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COMPOSING FOR CELLO: THE EXPERIENCE OF LIGHT IN TIMBRE

Abstract

This article approaches the compositional process of the piece *The Shimmer Beneath: A Scattering Attempt*, for cello duo with amplification (2019). This research is part of my doctoral thesis *The Composition of Timbre: A Multidimensional Approach* (University of Leeds, 2021), in which I approach the timbral complexity from the possible correlations between its semantics and physicality. Here I focus on the study of luminance as one of the semantic dimensions of timbre, presenting different perspectives from psychoacoustics to contemporary repertoire for bowed strings. The compositional methodology includes the development of a scale for measuring the amount and intensity of light perceived in a series of cello techniques and their corresponding timbral qualitative descriptors. These technical explorations are spectrally analyzed to identify their timbral content and structure. The cello techniques are the 'device' for the timbral formation and development of the piece, according to a conceptual reference related to the experience of light.

Keywords

Timbre | Cello | Luminance | Composition | Light.



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1. Introduction

This article presents the compositional process of the piece *The Shimmer Beneath: A Scattering Attempt* (2019), for cello duo with amplification, with an emphasis on the study of luminance as a semantic dimension of timbre. Luminance has been understood as the dimension that describes timbre in terms of how brilliant it is. 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 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*).¹

This research seeks a deeper understanding of timbral complexity as a main resource as well as a formal and aesthetic objective in composition, in this case, for and from the materiality, corporeality, as well as technical and sonic possibilities of cello. Consequently, the piece is structured as a process of timbral transformation directly associated with specific visual experiences, where dust acts as a filter, an amplifier, or means of refraction in the perception of light, following which there is an exploration of cello 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 the instrument itself, watching video tutorials, and analysing musical repertoire (scores and recordings, when available), in the best cases, it is a direct exploration with cellists (in person or virtually). The recordings of these instrumental explorations are spectrally analysed using software like Spear and Sonic Visualiser to identify spectral content and structure by identifying levels of loudness and inharmonicity, pitch register, presence of upper partials, or spectral centroid fluctuations in order to understand how the perceptual experience of these timbral parameters may lead to associations with the semantics of timbre according to particular psychoacoustic and compositional perspectives that will be addressed later in this paper.

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 instrument? 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 by exploring timbre as a multidimensional and dynamic interaction, understanding the whole timbral experience as a single percept.

¹ An excerpt of my study of luminance was published as an extended abstract in: ABONDANO FLÓREZ I. M., *Distorted Pieces of Something: A Compositional Approach to Luminance as a Timbral Dimension*, in ZACHARAKIS A., CHARALAMPOS SAITIS & KAI SIEDENBURG (Eds.), *Proceedings of the 2nd International Conference on Timbre (Timbre 2020)*, Online Conference, Aristotle University of Thessaloniki, pp. 125-128.

Part of this exploration includes experiments from unconventional techniques that extend the timbral field of cello. The techniques are classified from a recognition of the acoustic correlates for luminance: 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 the piece.

2. Light in Timbre: From Psychoacoustics to Contemporary Repertoire for Bowed Strings

Luminance is an approach to timbre from the experience of light as a creative and technical strategy for composition. 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.²

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. Judy Lochhead approaches 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 range, spectral attributes, and culturally derived timbral associations».³

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.⁴

² Konica Minolta Sensing Americas Website, *Luminance vs. Illuminance*. Available at: <https://sensing.konicaminolta.us/blog/luminance-vs-illuminance/> (Accessed: 1 December 2018).

³ LOCHHEAD J., *Reconceiving structure in contemporary music: New tools in music theory and analysis*, Routledge, New York 2016, p. 111.

⁴ RUTHERFORD-JOHNSON T., *Patterns of Shimmer: Liza Lim's Compositional Ethnography*, «Tempo», LXV, 258, 2011, p. 3.

These ideas of ‘flickering’ and ‘shimmer’ 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. 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 that respond to the unstable behaviour of light.⁵ 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 traveling at changing speeds, pressure and position.⁶

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.

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 the undesirable».⁷ 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:

⁵ LOCHHEAD J., *Reconceiving structure in contemporary music: New tools in music theory and analysis*, Routledge, New York 2016, p. 114.

⁶ RUTHERFORD-JOHNSON T., *Patterns of Shimmer: Liza Lim’s Compositional Ethnography*, «Tempo», LXV, 258, 2011, p. 8.

⁷ AMATO J. A., *Dust: a history of the small and the invisible*, University of California Press, London 2000, p. 127.

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.⁸

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».⁹ 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.

These relations between timbre and the perception of light are studied by Asterios Zacharakis, Konstantino Pastiadis, and Joshua D. 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».¹⁰ Although brilliance and brightness are not necessarily synonyms, in the musical practice both terms are frequently used in this way to describe timbre from the experience of light. However, brightness is a term highly associated with the spectral energy and even addressed as a dimension of timbre in psychoacoustics. For Stephen McAdams and Bruno L. Giordano, «[t]he most ubiquitous correlates derived from musical instrument sounds include spectral centroid (representing the relative weights of high and low frequencies and corresponding to timbral brightness)».¹¹ The results of auditory experiments by Jeremy Marozeau and Alain de Cheveigné also suggest a close relation between timbral brightness and pitch height (2007).¹²

Metaphorical associations with brightness 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. From a semantic perspective, it seems to be common to understand brightness as an equivalent of transparency or clearness, but there may be a place for subtle nuance in between. The experience of clearness could be related

⁸ Ivi, p. 20.

⁹ Ivi, p. 5.

¹⁰ Ivi, p. 348.

¹¹ Ivi, p. 73.

¹² As cited in MCADAMS S. & GIORDANO B., *The perception of musical timbre*, in HALLAM S., CROSS I. & THAUT M., eds., *The Oxford handbook of music psychology*, Oxford University Press, Oxford 2008, p. 74.

to the possibility of perceiving the qualities of timbre without any obstacle, transparently, while brightness could imply a 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'.¹³

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».¹⁴

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

The word 'transparent' in the title (*durchsichtig*) suggests an experience of light that I have previously associated with clearness. 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 of light.

The score excerpt in figure 1 shows how Seyed attributes a particular identity to each instrument by developing different but still related techniques (Seyed, 2016, score). 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 an 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.¹⁵

¹³ DI SCIPIO A., *Systems of Embers, Dust, and Clouds: Observations after Xenakis and Briin*, «Computer Music Journal», XXVI, 1, 2002, p. 26.

¹⁴ Ivi, p. 31.

¹⁵ Cello 2 and 3, as well as the pedal steel string are tuned differently approaching microtonal deviations from the standard tuning.

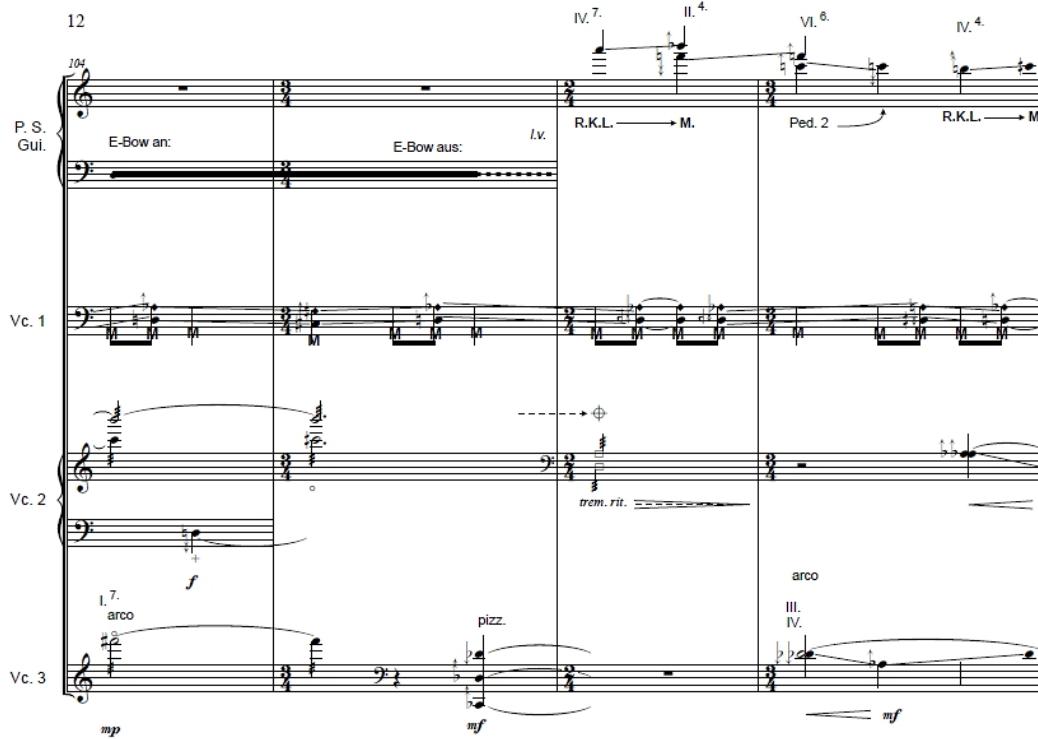


Figure 1. Score excerpt from “durchsichtig, verzweigt” by Elnaz Seyed.¹⁶

The perspective presented so far shows how diverse the experience of light in repertoire for bowed strings can be. 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 in the composition.

3. Luminance Scale

In order to clarify the use of qualitative qualifiers for luminance in my own compositional process, I propose a scale of two phases to measure the ‘amount’ of light going from dark to clear, as well as the ‘intensity’ of light for qualities from clear to distorted (figure 2). However, this scale is a creative strategy for the development of the compositional design of the pieces, which works through a process of crossmodal associations between the adjectives and the timbral parameters. Consequently, it does not imply a precise measurement of light in timbre.

¹⁶ Reproduced by kind permission of the composer (Edition Juliane Klein, Berlin 2021).

The terms used to mark each level were taken from a list of thirty qualitative 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'¹⁷. He additionally obtains a collection of free verbalizations from the listeners of his experiments, that includes other qualities such as 'blurred' and 'distorted'.¹⁸ Other terms were selected from the analysis of instrumental repertoire, as well as my own experience and compositional criteria, like 'incisive', 'veiled', and 'opaque'.¹⁹

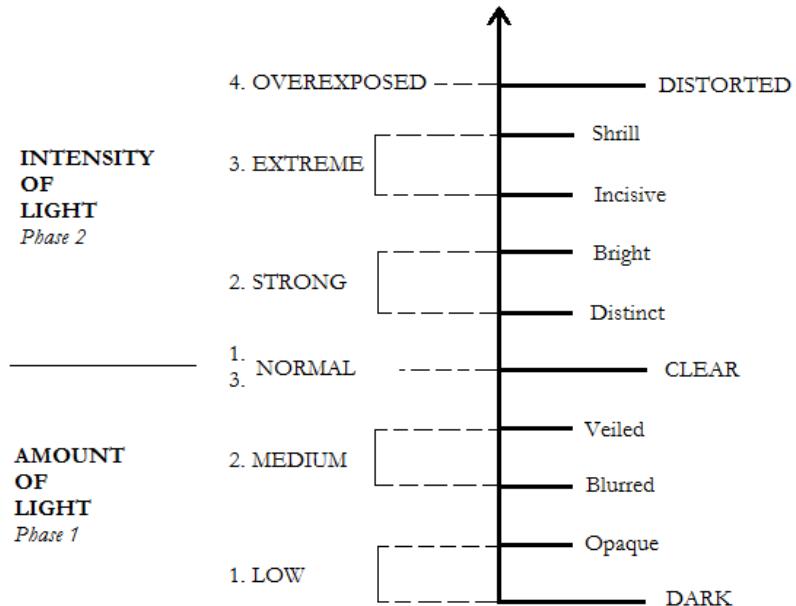


Figure 2. Two-phase luminance scale for the measurement of amount and intensity of light according to the correlations between the acoustic features and the semantics of timbre.

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:

¹⁷ ZACHARAKIS A., *Musical Timbre: Bridging Perception with Semantics*, unpublished doctoral thesis, Queen Mary University of London 2013, p. 79.

¹⁸ Ivi, p. 96.

¹⁹ 'Incisive' could be understood as a synonym of 'piercing', which actually appears in Zacharakis, 'Musical Timbre', p. 96. 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.

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.²⁰

Additionally, Lochhead argues that the events of luminance include sounds with prominent upper partials, higher pitch, and a louder dynamic.²¹ 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).

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.

²⁰ ZACHARAKIS A., PASTIADIS K. & REISS J., *An Interlanguage Study of Musical Timbre Semantic Dimensions and Their Acoustic Correlates*, «Music Perception: An Interdisciplinary Journal», XXXI, 4, 2014, p. 350.

²¹ LOCHHEAD J., *Reconceiving structure in contemporary music: New tools in music theory and analysis*, Routledge, New York 2016, p. 111.

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 (qualitative descriptor) rely on contextual factors and the combination of specific conditions in the composition. Therefore, the conceptual approach delineates the structure of the luminance experience in the piece.

4. Composing for Cello from a Luminance Perspective

The Shimmer Beneath: A Scattering Attempt (2019), for cello duo with amplification, is inspired by an imaginary scene in which dust acts as a metaphorical barrier—a layer that interferes 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. Dust has therefore 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. From a technical perspective, the amplification has also a timbral purpose, acting as a magnifier glass that amplifies the inner interaction of timbre from the material and corporeal conditions. The highly subtle details are meant to be perceived in first plane without losing their fragility and ambiguity, thus amplification does not clarify timbre, but allows the perception of its complexity.

The composition started in an exploratory session with Scott McLaughlin to recognise the timbral qualities of cello multiphonics.²² 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

²² 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.

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.²³

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 3) could be classified as a blurred-veiled timbre.

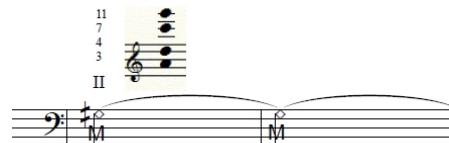


Figure 3. Score excerpt from *The Shimmer Beneath: A Scattering Attempt (a)* showing a multiphonic that could be classified as blurred-veiled.

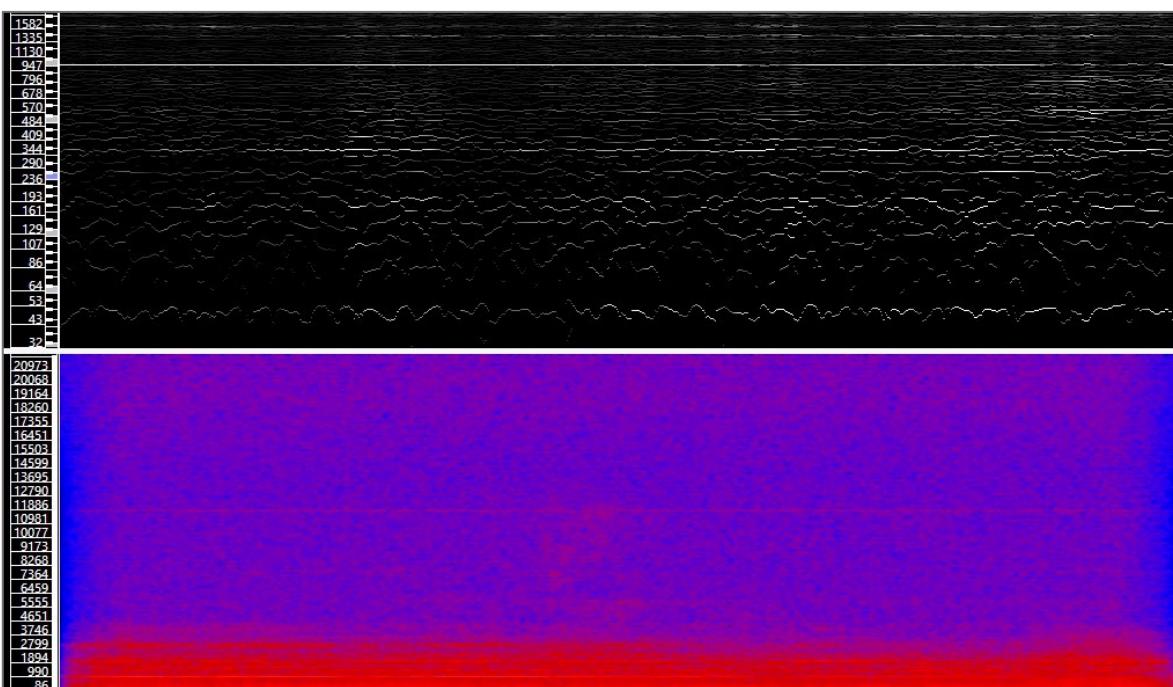


Figure 4. Peak frequency analysis and spectrogram of excerpt in figure 3.²⁴

²³ DILLON F., *Francesco Dillon parle sur les multiphoniques dans le quatuor n.9 de Salvatore Sciarrino*. Available at: <https://www.youtube.com/watch?v=lFpuv1N4frY/> (Accessed: 10 February 2019).

²⁴ 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). Available at: <https://on.soundcloud.com/to79ZRGThDUB9dyr9>

Although in the peak frequency analysis (top image in figure 4) 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 4), 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 cellist has to do, although with this approach the score wouldn't represent the unpredictable timbral results. Jessie Marino's *Cello Multiphonics* blog became a rich source of information for writing the multiphonics in the piece.²⁵ 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 (2019) was another important resource.²⁶

The transitions between moments of transparency and ramification in the experience of light were one of the compositional approaches I was interested in the most. Consequently, I also worked with Martin 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.²⁷ The timbral result of the pinched string (P. S. in the score), or very light finger pressure (notated in the score with a square-shaped notehead) 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.

²⁵ MARINO J., *Multiphonics Notation*. Available at: <http://celломultiphonics.blogspot.com/> (Accessed: 7 February 2019).

²⁶ Cello Map is a practical resource for those who are interested in performing and writing contemporary music for cello. Available at: <https://cellomap.com/>

²⁷ The instrumental approach described with Martin Iddon was part of a supervision meeting on 22 February 2019.

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.²⁸

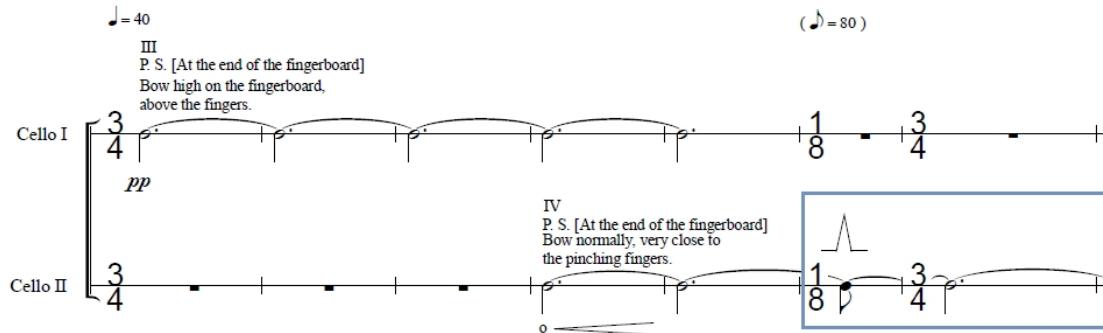


Figure 5. Score excerpt from *The Shimmer Beneath: A Scattering Attempt (b)* showing a technical approach to producing a timbre in the first phase of the luminance scale.

The score excerpt in figure 5 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*.

The technique described above produces a timbre that could be classified as opaque. From the spectral analysis in figure 6 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 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 absence of 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.

²⁸ 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.

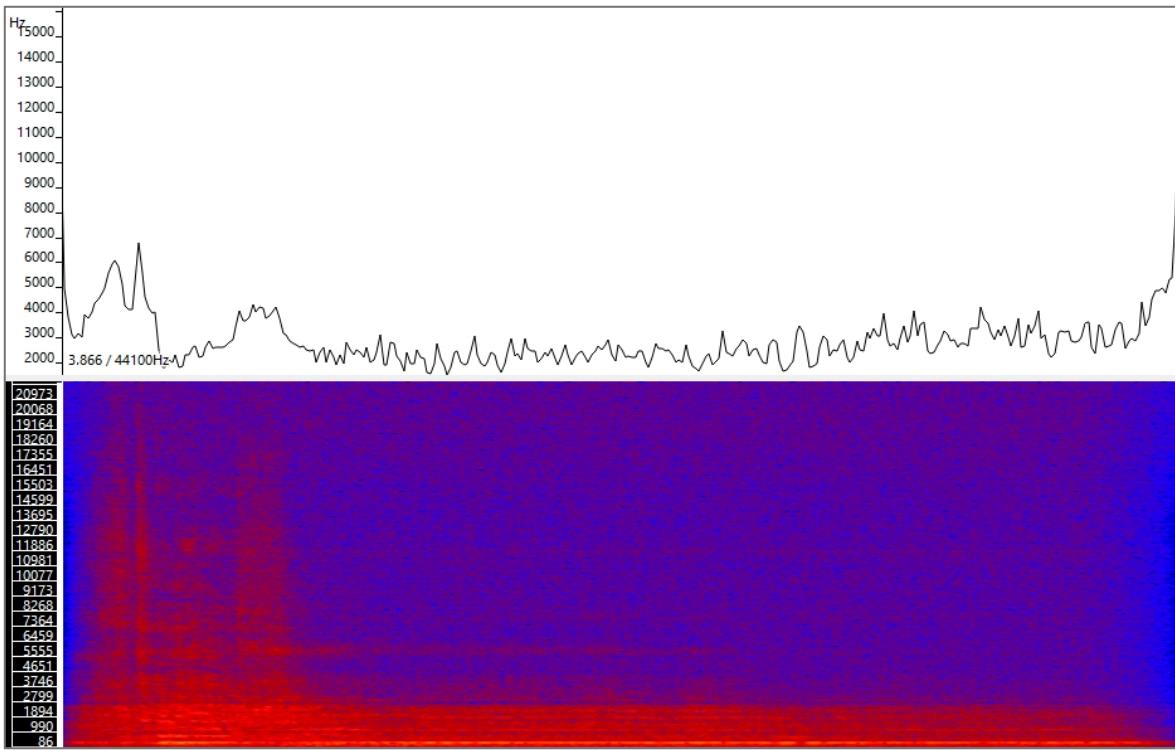


Figure 6. Spectral centroid and spectrogram of the boxed excerpt in figure 5.²⁹

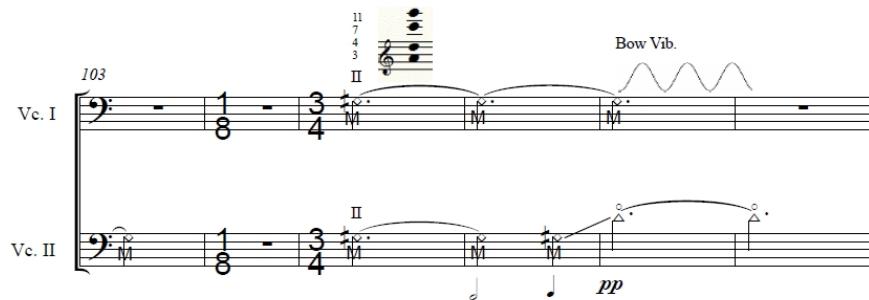


Figure 7. Score excerpt from *The Shimmer Beneath: A Scattering Attempt* (c) showing the 'dispersion of light' effect created in the piece.³⁰

²⁹ 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). This image corresponds specifically to the analysis of the boxed score excerpt in figure 5. Available at: <https://on.soundcloud.com/rwrH2PWgek-CF5ZmA7>

³⁰ 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). Available at: <https://on.soundcloud.com/DSko3Ujtt6P5oSsr9>

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 7). 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.

5. Discussion

Composing for cello from a luminance perspective leads to the recognition of how this semantic dimension accounts for the amount and intensity of light perceived in timbre, and how it propitiates cross-modal associations with particular conditions of spectral content and dynamic envelope. The composition of the piece *The Shimmer Beneath: A Scattering Attempt* was based mainly on the exploration of the first phase of the luminance scale. Cello techniques were therefore approached and developed in order to produce timbral experiences which could be described as dark, opaque, blurred, or veiled.

The composition was developed through the deployment of three core cello techniques. Although some multiphonics may produce timbres measured in the second phase of the scale, according to their spectral structure (partials distribution), the exploration process for this piece was focused on the possibility to create ambiguity of pitch and lack of clarity, which are associated with the perceptual experience of the first phase, by altering and controlling fingering and bowing position and pressure. With techniques like very soft pressure of fingering or pinched strings, it was possible to develop a kind of mute with which the string is still vibrating, but not reaching a perfect pitch, thus the cellist is able to modulate the timbral experience into the lack of light, by impeding the presence of clear fundamental and upper partials. Moreover, the exploration of different kinds of bowing worked as a mechanism to modulate the level of inharmonicity in timbre. With vertical bowing, or with normal bowing but very close to the fingers, timbre responds to the friction sound itself, since the string is not vibrating properly, the interaction with the bow's hair adds a layer of noise (hiss) that veils the pitch perception.

Consequently, it is possible to recognise through the spectral analysis of these cello techniques that high inharmonicity and soft dynamics could be perceived as timbres that are 'covered' or have a low amount of light. 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. Clearness of timbre is therefore the consequence of middle range pitch, clear fundamental frequency, low inharmonicity, and general stability of the spectral centroid. 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 because 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. Furthermore, 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.

The proposed scale for the compositional measurement of luminance in two phases therefore seems to be a productive strategy for the study and organisation of particular cello 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 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.

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