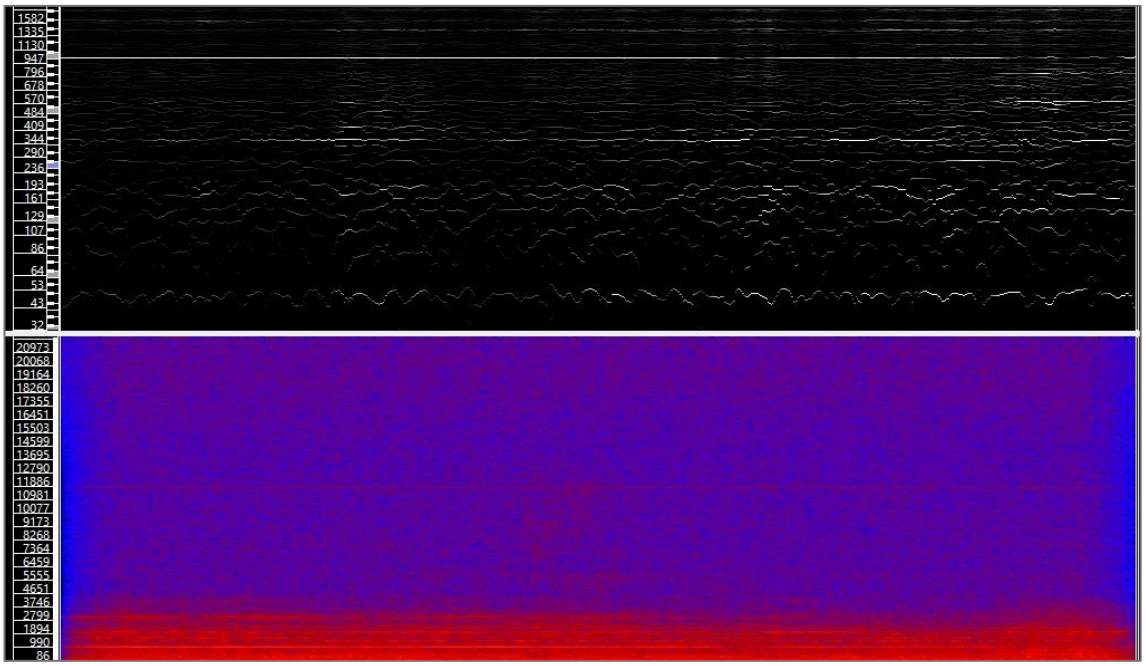

Figure 11. Peak frequency analysis and spectrogram of excerpt in figure 10.[95]

Although in the peak frequency analysis (top image in figure 11) it is possible to identify a high frequency (C6: 1046.50 Hz), in this performance other partials are not so consistent (D5: 587.33 Hz, A4: 440 Hz, and F4: 349.23 Hz). This condition is reflected on the spectrogram (bottom image in figure 11), which shows how the whole spectrum is almost homogeneously diffused, with a major concentration in the low part of the register (below 3 KHz). From this perspective, this multiphonic could be metaphorically approached as the timbral experience of dust filtering light.

This compositional strategy of associations between metaphor and technique allows me to structure the piece out of the creation of obstacles, filters, and barriers for light. Therefore, the development of an interrupted trajectory of light is a conceptual lineament for the timbral exploration and technical approach to the two cellos in the piece. During the composition process, I wondered about the most appropriate notation for the techniques developed, especially for their interrelatedness in respect of time and their inevitable transformations and transitions. My first proposal was to write instructions and use symbols to describe what the performer has to do, although with this approach the score wouldn't represent the unpredictable timbral results. Jessie Marino's Cello Multiphonics

[95] Audio recording of a rehearsal with Gaia Blandina and Ali Baumann on 4 June 2021 at the Department of Music, University of York (Zoom H4n digital recorder, XY mic/stereo).

blog became a rich source of information for writing the multiphonics in the piece.[96] Nonetheless, I studied different possibilities in order to identify the most appropriate way of communicating the required action and the expected timbre. For this the blog Cello Map by Ellen Fallowfield was another important resource.[97]

Analysis of the piece *durchsichtig, verzweigt* (2016), for pedal steel guitar and three cellos, by Elnaz Seyedi contributed to my research into timbral development, especially from the interaction of several equal instruments.

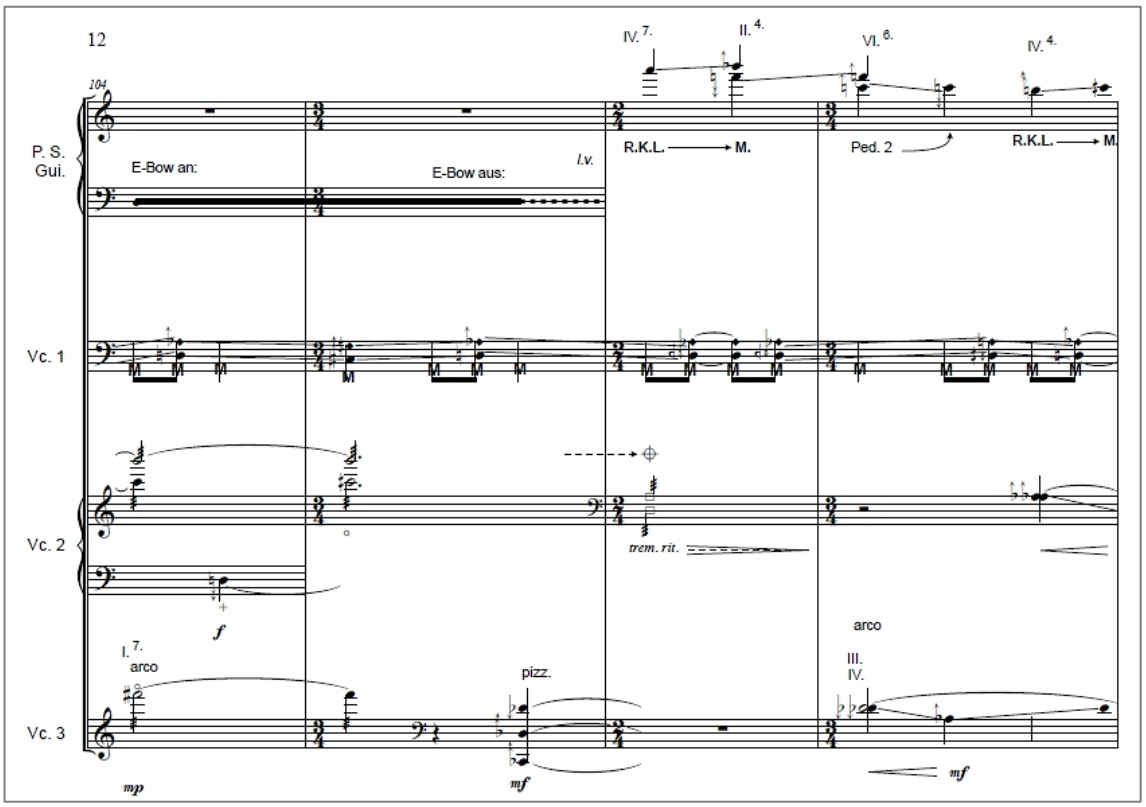

Figure 12. Score excerpt from *durchsichtig, verzweigt* by Elnaz Seyedi.[98]

The word 'transparent' in the title (*durchsichtig*) suggests an experience of light that I have previously associated with clearness, the centre of the luminance scale. From an instrumental approach, this clearness could come from the homogeneity of the sources and their interaction as a mutual expansion. However, I was interested in the idea of 'branched' (*verzweigt*) as a ramification, a bifurcation that can be associated with the effect of dispersion

[96] Jessie Marino, 'Multiphonics Notation', *Cello Multiphonics Website*, 10 August 2010 <http://cellomultiphonics.blogspot.com> [accessed 7 February 2019].
[97] Ellen Fallowfield, 'Multiphonics: Multiphonic fingering charts', *Cello Map Website* <https://cellomap.com/multiphonics-multiphonic-fingering-charts/> [accessed 7 February 2019]. Fallowfield, 'Multiphonics: Basics', *Cello Map Website* <https://cellomap.com/multiphonics-basics/> [accessed 7 February 2019].
[98] Elnaz Seyedi, *durchsichtig, verzweigt*, 2016, score (Berlin: Edition Juliane Klein, 2021). Reproduced by kind permission of the composer.

of light. The score excerpt in figure 12 shows how Seyedi attributes a particular identity to each instrument by developing different but still related techniques.[99] Therefore, the composer creates a timbral entity with internal movement through the e-bow glissando in the pedal steel string, the multiphonics glissando in cello 2, and the tremolo harmonics in cello 1 and 3. Nonetheless, it is when cello 3 presents a more contrasting material, the pizzicato, that the bifurcation is realised through the high glissandi in the pedal steel string emulated like and echo by, again, cello 3. The dispersion is also emphasised by a technical divergence in cello 2 which, from my compositional perspective, creates an explicit blocker for light by damping the strings on the harmonic fingering position. These transitions between moments of transparency and ramification in the experience of light was one of the compositional approaches I was interested in recognising for my own piece.

In this process, I also worked with Iddon on the exploration of different finger pressures or mutings to alter the natural vibration of the strings and generate fluctuations in pitch, loudness, and upper partials. We used a viola to approach the potential of these techniques arising from the physical interaction, that is, type of movement, speed and displacement.[100] The timbral result of the pinched string or very light finger pressure tends to be perceived as unclear and more likely to be described with the terms of the first phase of the luminance scale (dark to veiled), an experience that is pursued at the beginning of the piece, especially inspired by Iddon's *Ptelea* and my own timbral associations with such an introspective experience.

A fragment of the piece was workshopped with Rohan de Saram and Claudio Pasceri, who shared important reflections on the most appropriate way to notate temporality as a fundamental aspect of timbral transformation. For them, time should be naturally conceived, as an inner pulse that allows the sound to flow; therefore, the time signature should be coherent with the temporal evolution of timbre in order to give voice to the conduction of energy and the perception of its transformation.[101]

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[99] Cello 2 and 3, as well as the pedal steel string are tuned differently approaching microtonal deviations from the standard tuning.

[100] The instrumental approach described with Martin Iddon was part of a supervision meeting on 22 February 2019.

[101] The three-hour long workshop with Rohan de Saram and Claudio Pasceri was organised by the School of Music, University of Leeds and took place on 9 May 2019.

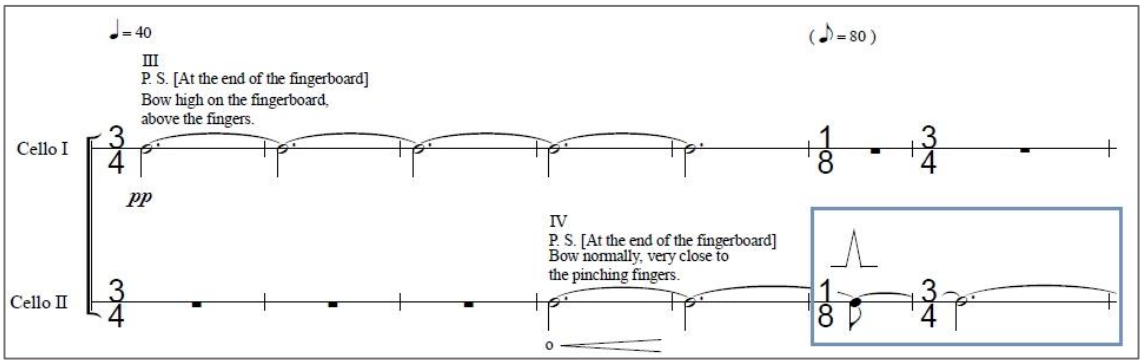

Figure 13. Score excerpt from *The Shimmer Beneath: A Scattering Attempt* (b) showing a technical approach to producing a timbre in the first phase of the luminance scale.

The score excerpt in figure 13 corresponds to one of the initial techniques, in which the second cello pinches the IV string at the end of the fingerboard and makes a fast accent with the bow by going vertically along the string crossing the bridge and coming back to a point very close to the pinching fingers to continue the normal bowing, *pianissimo*.

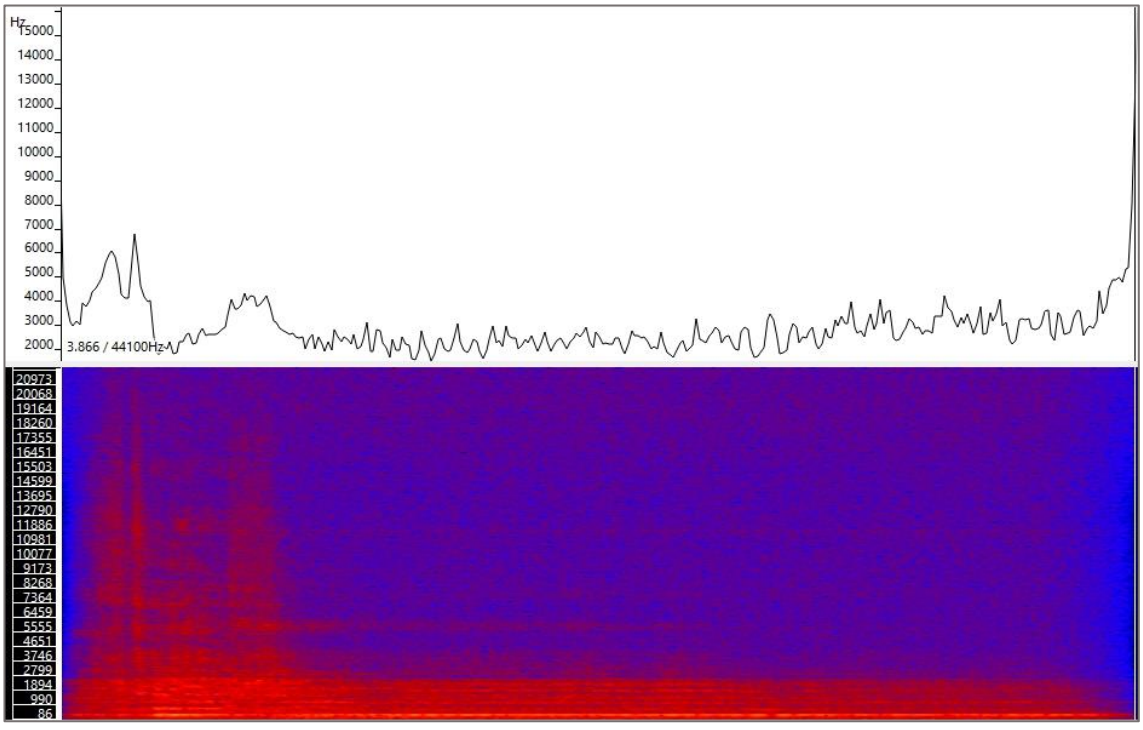

Figure 14. Spectral centroid and spectrogram of the boxed excerpt in figure 13.[102]

The technique described above produces a timbre that could be classified as *opaque*. From the spectral analysis in figure 14 it is possible to identify that the spectral centroid mainly fluctuates from G6: 1567.98 Hz to B7: 4047 Hz, which may be considered moderate. The

[102] Audio recording of a rehearsal with Gaia Blandina and Ali Baumann. This image corresponds specifically to the analysis of the boxed score excerpt in figure 13.

bow accent can be identified at the beginning in both spectral centroid largest fluctuations and the columns in red in the spectrogram as a consequence of prominent upper partials and increase of loudness, which can be approached as a brief escape of light that is rapidly covered again with dust. This 'covering' effect could be associated with the opacity of timbre owing to the blurring of the upper partials across the spectrum by a drastic reduction of intensity, and the emphasis on the hiss of the bow on the damped (pinched) string very close to the fingers, which prevents the string from vibrating properly to produce a clear fundamental and its partials.

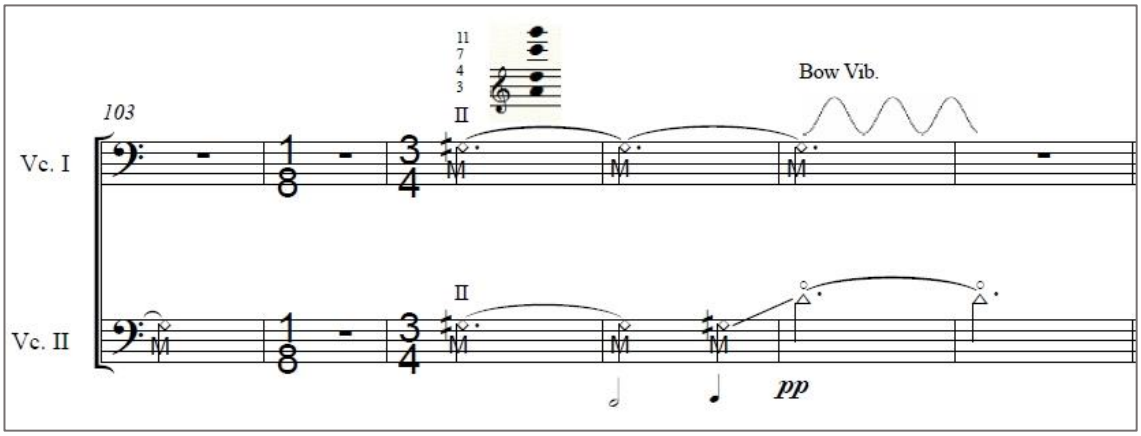

Figure 15. Score excerpt from *The Shimmer Beneath: A Scattering Attempt* (c) showing the 'dispersion of light' effect created in the piece.

From my exploration of the interaction of both cellos, I attempted a development of the *dispersion of light* (from m. 75 to the end of the piece) through the configuration of moments of coincidence that generate a condensation, a concentrated energy that is released by a separation of its components (figure 15). In this way the scattering comes as a consequence of the division of activity, in which each cello follows different directions or presents different techniques by which to separate their trajectories, thus emphasising the dispersion. The final version of the piece was selected in the 'Yorkshire and the North East' Call for Scores 2020, organised by The Chimera Ensemble (University of York), and was premiered by Ali Baumann and Gaia Blandina in a concert on 20 June 2021 as part of the York New Music Weekend 2021.

2.1.3 Distorted Pieces of Something. A Study on Light (when it rains)

Spending hours working next to a window while it was raining, I recognised another kind of filter and distortion effect in the perception of light. Woolf uses the following metaphor: 'the lights were rippling and running as if they were drops of silver water held firm in a wind'.[103] Toni Morrison, for her part, explores the association with tears: 'Queen of France was already showing lights scattered like teardrops from a sky pierced to weeping by the blade tip of an early star'.[104] In *Distorted Pieces of Something. A Study on Light (when it rains)* (2019), for saxophone soprano and viola, the first phase of the luminance scale is approached in association with the moment of heavy falling rain, when there is also mist, that thick and untouchable presence that fills a space and makes seeing the other side impossible, turning everything into faint images, like pieces of something that has no form at all, almost vanished, but still there. The second phase is related to the moment immediately after the rain stops, when everything is wet and many drops cover the windows, making light reflect and refract widely at the same time, spreading its presence as distorted pieces of something that shines ambiguously.

In this composition process, I deepened my understanding of the strings through the study of the piece *yet another example of the porousness of certain borders* (2014), for contrabass, by Oliver Thurley. This composition was fundamental to approach the complex vibratory behaviour of the strings from a particular technical and aesthetical perspective: the idea of fragility.

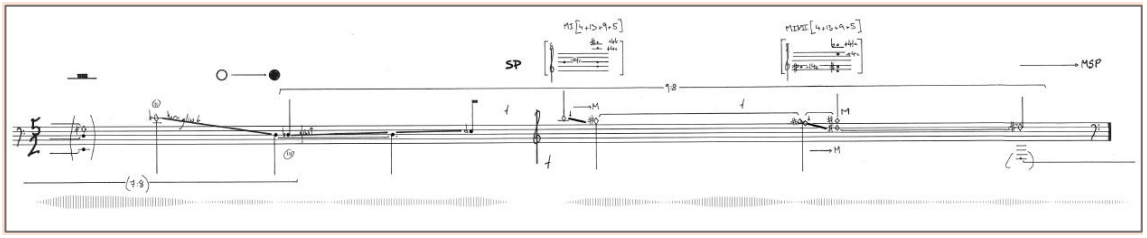

Figure 16. Score excerpt from *yet another example of the porousness of certain borders* by Oliver Thurley.[105]

[103] Woolf, *To the Lighthouse* (London: Penguin, 1964), p. 97.
[104] Toni Morrison, *Tar Baby* (New York: Vintage, 2004), pp. 4–5.
[105] Oliver Thurley, *yet another example of the porousness of certain borders*, 2014, score. Reproduced by kind permission of the composer.

The score excerpt in figure 16 shows how Thurley deploys a notation through which he can guide the performance while allowing unexpected timbral fluctuations. This is clarified in the general notes of the score as 'remarks on quietness':

> It is intended that many of the notes (particularly the multiphonics) will not sound as written. Indeed, many pitched tones will falter, fail to sound, or fracture completely. The entire piece is fragile and remains porous to the agency of the performer.[106]

Moreover, Thurley approaches the consequences of using different levels of finger pressure in his exploration of fragility. These levels are determined by circles that represent harmonic pressure (white), normal pressure (black), and between harmonic and normal, sounding unstable (half white/half black). Although this is a technique on which I have been working from the composition of the cello duo, Thurley takes it to a very interesting perceptual limit. Consequently, the general experience of quietness in the piece is emphasised through low dynamics in a range that the composer determines between: *pppppp-ppp*. This severe restriction of loudness may contrast with the dynamic notation of waveforms below the stave, which should be approached as a continuous state of flux.

Inspired by Thurley's technical perspective, I approached the idea of fluctuation of light through the rain from an exploration of techniques that allowed me to emphasise the perception of timbral instability. Furthermore, I specifically worked on the exploration of analogies between saxophone and viola from Sandells's idea of *emergent timbre*, seeking moments of fusion of both sources of sound into a novel percept. Contrary to my previous compositions in which the timbral experience is given as a fluctuating trajectory, this time I decided to structure the piece in five uninterrupted micro-sections, according to a process of interconnection of specific and contrasting temporal luminance experiences created from the instrumental techniques (table 3). Some of them had been explored before with bass clarinet and cello; nonetheless, the book *Hello, Mr. Sax!, or, Parameters of the Saxophone* by Jean-Marie Londeix was an important resource for studying the possibilities of this instrument.[107]

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[106] Thurley, general notes (iii).
[107] Jean-Marie Londeix, *Hello, Mr. Sax!, or, Parameters of the Saxophone*, trans. by William and Anna Street (Paris: Alphonse Leduc, 2010).

Sections	Soprano Saxophone Techniques	Viola Techniques
a Bright-incisive	Altissimo register Harmonics	Harmonics Behind the bridge
b Shrill	Multiphonics High register with strong dynamics	Highest register with strong dynamics Double stop (harmonics, high pitches) Molto sul ponticello
c Distorted	Growling Flutter-tongue Very strong dynamics	Heavy pressure of bow (scratch) Heavy pressure with low part (close to frog) of bow (shake) Bowing on the bridge Vertical movement of bow with heavy pressure
d Clear-distinct	Low-medium register Closed slap tongue Key clicks Snap tongue	Col legno battuto Jeté Pizzicato Silent fingering
e Opaque-blurred-veiled	Air sound Aeolian sound	Very light finger pressure Light bow pressure/flautato Slow bowing Molto sul tasto Low register with soft dynamics Col legno/Mezzo legno

Table 3. Techniques in *Distorted Pieces of Something. Study on Light (when it rains)*: classification by instrument.

Based on the idea of intermittent periods of rain and the unexpected changes of light that they produce, the general structure of the piece presents the five sections more than once (except for section e), but never in the same way (table 4).

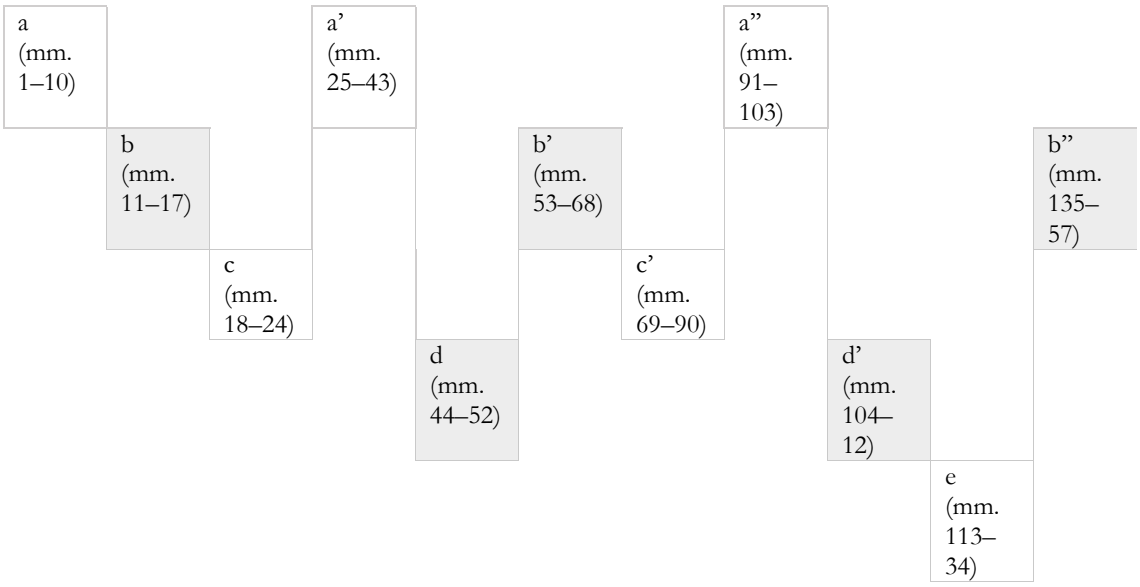

Table 4. Structure of *Distorted Pieces of Something. Study on Light (when it rains)*.

The piece was workshopped with Wojciech Psiuk (saxophone) and Aleksandra Demowska-Madejska (viola) during the Synthetis International Course for Composers (15–27 July 2019). Additionally, composition lessons with composers Chaya Czernowin, Toshio Hosokawa, Zygmunt Krauze, and Justė Janulytė gave me the opportunity to discuss luminance from the point of view of the compositional strategies.

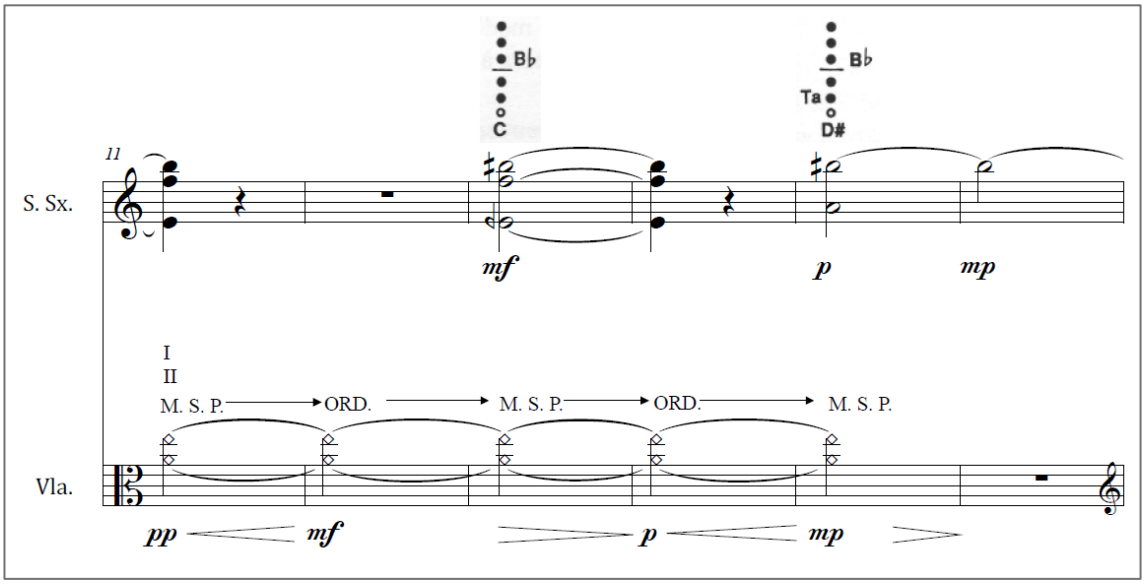

Figure 17. Score excerpt from *Distorted Pieces of Something. Study on Light (when it rains)* (a), corresponding to section b: shrill timbre.

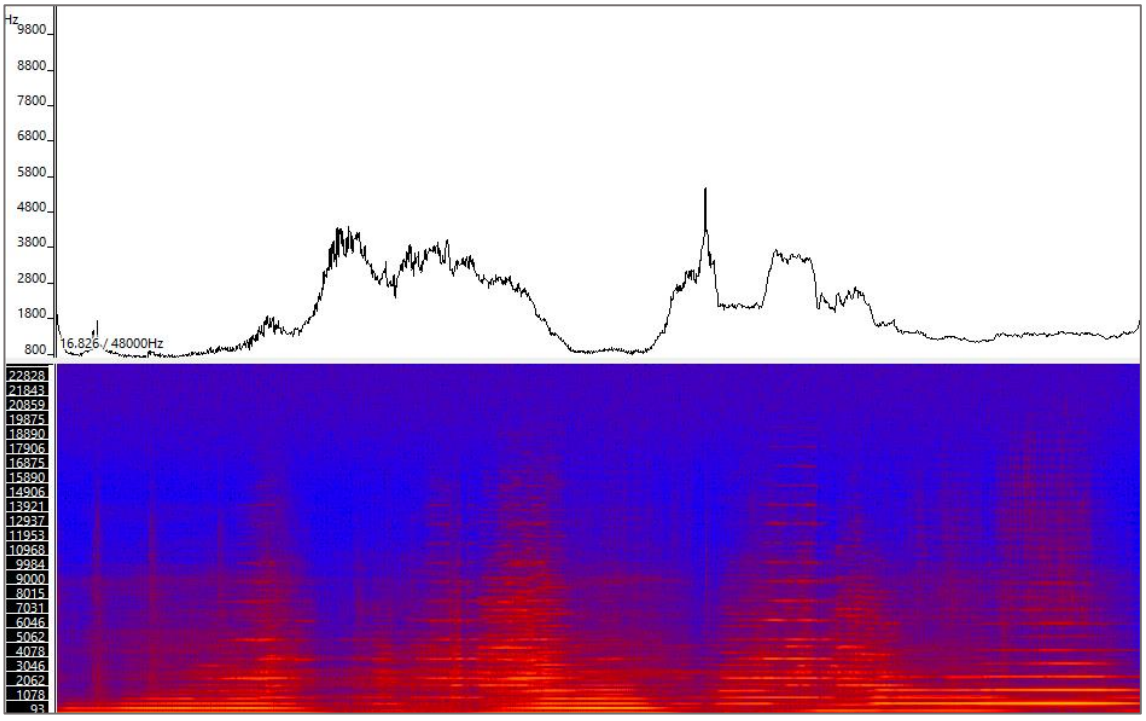

Figure 18. Spectral centroid and spectrogram of excerpt in figure 17.[108]

[108] Audio recording of the premiere by Wojciech Psiuk and Aleksandra Demowska-Madejska.

The score excerpt in figure 17 corresponds to section b, in which there is an exploration of shrillness in timbre. The spectrogram in figure 18 shows how the perception of light is directly affected by the increase in *loudness* in those parts where red and orange colours are prominent. Moreover, the presence of *upper partials* with a very stable intensity, especially below 5 KHz, coming from the saxophone multiphonics and the layer of viola *high harmonics* make characterise this timbre as *shrill*. The large fluctuations of the spectral centroid (from 800 Hz to 4.800 Hz) reinforce the association of this timbre with the perception of extreme levels of light.

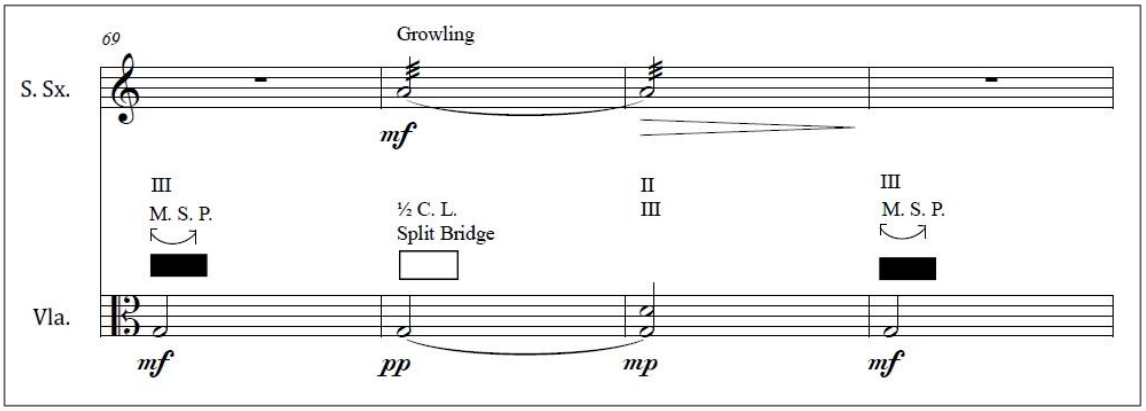

Figure 19. Score excerpt from *Distorted Pieces of Something. Study on Light (when it rains)* (b), corresponding to section c: distorted timbre.

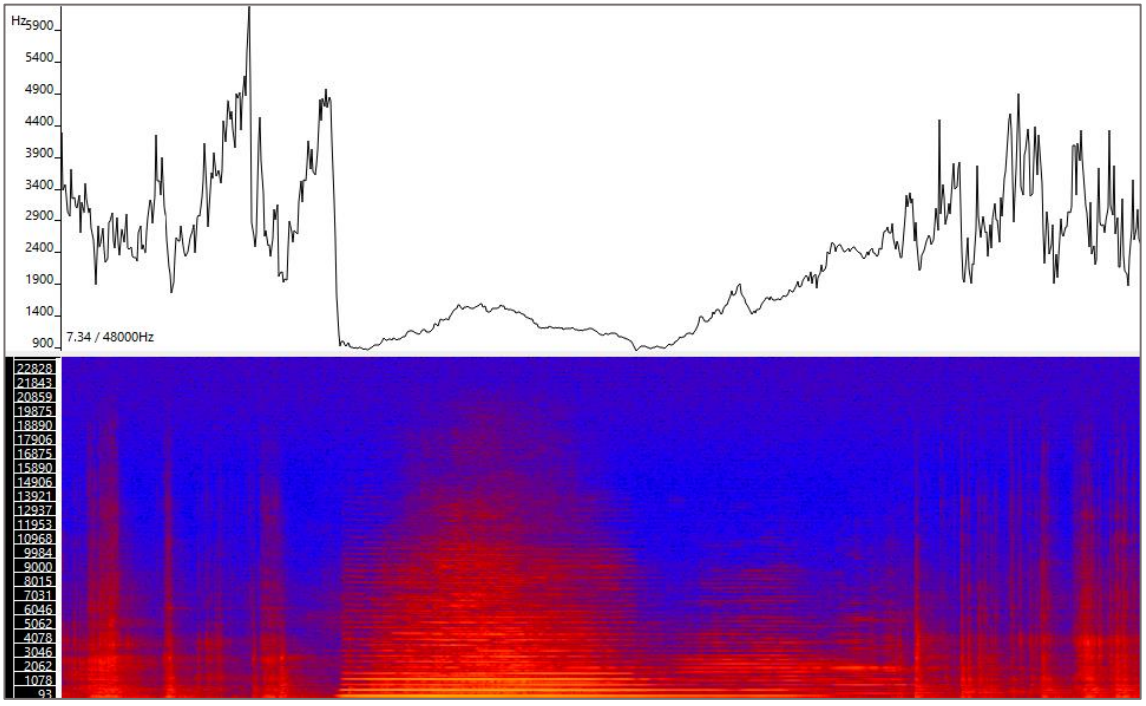

Figure 20. Spectral centroid and spectrogram of excerpt in figure 19.

The way in which distortion of timbre is developed in section c (figure 19) can be analysed from the correspondent spectrogram (figure 20), which shows more parts in red/orange, representing greater loudness, as well as more presence of upper partials. The saxophone boosts the harmonic dissonances by adding a growling voice. The viola adds to the distortion of timbre as a consequence of the split ½ legno bowing around the bridge—a technique that produces many frequencies without emphasising any in particular (that is, a kind of white noise). From the estimation of the spectral centroid, it can be recognised that overpressure of the bow on the string in a vertical movement without displacement generates the largest fluctuations, oscillating between 1.9 KHz and 6 KHz; along with the increase of dynamics to the limit this contributes to the general perception of overexposure of light, a *distorted* timbre.

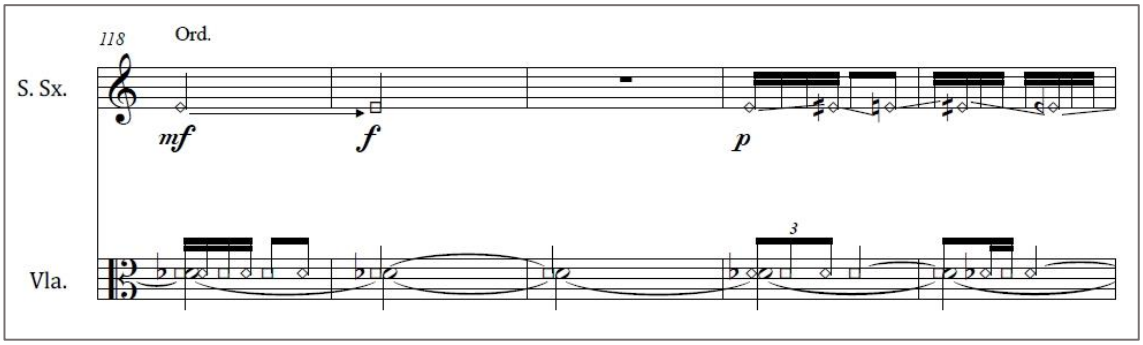

Figure 21. Score excerpt from *Distorted Pieces of Something. Study on Light (when it rains)* (c), corresponding to section e: dark to veiled timbre.

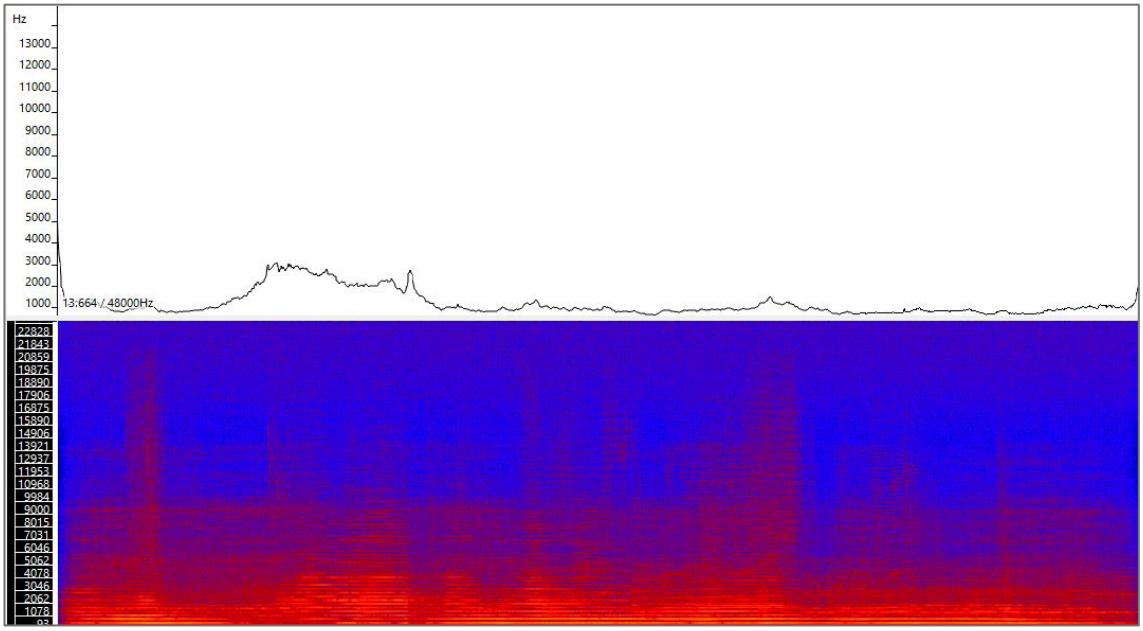

Figure 22. Spectral centroid and spectrogram of excerpt in figure 21.

Although timbre in section e could be categorised as *opaque-veiled-blurred*, the excerpt in figure 21 responds more evidently to the flickering experience of light, through unpredictable changes that can be perceived as *bright* because of the intermittent presence of upper partials, especially owing to the viola technique that alternates harmonics and muffled sounds through changes in finger pressure. The fundamental frequency is weak because of the instrumental techniques employed: the saxophone's aeolian sounds and the viola's very light finger pressure. The layer of noise produced by these techniques acts as a filter that prevents the perception of a completely revealed timbre. This condition is reinforced by general low levels of loudness. However, the spectral centroid remains relatively stable, except for the point at which the saxophone plays only air and the viola uses the lowest finger pressure: this actually increase the perception of the centre of the spectrum from around 1 KHz to 3 KHz (figure 22). Finally, this composition responds to a particular experience of luminance in which light is filtered or distorted by rain, as unpredictable, instable, and disturbing as it can be.

2.3 Reflections

As the semantic dimension that accounts for the amount and intensity of light perceived in timbre, luminance allows for work on pieces according to cross-modal associations with particular conditions of spectral content and dynamic envelope. From the spectral content it may therefore be seen that the presence of upper partials can lead to a perception of the second phase of the scale. Moreover, the perception of high intensity of light in timbres could be a consequence of inharmonicity with high loudness, while high inharmonicity and soft dynamics could be perceived as timbres that are 'covered' or have a low amount of light. In addition, timbres with a strong fundamental frequency and low perception of upper partials seem to be perceived as clear. Low pitch fundamentals in particular are more likely to be perceived in the range of the first phase of the scale. With regard to dynamic envelope it could be said that a soft attack tends to make timbres unclear or undefined, largely parameters like pitch and harmonic content cannot be easily discriminated, leading listeners to perceive qualities like those in the first phase of the scale; while a medium attack makes these parameters more precise, making timbres clearer or even distinct and

bright. Very strong attacks could emphasise the presence of upper harmonics and lead to the perception of high inharmonicity, more likely placing the timbre in the third and fourth stages of the intensity phase of the scale. Moreover, an increase or reduction in loudness could have direct consequences for the spectral centroid: that is, constant medium dynamics could make timbres steady or stable during the course of their development and likely to be perceived as clear. Consequently, loud dynamics could stimulate large fluctuations in the spectral centroid, resulting in timbres that are more likely to be in the top range of the intensity of light.

The proposed scale for the measurement of luminance in two phases therefore seems to be a productive strategy for the study and organisation of particular instrumental techniques, as well as the attribution of a specific metaphorical meaning to the timbral experiences composed. Moreover, the association between descriptors that mark the levels of the scale with the perceptual experiences of natural phenomena like *dust* and *rain* is pertinent to the exploration of nuances in the experience of light and its instability in timbre. From this it is possible to develop particular compositional relations between technique, metaphor, and structure.

CHAPTER 3: MASS

In this thesis, mass is approached as a technical and creative strategy by which to address timbre from the perceptual experience of *resistance*. This concept emphasises the idea of timbre as an *interaction*, giving rise to an understanding of mass as the kind of resistance that emerges between the parameters of sound when interacting. This responds to the following statement by Richard Feynman:

> In the Einstein relativity theory, anything which has energy has mass—mass in the sense that it is attracted gravitationally. Even light, which has an energy, has a 'mass' […] in recent years we have discovered that all mass is made of tiny particles and that there are several kinds of interactions, such as nuclear forces, etc.[109]

However, it seems that mass in music relies on notions that are not well defined, or delineated. In fact, for Chelsea Douglas, Jason Noble and Stephen McAdams, the ambiguity around this concept has opened spaces for different compositional practices:

> Sound mass [*sic*] has been created with many different musical resources, including instrumental, vocal, electroacoustic, and mixed media, and also many different musical techniques, including granular synthesis, tone clusters, *musique concrète*, *musique concrète instrumentale*, spectral fusion, registral extremity, rhythmic complexity, rhythmic stasis, micropolyphony, and aleatoric and stochastic procedures. […] While the idea of sound mass is fairly intuitive, the many connotations of the everyday term *mass* and the variety of poetic and semantic emphases of composers and theorists have resulted in a diffuse and polysemic concept in need of clarification. The term's many senses, including formlessness (amorphous mass), materiality (physical mass), spatiality (voluminous mass), solidity (impenetrable mass), numerousness (the masses), enormity (massive), and aggregation (amassed), are not necessarily synonymous, nor is it always clear which connotations authors intend to imply and/or exclude or how those connotations relate to the experience of the listener.[110]

It can be seen how the semantics of mass offer a wide range of meanings, which may be explicitly but not necessarily determined by composers in their technical approaches, meaning that other connotations may be left intentionally unclear for creative reasons. Zacharakis, Pastiadis, and Reiss focus on the words most used to describe timbre according to listeners' experiences in their experiments. They state: 'the third dimensions in both groups describe whether a sound is perceived as thick-dense-rich-and-full or light. We suggest mass as an appropriate general semantic label for this dimension'.[111] It could be said that the use of adjectives like *thick*, *dense*, *rich*, and *full* shows a more spontaneous ability to describe mass in relation to 'large amounts', while the reverse is scarcely described as *light*.

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[109] Richard Feynman, Matthew Sands, and Robert B. Leighton, 'The Theory of Gravitation', in *Feynman Lectures on Physics (New Millennium Edition)* (Boston: Addison Wesley, 2006) <https://www.feynmanlectures.caltech.edu/I_07.html > [accessed 8 June 2020].
[110] Chelsea Douglas, Jason Noble, and Stephen McAdams, 'Auditory Scene Analysis and the Perception of Sound Mass in Ligeti's Continuum', *Music Perception*, 33, 3 (2016), 287–305 (p. 288).
[111] Zacharakis, Pastiadis, and Reiss, 'An Interlanguage', p. 349.

Consequently, my compositional approach explores the experience of mass in timbre from the possibility of recognising its ethereality and the nuances of its lightness up to its smallest expression, a desire in which I feel inspired by Eliane Radigue:

> I dreamt of an unreal, impalpable music appearing and fading away like clouds in a blue summer sky. Frolicking in the high mountain valleys around the wind, and grey rocks and trees, like white runaways. This particular music, that always eluded me. Each attempt ended in seeing it come closer and closer but remain unreachable, only increasing the desire to try again and yet again to go a bit further. It will always be better the next time …[112]

3.1 Perspectives on Mass

The following compositional approaches to mass represent the technical and aesthetical diversity emerging from this concept that has particularly enriched my own research and approaches from a timbral perspective. I start with Schaeffer's approach to the concept of mass, in which can be recognised the importance of pitch perception in relation to harmonic and inharmonic content: '[w]e will use the term *mass* for the quality through which sound installs itself (in a somewhat a priori fashion) in the pitch field'.[113] Moreover, Schaeffer presents *thickness* as a related-concept to perception of mass, which is fundamental to his compositional approach:

> We suggest that if the tonic notes are far enough apart to be perceived in the traditional way, this is precisely because of the presence of harmonics (not perceived in isolation, although contributing to the timbre) that put a sort of grid in the pitch field and thus give a defined context for perception; but as soon as adjacent notes are piled on top of each other, these notes and their respective spectra occupy the pitch field in too confused a manner to impose any sort of order on the ear, and then we find ourselves in the perceptual conditions for the calibration in mels. Even if it does not explain the criterion of mass, this property of the field, explored by physicists with pure sounds, at least demonstrates why in certain cases the notion of thickness replaces the notion of interval.[114]

Notwithstanding this, it can be said that sound-mass represents one of the most common perspectives taken in relation to the perceptual experience of mass in composition. In fact, Douglas, Noble, and McAdams's analysis of the perception of sound-masses in György Ligeti's *Continuum* (1968), for harpsichord, leads them to the following definition:

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[112] Eliane Radigue, 'The Mysterious Power of the Infinitesimal'. *Leonardo Music Journal* 19 (2009), 47–49 (p. 49).
[113] Schaeffer, 'Theory of Homogeneous Sounds', p. 412.
[114] Schaeffer, 'Theory of Homogeneous Sounds', p. 415.

> Approaching sound mass [composition] from the perspective of auditory scene analysis, we define it as a type of auditory grouping that retains an impression of multiplicity even as it is perceived as a perceptual unit. Sound mass requires all markers of the individual identities of sounds to be deemphasized to prevent them from splitting off into separate streams.[115]

From this auditory analysis, the researchers identify some of the compositional strategies in sound-masses, such as obliteration of individual identities of musical lines, use of dense pitch constructions in all registers, high number of simultaneous voices, and overlapping.[116] Edgard Varèse also describes his music in relation to this perceptual experience, giving a remarkable role to the forces of interaction between different planes:

> When these sound-masses collide the phenomena of penetration or repulsion will seem to occur. Certain transmutations taking place on certain planes will seem to be projected onto other planes, moving at different speeds and at different angles. There will no longer be the old conception of melody or interplay of melodies. The entire work will be a totality. The entire work will flow as a river flows. […] Moreover, the new musical apparatus I envisage, able to emit sounds of any number of frequencies, will extend the limits of the lowest and highest registers, hence new organizations of the vertical resultants: chords, their arrangements, their spacings, that is, their oxygenation. Not only will the harmonic possibilities of the overtones be revealed in all their splendor but the use of certain interferences created by the partials will represent an appreciable contribution. The never before thought of use of the inferior resultants and of the differential and additional sounds may also be expected.[117]

These compositional perspectives recognise the influence of the spectral content (pitch and harmonic or inharmonic partials) on the perceptual experience of mass. Furthermore, there is an emphasis on generating a sense of *unity* with internal activity—the flow, the continuum—a principle that has also been used by Fayers to describe Xenakis's music:

> The music is characterised by overall global shapes, sonic events, and gradual evolutionary transformation with a focus upon the temporal domain. Xenakis himself suggested that his music should be seen as 'a whole, as an entity'. […] Every sonic event is perceived as a set of qualities that is modified during its life. On a primary level we perceive pitch, duration, timbre, attack—on another level we may distinguish complexities, degrees of order, variabilities, densities, homegeneties [*sic*], fluctuations, thicknesses.[118]

Peter Hoffmann further references space as an essential component of Xenakis's architectural approach to music: '[t]his connection between physical and abstract space is displayed most clearly in the *Polytopes* with their extensive use of line and compositional density to unite musical and architectural experience in one Gesamtkunstwerk'.[119]

These compositional perspectives are the starting point for my own exploration of mass in my music. Consequently, I distance myself from the principles of sound-masses, in the

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[115] Douglas, Noble and McAdams, p. 287.
[116] Douglas, Noble and McAdams, p. 288.
[117] Varèse and Wen-Chung, p. 11–12.
[118] Fayers, p. 4.
[119] Peter Hoffman, 'Xenakis, Iannis', *The New Grove Dictionary of Music and Musicians* (Oxford: Oxford University Press, 2001), cited in Fayers, p. 5.

consolidated sense of this compositional practice, with the purpose of approaching this semantic dimension of timbre as a *kind* of resistance that responds to the perception of *force*, *distribution*, and *space* in the timbral interaction, and giving emphasis to three mass-related concepts—weight, density, and volume—from which each piece develops a different process of the disintegration of timbre (figure 23).

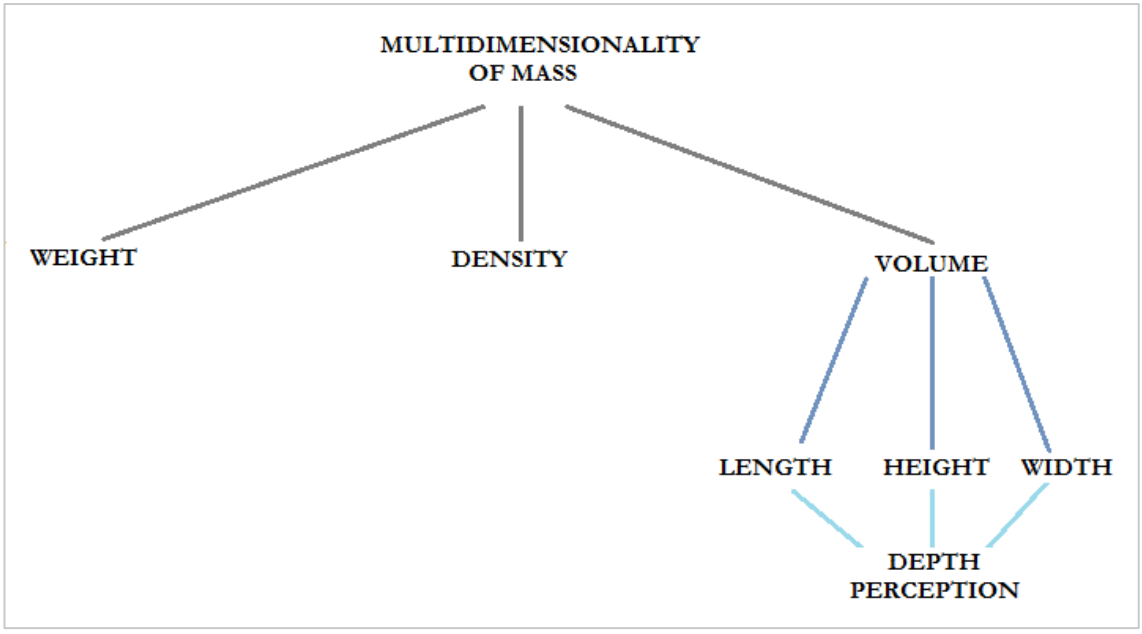

Figure 23. Multidimensionality of mass for the development of my compositional approach.

3.2 Compositional Approach: A Desire for Disappearing

Sometimes I lose myself in thoughts about disappearing as an insistent desire for freedom. It is an exercise of imagining a non-material existence. What would it be like? The disintegration of one's own materiality seems a gratifying process of liberation from having a body, from being that body. The compositions discussed in this chapter try to respond to that urgency through the influence of *dust* as an idealised and unattainable emptiness that enables drift. In Amato's words, dust 'can be associated with the dead leaves blown by the wind or the emptiness and sterility of the wind itself'.[120] From a creative perspective, mass

[120] Amato, p. 24.

becomes ethereal or *dissipates* if it is divided or fragmented, making its smaller and lighter pieces able to escape from the forces that previously 'held them in place' as a unity. Thus disappearance in timbre is developed through a process of *separation*:

> Bregman describes how a variety of perceptual principles, such as fundamental frequency (the perception of identifiable pitch in a given sound, related to the acoustical phenomenon of harmonicity) and common fate (correlated trajectories of frequency or amplitude of simultaneous sounds or sound components) allow the auditory system to parse simultaneous incoming vibrations into separate real or virtual sound sources. Other principles such as temporal proximity (the durations of gaps between subsequent sound events), loudness, and spectral shape (relative amplitudes of partials over time) determine the integration of temporally extended auditory streams.[121]

Furthermore, Zacharakis, Pastiadis, and Reiss identify correlations between the descriptors for mass and the acoustic features that seem to determine its qualities. These coincide with some of Bregman's perceptual principles: mass 'exhibited two strong correlations in the English group. These correlations suggested that sounds with higher F0 were perceived as lighter and also that auditory thickness and density increased with inharmonicity and with fluctuation of the spectral centroid'.[122] Although the influence exerted by *fundamental frequency*, *inharmonicity*, and *spectral centroid* on the general perception of mass constitutes a basis for this compositional approach, the concepts of *weight*, *density*, and *volume* are studied separately in the development of specific strategies for each piece.

The following organisational strategy developed by Douglas, Noble, and McAdams to measure the perception of sound-masses offers an interesting starting point for the development of strategies for transforming mass in my pieces:

> *No Sound Mass* meant that the sounds they heard retained their distinct, individual character. A rating of *One Complete Sound Mass* meant the sounds they heard were completely integrated into a single mass. Finally, an *Intermediate* rating would represent situations in which some but not all of the sounds were integrated into a sound mass, or in which multiple simultaneous masses were perceived, or in which sounds were partially integrated but still retained distinct individual identities.[123]

Consequently, my research explores the disintegration of mass in timbre from a multidimensional perspective, going from the greatest perception of weight, density, and volume to the minimal expression possible in a non-linear process of mass reduction according to a particular metaphor and the acoustic conditions of the sources of sound involved.

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[121] Douglas, Noble, and McAdams, p. 287.
[122] Zacharakis, Pastiadis, and Reiss, 'An Interlanguage', pp. 350–51.
[123] Douglas, Noble, and McAdams, p. 295.

3.2.1 A Weightlessness Process (… or how to become ethereal)

A Weightlessness Process (… or how to become ethereal) (2019–20), for solo cello, presents an exploration of mass specifically from the point of view of *weight* as the *force* exerted on the timbral interaction; this weight could be perceived as an internal energy as well as a corporal action. The weightlessness process functions by separating the timbral mass into lighter 'pieces' that are able to drift, inspired by Amato: 'Dust goes where the wind lists. As if it were nothing at all—without mass, without volume, the featherweight of featherweights—it rises up and forms a vapor and haze'.[124] Nonetheless, the unstable nature of the timbral experience does not allow for a linear transition to ethereality. Instead, fluctuations occur over time, sudden interruptions produced by cycles of energy accumulation that tend to reach points of heaviness before exploding, each time leaving a slight impression.

Richard Serra works with the concept of *weight* as a synonym for *heaviness*. This admittedly corresponds to only one of its possible measures; nonetheless, his description of weight opens many creative perspectives for my compositional approach:

> Weight is a value for me—not that it is any more compelling than lightness, but I simply know more about weight than about lightness and therefore I have more to say about it, more to say about the balancing of weight, the diminishing of weight, the addition and subtraction of weight, the concentration of weight, the rigging of weight, the propping of weight, the placement of weight, the locking of weight, the psychological effects of weight, the disorientation of weight, the disequilibrium of weight, the rotation of weight, the movement of weight, the directionality of weight, the shape of weight. [125]

Following Serra's perspective, weight in timbre could be approached from the possibility of exerting *force* to construct, control, morph, conduct, move, or even shape the *resistance* of sonic parameters in the timbral interaction. Similarly, *weight* and *body*, even *frame*—conceived as a delimitation of the space occupied by a body of mass, the boundaries of its extension—can be found in Rebecca Saunders' description of *vermilion*:

> I have explored this phenomenon of silence often, but never so precisely as in *vermilion*. How does silence sound, what are its inner qualities, what are its weight and body, how does it relate to past and future sounds, how does it frame musical gestures, what function does it have between stasis and passion?[126]

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[124] Amato, p. 4.
[125] Richard Serra, 'Reverse Curve', *Gagosian Website* <https://gagosian.com/exhibitions/2019/richard-serra-reverse-curve/> [accessed 22 January 2020].
[126] Struck-Schloen, p. 16.

Although *vermilion* develops through the contrast between aggressive gestures and quiet states, calm is not necessarily reflected in or by silence, Saunders explains:

> So, I do explore on another level, I think, not what is the role of silence, but what kind of different silences do we have, are they moving, are they active, are they passive. So, it's very important that the silence is just right, and it took me quite a long time to, what I would say, weight the silence. I think, how pregnant is that silence, how heavy is that silence, if it had to be a dead one, how long should it be.[127]

Therefore, weight in silence could be understood as a force of tension perceived in relation to the gestures that surround it, inside its intangible content, the perception of its existence and extension. From my compositional perspective, there could be an association between *aggressiveness* and *heaviness*, highly influenced by the level of *loudness* and the *simultaneity* of actions that construct a gesture. At this point, I recall Zacharakis, Pastiadis, and Reiss's conclusions regarding mass in my approach to the main element related to the perception of weight: 'sounds with higher F0 were perceived as lighter'.[128] Consequently, *pitch register*, *loudness*, and *simultaneity* are specifically addressed in the composition of this piece from the development of techniques that particularly respond to the modulation of these conditions. Nonetheless, I consider it necessary to analyse also *inharmonicity* and *spectral centroid*, since these features seem to influence the general perception of mass.

	Heaviness	**Reduction process**	**Ethereality**
Conditions	1. High pressure in physical interaction 2. High instability 3. High inharmonicity 4. High loudness 5. Low pitch register	1. Development of inharmonicity 2. Reduction in loudness 3. Increase in pitch register	1. Less force exerted 2. Release of resistance 3. Low level of inharmonicity 4. Low level of loudness 5. High pitch register
Techniques	• Heavy finger pressure on magnetic tape (knotted to Strings III and IV). • Heavy bow pressure on strings and polystyrene.	• Multiphonics • Oscillations by dissonance of quarter of tone. • Strings II and III.	• Harmonics • Highest pitch possible. • Very low pressure bowing on string and polystyrene. • ½ Col legno split on bridge. • Strings I and II.

Table 5. Techniques in *A Weightlessness Process (… or how to become ethereal)*: classification according to a general three-stage process of weight reduction in timbre.

[127] Rebecca Saunders, *Entrevista/Interview Rebecca Saunders sobre/about 'vermilion'*, online video recording, YouTube, 1 January 2017 <https://www.youtube.com/watch?v=_aelD1yA4q8> [accessed 2 May 2020].
[128] Zacharakis, Pastiadis, and Reiss, p. 350–51.

The classification outlined in table 5 resulted from the spectral analysis of techniques recorded by me in a preliminary exploration of the instrument as well as research material from the previous composition for cello duo. The semantic approach to weight presents the extreme points of the process: *heaviness* and *ethereality*, with an intermediate stage which allowed me to explore structural development with more flexibility. First, I worked on the perception of heaviness with pieces of magnetic videotape knotted to the lowest strings. The friction produced by the fingers sliding across the tape allowed me to study the concept of resistance from the point of view of materiality, the corporeal interaction. In the first version of the piece, the tape was measured at three points: starting, middle, and end, to determine the speed of movement and the timbral consequences. However, during a workshop with Séverine Ballon, I realised that the points could not be marked exactly on the tape. It also became clear that the points could be harder to reach for one person than another, which represented more an obstacle for the performance than a timbral contribution to the piece. Instead, Ballon suggested using specific dynamics to control the technique, allowing time to look for the intended timbre.[129]

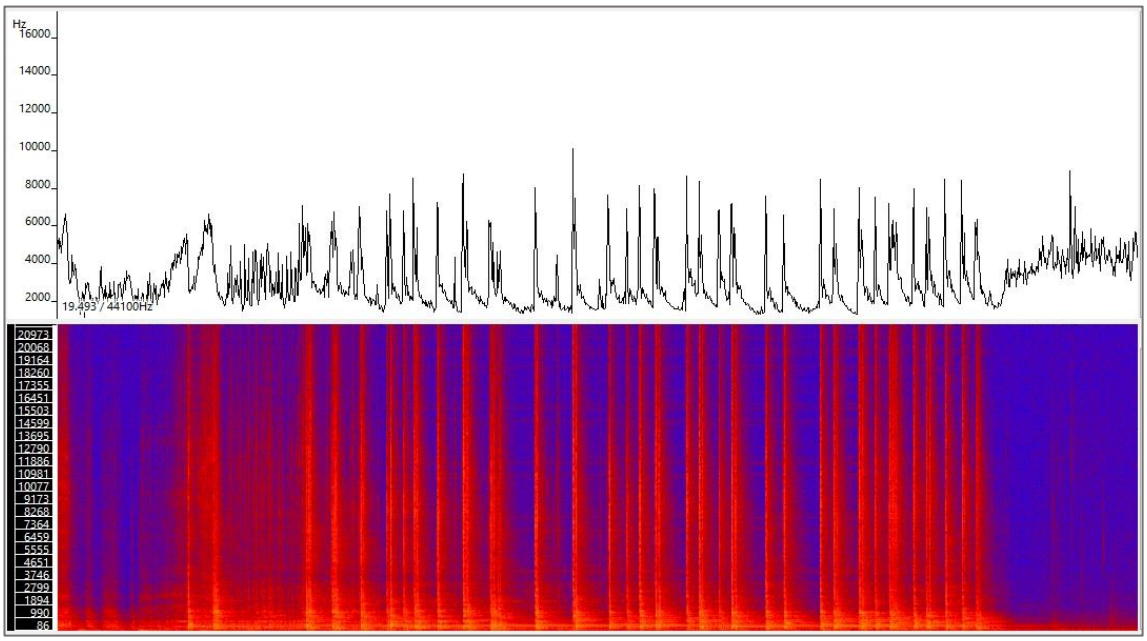

Figure 24. Spectral centroid and spectrogram of a finger slide on a piece of magnetic tape knotted to string IV played forte in *A Weightlessness Process (… or how to become ethereal)*.[130]

[129] The two-session workshop with Séverine Ballon was organised by the School of Music, University of Leeds, and took place on 11 and 13 November 2019.
[130] Audio recording of the workshop with Séverine Ballon.

From the spectrogram in figure 20 it can be seen that this technique produces a timbre with high loudness, represented by the orange/red colour. The nineteen-second excerpt analysed presents large fluctuations of the spectral centroid, going continuously from 2 KHz to 10 KHz, indicating its high instability. It can be seen that a fundamental frequency is not discernible, and there is a strong presence of transients across the spectrum. These conditions make this timbre *heavy*. Here, weight is explicitly undertaken by an instrumental technique that itself requires corporal *force* to press and pull the tape with the fingers. One particular condition is that the timbre produced is different every time that it is played, thus if the tape has more adherence the fingers experience a greater resistance to the displacement, which requires more force and it leads to the perception of a heavier timbre. Reducing the level of pressure reduces the resistance. Thus, the perception of the string vibration (a discernible pitch) is boosted, making the timbre less heavy.

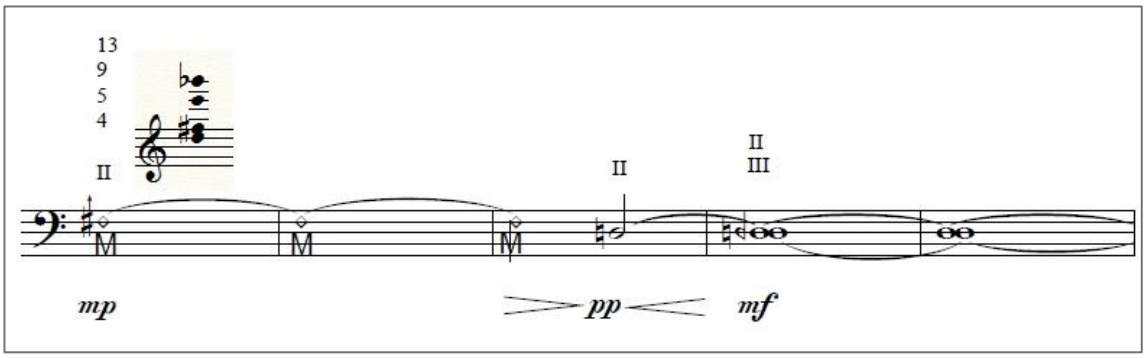

Figure 25. Score excerpt from *A Weightlessness Process (…or how to become ethereal)* (a) corresponding to a point in the intermediate stage of weight reduction.

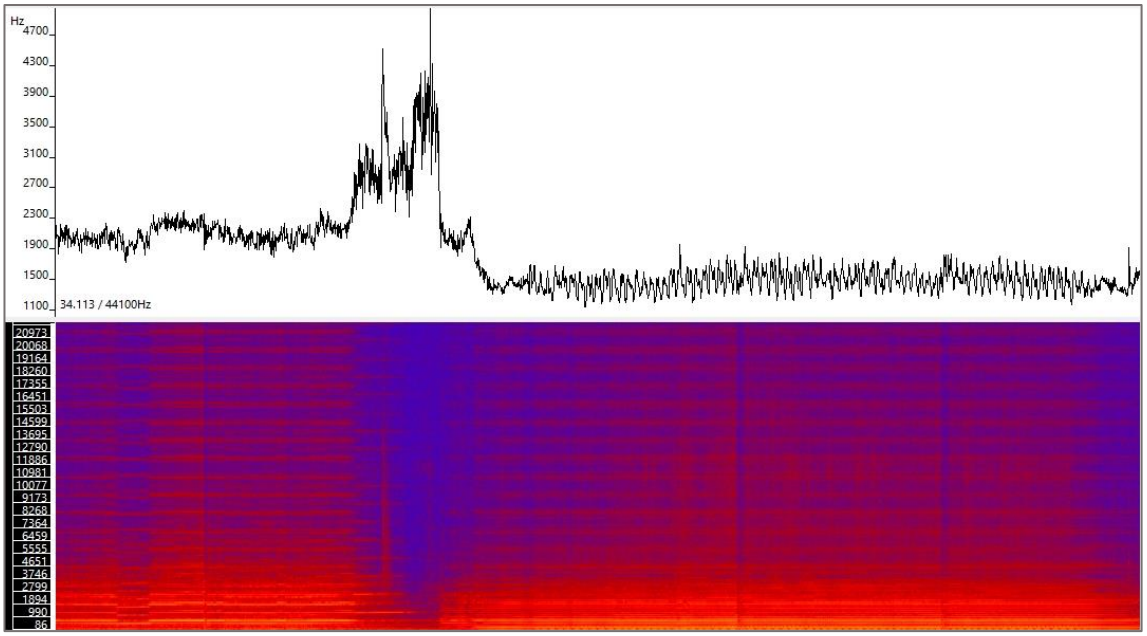

Figure 26. Spectral centroid and spectrogram of excerpt in figure 25.

Both multiphonics and simultaneous quarter tones (figure 25) create timbres with high inharmonicity; however, the spectrogram in figure 26 shows that the level of loudness is relatively lower, compared to the previous excerpt. According to the spectral centroid estimation, the multiphonic presents larger fluctuations, especially at the end when Ballon uses less bow pressure and briefly moves close to the bridge, before attacking the next quarter tone superposition, which tends to be more stable. The harmonic dissonance produced by the proximity of the pitches could be understood as a force of repulsion, the constant beating of adjacent partials 'fighting' to consolidate their presence in the spectral field. In this case, heaviness is developed as a discrepancy of pitch in both multiphonic and quarter tones, as well as in the tape knotted to string III that subtly interferes with the string vibration. Moreover, the low pitch register emphasises the perception of heaviness although in a minor level at this stage of the process.

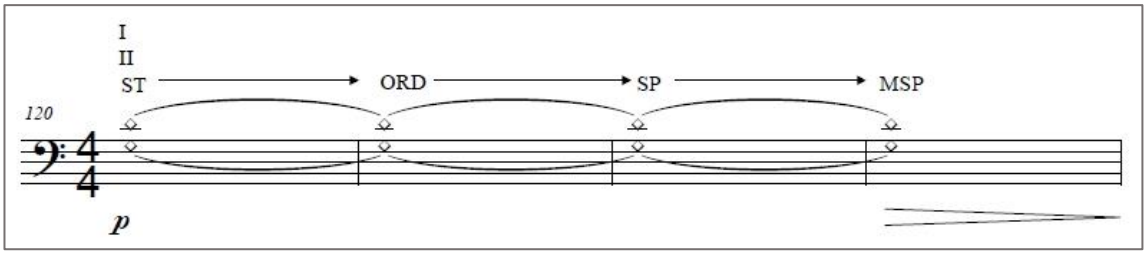

Figure 27. Score excerpt from *A Weightlessness Process (… or how to become ethereal)* (b) corresponding to a point of timbral ethereality.

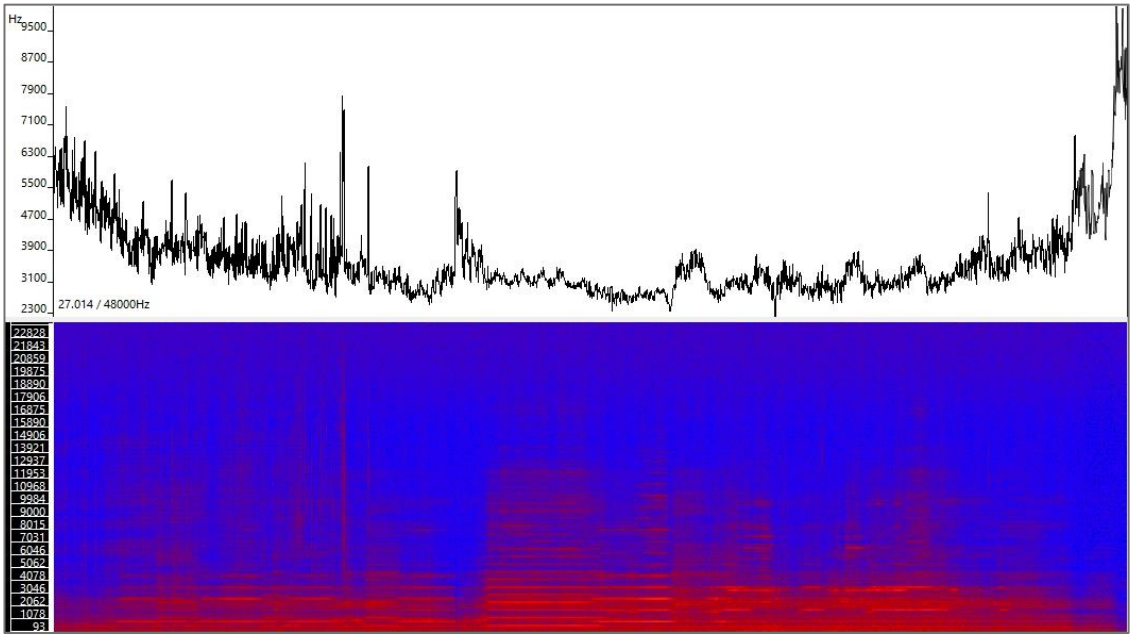

Figure 28. Spectral centroid and spectrogram of excerpt in figure 27.[131]

[131] Performance by Lola Malique. Audio recording by Grégoire Letouvet, audio mixing by Lola Malique and Grégoire Letouvet. Recorded at Le Nouveau Pretexte (1 Neumann TLM 49, and 2 Oktava MK-012), 22 March 2021.

The final version of the piece was performed by Lola Malique, and this collaboration allowed me to shape more coherently the weightlessness process in the piece; for instance, Malique suggested emphasising the interaction with the tape by allowing it to intensify unexpected overtones when slightly touching the strings. As a result, the explicit approach to the cello preparation subtly became part of the ethereal experience. The spectrogram in figure 28 shows the fourth partials on strings I and II, bowing from *sul tasto* to *molto sul ponticello* with soft dynamics (figure 27), from which it could be said that the perception of *ethereality* in timbre is more likely to respond to a *low level of loudness* and *high frequencies*. Although the apparent static condition of a single high harmonic played *piano* (or *pianissimo*) could be generally perceived as a very light timbre, from my compositional perspective the ethereality is reached through a kind of instability similar to the flickering of light, which in this case is a result of the simultaneity of two harmonics, especially bowing very close to the bridge where so many more overtones are excited. This is indicated by the large fluctuations of the spectral centroid, from 2.5 KHz to 8 KHz. This kind of fragility could be associated with the image of dust drifting in the wind; however, at the end, the noise generated by techniques like bowing the polystyrene *pianissimo*, or ½ legno split bridge, acquires such a relevance that, in a certain way, it itself becomes heavy, acting as a counterweight to the total disappearance of timbre.

3.2.2 Just An Attempt To Dissipate

Just An Attempt To Dissipate (2019), for soprano voice, alto flute, bass clarinet, and acoustic guitar, was commissioned by the collective Lovemusic. In it I continued the research on mass from the study of *density*. In this compositional approach *density* responds to the *distribution* of the matter of mass in a determined space, which may be studied through the relational idea of *condensation-dissipation*. Thus, timbre could be perceived as 'solid' when it avoids holes or empty spaces, or 'sparse' if it alludes more to dispersion or emptiness. Dust remains the metaphorical reference for this timbral process, since it can be thick, when highly condensed on a surface, and also sparse, when it is scattered in the air. Generally, mass seems to be understood as (a) solid. This piece is therefore an opportunity to explore the dissipation as a process of internal separation of its content, the defragmentation of timbre, disappearing as a need for release. Although mass may seem, at a certain point,

unbreakable or impossible to dissipate completely, the composition presents different levels of condensation, from which both abrupt and gradual changes of density are experienced. The frustrated expectation of a complete solidification of mass, or its disappearance, is the main element of the compositional process that structures the piece.

Douglas, Noble, and McAdams recognise *saturation* as a state of mass related to *density*:

> Sound mass [*sic*] exists when the individual identities of multiple sound events or components are attenuated and subsumed into a perceptual whole, which nevertheless retains an impression of multiplicity. Typically this involves one or more parameters of sound—for example, rhythmic activity, pitch organization, or spectral content—attaining a degree of density, complexity, and/or homogeneity that is perceived as saturation.[132]

Franck Bedrossian particularly addresses *saturation* in his string quartet *Tracés d'ombres* (2007). The piece presents polyrhythmic structures that aim not at patterns but at the creation of a multidimensional hyperactivity. The approach to saturation as noise allows the composer to create a pitch complexity through different bowing techniques and an emphasis on the highest register of the string quartet. This is linked to the influence exerted by spectral content on density, amplified through techniques like 'excessive bow pressure' in a gradual transformation between normal sound (white rectangle), combination of tone and noise (half white/half black rectangle), and noise only (black rectangle), which can be seen in figure 29.

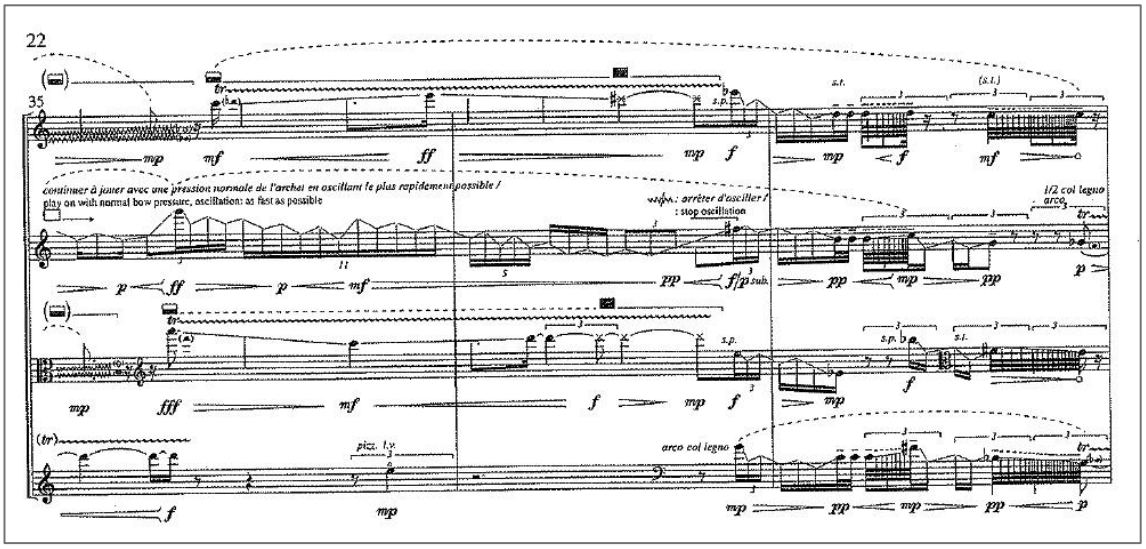

Figure 29. Score excerpt from *Tracés d'ombres* by Franck Bedrossian.[133]

[132] Douglas, Noble, and McAdams, p. 287.
[133] Franck Bedrossian, *Tracés d'ombres*, 2007, score (Paris: Gérard Billaudot Editeur, 2008). Reproduced by kind permission of the composer.

Moreover, the characteristics of the saturation are also transformed through changes in bowing position, including behind the bridge or right at the bridge to increase the inharmonicity and instability in the timbral behaviour. Nevertheless, saturation is not necessarily a synonym for loudness. Most of the techniques are played *pianissimo* and *piano*, or with strong pressure of the bow, allowing the exploration of different timbral possibilities of noise. Thus saturation, understood as the highest condensation of mass, may also respond to a subtle and quiet experience. These elements seem to coincide with Zacharakis's conclusions: 'auditory thickness and density increased with inharmonicity and with fluctuation of the spectral centroid'.[134]

Consequently, in my compositional approach the perception of *density* is conducted through the distribution of timbral components by coincidences (homogeneity) or divergences (separations), the level of activity (individual and collective gestures), and the increase or reduction of inharmonicity and fluctuations of the spectral centroid. Since the piece is inspired by dust as a *physical* (tactile and visual) experience of fragility and permanence, it responds to the perception of the disappearance of mass as a never completely fulfilled desire.

The compositional process started with the exploration of the individual identity of each source of sound and the possibilities for fusion of and discrimination between their qualities in interaction. The vocal part has no text. Instead, I worked with selected phonemes according to specific timbral conditions for each stage. In this exploration Clarice Assad's 'Extended Vocal Techniques: Your voice as an instrument' video tutorial was an important compositional resource.[135] Furthermore, Gelsey Bell's lecture, 'Extended vocal technique', was a remarkable contribution to my understanding of the timbral possibilities of the voice.[136] For specific explorations of individual parts of the flute I made use of Chris Lawhead's video tutorial, 'Flute - Just the Head Joint'.[137] Likewise, Robert Lunn's 'Extended Techniques for the Classical Guitar (#1, The Left Hand)' video tutorial

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134 Zacharakis, 'Musical Timbre', p. 103.
135 Clarice Assad, *Extended Vocal Techniques: Your voice as an instrument*, online video recording, YouTube, 2 February 2019 <https://www.youtube.com/watch?v=U5-5NdRq0q8> [accessed 30 October 2019].
136 Gelsey Bell, 'Extended vocal technique', Lecture at Gerrit Rietveld Academie, online video recording, YouTube, 30 January 2015, <https://www.youtube.com/watch?v=9m6viNRSzZs> [accessed 30 October 2019].
137 Chris Lawhead, *Flute - Just the Head Joint*, online video recording, YouTube, 24 February 2012, <https://www.youtube.com/watch?v=eA0Yt2pmcLs> [accessed 5 November 2019].

was an inspiring resource.[138] Finally, my previous experience with the bass clarinet was fundamental to approaching the instrument as part of an ensemble.

Following the same compositional approach to weight, the classification in table 6 presents two contrasting points of density: fusion/condensation and separation/dissipation, from which the individual and collective conditions of the sources of sound are explored.

	High Perception of Density (Condensation)	**Low Perception of Density (Dissipation)**
	General conditions/correlations: High inharmonicity, high fluctuation of spectral centroid, multidimensional hyperactivity.	General conditions/correlations: More presence of fundamental, more stable spectral centroid, independent activity 'patterns' or even low action.
Voice	• frullato <r> • nasal sounds < ŋ>, hummed voice • vocal fry	• snap tongue • highest pitch possible with air • normal sung voice • scotch tape (not vocal)
Flute	• voice (inside instrument) and normal sound (played) simultaneously • multiphonics	• air sound (only head joint) • wave hand/ tremolo • low register • tongue pizzicato (solely, not elaborated rhythmical structures) • air and aeolian sounds
Clarinet	• multiphonics • harmonics • frullato • air and aeolian sounds (aluminium foil preparation)	• dyad multiphonics • air and aeolian sounds • slap (solely, not elaborated rhythmical structures)
Guitar	• tremolo with glissando. • rubbing the wood with superball mallet • tremolo (string) with superball mallet	• jeté (bow) • harmonics (bow and normal)

Table 6. Techniques in *Just An Attempt To Dissipate*: classification according to the perception of two contrasting levels of density.

One special condition in this piece was the opportunity to work with four instruments of different families (soprano voice, alto flute, bass clarinet, and guitar), which allowed me to explore density from the possibility to develop analogous techniques and preparations that could lead to the perception of timbre as a unity (emergent timbre), or the individualisation of each source of sound to produce a timbral defragmentation. Consequently, I worked on

[138] Robert Lunn, *Extended Techniques for the Classical Guitar (#1, The Left Hand)*, online video recording, YouTube, 19 September 2012 <https://www.youtube.com/watch?v=p5r8Giss9hs> [accessed 7 November 2019].

a specific structure which starts with a medium dispersion in which the timbral mass is partially merged, while some independent elements still interact without apparent cohesion. Everything moves gradually towards a state of high condensation where the ensemble is almost founded in a dense mass that is soon released, leaving behind a state of stillness and low density, from which timbre slowly starts to be condensed again (table 7).

Density 50% Medium mm. 1–30	**Transition** mm. 31–61	**Density 85%** High mm. 62–91	**Transition** mm. 92–101	**Density 30%** Low mm. 102–32
Inharmonicity: medium/high Spectral centroid: medium fluctuations Activity: high Merger: medium	Process of Condensation	Inharmonicity: high Spectral centroid: large fluctuations Activity: medium Merger: high	Process of Dispersion	Inharmonicity: medium/low Spectral centroid: low fluctuations Activity: medium/low Merger: low

Table 7. Structure of *Just An Attempt To Dissipate*.

This structure is developed through the relationship between instrumental techniques, which can involve interactions with diverse objects or even several sources of sound interconnected by resonance, camouflage, expansion, filtration, or contrast and disjunction. It emphasises a core argument of this research: that is, rather than timbre being perceived as the identity of a sonic source, timbral experience is the perception of a complex process of interaction.

After the first version of the score was sent to Lovemusic in early December 2019, we started to work remotely by video calls and messages to solve mutual questions about the timbral approach. The clarinettist, Adam Starkie, especially helped me to make the most of the preparation, in which aluminium foil covers the bell of the clarinet. We worked on the pure tone, aeolian and air sounds, frullato and growling (vocal technique), harmonic glissando, harmonics, and multiphonics. Similarly to the cardboard mute used in the solo bass clarinet piece, the aluminium only works with the Low C fingering (where all the holes are closed). The airstream goes directly to the bell, finding the resistance of the foil that blocks the exit and creating a 'metallic' (as the material itself) interference. This adds a layer of inharmonicity to the original timbre.

In January 2020, I travelled to Strasbourg to have a two-session rehearsal for the premiere. One of the major difficulties in documenting this process was the impossibility of managing simultaneous aspects: audio recording, pictures of the techniques and preparations, and the rehearsal itself. Consequently, there are no recordings of the individual instrumental approaches; nevertheless, it is possible to understand the ensemble as a complete entity.

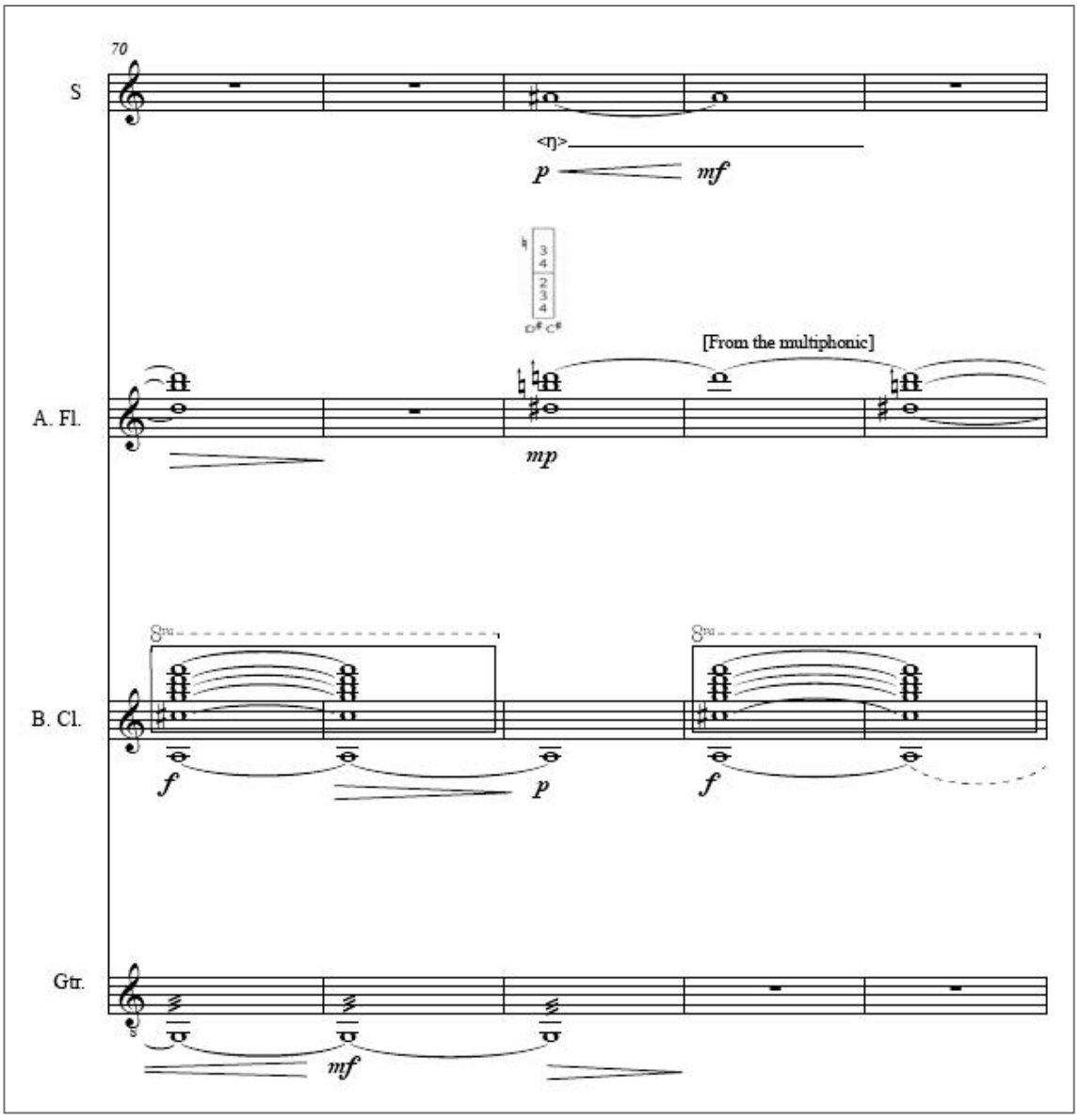

Figure 30. Score excerpt from *Just An Attempt To Dissipate* (a) showing a point of mass condensation.

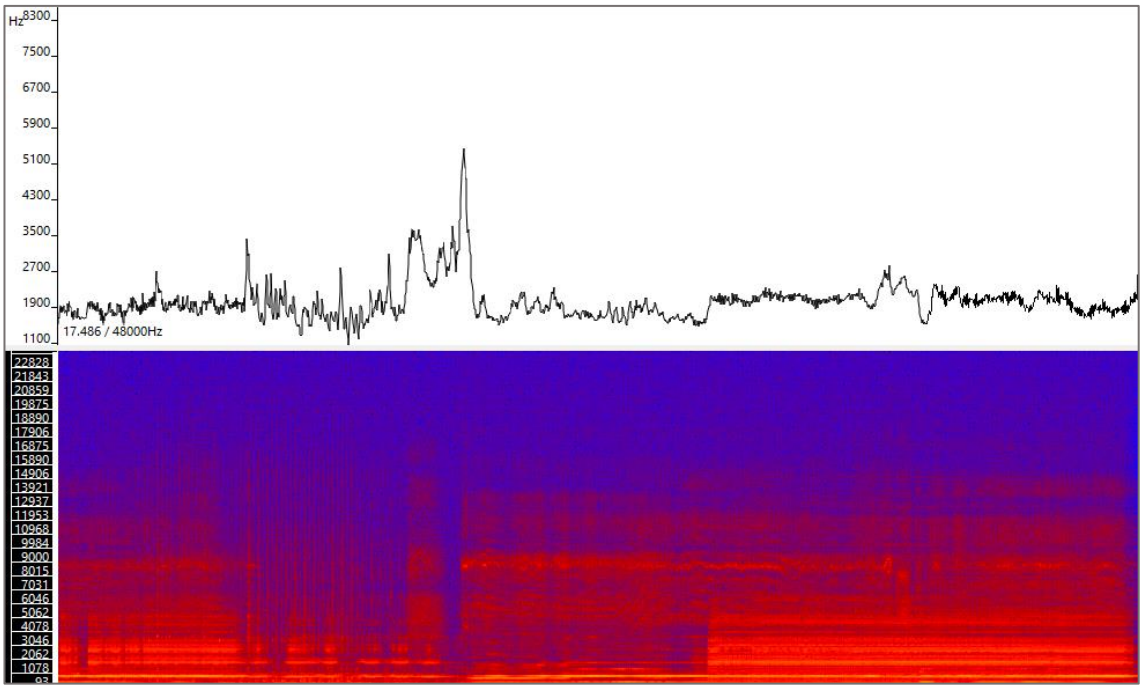

Figure 31. Spectral centroid and spectrogram of excerpt in figure 30.[139]

The spectrogram in figure 31 shows how the clarinet and flute multiphonics (figure 30) produce high condensation, through the superposition of different spectra and the inharmonicity generated by the interaction of adjacent partials. There is a strong discernible pitch from the clarinet and flute multiphonics (A5: 880 Hz) slightly altered upwards in the flute to create more dissonance. The condensation also responds to a superball tremolo on guitar string VI, which stimulates the resonance of the whole instrument. Moreover, a nasal sound from the voice in a middle range functions as a resonance for the ensemble. Since the pitch is in unison with the fundamental of the flute's multiphonic (A sharp 4: 466.16 Hz), it connects the gestures of the different sources and helps to fuse their individual identities. The spectral centroid shows a larger fluctuation when the flute multiphonic and voice attack together, going from 1.9 KHz to 5.9 KHz. The level of loudness represented in red could be described as medium.

[139] Audio recording of the premiere by Lovemusic.

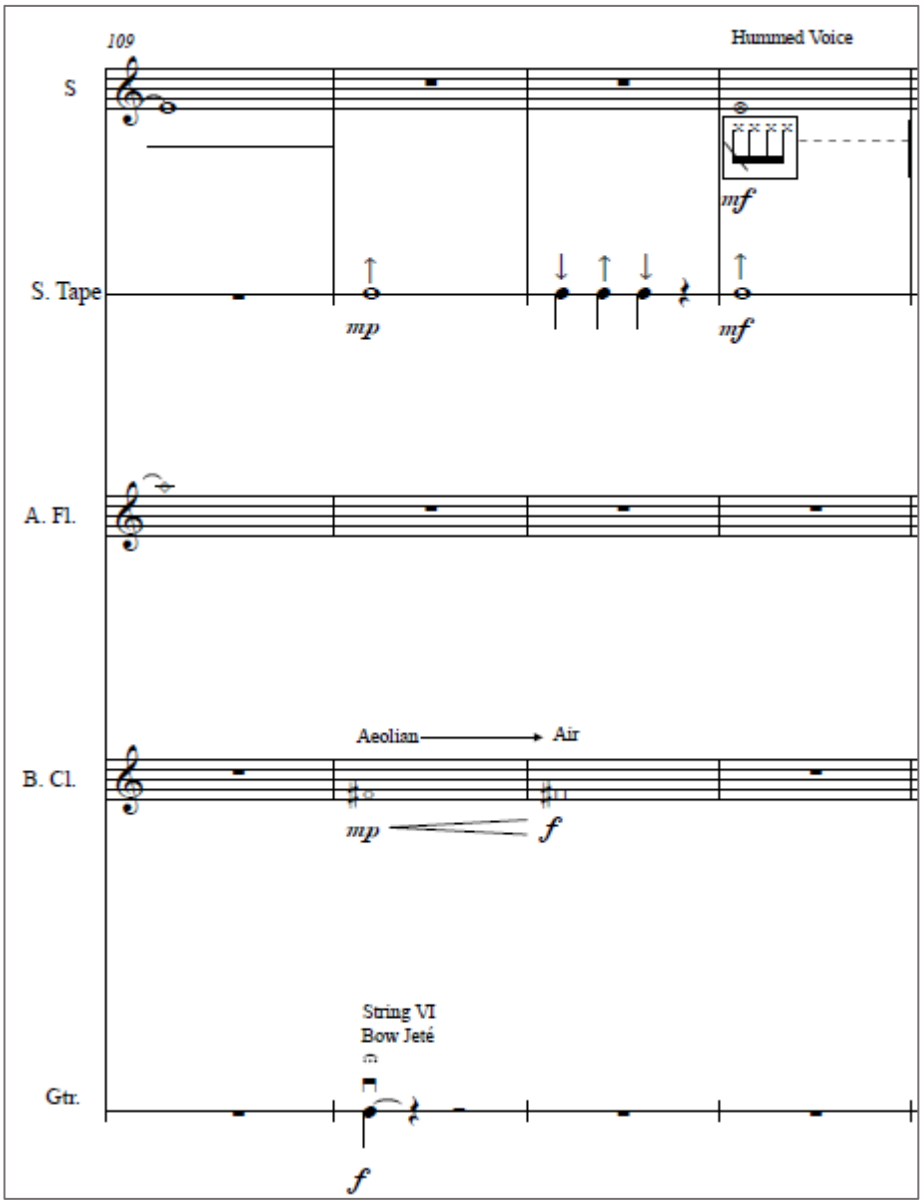

Figure 32. Score excerpt from *Just An Attempt To Dissipate* (b) showing a low level of density.

At the beginning of the spectrogram in figure 33 it can be seen that timbre is mostly dispersed. Although a faint fundamental can be perceived at the bottom (E5: 659.25 HZ), which corresponds to the aeolian sound of the flute an octave higher than the voice, there is also high noisiness in the spectrum produced by the air involved in the technique, later extended through the clarinet and turned into only air (figure 32).

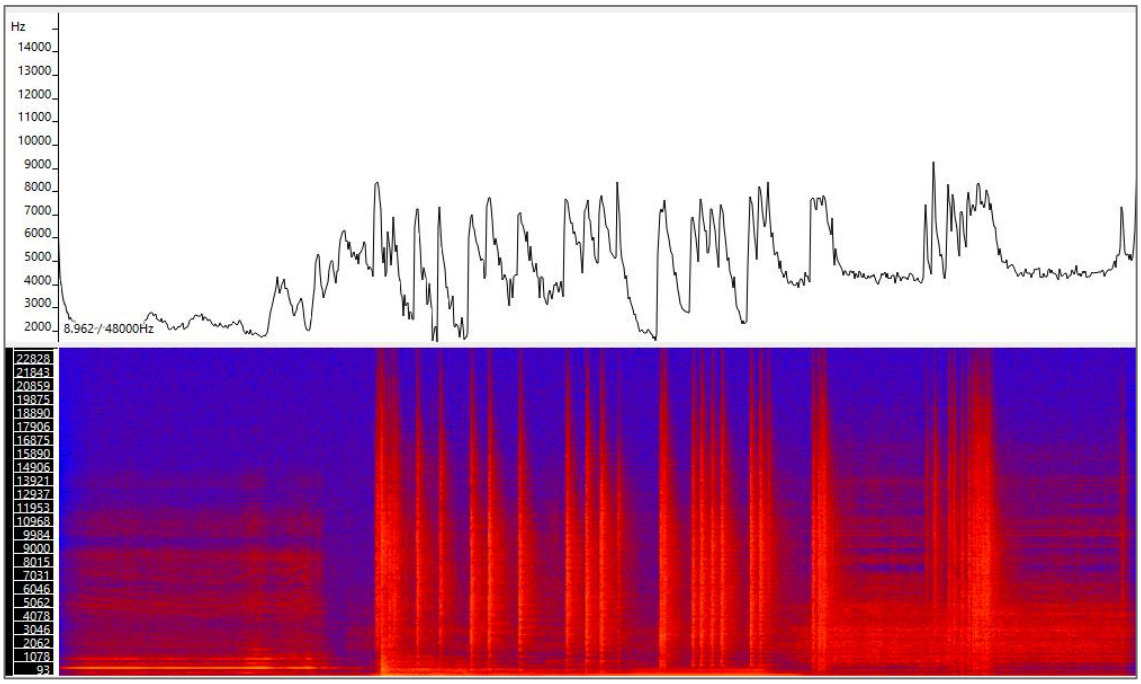

Figure 33. Spectral centroid and spectrogram of excerpt in figure 32.

Moreover, the spectrogram shows the transients in red/orange across the spectrum, which correspond to bow strokes on the guitar strings (*jeté*), as well as slaps produced by scotch tape lifted from the roll. These techniques present high loudness and an increase of the spectral centroid fluctuations, from which it could be said that strong attacks are naturally dense because there is a major concentration of energy. However, the kind of interaction between them is not developed as a unity: the experience is not perceived as a blending of activity. On the contrary, the scattered attacks are more likely to be perceived as an internal fragmentation in the process of dissipation of timbre. This makes possible a recognition that continuity is an important factor in the perception of mass: sporadic and short gestures seem more like explosions of energy that break and disperse the flow of mass. The dissipation attempt at this moment of the piece leaves an atmosphere of dusty quietness widely spread across the spectrum.

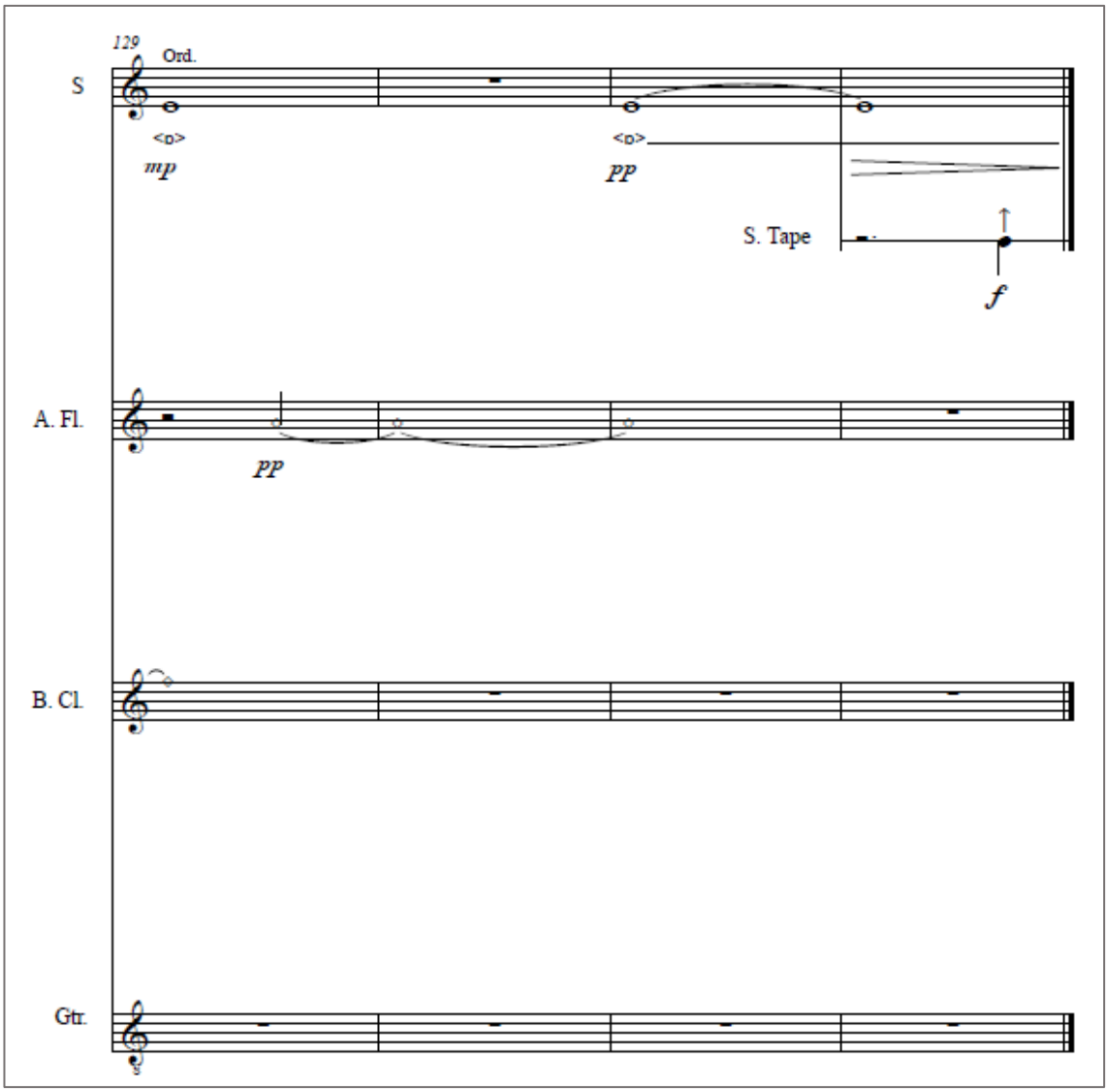

Figure 34. Score excerpt from *Just An Attempt To Dissipate* (c) showing the final gesture.

Nonetheless, there is a continuous inquiry into the experience of silence in timbral perception. As we noted earlier, silence is considered by Saunders to have a mass itself, to have a weight; nonetheless, in this piece there is an almost inevitable perception of silence as a hollow, an incommensurable emptiness, multidimensional in itself but, at the end, the realisation of the dissipation. That silence appears to fill the space that sound leaves, almost like an urgent response to the final slap of the scotch tape, and the abrupt interruption of the timbral experience (figure 34). It seems to contradict the compositional intention from the technical and structural perspective: silence is the space in which timbre dissipates; it makes possible the disappearance of timbre, not intended, but unavoidable.

3.2.3 We no longer sleep in the wind

We no longer sleep in the wind (2020), for solo Paetzold double bass recorder, was composed for Sylvia Hinz. It is based on the experience of *volume* as the third concept approached in my research into mass. Volume is a measurement of mass that refers to the perception of its size; however, Schaeffer's reflections on the perception of density and volume, and their dependence on intensity (loudness), are useful in developing the concept from a timbral perspective:

> We find, however, that with increases judged to be equal, the qualities of volume and density are linked to inverse variations of frequency […] at equal intensity the participant finds a low sound "more voluminous, less dense" than a high sound; for him to judge them to be of equal density, the low sound must have a greater intensity than the high sound; finally, these sounds do not seem to him to have the same volume until the high sound is louder than the low sound. […] what characterizes the concept of volume compared to density, and how can we so easily separate these perceptions from the notion of intensity? Surely these qualities are much more linked to a mode of operation? This would not be at all surprising, as we know that structural relationships depend on the order and frame of reference of the comparisons.[140]

This interrelation indicates the multidimensionality of timbre and implicitly permits to extend any understanding of volume through the perception of its particular dimensions: *length*, *height*, and *width*. I therefore develop this composition from the perception of *depth* as a direct consequence of the simultaneous interaction of these three dimensions (figure 35).

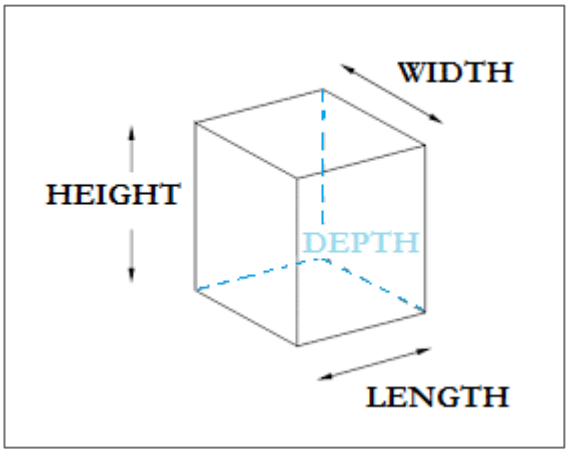

Figure 35. Depth as a perceptual consequence of volume multidimensionality.

According to the study of luminance, timbre may be clearly perceived if it is perfectly illuminated; on the other hand, it may become unintelligible if perceived from a great, deep distance. In fact, depth is generally described as a *dark* place where light cannot penetrate. Woolf makes this kind of association: '[b]eneath it is all dark, it is all spreading, it is all

[140] Schaeffer, p. 409.

unfathomably deep; but now and again we rise to the surface and that is what you see us by'.[141] Consequently, I studied Czernowin's piece *HIDDEN* (2013–14), for string quartet and electronics, to recognise the compositional strategies derived from a particular association between the concept of depth and the perceptual experience of *concealment*:

> HIDDEN tries to explore what lies concealed beneath the surface of expression—under the music. It is an attempt to break through into the realm of an almost inaudible presence that exists at the edge of our awareness. […] Our ears are given space and time to become accustomed to a totally unpredictable territory of sound; it is like a mountainous underwater landscape inhabited by vibrations that are more felt than heard, and by a fog that layer by layer disperses. Monolithic 'sound cliffs' are viewed and heard from different angles. This piece has to do with observation; it attempts to seek out and become aware of how expression comes into existence.[142]

Czernowin developed different spatial dimensions in the piece by dividing the electronics to four walls: front, right, left and back. Each wall has three kinds of loudspeaker configurations to make sound be perceived as 'regular' (square), 'behind a wall outside' (triangle), and 'from a large cave while the listener is outside' ('x' squared). The loudspeakers for the live quartet amplification can be placed next to the performer or spatialised with the electronics, which also contributes to blur what is played live. From Czernowin's approach, it could be said that depth is not only a consequence of distance where a clear perception is difficult, but a 'construction' through the superposition of layers that hide, fuse, and overlap the perceptual object. As Czernowin explains: 'one of the chords includes a woman screaming in the backwards [electronics]. Your body recognises the energy but not the explicit scream'.[143] The score excerpt in figure 36 allows to recognise how the composer explore depth through uneven rhythmical patterns of flesh pizzicatti with 2 fingers on the low register of the instruments (string IV in violins I and II is indeed detuned by a whole tone) and the cluster created by the quartet [F ¼ t down; F; F ¼ t up; G]. This condensation is counteracted by the pitch additions and transpositions in electronics, creating a dense granular mass in which the percussive attacks of the live strings seem to dive into. The use of very soft dynamics also contributes to this idea of concealment by making difficult the perception of the material, which contrast with the forte in some layers of electronics.

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[141] Woolf, *To the Lighthouse*, p. 73.
[142] Czernowin cited in Harald Hodeige, liner notes to Chaya Czernowin, *HIDDEN,* trans. by John Patrick Thomas and W. Richard Rieves (WERGO: Mainz, 2017), p. 15 [on CD].
[143] Czernowin, 'Composition Lecture', *Synthetis International Summer Course for Composition*, Poland, 15–27 July 2019.

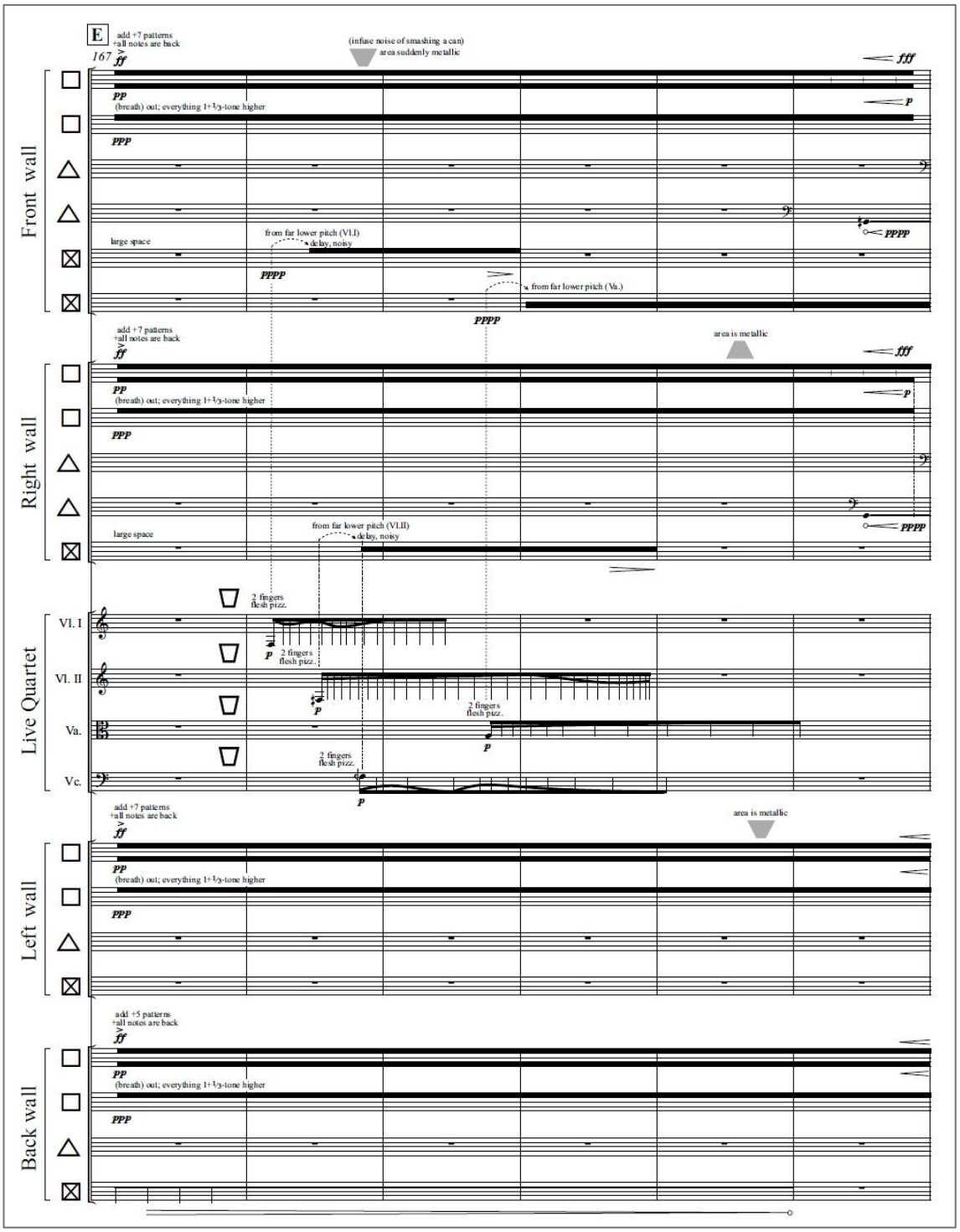

Figure 36. Score excerpt from *HIDDEN* by Chaya Czernowin.[144]

From this experience of depth, I started to work on the piece in January 2020 during a three-hour session of exploration of the instrument with Hinz in Berlin. This session had two objectives. First, it was a space for the timbral experimentation with different materials and unconventional techniques; second, it was a discussion on different notations used in

[144] Czernowin, *HIDDEN*, 2013–14, score ((Mainz: SCHOTT MUSIC, 2014). Reproduced by kind permission of the composer.

the repertoire that Hinz has played, and her reflections on the effectiveness of using corporal experience as a guide towards a resulting sound. Since the fabrication of Paetzold recorders is not standardised, each instrument responds differently to the techniques; as a consequence, Hinz suggested a more open notation to lead the performer in the search for a specific timbre, which seems to be more congruent with the nature of the instrument.

The title, *We no longer sleep in the wind*, is drawn from the poem *The Wind Sleepers* (1916) by Hilda Doolittle (H.D.), to which I felt very attracted.[145] I associate the experience of sleeping with *depth*; from which 'no longer sleep' makes a reference to coming toward the surface of 'reality'. As a poetical image, wind is a force and, at the same time, space for movement. Consequently, the title relates to this 'close-up' process in which timbre disintegrates when distance is reduced, in opposition to the expected revelation of its voluminous interior. Most of the time, the creative approach to depth reveals a spontaneous association with water, and the sea as the deepest experience possible. Nevertheless, I work on depth from the idea of an open space where the deepest point is the unknown, incommensurable sky, and the surface is the nearness to the earth.

Deep space of sky Distance	**Transition**	**Surface of earth** Nearness
High presence of fundamental pitch: low register, high loudness. Unison of voice and recorder (increasing harmonic dissonance). Frullato in low register pitches. Double trill from a low pitch fingering.	Underblown multiphonics. Pitches in the middle range as new fundamentals. Middle loudness.	Faint fundamental pitch, high inharmonicity, high pitch register, low loudness. Air sounds (closed labium). Aluminium foil covering labium.

Table 8. Techniques in *We no longer sleep in the wind*: classification according to three perceptual experiences of depth.

From Schaeffer's reflections on volume and my exploration of the Paetzold double bass recorder with Hinz, it could be recognised that low pitches are perceived as more voluminous because of the natural behaviour of their large waveform, the amplitude of the cycles. However, high pitches with loud dynamics could have a great volume too, especially if compared to a softer lower pitch. This information was important to attempting a

[145] Hilda Doolittle, 'The Wind Sleepers', in *Sea Garden* (London: Constable, 1916), p. 13.

classification of the techniques and preparations (table 8) according to the three-stage process of oncoming and disintegration of mass, in which the exploration of depth was both the perception of distance and the concealment of timbre as a perceptual object.

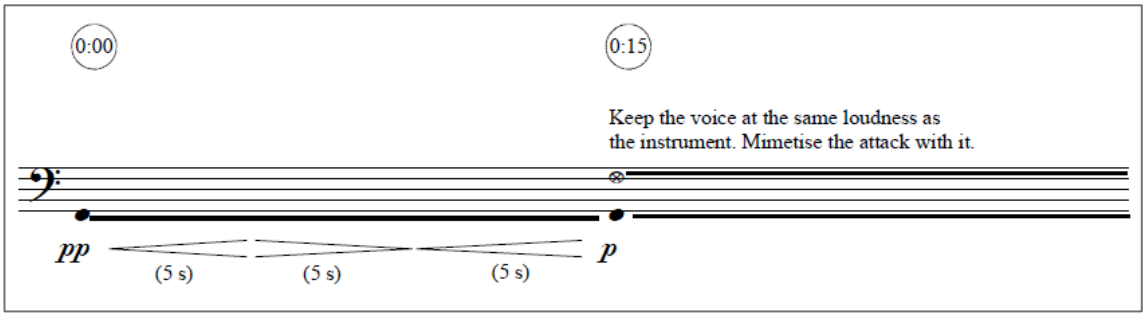

Figure 37. Score excerpt from *We no longer sleep in the wind* (a) showing the most deep and voluminous point of the timbral process.

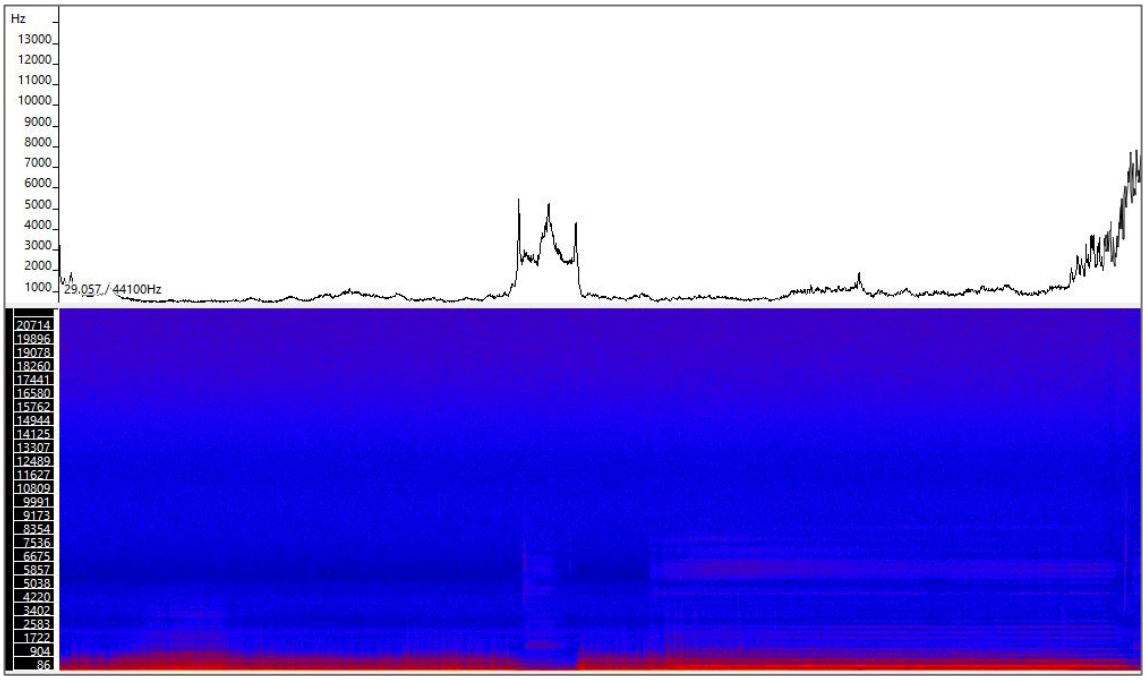

Figure 38. Spectral centroid and spectrogram of excerpt in figure 37.[146]

The first version of the piece was reviewed during a virtual reading session with Hinz, which was an opportunity to work on the congruence of the timbral structure.[147] The beginning takes the lowest pitch of the instrument (F2: 87.31 Hz), played pianissimo (figure 37), to create an experience of long distance, the deepest point in the timbral perception, so remote that it is almost inapprehensible. The idea of concealment is approached through the difficulty in clearly perceiving timbre because there is an intended technical contention

[146] Audio recording of the premiere by Sylvia Hinz. Recording and mixing by Jeanne Comateuse (two microphones Shure SM57, and one Rumberger WP1X In-Built Microphone).
[147] The reading session with Hinz was three hours long and took place on 22 May 2020 via Skype video call.

and limitation when playing long notes in the low register with very soft dynamics. According to the spectrogram shown in figure 38, there is no evident inharmonicity in this timbre and the spectral centroid is very stable, except for the presence of air from breathing that has been approached almost inside the instrument.

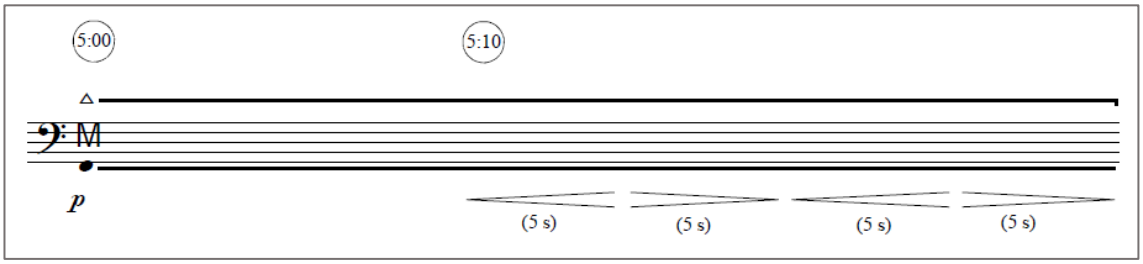

Figure 39. Score excerpt from *We no longer sleep in the wind* (b) showing an underblown multiphonic to produce a reduction of volume and distance in the timbral perception.

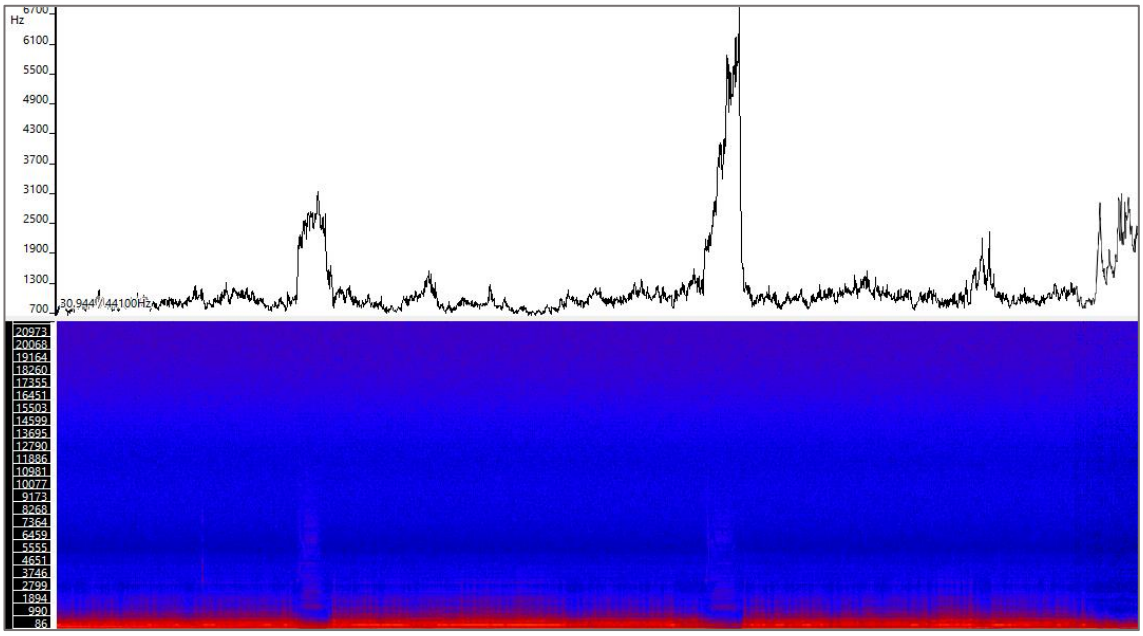

Figure 40. Spectral centroid and spectrogram of excerpt in figure 39.

The spectral centroid in figure 40 shows more fluctuations compared to the previous excerpt, which could be associated with a slight enhancing of inharmonicity from an underblown multiphonic that presents a major spectral concentration under A6: 1760 Hz, the highest pitch possible from the lowest fundamental of the instrument (figure 39). It is particularly interesting that volume doesn't lend itself to graphic representation. In fact, it contributes to the idea of depth in association with a hidden, profound, and unintelligible timbre, which is specially stressed by the perception of 'not totally revealed' partials in the multiphonic and the required use of soft dynamics. Furthermore, the gradual presence of higher pitches with soft dynamics leads to the perception of reduction of volume.

Therefore, the timbral experience becomes closer and 'smaller' by introducing the first (F3: 174.61 Hz) and second (C4: 261.63 Hz) partials of the initial fundamental frequency, which, in turn, become the new energy fields for revealing timbre.

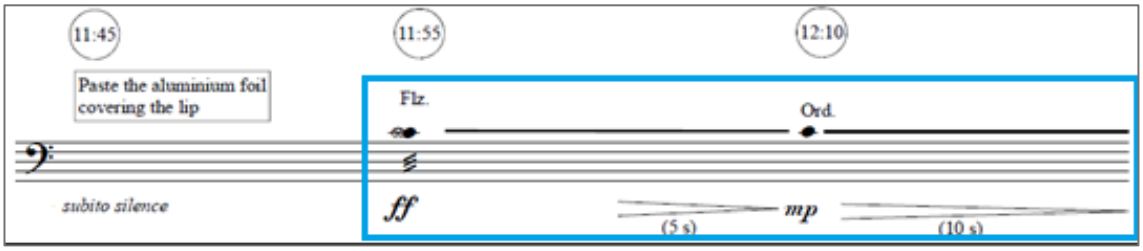

Figure 41. Score excerpt from *We no longer sleep in the wind* (c) showing a voluminous close-up in timbre.

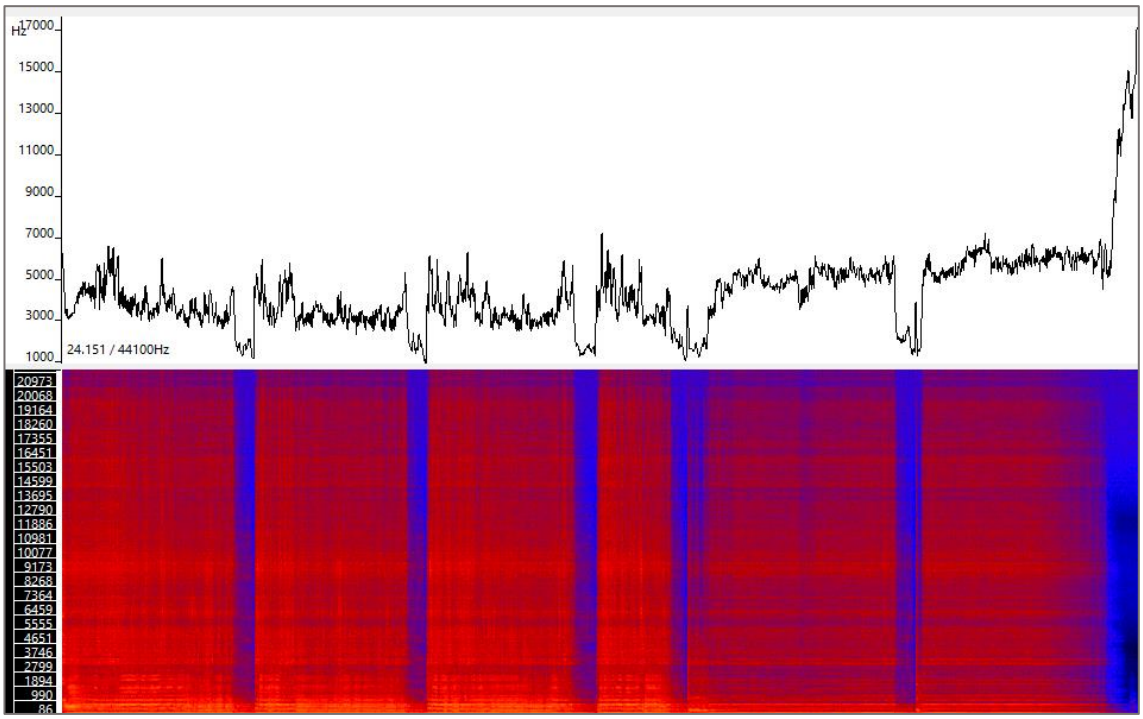

Figure 42. Spectral centroid and spectrogram of the boxed excerpt in figure 41.

However, a sudden extreme close-up creates an overwhelming proximity that seems to put the timbral 'object' in the first plane. The level of complexity showed in figure 42 is constructed by introducing the *frullato* singing voice in unison with the recorder and the use of a piece of aluminium foil to cover the labium of the instrument. As it can be seen in the score excerpt in figure 41, the sounds must be held for 15 and 10 seconds respectively, which is technically impossible without interruptions to breath, especially owing to the loud dynamics. Therefore, Hinz breathes as needed, which is reflected on the spectrogram as gaps between the red columns. The spectral centroid fluctuates between 3 KHz and 7 KHz (omitting the low frequencies of breathing). There is also a high level of inharmonicity

generated by the foil vibration. Additionally, the level of loudness is high across the spectrum, conditions that generally increase the perception of thickness of timbre, but in this case it may be more related to the closeness of timbre, the awareness of its presence owing to the aggressiveness of the gesture. However, the experience is gradually dissolved, leaving just the fundamental frequency with the aluminium, a timbre subtly distorted by a layer of noise, represented by a dim red in the spectrogram, an interference that presents itself as the focus of the attention. Hinz premiered the piece in her virtual concert series *I realitätsverschwinden solo* on 13 February 2021.

3.3 Reflections

From my study of mass as the kind of resistance that emerges between the parameters of sound while interacting, it might be possible to understand weight as the force exerted on a timbre, an explicit experience of tension from the instrumental technique itself, or in another level, as a consequence of specific interactions across the timbral spectrum. Consequently, it could be said that timbres with a high fundamental frequency tend to be perceived as light, thus low register pitches are particularly associated with heaviness. Moreover, the influence of loudness on the perception of weight seems to be stronger than other conditions, such as the spectral centroid fluctuation. Timbres with loud dynamics are mostly perceived as heavy, which is likely to increase the perception of heaviness even in high pitches, while a low pitch with soft dynamics seems to reduce its weight. In principle, a stronger force could lead to the perception of a major resistance (greater mass), which would increase weight of timbre, while less force is likely to generate a minor resistance (smaller mass), making timbre lighter; these associations can also be developed in terms of spectral content, leading to a general perception of lightness in more harmonic timbres. However, although the ethereality seems to be reached mainly through high pitches and low dynamics, from my compositional perspective there is a special association with the ethereal in unstable timbres—the unpredictable behaviour of the timbre allowing certain level of inharmonicity and fluctuations of the spectral centroid, similar to the flickering condition of light.

The perception of high density in timbre seems to rely on high levels of inharmonicity and large spectral centroid fluctuations. Therefore, particular conditions of distribution of the timbral components—like distance between pitches (intervals), activity layers (attacks and durations), and interrelation of the timbral components (homogeneity or diversity)—contribute to create and conduct density in a composition. Furthermore, timbre could be more or less dense, depending on the level of concentration or dispersion given in the interaction: that is, the perception of high density is related to the perception of fusion—the mixture, the perfect mimicry of the inner elements of the timbral experience.

Dynamics and pitch register are the parameters that exert a major influence on the perception of volume. However, the multidimensionality of volume itself showed a richer way to approach this concept in a composition. Thus, the interaction of width, height, and length permits the understanding of mass from the perception of depth. This concept emphasises the impact of space in terms of distance-proximity as a conditioning factor in the perception of timbre, leading to the definition (that is, perfect perception) of timbre in a close surface, or the concealment that makes a deep timbre 'unintelligible'. Furthermore, the relation between the perception of luminance and mass may be recognised in terms of the metaphorical association between darkness and depth, which coincides with the perception of a low register fundamental frequencies and, in some cases, very soft dynamics.

In this multidimensional approach to mass, dust functions as a metaphorical objective for the structure and development of an attempted disappearance. Furthermore, the exploration of different possibilities of disintegration contributes to the composition of pieces in which mass is also understood in its minimal expression, as a dynamic entity that is transformed in a fluctuating process of separation, fragmentation, and liberation.

CHAPTER 4: TEXTURE

Generally, texture is understood as a quality that determines to what degree something is *rough/harsh* in opposition to *smooth/round*, or *hard* in opposition to *soft*. This distinction of textural qualities is associated with both visual and tactile perceptual experiences, as approached in the neuroimaging field:

> We tested how surface properties of viewed objects evoke activity in different parts of the cerebral cortex. We found that visually responsive areas of the brain discriminated between different classes of objects, as might be expected. Surprisingly, we found that these same images lead to differential responses in somatosensory cortex: rough and smooth surfaces lead to different patterns of activation in areas that were localised based on their processing of tactile stimuli. These findings suggest that surface properties retrieved from visually presented stimuli activate a visual-somatosensory crossmodal network. […] Notably, we showed that rough and smooth surfaces were no longer discriminable by somatosensory cortex if observers were asked to imagine, rather than view, the visual properties. […] Thus, the activity in somatosensory areas is likely to reflect the specific tactile information (e.g., related to roughness) retrieved from visual cues.[148]

Massimiliano Di Luca and Marc O. Ernst describe the impact that this perceptual connection has on the understanding of the surrounding environment and how it works as a mechanism of adaptation:

> The visually induced somatosensory activation found here is compatible with an anticipatory system that extracts surface properties from visual information, perhaps in preparation for a possible interaction with it. Such an anticipatory system might be crucial for providing information about surface and material properties that determine friction and dynamic properties (i.e., deformability), which in turn could be considered in planning an action.[149]

This tactile-visual association between surface and material properties, or friction and dynamic properties, is fundamental to understanding texture as a timbral dimension because these concepts can be directly approached from the instrumental technique as a starting point for the generation and modulation of each timbral experience. In fact, timbral descriptors that refer to textural qualities such as rough, metallic, smooth, rounded, harsh, shrill, sharp, soft, messy, dry, glassy, scraping, wet, plastic, steely, raspy, grating, wooly, and squeaky have been classified by Zacharakis in the semantic categories of *source properties* and *sense of touch*, which make possible the identification of cross-modal associations in the experience of texture.[150] Furthermore, some of these descriptors demonstrate a strong correlation with the perception of luminance, a dimension associated

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[148] Hua-Chun Sun, and others, 'Look But Don't Touch: Visual Cues to Surface Structure Drive Somatosensory Cortex', *NeuroImage* 128 (2016), 353–61 (pp. 358–59).
[149] Massimiliano Di Luca and Marc O. Ernst, 'Computational Aspects of Softness Perception', in *Multisensory Softness: Perceived Compliance from Multiple Sources of Information*, ed. by Massimiliano Di Luca (London: Springer, 2014), cited in Sun, and others, p. 359.
[150] Zacharakis, 'Musical Timbre', pp. 79 and 96.

with vision, as Zacharakis, Pastiadis, and Reiss recognise, especially with regard to sharpness:

> Luminance is conceptually related to texture in the English language as suggested by the fact that sharpness […] is highly loaded on the luminance dimension. This last finding is not unexpected as Štěpánek has supported that sharpness is an auditory attribute that lies between luminance and texture (i.e., a sound object featuring both high luminance and high texture is described as sharp).[151]

From my compositional perspective, the difference between each dimension is therefore intentionally guided by the conceptual or metaphorical meaning that determines the structural development of the pieces. That is, timbre manifests as a single percept, a complex multidimensional experience; however, as a compositional strategy, I address it with a specific objective and develop a convenient approach to its qualities for each timbral experience. Below, I will focus on particular perspectives on texture that can contribute to the study of this timbral dimension in compositional practice.

4.1 Perspectives on Texture

Texture, as a consequence of an interaction realised in timbre from the experience of contact, has been explored by composers like Cecilia Arditto Delsoglio, who uses descriptors for texture to guide the technical approach in her orchestral work *Tissue* (2019). In section VI, Arditto Delsoglio writes: 'tissue scratched, pierced, burned, wounded'. She additionally makes textural associations from the orchestration, organising the instrumental interactions as global gestures: 'the Gran Cassa is played with fingers with a circular movement. The orchestra crumples kitchen-paper and rubs strings also with fingers.'[152] Consequently, the textural conditions in the piece are related to words that describe material conditions that are visually and haptically perceivable. Nonetheless, Arditto Delsoglio expands that physical experience to the configuration of a wider dimension of texture that comprises the articulation of all the layers of activity.

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[151] Zacharakis, Pastiadis, and Reiss, 'An Interlanguage', p. 348.
[152] Cecilia Arditto Delsoglio, *Tissue*, 2019, score.

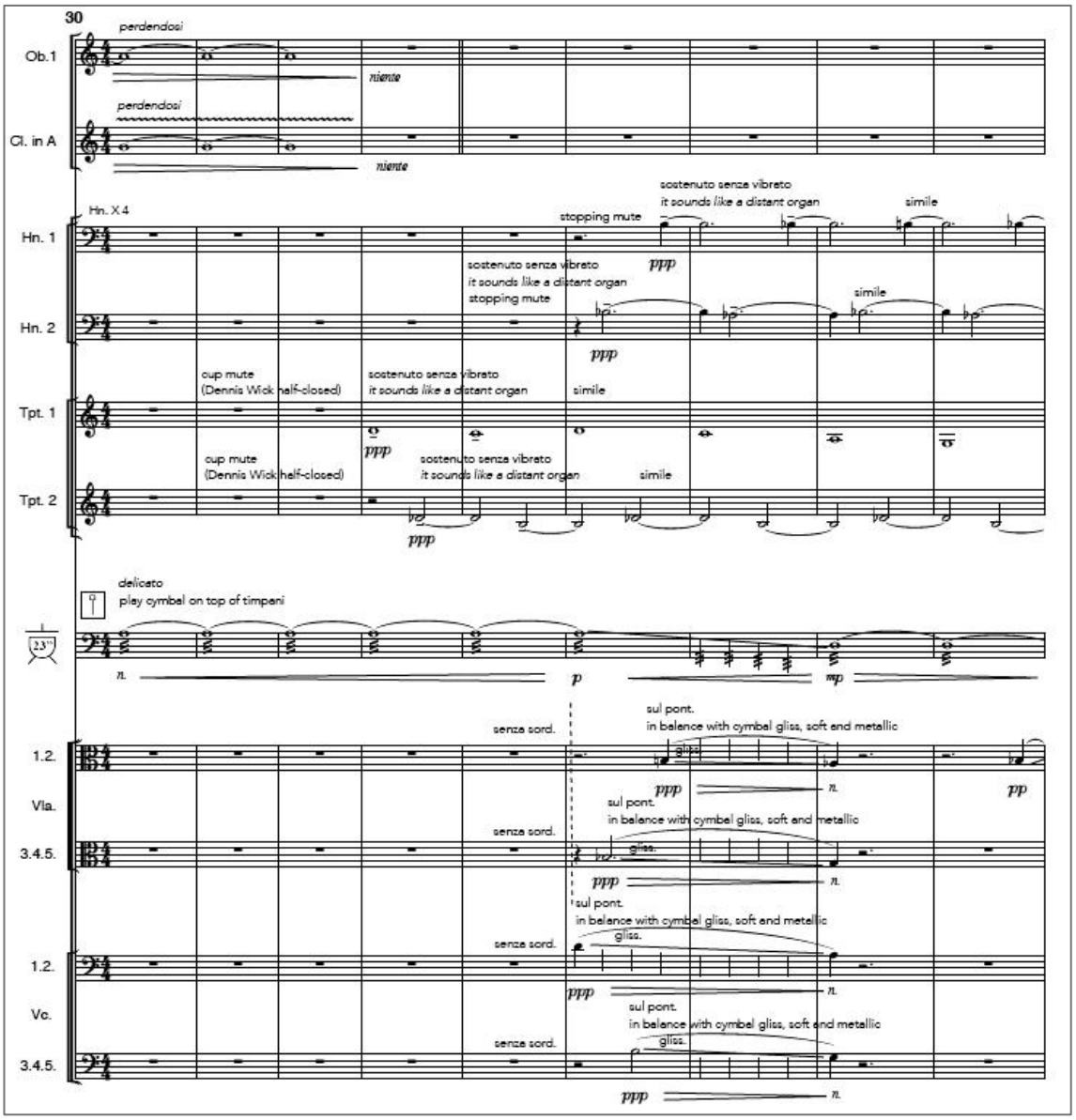

Figure 43. Score excerpt from *Tissue* by Cecilia Arditto Delsoglio.[153]

The score excerpt in figure 43 shows how Arditto Delsoglio creates a global texture by associating different sources of sound through articulated techniques. In section II, titled *Skin full of rumours*, the composer states that the full orchestra is the resonance body of the cymbals, which is placed on top of timpani. The orchestra could therefore be an analogy of the timpani itself. Consequently, the use of muted horns and trumpets playing static long notes seeks to generate an expanded dimension of the resonance of the cymbals tremolo.

Similarly, violas and cellos develop a kind of expansive glissando that is required to be in balance with the cymbals, for which the composer guides the performance with the

[153] Arditto Delsoglio, *Tissue*, 2019, score. Reproduced by kind permission of the composer.

expression: 'soft and metallic'. The resemblance with the metallic condition of the cymbals is also addressed by playing *sul ponticello* and without mute, looking for a high level of inharmonicity.

Malin Bång, for her part, has extensively developed the concept of texture from what she calls *a micro perspective*, in which texture is the result of the perception of the duration and the physicality of a sound.[154] In her piece *ripost* (2015), for symphonic orchestra, solo contrabass, and solo percussion (both amplified), it is possible to recognise a particular semantic approach to texture in association with instrumental and compositional techniques.

The score excerpt in figure 44 shows how the composer uses the expression 'very rough and shrill squeak' to guide the performance of woods (except for flutes) in the construction of a cluster of semitones (G, G#, A) which moves in a crescendo that reaches the *fortissimo*. Bassoon and contrabassoon are pushed to their high register emphasising the shrillness intended. Meanwhile, flutes join the brass section to create a layer of whispers, articulated by different phonemes, which leads to the perception of internal movement through a rhythmical structure built on subdivisions. This airy and granular texture is released in a glissando, notated in three lines to guide the change of register: all holes open (top), upper half of holes closed—left hand (middle), and all holes closed (bottom). Trumpets, trombones and tuba sustain the glissando with a layer of long airstreams.

[154] Malin Bång, 'Portrait Lecture', *Composers Forum: Malin Bång*, Cornell University virtual event, 23 October 2020.

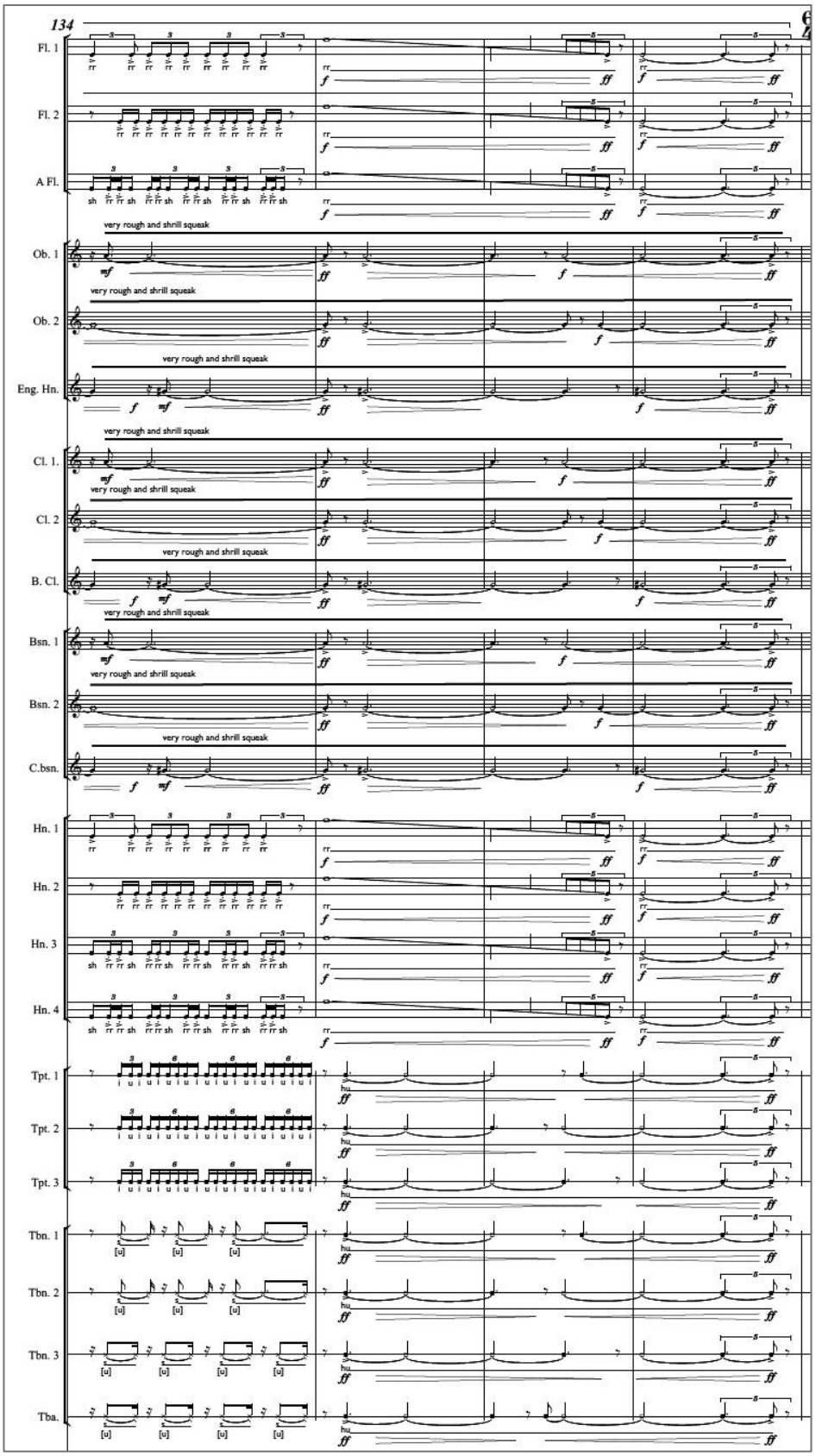

Figure 44. Score excerpt from *ripost* (a) by Malin Bång.[155]

[155] Bång, *ripost*, 2015, score (Stockholm: Svensk Musik, 2015). Reproduced by kind permission of the composer.

The importance that Bång attributes to the interaction between the performer and the material conditions is evident in the immediately subsequent gesture. The score excerpt in figure 45 allows to appreciate a third layer created from the interaction of the percussion section and low strings, which can be perceived as an extension of the brass section, so much more rhythmically accentuated. Violas and violins, for their part, play a scratch behind the bridge, producing a kind of dry roughness that allows to introduce the solos. Here, Bång works with different sources of sound to develop particular textural conditions, thus the solo percussionist should play a metal pipe with two metal brushes (each brush is notated in a different staff to individualise dynamics). The technique is expected to produce 'an intimate, crunchy, crackling sound'. With a similar timbral purpose, the solo contrabassist should use two combs on the bridge, pulling back and forth in opposite directions against the edge. Both performers produce a kind of gentle granulation that seems to dissipate the hostility previously intended with the woods.

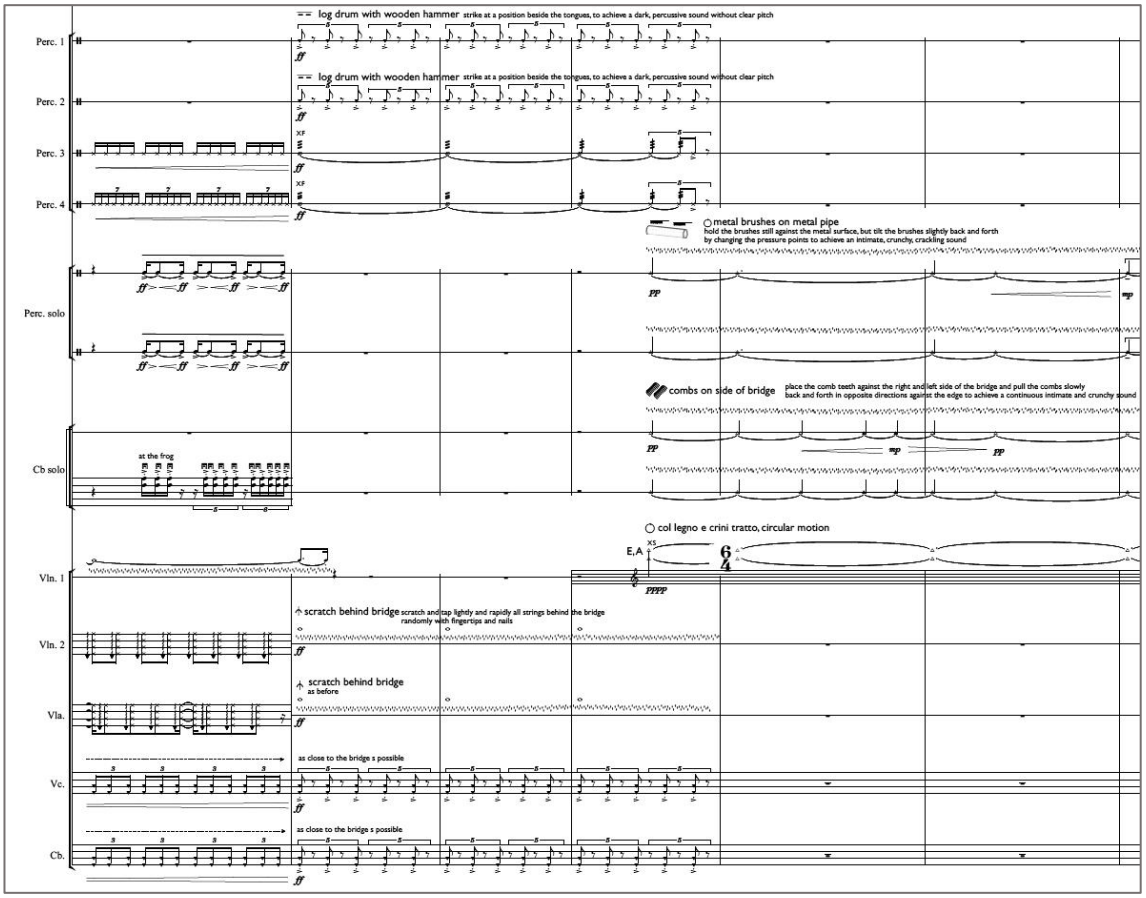

Figure 45. Score excerpt from *ripost* (b) by Malin Bång.[156]

[156] Bång, *ripost*, 2015, score (Stockholm: Svensk Musik, 2015). Reproduced by kind permission of the composer.

Additionally, Bång's compositional approach emphasises the relation between the perception of *texture* and two of the concepts studied in the chapter of mass: *density* and *depth*, as she describes it:

> To achieve a density and a depth in the sounds that interact in a piece I create a textural layer by combining several instruments. […] A texture that can in one passage act in the background, to create the room for other actions, and then gradually grow and become more active and intense and appear in the foreground as the sounding object closest to the listener. In this way the role of the textures are to create the sounding perspective of the piece, to define the depth of the room and also to perform seamless and resilient shifts of the perspectives, into a fluctuating relief.[157]

This attribution of *structural functions* to each layer gives rise to another connotation of texture as the perception of *organisation* of the timbral components. From an intangible experience, therefore, texture could be understood as the perception of internal distribution (space) and behaviour (time) of the timbral components in the interaction. This perspective could be recognised in Xenakis's music, as Fayers explains:

> In practice Xenakis' efforts were initially done through group theory that used probability to determine musical occurrences, seen in *Akrata* (1964–65)*, Nomos Alpha* (1966)*, Nomos Gamma* (1967–68)*,* and *Anaktoria* (1969), and his Sieve theory, through the study of outside-time musical structures developed in his application of stochastic processes to form musical textures that we see in his large-scale orchestral works such as *Pithroprakta* and *Metastaseis*.[158]

Fayers' approach to Xenakis's music also makes evident the correlations between the timbral dimensions, especially in the 'construction' of *mass* and the perception of its *textural* qualities:

> The glissandi give sonic appearance to concave and convex surfaces. In *Metastaseis* the sound mass is constructed through complex glissando textures and massive vertical sonorities, the glissando develops spatially by moving from one instrument to the next while the pitch gradually modifies.[159]

At this point, it is necessary to study the association between the physicality of timbre and the textural qualifiers that could contribute to a deeper understanding of texture as a dimension of timbre. From this perspective, Zacharakis, Pastiadis, and Reiss state:

> The most important factor for the auditory perception of texture seems to be the energy distribution of harmonic partials. The correlations for both linguistic groups indicate that sounds with stronger high partials are more likely to be characterized as rough or harsh and the opposite as round or soft. This appears to support Faure et al., Howard and Tyrrell, Barthet et al. and Barthet et al. who have generally associated higher spectral centroid values with roughness and shrillness and lower spectral centroid values with softness.[160]

The *energy distribution* of harmonic partials mainly refers to the perception of harmonics present across the spectrum, especially in relation to *loudness*, *quantity*, and *proximity*. This

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[157] Bång, e-mail to the author, 10 November 2020.
[158] Fayers, p. 3.
[159] Fayers, p. 6.
[160] Zacharakis, Pastiadis, and Reiss, 'An Interlanguage', p. 350.

suggests a need to analyse the levels of inharmonicity in the timbral texture. Furthermore, the particular influence of inharmonicity on the experience of texture could be studied from James W. Beauchamp's perspective, who determines three inharmonic categories according to the kind of distribution of harmonics:

> *Sounds with nearly harmonic partials*: the partials of this spectrum diverge slightly, but increasingly, from the harmonic partials so the higher the partial, the greater the divergence. This phenomenon results in a clearer, colder, more tense and brighter sound. *Sounds with widely spaced (sparse) partials*: since the partials are dispersed and are separate from each other, there is no 'roughness' between them. At the same time some partials could be in harmonic relation so they fuse better than others. *Sounds with closely spaced (dense) partials*: since the partials are very close to each other, the roughness of the spectrum is very evident. Therefore no pitch content can be heard.[161]

Beauchamp's categories of inharmonicity coincide with Zacharakis, Pastiadis, and Reiss's conclusions, since roughness is mostly attributed to the presence of the higher partials in the spectrum (especially after the 17th partial), which are closely spaced (dense); while the perception of smoothness is relevant when the partials are widely spaced and/or in harmonic relation (no deviation), so they fuse better in the spectrum perception, which generally happens with the lower partials. Likewise, roughness can be approached via Stephen McAdams's definition: 'the sensation of rapid fluctuations in the amplitude envelope that can be generated by proximal frequency components that beat with one another'.[162] From a compositional perspective, these proximal frequencies may be the result of simultaneous close fundamental frequencies producing different harmonic series that interact by 'beating' against each other, or of timbres with a strong presence of the highest partials, as explained above. Consequently, in the present research, texture is a direct consequence of the experience of contact with/between the sources of sound as well as the result of a specific internal organisation, distribution, and development of timbral components.

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[161] James W. Beauchamp, 'Analysis and Synthesis of Musical Instrumental Sounds', in *Analysis and Synthesis, and Perception of Musical Sounds, The Sound of Music*, ed. by James W. Beauchamp (New York: Springer, 2007), cited in Andrea Szigetvári and Balázs Horváth, *Timbre Solfege* (Typotex Ltd. Electronic Publishing House, 2014), [n.p.] <https://regi.tankonyvtar.hu/en/tartalom/tamop412A/2011-0010_szigetvari_timbre_solfege/index.html> [accessed 18 November 2020].
[162] McAdams, p. 96.

4.2 Compositional Approach: An Exploration of the Unpleasant

Both *dryness* and *rust* are perceptual experiences that give me, personally speaking, a high level of discomfort and a reaction of annoyance. As a result, my exploration of these conditions in timbre led me to approach the pieces from a different perspective, pushing the boundaries of my own compositional tendencies towards aesthetic delight. Having a skin condition of high sensitivity, *dryness* can even become painful; nonetheless, what I pursue in the timbral exploration is an attention to extremely subtle details of touch: the levels of roughness of the interacting surfaces, the noise of friction between materials. From this perspective, my compositional approach to texture responds to a more explicit tactile experience, an intimate relation of contact with the sound sources, which also includes working with everyday objects found at home.

In terms of *rust*, my aversion comes much more from visual experience. I have multiple memories of rusted objects that turned into secret obsessions through a rejection of the reddish, corroded, destroyed surfaces, which make me feel shivers even without touching them. Therefore, rusting is approached as a liminal experience of degradation and invasion by which something loses its identity as rust spreads across and consumes it. This compositional approach responds more (although not exclusively) to the intangible perception of texture as a directly intended organisation and distribution of timbral components, a process through which a visual perceptual experience is modulated into timbre, from the photography of a rusted object to the timbral experience of oxidation in my piece.

4.2.1 suelo seco

suelo seco (2020–21), for amplified cello and piano, was commissioned by Illuminate Women's Music to be premiered by Ivana Peranic (cello) and Rachel Fryer (piano) on 1 October 2021. The piece was developed through the kinds of contact determined by level of pressure and type of movement between sources of sound. The title (Spanish for 'dry soil') responds to an exploration of *dryness* as an opportunity to study the fragility of timbre from the particular and intimate experience of *friction* on the strings. Therefore, the

performers are invited to approach their instruments as dry soil territories in which they move to discover each textural identity. Cello and piano are explored as mirrored sources of sound, thus both instruments respond to each other as mutual extensions of their timbral conditions.

In this composition, noise is especially approached as a dynamic entity, allowing me to explore the hiss created by the gentle friction of two surfaces as an analogue for *dryness*. Additionally, *roughness* is addressed as a direct consequence of the friction in which movement and displacement are difficult or interrupted: that is, *harsh*. Hence this timbral condition is constructed through the level of interference generated by the materials that rub, brush or scrap the string. However, roughness is also approached in terms of the closeness of the upper partials, a high level of harmonic dissonance, which can be the result of specific vibratory conditions of the strings. Furthermore, overtones are generated as a consequence of 'touching' the strings at specific points, especially by rubbing, also contributing to the creation of different levels of inharmonicity.

Generally, the textural experience of dryness in this piece requires attentive listening in order to discover the almost unperceivable, minimal expression of timbre produced by friction. Loudness is thus explored principally at its lowest levels, as a direct consequence of the materials selected and the kind of interaction developed for each technique. Consequently, amplification in this piece works as a microscope: rather than intensifying the sound, it is conceived as a magnifier of the inside of timbre, its movement, its structure, and its behaviour. It is a resource by which to appreciate the inner nature of dryness and its transformation through the physical interaction.

In May 2020, I had a first conversation by e-mail with Fryer and a video call with Peranic, in which I asked questions about the technical possibilities of the instruments in order to develop my ideas. Later, with the composition more worked out, I had a video call with Fryer to evaluate the efficiency of the materials selected in terms of the textural approach to timbre in the piece.[163] After this virtual session, Fryer recorded a sample of each technique workshopped, trying each material on several strings. Although the quality was not suitable for a spectral analysis, the recordings were fundamental to my composition of the first version of the piece.

[163] The video call with Rachel Fryer took place on 24 June 2020 by Skype and was one-and-a-half hours long.

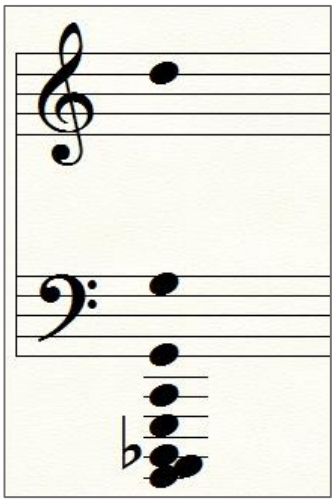

Figure 46. Cello scordatura and piano strings in the final version of *suelo seco*.

As a consequence of my compositional perspective, pitches are part of the timbral interaction, but are never more important than other components. Therefore, the strings chosen for this composition (figure 46) do not emphasise any kind of pitch organisational system. In fact, my flattening of the cello string I—by a whole tone—creates more flexibility to vibrate through friction. Thus, the change of tuning seeks a reduction of tension in the instrument and an increase in sympathetic resonance with the corresponding octave between string III and I. Nevertheless, a certain increase in roughness is aimed at by changing the harmonic structure of the instrument. Three specific soil textures inspired me to structure this composition. First, the experience of a *dry surface*, softly granular; this can seem smooth and condensed, but it is not static. Second, *cracked soil*, broken and separated, hostile and crumbly at the same time. And finally *dust*, the remains, multiple particles that drift in the wind and fall down to the soil again, forming fragile layers ready to be scattered at any impulse.

Timbre in each section is composed from the exploration of *friction* between the strings and particular objects—initially, a paper sheet, a toothbrush, a piece of compressed polystyrene, a rubber band, and wool strands. These elements are used to rub, scrape, or brush the strings at a determined speed and direction, while exploring different distances during the displacement to generate specific timbral experiences associated with the three states of dry soil described above. Consequently, the vertical displacement should always be approached from a vertical movement, that is, moving the element with both hands up and down along the string. However, with the rubber band and the wool strands there is also the possibility of diagonal movement. In these cases, one hand is higher than the other, and the vertical displacement occurs at the same time as the string is rubbed by pulling the element from

one side to the other one continuously. In the horizontal movement there should not be displacement along the string: the contact point should remain the same while the object is pulled across, from left to right and vice versa (figure 47).

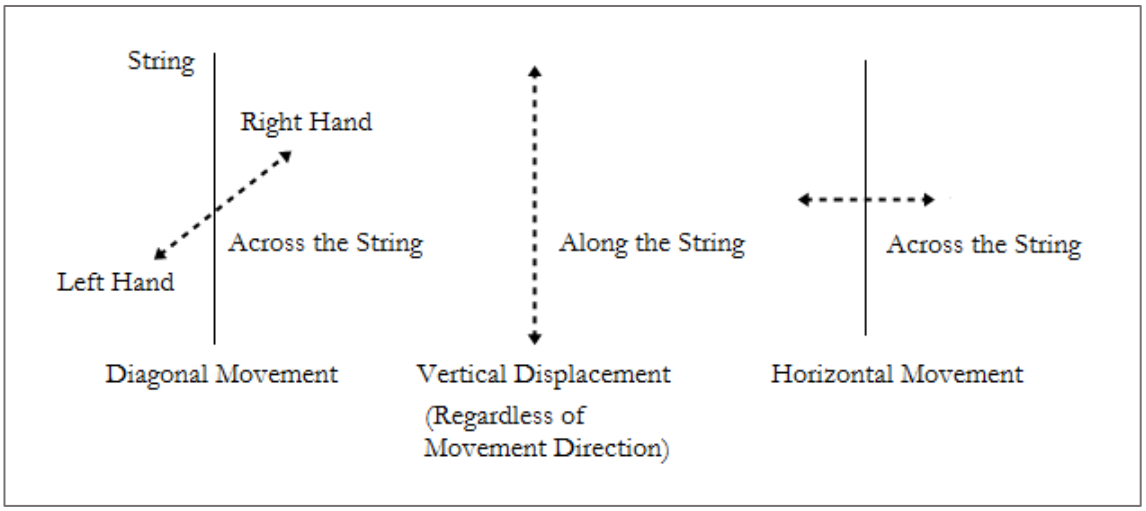

Figure 47. Direction of movement and displacement of objects along and across the strings in *suelo seco*.

Dry Surface

The exploration of dryness in association with qualities like smoothly granulated and unstable (non-static) led me to work with a standard printing sheet paper A4 on the piano and cello strings. The technique requires taking both edges of a landscape sheet to form an arch. Thus, the performers scrape the cello string IV (*scordatura* B1), and the piano string B0 with the bottom edge of the paper at the middle point (the top of the arch). In order to emphasise the textural experience of dryness, the pedals of piano are not activated in this section. This technique does not allow for significant differences in loudness. Nevertheless, subtle changes from *piano* to *mezzo-piano* are notated to guide the kind of interaction from a very superficial contact to a more gritty scraping.

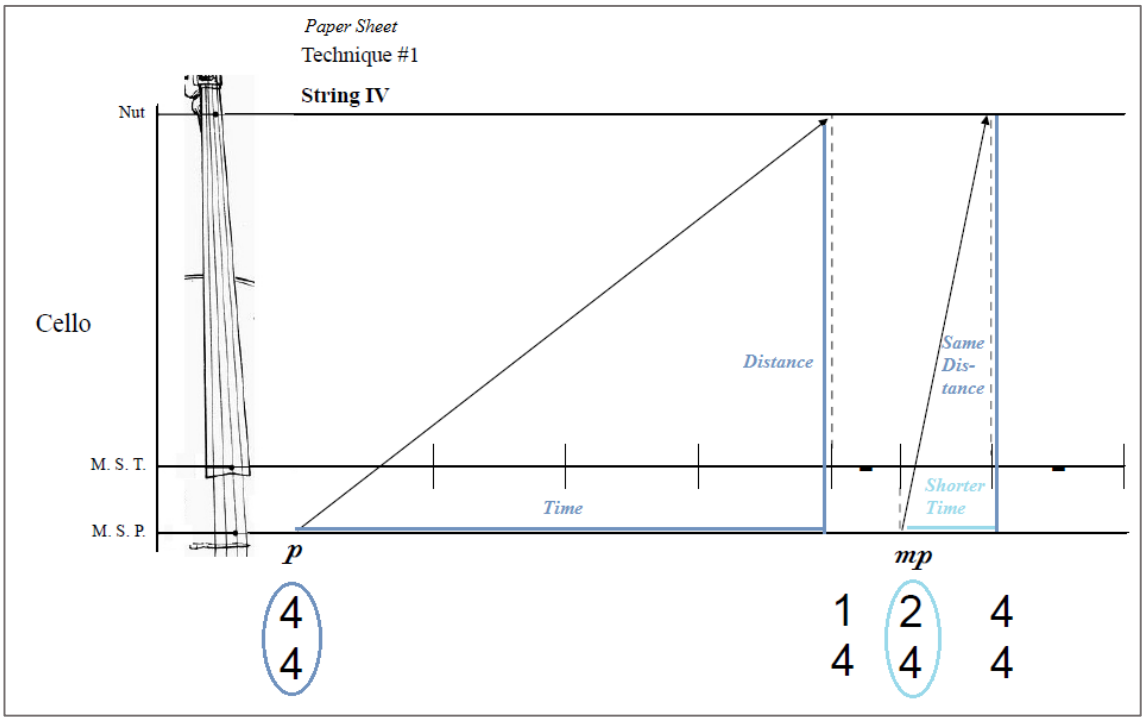

Figure 48. Score excerpt from *suelo seco* (a) showing how time and distance should be controlled.

Moreover, the characteristics of the friction are determined by the conditions of time and distance for the movement of the sheet on the string (figure 48); consequently, slower friction can be conducive for a more granulated interaction, while faster movement can produce more harshness, always within a reduced range of possibilities, restricted by the conditions of the paper in terms of materiality, like its reduced flexibility to vibrate and its fragility, which limits the execution of pressure to a very low level. The performers are required to shift the side of the paper or use a new sheet if its edges wrinkle, in order to produce the intended timbre. Other characteristics for superficial dryness in this section are explored by brushing the same string of the piano with a soft toothbrush. The technique is approached by brushing with the bristles along the string (vertical displacement) as well as by pressing the bristles from bottom to top, across the string on one point (horizontal movement without vertical displacement), as seen in figure 49.

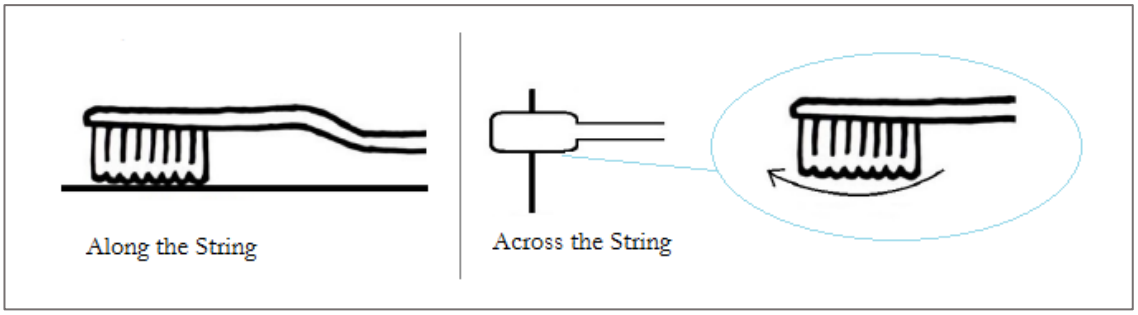

Figure 49. Two different brushing techniques on string B0 of piano approached in *suelo seco*.

The contact between the brush bristles and the string produces a certain roughness, enhanced by the fact that the bristles have their own internal independence and stimulate the string differently each time. The time-distance relation on the string also has an impact on the resulting timbre because the level of pressure exerted to complete the notated movement is not the same every time. Additionally, a new element is introduced when the pianist brushes the string with small up and down movements over a reduced distance, like a tremolo, stressing the passing of the bristles through the small indentations in the winding of the strings. This kind of friction can lead to major levels of noisiness, which works as a transition to the next section.

Cracked Soil

The fragility or crumbliness of the timbral texture in this section is explored as an extension of the previous conditions via a change of element introduced by the cellist: a piece of compressed polystyrene rubbed on string IV. Since the surface of the polystyrene is haptically perceived as even and smooth, a soft and slow friction generates a *static* timbre, a kind of noise described as hiss, which leads to an association with the brushing experience in the piano that is emphasised through a resemblance to the tremolo technique (figure 50).

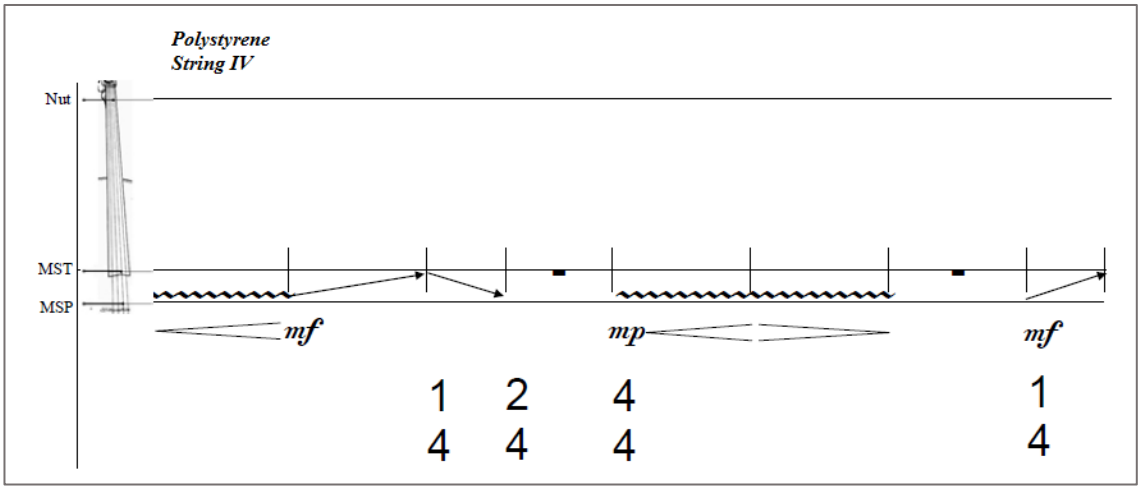

Figure 50. Score excerpt from *suelo seco* (b) showing the same time-distance approach for the use of polystyrene.

The idea of a hostile soil, in which the surface continuously cracks until its collapse, was approached via the introduction of a new element in the piano: a twisted rubber band, which was intended to be used on string G1. Although the vertical displacement along the string produces a very subtle timbre, compared to the toothbrush, the main timbral transformation coming from this technique was supposed to be the perception of a kind of 'iterated' timbre, which resulted from rubbing the string in a horizontal movement (across the string). Unpredictable slaps should be heard through the release of tension generated during the friction with the elastic material, which would stimulate vibration of the string, producing the fundamental frequency or even upper partials. These slaps were expected to 'break' the previous shallow dryness and create a sensation of cracking. The use of the sustain pedal with this technique seek to boost the vibration of the rubber band itself, such that the interaction of band and string would be perceived as a rougher timbre. The same technique would be presented later by the cellist on string III, behind the bridge, where the rubber band was expected to produce a high-pitched iteration which would be much drier owing to the rigidity of the string and reduced resonance. In this case, the vibration of the band itself when being rubbed on the string would be the main source of sound.

Dust

The final section explores the residue of soil, dust as the minute pieces of a past life already disintegrated, the pile of remains, soft and dispersible, the final state of mass, following Amato's approach: 'dust forms the ceaseless tides of the becoming and dissolution of things. Out of it things are made; into it they dissolve'.[164] Thus, in a preliminary version of the piece, texture was explored by rubbing two wool strands on string I, *scordatura* G3 in cello, and strings D5 and G6 (each at a time) in piano (figure 51). In all cases, the strings are not wound, so the friction should tend to be *smooth* and *flat*. Consequently, the lack of adhesion would reduce the possibility for the string to vibrate and the hiss of the fibres of the wool would constitute most of the (barely perceivable) timbre. Nonetheless, the strings behave differently in each instrument because of the levels of tension and the length, the piano strings being less stimulated to vibrate compared to the cello, which is longer and looser, allowing for subtle production of the fundamental. Generally, the vertical

[164] Amato, p. 20.

movement tends to produce a little more resistance to the displacement; however, most of the time it is a very quiet and ethereal timbre. At the end of the piece, the sustain pedal of the piano was used to incorporate the resonance within the final state of timbre, as an extended layer of dust desperately waiting to rise and spread.

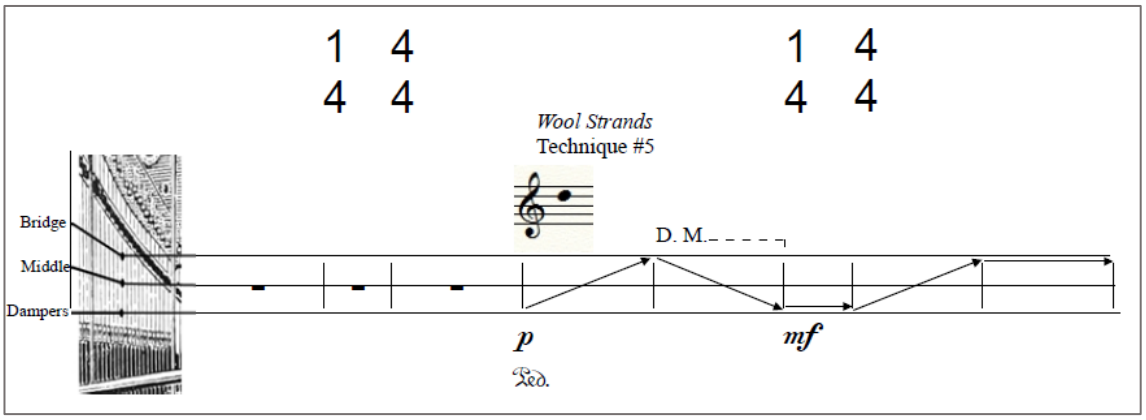

Figure 51. Score excerpt from a preliminary version of *suelo seco* showing the intended use of wool strands and the sustain pedal of piano at the end of the piece.

The piece was finally workshopped with Peranic and Fryer on 5 August 2021. Part of the technical approach to the instruments in section 2 (Cracked Soil) and section 3 (Dust) had to be reconsidered owing to the extreme unreliability of the elements. The wool threads produced a quiet timbre, which was expected during the composition; nonetheless most of the time it was simply imperceptible. Some elements showed very limited response to the different kind of movements and displacements. Contrary to the recording previously sent by Fryer, the rubber bands used did not allow the expected friction of the strings; maybe because of the high temperature at the time it became stuck at a point while the performers tried to move it unsuccessfully. The idea of twisting the band was useless since it had great elasticity and the expected iteration never occurred. For these reasons, the rubber band and wool threads were replaced with cello bow hair and the bow itself (cellist). Although the amplification of the instruments is an essential part of the composition, I decided to work on timbres that could be heard in acoustic conditions, thus the microphones function as microscopes on timbre rather than just loudness boosters. As a radical position in terms of dryness, I decided to completely avoid the use of the piano pedals in the piece, relying exclusively on the capacity of the microphones to capture the friction of the elements on the strings. Moreover, it was necessary to limit the space of interaction inside the piano owing to the physical demands on Fryer. Consequently, the final adjustments were intended to consolidate the textural experience of dryness while being coherent to the timbral behaviour of the different kinds of friction developed in the piece.

4.2.2 The Loneliness of the Rusted Things

The Loneliness of the Rusted Things (2020), for flute, clarinet, oboe, violin, viola and cello, was written for the Riot Ensemble as a result of being selected to participate at the CROSSROADS International Contemporary Music Festival.[165] The composition is an exploration of *rust* as a timbral experience, where different dimensions of the oxidation process seem to be augmented to perceive the subtle details of their inner transformation. The relentless consequences are manifest through sudden squeaks and rough interactions until an almost total disintegration.

Gaston Bachelard studies this historical obsession with the inward, the *myth of interiority* from which the essence of things is expected to be explained, or understood:

> At about the same time, in 1722, Crosset de la Heaumerie writes: 'Quick-silver, though white on the outside… is red inside… The red tincture… appears when it is precipitated and calcined by fire.' Chemists will recognise the oxidation of mercury here and will use this to indicate a *rationalisation* of alchemical thought. […] If substance has an inside, there must then be an attempt to *search deeply* into it. This operation is called 'the extraction or eccentricity of the soul'. The cosmopolite says to the mercury that has for a long time been 'scourged and deeply searched': 'Tell me what you are in your centre and I will no longer torment you'. Inside substance 'at the centre of the very smallest atom of metals lie hidden virtues, their colour, and their tincture'. It is pretty clear from this that substantial qualities are thought in terms of inner qualities. From their experiments, alchemists learn secrets rather than any lesson.[166]

The visual reference to rust shown in figure 52 could be connected to ideas like desolation: something abandoned, forgotten, disintegrated in the oxidation process. It also refers to a kind of poetic stillness, the object that is not in activity or use, or has not been cared for, or protected, causing it to lose its original qualities, its purpose, and leaving it with no option but to corrode in complete bleakness. From the image, it could be said that rusted things seem to be fragile and be able to harm at the same time. Consequently, I focused on the creation of a timbral experience that could be associated with the perception of iron oxidation, which for me is mostly related to qualities like roughness, sharpness, shrillness, and harshness.

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[165] The premiere has been programmed for 29 October 2021 in Salzburg.
[166] Gaston Bachelard, *The Formation of the Scientific Mind* (Manchester: Clinamen, 2002), p. 107.

Figure 52. Detail of an object disintegrated by rust that works as a visual stimulus for the timbral experience of *The Loneliness of the Rusted Things*.[167]

From the literature review on texture, it can be said that the perception of *roughness* in timbre is associated with the prominent presence of *high partials*, to which it is important to add a high fundamental frequency able to produce harmonics that respond to Beauchamp's category of 'closely spaced' partials beating against each other. Similarly, *high spectral centroid values* are associated with the quality of rough or harsh mainly because of the predominant upper partials in the spectrum, and the consequences that have been explained above. However, two particular correlations could be added from my compositional perspective, first the emphasis on the instability generated when there are strong *spectral centroid fluctuations*, and second, a high level of *loudness*. Both are fundamental conditions for an experience of shrillness or sharpness in luminance that could be associated with the rusting of timbre from a textural perspective.

In the light of this, the composition process started with the analysis and classification of specific techniques for the six instruments according to a six-phase process of timbral oxidation (table 9), constructed through the perception of high values and large fluctuations of the spectral centroid, high inharmonicity, and prominent high harmonic partials. This is the largest instrumentation I worked with in this research, which allowed me further explorations of compositional strategies previously presented such as enhancing timbre from a single source of sound by using particular preparations and techniques, and the fusion of various sources by articulating the techniques to create a novel timbral percept.

[167] Original photograph by Giuseppe Murabito, 'The Sound of Silence', in *Unsplash Website*, 11 May 2017 <https://unsplash.com/photos/Mum_3Kw7HgY?utm_source=unsplash&utm_medium=referral&utm_content=creditShareLink> [accessed 20 June 2020].

Although the ensemble works as part of a single timbral experience, sometimes there is a subdivision in strings and winds as contrasting entities in order to emphasise the multidimensional and dynamic conditions of timbre through the complex inner interaction; the composition of rusting from inside.

Phase 1 Internal Rusting **[mm. 0–21]**	***Phase 2*** Oxidation Spreading **[mm. 22–53]**	***Phase 3*** Rusted Friction **[mm. 54–77]**	***Phase 4*** Major Level of Rusting **[mm. 78–95]**	***Phase 5*** Breaking of Surface **[mm. 96–145]**	***Phase 6*** Total Dis-integration **[mm. 146–90]**
Timbral descriptors: Medium roughness *Instrumental techniques:* Winds: Can over steel spiral Aeolian bisbigliando Strings: Vertical bowing *scordatura *aluminium foil	*Timbral descriptors:* High roughness *Instrumental techniques:* Winds: Multiphonics Double trill medium high register Flutter-tongue Strings: Bow overpressure vertical	*Timbral descriptors:* Shrills and squeaks *Instrumental techniques:* Winds: High register short interval glissandi Multiphonics Strings: Diagonal bowing (anticipated at end of phase 2) Harmonic glissandi	*Timbral descriptors:* High roughness *Instrumental techniques:* Winds: Air sounds Beat multiphonics Multiphonics trill Multiphonics Strings: Bowing behind the bridge and on polystyrene–overpressure and vibrato (anticipated at end of phase 3)	*Timbral descriptors:* Maximum sharpness and shrillness *Instrumental techniques:* Winds: Intensity vibrato Harmonics trill Slow lip vibrato High harmonics Aeolian and air sounds Only reed (oboe) Flutter-tongue Strings: High harmonics Very low fingering pressure Slow finger vibrato Double harmonics: One finger–slight touching second one	*Timbral descriptors:* Highest harshness *Instrumental techniques:* Winds: Can over steel spiral Harmonics Multiphonics Strings: Different bowing directions and displacements *scordatura *aluminium foil Bow vibrato Slow finger vibrato Double harmonics: One finger–slight touching second one Bow overpressure horizontal

Table 9. Techniques in *The Loneliness of the Rusted Things*: classification according to a six-phase oxidation process.

The exploration of the timbral experience of rust led me to work with objects that allowed me to reach a high level of roughness. For example, I used a metallic can of 7 cm diameter and 10 cm height, and pressed the perimeter of the open side against a spread steel spiral (a pan scourer) following the contour in a circular movement (figure 53).

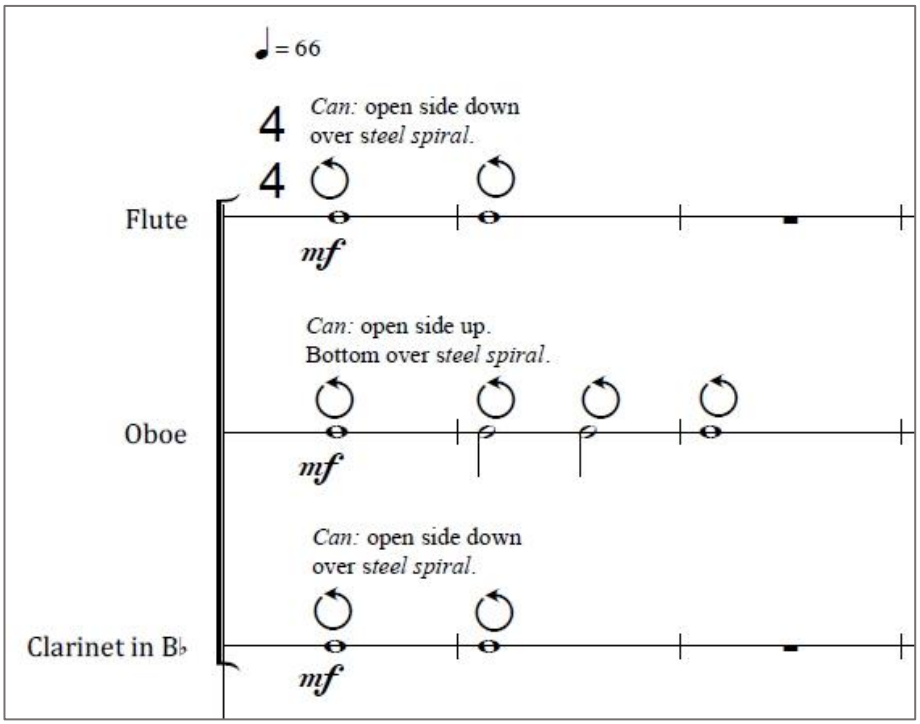

Figure 53. Score excerpt from *The Loneliness of the Rusted Things* (a) showing the notation for the circular movement of the 'can over steel spiral'.

Figure 54. Execution of the technique corresponding to the score excerpt in figure 53.

The technique illustrated in figure 54 produces a granular internal movement from the web of thin steel fibres, which scrape against themselves as a consequence of the pressure of the can crushing them. This dynamic quality contributes to the perception of gradual degradation, the subtle inner rust spreading in timbre and enhanced by the general saturation perceived from it. This particular exploration was recorded and analysed in order to identify the parameters and conditions of the timbral experience produced.[168]

The spectrogram in figure 55 shows a homogeneous energy distribution, which leads to the perception of what is often categorised as 'white noise', the maximum presence of frequencies across the spectrum without a particular emphasis (loudness) in any fundamental or specific partials. Nonetheless, it can be said that the opening of the can works as a notch filter that subtly emphasises the frequencies around 9 KHz and 11 KHz, which can be identified in both the spectrogram (a slight tendency to orange over red colour) and the calculation of the spectral centroid (most of the peaks reach the region between these frequencies). This timbre could be perceived as highly rough.

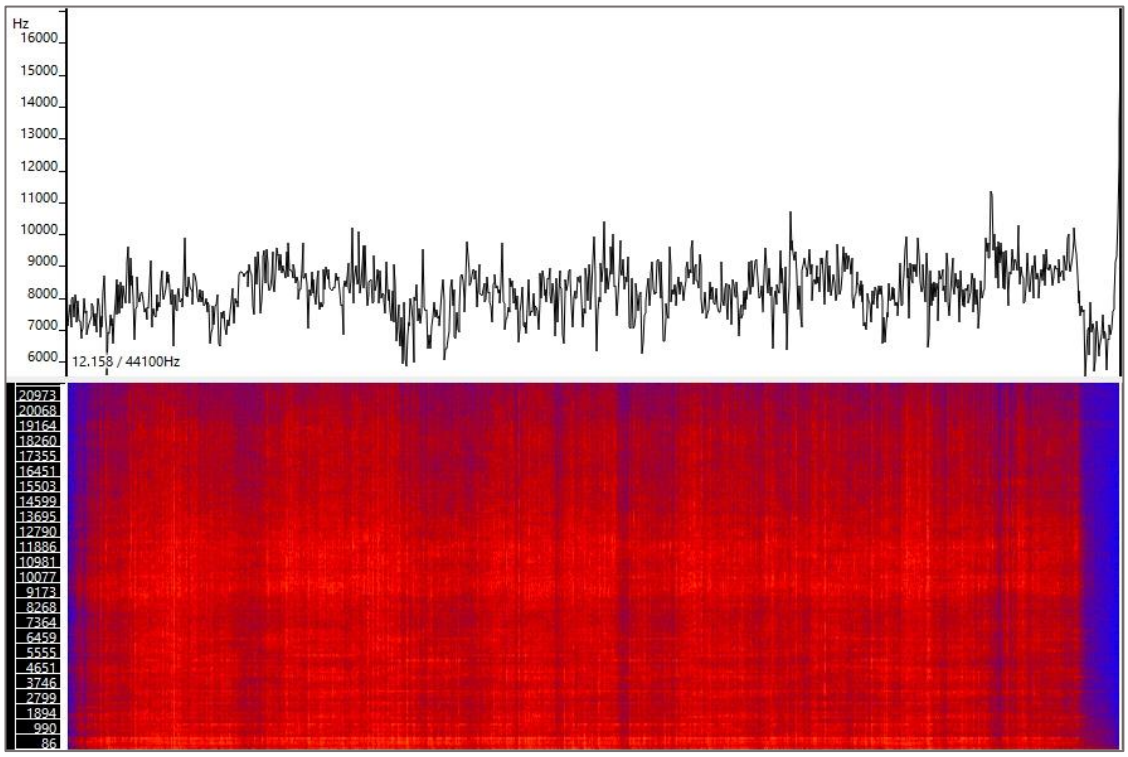

Figure 55. Spectral centroid and spectrogram of excerpt in figure 53.

[168] 'Can over steel spiral' technique, performed by the author on a wood desktop (Zoom H4n digital recorder, XY mic/stereo).

Figure 56. Photograph of the violin preparation by wrapping 4cm of string IV (scordatura E3) with aluminium foil.[169]

The compositional process continued with an exploration of the exacerbation of inharmonicity in the strings. At that point, I had the opportunity to remotely work with the violinist Irene Guerra Rudas, who recorded short clips of the preparation and *scordatura* of string IV, a minor third down, E3 (figure 56). Although my work in collaboration with Guerra Rudas was invaluable for the development of specific timbral experiences of rust from the violin, the video recordings she provided were used only as references in the compositional process because the quality of the audio (recorded with a smart phone camera) did not guarantee a spectrogram or a spectral centroid estimation that would lead to accurate assessment of timbral qualities in the techniques used. Additionally, I decided to extend the exploration of the strings following my previous composition *suelo seco*, in which timbre is constructed through the experience of friction. Here, I worked on three kinds of bowing techniques: vertical, diagonal, and horizontal (normal), as well as particular bow displacements across the strings. Consequently, the performers conduct the energy through the displacement and movement of bow and fingers creating a particularly dynamic timbral experience (figure 57).

[169] Photograph by Irene Guerra Ruda, 28 July 2020.

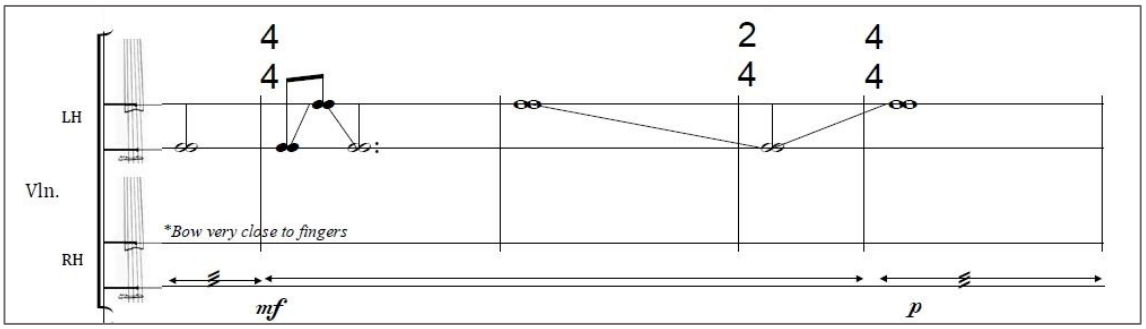

Figure 57. Score excerpt from *The Loneliness of the Rusted Things* (b) showing the notation used to independently determine the displacement and kind of movement for fingering (LH) and bowing (RH) on the strings.

Besides the preparation with a piece of aluminium foil explained above, a block of polystyrene behind the bridge, between strings I and II, is used to create more specific experiences of roughness and shrillness through the bow friction near or directly on the object (figure 58).

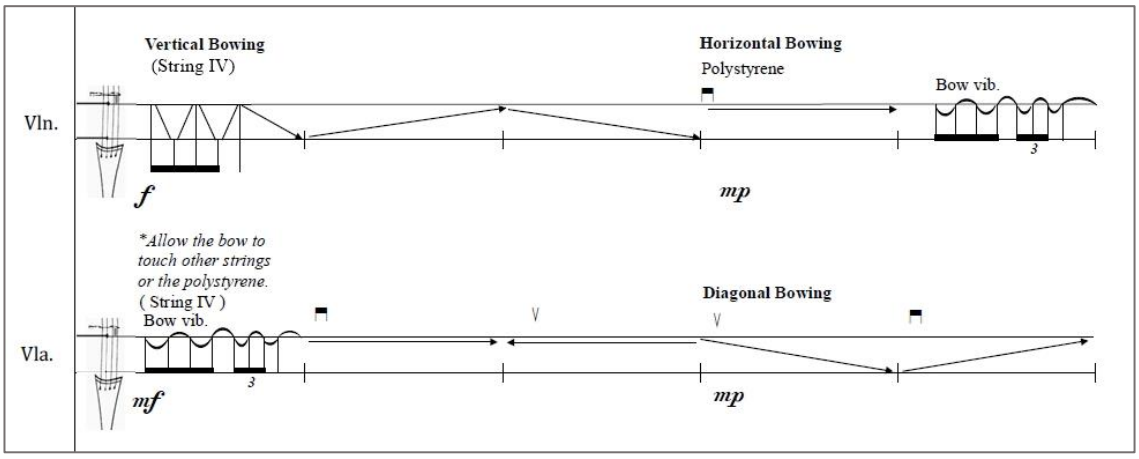

Figure 58. Score excerpt from *The Loneliness of the Rusted Things* (c) showing the notation of different bowing techniques at the region behind the bridge where the preparation with a polystyrene takes place.

Some of the strings techniques were derived from Geoffrey Fitzhugh Perry's 'How NOT to Scratch & Squeak on the Violin' tutorial, such as, for example, the idea of using what can be considered a common mistake made by beginner violinists: touching the next open string (low) with the back side of the finger, causing both to sound while bowing.[170] In the piece, the squeak was enhanced by bowing in different directions and positions (figure 59).

[170] Geoffrey Fitzhugh Perry, *How NOT to Scratch & Squeak on the Violin*, online video recording, YouTube, 20 December 2013 <https://www.youtube.com/watch?v=HKS6CwNez5U> [accessed 13 July 2020].

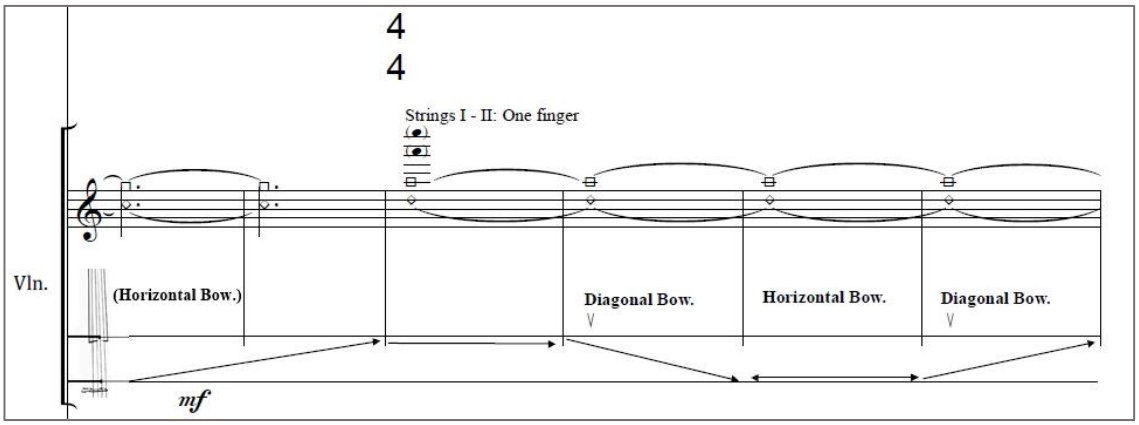

Figure 59. Score excerpt from *The Loneliness of the Rusted Things* (d), showing the notation of a fingering-bowing technique from which a squeaky timbre is produced.

Specific techniques for flute were addressed through the book *The Techniques of Flute Playing* by Carin Levine and Christina Mitropoulos-Bott.[171] Likewise, the DMA dissertation 'Clarinet Multiphonics: A Catalog and Analysis of Their Production Strategies' by Jack Yi Jing Liang was consulted for the study of clarinet multiphonics.[172] In fact, in order to develop the different phases of the timbral oxidation, I focused on the study of multiphonics as *roughness fields* in which different levels of inharmonicity are approached, according to the distribution of energy of the partials and the interaction of the prominent pitches produced. The first multiphonic appears in phase 2, only in the oboe (m. 27), and could be categorised as a medium level of roughness due to the amount and extension in register of the three prominent pitches (separated by a diminished fifth and augmented sixth), as well as the level of loudness (*piano*, with a crescendo to *mezzopiano*). The roughness is increased by adding *frullato*. The rusting process develops through the addition of flute multiphonics, in an attempt to explore inharmonicity from a low level of loudness and the transition through different multiphonics using a similar fingering for the same low pitch. In phase 3, it is the clarinet which presents wide dyad multiphonics, retaining the low intensity and fragility from the flute and oboe of the previous phase. The oboe's beating multiphonics create a particular inner movement; roughness, in this case, is the result of the closeness between two predominant pitches, one trying to stay still while the other (notated in parenthesis) acts as a beater, creating a kind of granular timbre with high roughness. The beating speed increases with the loudness although it also can be controlled from the embouchure.[173]

[171] Carin Levine and Christina Mitropoulos-Bott, *The Techniques of Flute Playing* (Kassel: Bärenreiter, 2002).
[172] Jack Yi Jing Liang, 'Clarinet Multiphonics: A Catalog and Analysis of Their Production Strategies', (unpublished doctoral dissertation, Arizona State University, 2018).
[173] Nora Post, 'Multiphonics for the Oboe', *Interface*, 10, 2 (1981), 113–36 (p. 117).

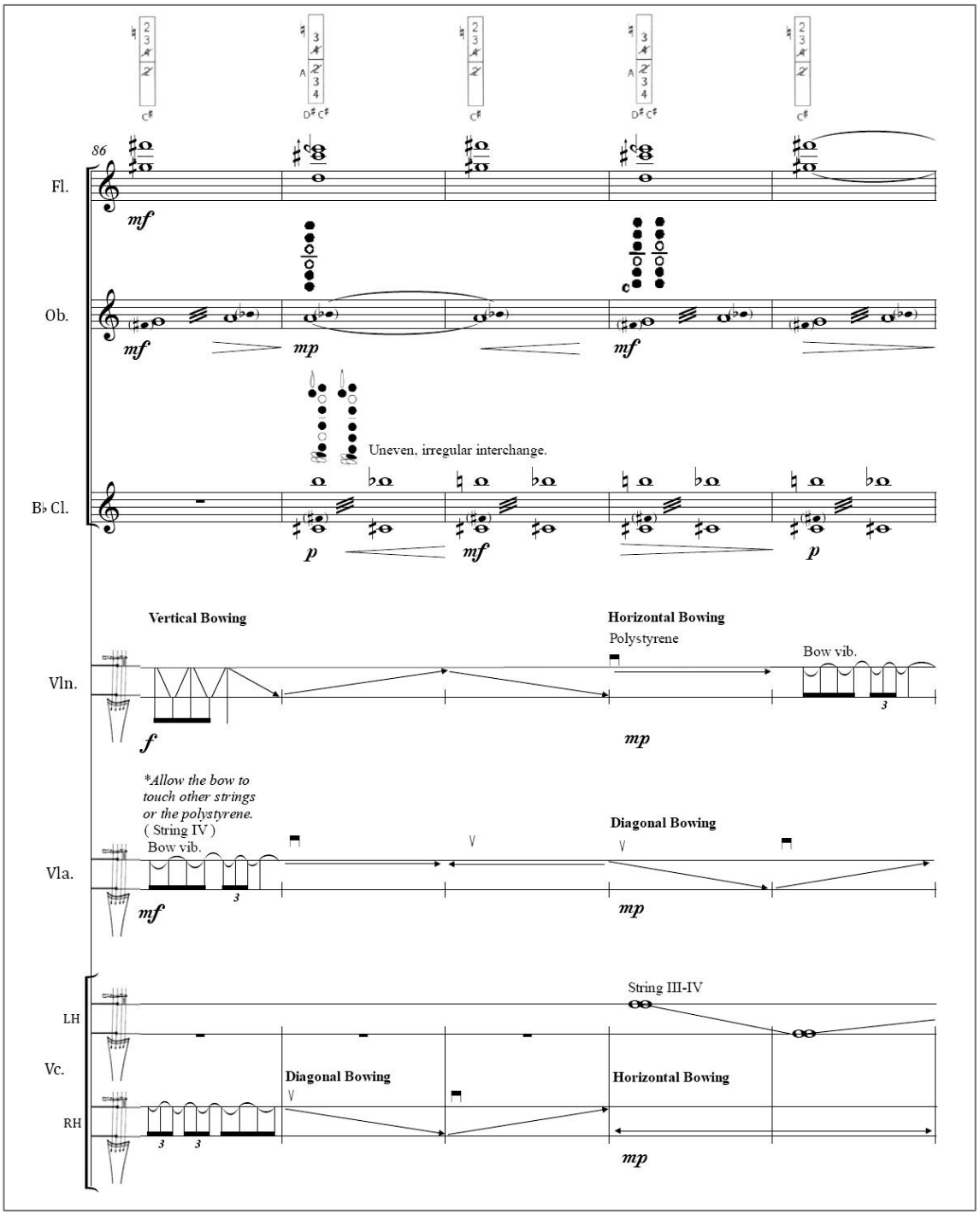

Figure 60. Score excerpt from *The Loneliness of the Rusted Things* (e) showing the development of major rusting in phase 4 from the interaction of different kind of multiphonics and the strings preparation with polystyrene behind the bridge.

This technique is introduced in phase 4 (figure 60) and its rough qualities are increased by adding a tremolo between two beating multiphonics, which contribute to the perception of the internal development of the oxidation of timbre. The major rusting attempted in this phase is also addressed by the introduction of multiphonic trills in the clarinet and a layer

of two higher multiphonics in flute alternating every four beats, in contrast with the rapid and unstable fluctuation of oboe and clarinet.

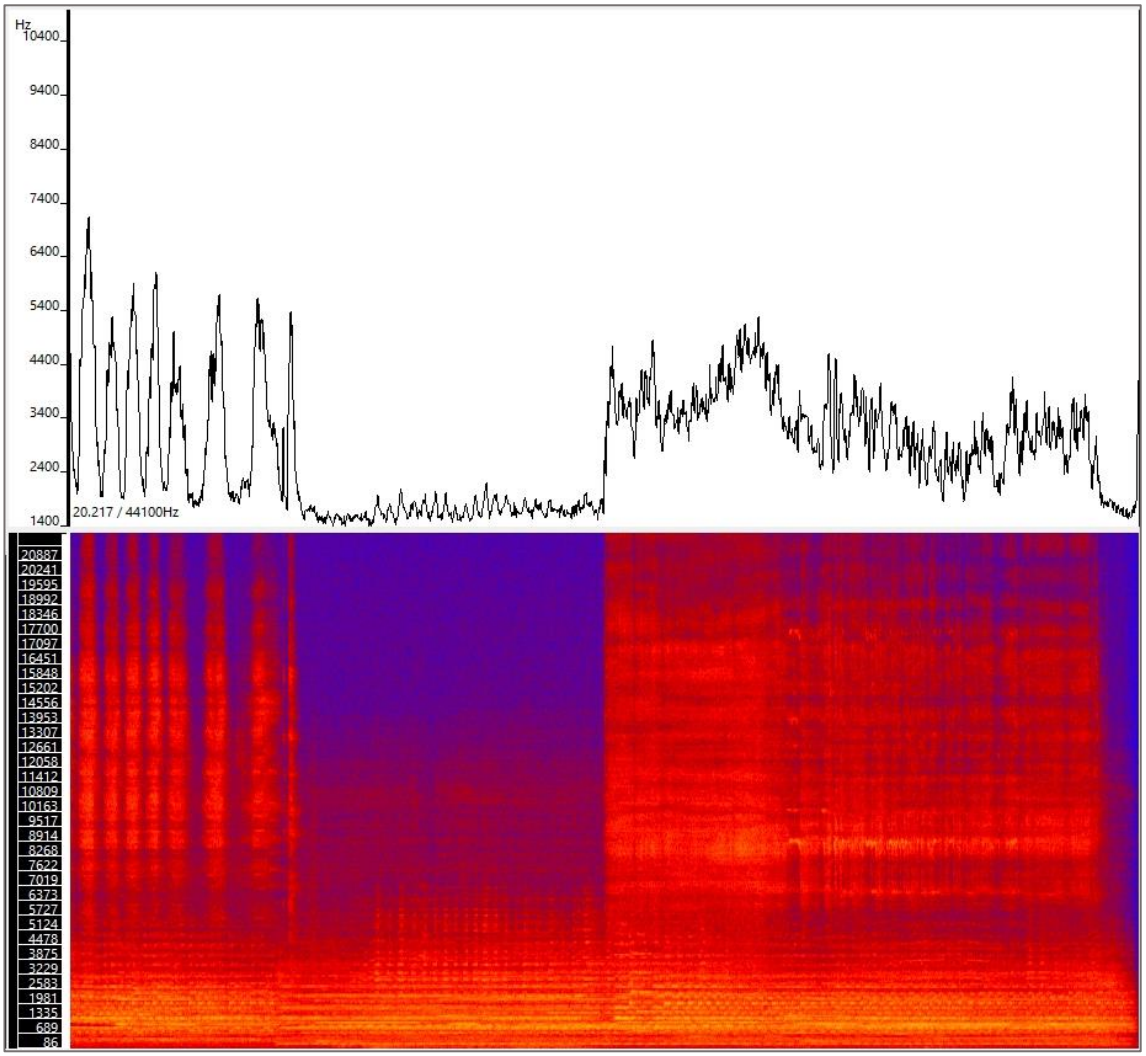

Figure 61. Spectral centroid and spectrogram of excerpt in figure 60.[174]

The spectral analysis in figure 61 allows to recognise two important factors that contribute to the perception of oxidation of timbre. First, the instability and high values of the spectral centroid which can be associated with high levels of shrillness. Second, the spectrogram makes evident how the polystyrene increases the noisiness in timbre by boosting the presence of high partials across the spectrum, generating a great roughness that is extended from the lower layer of multiphonics, which are under 4 KHz.

[174] Recording of a rehearsal with Riot Ensemble at Crossroads International Contemporary Music Festival on 29 October 2021 (Zoom H4n digital recorder, XY mic/stereo).

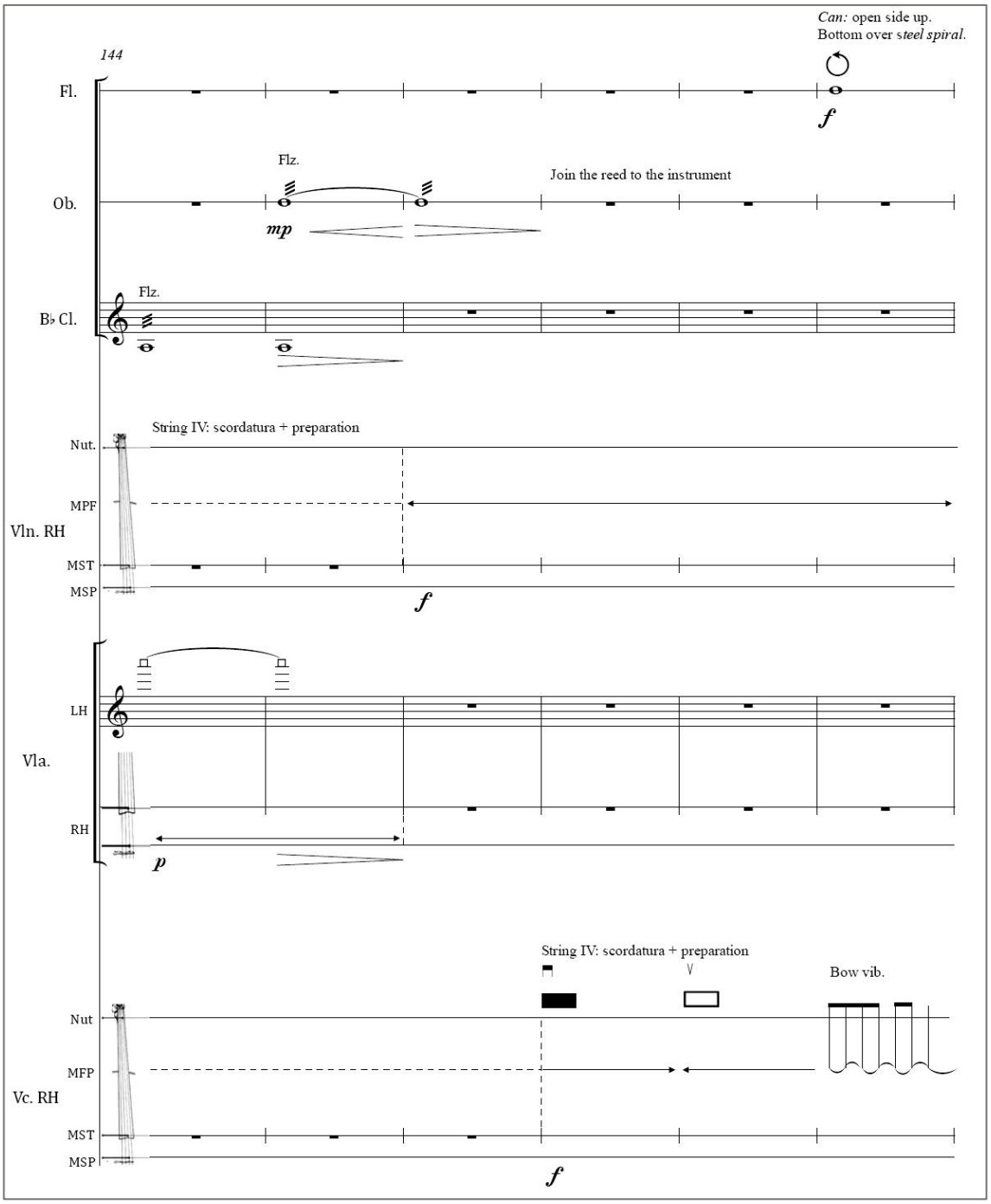

Figure 62. Score excerpt from *The Loneliness of the Rusted Things* (f) showing the construction of shrillness in phase 5 through the use of the oboe's reed and the aluminium foil preparation in strings.

The study of texture from the oboe led me to work on/from independent parts of the instrument such as playing only the reed, following Joost Flach and Kangyi Zhang's advice and commentaries in their tutorial, 'Contemporary Oboe Techniques—A Guide for

Composers (Part I)'.[175] This approach allowed me to create a high level of sharpness and shrillness in phase 5 of the piece, not intended to be controlled in terms of pitch (a discernible high pitch can be easily produced), but as a complex entity that contributes to the experience of rusting from the exploration of air, *frullato*, and different levels of loudness. This timbral experience is reinforced by the aluminium foil preparation of the strings, whose effect is so much more evident when the bow is in the middle point of the fingerboard (figure 62).

The final phase presents the consequence of oxidation: the disintegration of timbre, the breaking of its components into total bleakness. Some technical approaches to the instruments that have been already presented appear again, but with a different purpose: the externalisation of the total breakdown of timbre through the highest levels of roughness. Thus, nothing but rust remains.

4.3 Reflections

The cross-modal associations between tactile, visual, and timbral experiences offer the opportunity to modulate texture from an image (imaginary or real) to the pieces through the development of compositional strategies that respond to the acoustic conditions that seem to determine texture in timbre. Thus, this dimension can be approached from the experience of contact—the instrumental technique as device for generation and modulation of the timbre. However, texture can be an intangible result, too—the perception of the internal organisation of the timbral content; and the energy distribution of harmonic partials in terms of amount, intensity, duration and distance, which also allows to study the impact of noise, inharmonicity, and spectral roughness in the composition of textural conditions. The relation attributed between dryness and high inharmonicity, or even noise, allowed me to explore timbre from the point of view of physicality—its acoustic conditions and materiality, the consequence of friction between two surfaces of different qualities—while modulating its behaviour by controlling conditions of movement

[175] Joost Flach and Kangyi Zhang, *Contemporary Oboe Techniques - A Guide for Composers (Part I)*, online video recording, YouTube, 26 July 2016 <https://www.youtube.com/watch?v=dHr8KeNCF1g> [accessed 15 July 2020].

and displacement, emphasising or hinting the perception of a fundamental frequency, exalting or muffling the presence of upper partials. Dust, approached as a residue in dry soil, tiny little pieces of something unknown, and rust as a metaphor for the condition of bleakness and abandonment, allowed me to develop a relentless process of deterioration, both phenomena comparable to the disintegration of mass as an after-thought of the exploration of the previous chapter. In fact, the multidimensionality of timbre manifests through the correlations between certain qualities of the experience of luminance and texture, such as sharpness and shrillness, or texture and mass, especially from the perspective of density and depth, which allowed me to use previously developed instrumental techniques and study and develop their acoustic conditions and timbral behaviour in terms of texture according to the metaphorical approaches that structure the transformational process of each timbral experience.

CONCLUSIONS

Understanding timbre as a percept, in a more philosophical sense, has been an appropriate approach to timbral complexity and has created a space for the exploration of its multidimensional and dynamic condition as a main compositional resource. In fact, the study of the multidimensionality of timbre has permitted the development of useful creative strategies for the composition of the eight chamber music pieces that are part of this research. First, working from the correlations between the timbral physicality—the timbral components susceptible to measurement—and luminance, mass, and texture as timbral semantic dimensions has allowed me to develop a methodology of analysis and classification of instrumental techniques according to three different and correlated experiences of timbre. Second, the structural approach based on metaphorical or conceptual associations with these timbral dimensions shows itself to be a rich source of inspiration that affords the instability and complexity of the inner interactions of timbre from a compositional perspective in which each piece, rather than attempting a representation of other perceptual experiences, manifests itself as a new percept.

From the literature review and the compositional process of the pieces *and it comes like a piece of light through the dust* (2018–20), *The Shimmer Beneath: A Scattering Attempt* (2019), and *Distorted Pieces of Something. Study on Light (when it rains)* (2019), it could be recognised that the luminance scale is a useful tool for studying the perceptual experience of amount and intensity of light in timbre. This compositional strategy allowed me to recognise that the first phase (dark to veiled) generally presents low pitches, lack of upper partials, high inharmonicity, and low levels of loudness. In contrast, the second phase (distinct to distorted) is more likely to manifest a significant presence of upper partials, high pitches, large fluctuations of the spectral centroid, high inharmonicity, and high levels of loudness. Although inharmonicity can be a condition of both phases, the difference seems to rely on the level of loudness. In fact, the association of very soft dynamics with low luminance is also influenced by the frequent idea of darkness as a metaphor of silence; as a result, the strongest dynamics lead to the perception of shrillness or distortion. Clearness of timbre is therefore the consequence of middle range pitch, clear fundamental frequency, low harmonic partials, and general stability of the spectral centroid. Dust and rain as metaphorical filters in the experience of light allowed me to explore subtle nuances in the

timbral transformation that were fundamental for the understanding of conditions like instability and flickering in timbre.

Approaching mass as the kind of resistance that emerges in the process of interaction between the parameters of sound allowed me to explore other related perceptual experiences: weight, density, and volume. From the perspectives studied and the composition of *A Weightlessness Process (… or how to become ethereal)* (2019–20), it might be possible to approach weight as the force experienced from the explicit corporal approach to the sound sources (instrumental technique) as well as the force perceived in the internal behaviour of timbre owing to tension emerged from the pitch register, the level of inharmonicity, and the level of loudness. High inharmonicity and large spectral centroid fluctuations could be recognised as the parameters that exert a major influence on the perception of a dense timbre; however, from the literature review and the composition of *Just An Attempt to Dissipate* (2019), it is possible to say that loudness seems not to influence the perception of density so much as it does weight. As a result, density could respond more to the spectral structure (distribution) and the sense of merger of the timbral components in the interaction. The study of volume and the composition of *We no longer sleep in the wind* (2020) suggested that loud dynamics and low fundamental frequencies would lead to the perception of voluminous timbres; however, the study of depth as the multidimensional consequence of the three measures of this parameter (width, height and length), was a richer approach to understanding the timbral experience in terms of distance and concealment, which was very inspiring from a compositional perspective. Furthermore, weight, density, and volume also functioned as descriptor categories for specific timbral conditions in which the 'anchor' was the experience of dust as a poetic reference to the dissolution of mass, the process of disappearing as an exploration of the minimal expression of mass in timbre.

Texture was approached in direct association with the experience of contact from the technical approach to the sources of sound. However, textural qualities are also a result of the internal organisation of the timbral components, the inner structure and behaviour of timbre. In *suelo seco* (2020–21) the exploration of friction with different materials was guided by the experience of dryness in association with the perception of the subtle and intimate in inharmonicity, or noisiness. This gave a basis to the construction of different levels or qualities of roughness from the kind of movement and displacement of each object on the strings. In *The Loneliness of the Rusted Things* (2020) the image of a rusted object was modulated into timbre by an inner exploration of the process of oxidation of iron as a

projected, imagined (perhaps recalled) experience, which was developed through the perception of particular conditions of pitch register, inharmonicity, spectral centroid, and loudness in correlation with the perception of qualities like roughness, shrillness, or sharpness.

From the general compositional experience, the work in collaboration with the performers contributed to a more specific development of instrumental techniques as devices for the generation and modulation of the timbral experience, which is a substantial part of my compositional approach. This is because it allowed me to work on aspects like the instability of timbre from the acoustic condition of the sources of sound, their corporeality as bodies and territories, and their preparation as an expansion of the timbral field. The instrumental technique is also fundamental to the composition of timbre, from its physicality—content and structure—to the formal and aesthetic objective(s) of the pieces. However, the instability, fragility, or even volatility of timbre was very difficult to address in the scores. One of my persistent inquires in this research was how to notate timbre, which, as argued in the first chapter, seems to be a widespread concern. Feeling the need to use a notation that allowed me to determine specific timbral experiences which may not be transcribed as a result, I used a variety of different notational approaches that responded to the technical requirements that proceeded from the objectives suggested by each semantic dimension: that is, the correspondence between poetical or metaphorical associations, the instrumental techniques and preparations, and the performers' needs, skills, or experience (especially when the pieces were commissioned). If not always according to my aesthetical preferences, it definitely enabled the most accurate and effective way of responding to the complexity of timbre from the instrumental approach.

Although this PhD portfolio has been developed in the field of chamber music (solo, duo, quartet, and small ensemble pieces) it is possible to say that the composition of timbre can be approached in music with a larger instrumentation applying similar strategies. Regardless of the amount or type of sources of sound, the study of the semantics, physicality and philosophical aspects of timbre approached in this research afford further development of compositional strategies like those presented in agreement with Sandell's categories of timbral concurrency: timbral augmentation, emergent timbre, or even my attempt at timbral disappearance. Nonetheless, timbral composition may require a preliminary exploration of sources and techniques, which can be considered fundamental for any kind of instrumentation objective or condition.

Finally, each composition of this research is presented as a complex: a dynamic process, a timbral experience, and a new percept. Each process is modulated by the multiple associations that construct its meaning, the perceptual frame, and its structure. Far from trying to establish a methodology or a systematic approach, this research is a deep exploration of timbre as a compositional resource in instrumental music, a study of its physicality, its semantics, and its philosophical aspects, with a particular emphasis on its multidimensionality and dynamic conditions.

BIBLIOGRAPHY

Abondano Flórez, Ivonne Michele, 'Distorted Pieces of Something: A Compositional Approach to Luminance as a Timbral Dimension', in *Proceedings of the 2nd International Conference on Timbre (Timbre 2020)*, ed. by Asteris Zacharakis, Charalampos Saitis, and Kai Siedenburg (Aristotle University of Thessaloniki, 2020), pp. 125–28

———, 'El timbre: noción y experiencia creativa', *Ensayos: Historia y Teoría del Arte*, 21, 33 (2017), 87–103

Amato, Joseph A., *Dust: a history of the small and the invisible* (London: University of California Press, 2000)

Araya, Pablo, 'Objetos sonoros de múltiples componentes y escalas con uncomportamiento no-lineal', *Cuadernos de Análisis y Debate sobre Músicas Latinoamericanas Contemporáneas*, 2 (2019), 1–18

Assad, Clarice, *Extended Vocal Techniques: Your voice as an instrument*, online video recording, YouTube, 2 February 2019, <https://www.youtube.com/watch?v=U5-5NdRq0q8> [accessed 30 October 2019]

Bachelard, Gaston, *The Formation of the Scientific Mind* (Manchester: Clinamen, 2002)

Beckett, Samuel, *Company* (London: John Calder, 1980)

Bell, Gelsey, 'Extended vocal technique', Lecture at Gerrit Rietveld Academie, online video recording, YouTube, 30 January 2015, <https://www.youtube.com/watch?v=9m6viNRSzZs> [accessed 30 October 2019]

Cannam, Chris, Christian Landone, and Mark Sandler, *Sonic Visualiser*, V. 4.2 (2020), Windows, Linux, and MacOS

Courchene, Kim S. and Beatriz Ferreyra, 'A Conversation with Beatriz Ferreyra', *Computer Music Journal*, 25, 3 (2001), 14–21

Czernowin, Chaya, 'Analyse de Infinite Now', Lecture at ManiFeste, online video recording, IRCAM, 24 June 2017, <http://medias.ircam.fr/xfa50f4> [accessed 20 September 2019]

Deleuze, Gilles and Félix Guattari, 'Percept, Affect, and Concept', in *What Is Philosophy?*, trans. by Hugh Tomlinson and Graham Burchell (New York: Columbia University Press, 1994), pp. 163–199

Dillon, Francesco, *Francesco Dillon parle sur les multiphoniques dans le quatuor n.9 de Salvatore Sciarrino*, online video recording, YouTube, 17 June 2014, <https://www.youtube.com/watch?v=lFpuv1N4frY> [accessed 10 February 2019]

Di Scipio, Agostino, 'Formal Process of Timbre Composition. Challenging the Dualistic Paradigm of Computer Music', in *Proceedings of the International Computer Music Conference* (1994), pp. 202–08

———, 'Systems of Embers, Dust, and Clouds: Observations after Xenakis and Brün', *Computer Music Journal*, 26, 1 (2002), 22–32

Doolittle, Hilda, 'The Wind Sleepers', in *Sea Garden* (London: Constable, 1916), p. 13

Douglas, Chelsea, Jason Noble, and Stephen McAdams, 'Auditory Scene Analysis and the Perception of Sound Mass in Ligeti's Continuum', *Music Perception*, 33, 3 (2016), 287–305

Dufourt, Hugues, 'The Principles of Music and the Rationalization of Theory', in *Contemporary Music. Theoretical and Philosophical Perspectives*, ed. by Irène Deliège and Max Paddison (London: Routledge, 2010), pp. 19–50

Estrada, Julio, 'Focusing on Freedom and Movement in Music: Methods of Transcription inside a Continuum of Rhythm and Sound', *Perspectives of New Music*, 40, 1 (2002), 70–91

Fales, Cornelia, 'The Paradox of Timbre', *Ethnomusicology*, 46, 1 (2002), 56–95

Fallowfield, Ellen, 'Multiphonics: Multiphonic fingering charts', *Cello Map Website* <https://cellomap.com/multiphonics-multiphonic-fingering-charts/> [accessed 7 February 2019]

———, 'Multiphonics: Basics', *Cello Map Website* <https://cellomap.com/multiphonics-basics/> [accessed 7 February 2019]

Fayers, Eldon, 'Utopian aesthetics. Philosophical perspectives upon the work of Iannis Xenakis', in *Proceedings of the Xenakis International Symposium* (2011), pp. 1–13

Feynman, Richard, Matthew Sands, and Robert B. Leighton, 'The Theory of Gravitation', in *Feynman Lectures on Physics (New Millennium Edition)* (Boston: Addison Wesley, 2006) <https://www.feynmanlectures.caltech.edu/I_07.html > [accessed 8 June 2020]

Flach, Joost and Kangyi Zhang, *Contemporary Oboe Techniques - A Guide for Composers (Part I)*, online video recording, YouTube, 16 July 2016, <https://www.youtube.com/watch?v=dHr8KeNCF1g> [accessed 15 July 2020]

Grisey, Gérard, 'Did you say spectral?', trans. by Joshua Fineberg, *Contemporary Music Review*, 19, 3 (2000), 1–3

Hammer, Langdon, 'Imagism', Lecture at Yale University, online video recording, YouTube, 6 December 2012, <https://www.youtube.com/watch?v=2gU4F6ePhcM> [accessed 5 May 2020]

Hodeige, Harald, liner notes to Chaya Czernowin, *HIDDEN,* trans. by John Patrick Thomas and W. Richard Rieves (WERGO: Mainz, 2017) [on CD]

Holmes, Patricia A., 'An exploration of musical communication through expressive use of timbre: The performer's perspective', *Psychology of Music*, 40, 3 (2011), 301–23

Iannotta, Clara, 'Moulting Spaces', Lecture at Darmstädter Ferienkurse, online video recording, YouTube, 6 August 2021, <https://www.youtube.com/watch?v=XEHwkpaHylo> [accessed 9 August 2021]

Klingbeil, Michael. *Sinusoidal Partial Editing Analysis and Resynthesis SPEAR*. V. 0.7.4. (2009), Windows and MacOS

Lachenmann, Helmut, 'Sound Types of New Music (1966)', trans. by Peter Ivan Edwards, *Peter Ivan Edwards Website* <https://www.peterivanedwards.info/sound-types-new-music> [accessed 4 December 2020]

Lawhead, Chris, *Flute - Just the Head Joint*, online video recording, YouTube, 24 February 2012, <https://www.youtube.com/watch?v=eA0Yt2pmcLs> [accessed 5 November 2019]

Levine, Carin and Christina Mitropoulos-Bott, *The Techniques of Flute Playing* (Kassel: Bärenreiter, 2002)

Liang, Jack Yi Jing, 'Clarinet Multiphonics: A Catalog and Analysis of Their Production Strategies' (unpublished doctoral dissertation, Arizona State University, 2018)

Lochhead, Judy, *Reconceiving structure in contemporary music: New tools in music theory and analysis* (New York: Routledge, 2016)

Londeix, Jean-Marie, *Hello, Mr. Sax!, or, Parameters of the Saxophone*, trans. by William and Anna Street (Paris: Alphonse Leduc, 2010)

'Luminance vs. Illuminance', Konica Minolta, *Sensing Americas Website* <https://sensing.konicaminolta.us/blog/luminance-vs-illuminance/> [accessed 1 December 2018]

Lunn, Robert, *Extended Techniques for the Classical Guitar (#1, The Left Hand)*, online video recording, YouTube, 19 September 2012, <https://www.youtube.com/watch?v=p5r8Giss9hs> [accessed 7 November 2019]

Malloch, Stephen, 'Timbre and Technology: An Analytical Partnership', *Contemporary Music Review*, 19, 2 (2000), 155–72

Marino, Jessie, 'Multiphonics Notation', *Cello Multiphonics Website*, 10 August 2010 <http://cellomultiphonics.blogspot.com> [accessed 7 February 2019]

McAdams, Stephen, 'Perspectives on the Contribution of Timbre to Musical Structure', *Computer Music Journal*, 23, 3 (1999), 85–102

Morrison, Toni, *Tar Baby* (New York: Vintage, 2004)

Murail, Tristan, 'Spectra and Sprites', trans by Tod Machover, *Contemporary Music Review*, 24, 2 (2005), 137–47

Patil, Kailash, Daniel Pressnitzer, Shihab Shamma and Mounya Elhilali, 'Music in Our Ears: The Biological Bases of Musical Timbre Perception', *PLOS Computational Biology*, 8, 11 (2012), 1–16

Perry, Geoffrey Fitzhugh, *How NOT to Scratch & Squeak on the Violin*, online video recording, YouTube, 20 December 2013, <https://www.youtube.com/watch?v=HKS6CwNez5U> [accessed 13 July 2020]

Pitkin, Walter B, 'Time and the Percept' *The Journal of Philosophy, Psychology and Scientific Methods*, 10, 12 (1913), 309–19

Post, Nora, 'Multiphonics for the Oboe', *Interface*, 10, 2 (1981), 113–36

Pound, Ezra, 'A Few Don'ts by an Imagiste', *Poetry: A Magazine of Verse* (1913) <https://www.poetryfoundation.org/poetrymagazine/articles/58900/a-few-donts-by-an-imagiste> [accessed 5 May 2020]

Radigue, Eliane, 'The Mysterious Power of the Infinitesimal', *Leonardo Music Journal*, 19 (2009), 47–49

Roche, Heather, 'Buzzing, Noisy and Distorted Multiphonics for Bb Clarinet', *Heather Roche. Clarinettist Website*, 1 June 2018 <https://heatherroche.net/category/spectral-multiphonic/> [accessed 20 October 2018]

———, '…on Double Trills for Bb Clarinet', *Heather Roche. Clarinettist Website*, 11 May 2014 <https://heatherroche.net/category/double-trills/> [accessed 20 October 2018]

———, '…on Close Dyad Multiphonics for Bass Clarinet', *Heather Roche. Clarinettist Website*, 8 August 2014 <https://heatherroche.net/2014/08/08/on-close-dyad-multiphonics-for-bass-clarinet/> [accessed 20 October 2018]

Rudy, Paul, 'Timbral praxis: when a tree falls in the forest is it music?', *Organised Sound*, 12, 1 (2007), 5–13

Rutherford-Johnson, Tim, liner notes to Clara Iannotta, *a failed entertainment* (Edition RZ: Berlin, 2015) [on CD]

———, 'Patterns of Shimmer: Liza Lim's Compositional Ethnography', *Tempo*, 65, 258 (2011), 2–9

Saunders, Rebecca, *Entrevista/Interview Rebecca Saunders sobre/about 'vermilion'*, online video recording, YouTube, 1 January 2017, <https://www.youtube.com/watch?v=_aelD1yA4q8> [accessed 2 May 2020]

Schaeffer, Pierre, 'Playing an Instrument', in *Treatise on Musical Objects. An Essay across Disciplines*, trans. by Christine North and John Dack (Oakland: University of California Press, 2017), pp. 31–45

———, 'Theory of Homogeneous Sounds: Criterion of Mass', in *Treatise on Musical Objects. An Essay across Disciplines*, trans. by Christine North and John Dack (Oakland: University of California Press, 2017), pp. 406–21

Serra, Richard, 'Reverse Curve', *Gagosian Website* <https://gagosian.com/exhibitions/2019/richard-serra-reverse-curve/> [accessed January 22, 2020]

Smalley, Denis, 'Defining Timbre–Refining Timbre', *Contemporary Music Review*, 10, 2 (1994), 35–48

———, 'Spectromorphology: Explaining Sound-Shapes', *Organised Sound*, 2, 2 (1997), 107–26

Štěpánek, Jan, 'Musical Sound Timbre: Verbal Description and Dimensions', in *Proceedings of the 9th International Conference on Digital Audio Effects DAFx-06* (2006), pp. 121–26

Struck-Schloen, Michael, liner notes to Rebecca Saunders and musikFabrik, *Stirrings Still*, trans. by Steven Lindberg (Mainz: Wergo, 2008) [on CD]

Sun, Hua-Chun, Andrew E. Welchman, Dorita H.F. Chang, and Massimiliano Di Luca, 'Look but don't touch: Visual cues to surface structure drive somatosensory cortex', *NeuroImage*, 128 (2016), 353–61

Szigetvári, Andrea and Balázs Horváth. *Timbre Solfege* (Typotex Ltd. Electronic Publishing House, 2014) <https://regi.tankonyvtar.hu/en/tartalom/tamop412A/2011-0010_szigetvari_timbre_solfege/index.html> [accessed 18 November 2020]

Van Elferen, Isabella, 'Drastic Allure: Timbre Between the Sublime and the Grain', *Contemporary Music Review*, 36, 6 (2017), 614–32

Varèse, Edgar and Chou Wen-Chung, 'The Liberation of Sound', *Perspectives on New Music*, 5, 1 (1966), 11–19

Villegas Vélez, Daniel, 'The Matter of Timbre: Listening, Genealogy, Sound', in *The Oxford Handbook of Timbre*, ed. by Emily Dolan and Alexander Rehding (Oxford University Press, 2018) <https://www.oxfordhandbooks.com/view/10.1093/oxfordhb/9780190637224.001.0001/oxfordhb-9780190637224> [accessed 16 December 2020]

Wallmark, Zachary, 'A Corpus Analysis of Timbre Semantics in Orchestration Treatises', *Psychology of Music*, 47, 4 (2019), 585–605

Wolff, Franklin F., 'Concept, Percept, and Reality', *The Philosophical Review*, 48, 4 (1939), 398–414

Woolf, Virginia, 'Solid Objects' in *The Complete Shorter Fiction of Virginia Woolf*, ed. by Susan Dick (Orlando: Harcourt, 1989), 102–07

———, *To the Lighthouse* (London: Penguin, 1964)

Zacharakis, Asterios, 'Musical Timbre: Bridging Perception with Semantics' (unpublished doctoral thesis, Queen Mary University of London, 2013)

Zacharakis, Asteris, Konstantinos Pastiadis, and Joshua D. Reiss, 'An Interlanguage Study of Musical Timbre Semantic Dimensions and Their Acoustic Correlates', *Music Perception: An Interdisciplinary Journal*, 31, 4 (2014), 339–58

RECORDINGS

Arditto Delsoglio, Cecilia, *Tissue*, Musikkollegium Winterthur, cond. by Pierre-Alain Monot (online video recording, YouTube, 26 September 2019 <https://www.youtube.com/watch?v=oiM3Kj7-VIA> [accessed 13 December 2020])

Bång, Malin, *ripost*, Uli Fussenegger, Jonny Axelsson, Radio-Sinfonieorchester Stuttgart des SWR, cond. by Peter Rundel (online video recording, YouTube, 27 March 2016, <https://www.youtube.com/watch?v=_xYArzdSstY> [accessed 10 November 2020])

Bedrossian, Franck, *TRACÉS D'OMBRES*, Ensemble 2E2M (Aeon: AEGO361160, 2011)

Cleare, Ann, *eyam I (it takes an ocean not to)*, Carol McGonnell (online audio recording, Ann Cleare Composer Website <https://annclearecomposer.com/eyam-i-it-takes-an-ocean-not-to/> [accessed 3 November 2018])

Czernowin, Chaya, *HIDDEN*, JACK Quartet (Wergo: WER 73552, 2017)

Iddon, Martin, *Ptelea*, Heather Roche (Huddersfield Contemporary Records: HCR09CD, 2015)

Lim, Liza, Invisibility, Séverine Ballon (online video recording, Vimeo, 17 July 2010 <https://vimeo.com/13411678> [accessed 12 January 2019])

Saunders, Rebecca, *vermilion*, musikFabrik (Wergo: WER 6694 2, 2008)

Seyedi, Elnaz, *durchsichtig, verzweigt*, Wohltemperiertes Konsort Bern (online video recording, YouTube, 8 October 2018 <https://www.youtube.com/watch?v=TW634fJsq9A> [accessed 26 February 2019])

Thurley, Oliver, *yet another example of the porousness of certain borders*, Dario Calderone (online audio recording, SoundCloud <https://soundcloud.com/oliver-thurley/yet-another-example-of-the-porousness-of-certain-borders> [accessed 3 March 2019])

SCORES

Arditto Delsoglio, Cecilia, *Tissue*, 2019

Bång, Malin, *Ripost*, 2015 (Stockholm: Svensk Musik, 2015)

Bedrossian, Franck, *TRACÉS D'OMBRES*, 2005–07 (Paris: Gérard Billaudot Editeur, 2008)

Cleare, Ann, *eyam I (it takes an ocean not to)*, 2009–14

Czernowin, Chaya, *HIDDEN*, 2013–14 (Mainz: SCHOTT MUSIC, 2014)

Iddon, Martin, *Ptelea*, 2014

Seyedi, Elnaz, *durchsichtig, verzweigt*, 2016 (Berlin: Edition Juliane Klein, 2021)

Thurley, Oliver, *yet another example of the porousness of certain borders*, 2014

APPENDIX: PORTFOLIO OF COMPOSITIONS

Scores

1. *and it comes like a piece of light through the dust* (2018–20), for bass clarinet.
2. *The Shimmer Beneath: A Scattering Attempt* (2019), for cello duo.
3. *Distorted Pieces of Something. Study on Light (when it rains)* (2019), for soprano saxophone and viola.
4. *A Weightlessness Process (… or how to become ethereal)* (2019–20), for cello.
5. *Just An Attempt To Dissipate* (2019), for soprano voice, alto flute, bass clarinet, and guitar.
6. *We no longer sleep in the wind* (2020), for Paetzold double bass recorder.
7. *suelo seco* (2020–21), for amplified cello and piano.
8. *The Loneliness of the Rusted Things* (2020), for flute, oboe, clarinet, violin, viola, and cello.