Timbre: Transforming Perception into Sonic Expression

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The recent surge of interest in timbre studies has exposed a fundamental problem in its conventional framing: timbre is neither an inherent physical property nor merely a response to acoustic stimuli. Instead, it emerges as a contingent relationship between the listener and the sound event, shaping individual auditory realities. This paper challenges traditional perspectives, using sound art to explore a radical subversion in which timbre is understood as an expression of the cognitive structures that shape auditory perception. The sound installation *Sonic Iterations for Intangible Existences: Dark Matter* explores this paradigm shift by speculating on the possible timbral behaviors of sound in dark matter—a medium with no prior acoustic references. By transforming mental timbral constructs into acoustic physiognomies through Smalley's transformational discourse, the work externalizes the internal frameworks that govern individual perception. In doing so, it raises two key questions: Do the results reveal that our auditory realities are not immediate perceptions, but iterative constructions? Have we encountered an expressive dimension beyond the reach of current technology? This study suggests that timbre is not a fixed physical attribute but a possibility for building worlds.

1. Introduction

"Perhaps there is no thing in itself, only interpretations of the thing, or the way we perceive it, or feel it." (Maia 2024) This is the first phrase that is heard in the sound installation *Sonic Iterations for Intangible Existences: Dark Matter*. The reason I chose to start the article with this sentence, or seemingly vague thought, is because, in the end, it revealed itself through sound art, a perfect expression of the contingency that governs timbral perception, while also mirroring the research process itself. Throughout its academic and scientific heritage, the "problem of timbre"—the cherished term for the inability to define it—has always manifested itself tacitly. The apparent inconsistencies in how we explain this concept have always hinted that this *thing* we seek to describe, after all, is neither universally described nor universally experienced. Timbre, therefore, continues to be an amorphous concept, which expands and compresses with the advance of technology, society and in turn, art itself, causing its knowledge

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to often be developed under apparently very distant and repellent philosophies (Wallmark 2020). An example of this was the surprising conference “Timbre is a Many Splendored-Thing” which, as well as demonstrating a pick of resurgence of interest in this topic, brought together a panoply of researchers from the most diverse fields, including psychologists, composers, theorists, historical musicologists, ethnomusicologists, popular music scholars, performers, computer scientists, and acousticians to each debate their own perspectives on timbre (Thoret et al. 2018). However, our resistance to a truly comprehensive vision that admits and articulates its various forms, or the natural tendency we have to try to circumscribe the concept along defined lines, is part of the reason why there still doesn’t seem to be a consensus. And I say “seem”, because in fact, a larger consensus is manifested surreptitiously across all the many different areas of study that have focused on timbre in recent years (McAdams 2018):

Timbre is not liable to an absolute definition.

Therefore, in this study we embrace its indeterminacy and focus instead on exploring it as an individual expression of the contingent relationship we establish with the sound event.

Sonic Iterations for Intangible Existences: Dark Matter is a timbral speculation sound installation that emerges as a radical subversion of the conventional study of timbre. It proposes a methodology that liberates timbre from the saturated perspective that confines it to a mere response to acoustic stimuli, allowing it instead to express the pure mental operations inherent in how we “timbre” our auditory reality—A wordplay inspired by the Portuguese verb “timbrar[1]” which signifies an imposing action rather than a passive one.

1.2. “Perhaps There Is No Thing In Itself”

To navigate the elusive concept of timbre, it is often defined as that auditory sensation that allows us to distinguish between different sounds, even when pitch and intensity are similar (ANSI/ASA 2013). Many before me have pointed out that the prevailing issue of this definition is its negativity, defining timbre more for what it is not (Dolan 2018). I disagree, the prevailing issue is its latent ambiguity. This definition attempts to describe timbre while avoiding excluding anything from it. Instead, it leaves us with the impression *that perhaps timbre is no thing in itself*, but our individual interpretation of the whole. The term becomes a depiction of an all-encompassing auditory sensation that, while not representing all of what sound is, nevertheless reflects the articulation of all sound attributes and our subjective interpretation of them.

1.3. “Only Interpretations of the Thing…”

This perspective places timbre at the perceptual end of the auditory process, existing solely as a mental construct, aligning with the current views on sound source identification.

As McAdams’ studies have consistently shown, timbre plays a central role in perceiving, identifying, fusing, and segregating sound sources (McAdams 2013). However, timbral perception does not follow a linear process, nor does it always faithfully translate the acoustic stimulus that trigger it.

Identifying and characterizing sources through timbre is generally robust and effective, particularly in ambient listening mode, essential for daily survival and navigation (Gaver 1993). However, Smalley’s framework of spectromorphology (Smalley 1997) suggests that in other listening modes, such as when listening to music, the stability of source-bonding —the cognitive act of linking perceived timbre to its material cause—is disrupted, often leading to inferred or imaginary perceptions of the source. These perceptions can deviate entirely from what the acoustic signal represents in the physical world.

These dissonances in timbral perception are vividly explored in the fissuring “The Paradox of Timbre”, where Fales (2002) argues that while we can identify sources, what we perceive is a mental version of the source, one that does not always correspond directly to its acoustic reality under any measurable standard. This is exemplified by two key timbral anomalies: extraction and redistribution. In extraction, isolated partials are removed from a sound, yet the listener still perceives the original source, revealing that timbre is reconstructed cognitively rather than being entirely dependent on the acoustic signal. In redistribution, partials from different sources fuse into a single entity, demonstrating that timbral perception can completely override the physical distinction between sounds.

In chasing the essence of timbre, the above exploration of its perceptual operations finds a strong resonance in Voegelin’s philosophical notion of sonic possible worlds. In philosophy, contingency refers to something that exists as it is but could have been otherwise—its form is neither universal nor determined (Voegelin 2014). For Voegelin, listening operates on this same plane; it is not a fixed inevitability of the physical world but a possibility for its interpretation. The form timbre takes in the listener’s mind is neither assured nor necessarily the same in all possible worlds; instead, it emerges as an individual truth unique to each listener. Perceived timbre, then, reveals itself as an expression of the mental structures that shape our experience of the sonic world.

2. The Missing Perspective

This realization exposes a structural flaw in timbre studies: they often analyze a timbral perception already corrupted by the strength of acoustic stimuli. A source—real or synthesized—produces an acoustic signal carrying a set of cues that activate cognitive listening processes. These processes interpret the information heuristically, generating the most plausible hypothesis among multiple possibilities (Bregman 1990). Thus, perceived timbre always emerges as a result of the tension between the force of the acoustic signal vs. the interpretative power of the mind.

This presents a problem when attempting to access mental timbre—the pure, untainted core of the cognitive structures that shape our auditory reality.

Few studies focus on timbre's mental dimension before it is influenced by the acoustic stimulus. A rare exception is the very recent "Comparison of Heard and Imagined Blends of Instrumental Dyads" (Zhu and McAdams 2024), which marks a much-needed paradigm shift. By comparing imagined and heard timbral blends, the study shows that imagined timbre is contingent on the listener's individual relationship with the sound source. Rather than a mere echo of past auditory experiences, imagined timbre is an active reconstruction—an interplay between memory and internal simulation—resulting in a perceptual outcome distinct from what is physically heard. This reinforces the view that timbre is not a product of external sound but an already existing cognitive construct that shapes unique auditory realities.

2.1. Subversion

Such a perspective requires subverting listening paradigms. This means that timbral perception becomes an active, although preattentive act (Fales 2002) that colours the very reality we perceive. The fact that our everyday listening makes it seem as if the opposite is true, i.e. that what we hear is only what we pick up from the acoustic world, shows the ability of our mind to hide from us its own role in perceptualisation, the very process of generating coherent auditory realities from fragmented signals.

Perceptualisation, as Fales defines it, encompasses the set of cognitive mechanisms that transform the acoustic stimuli into mental percepts that deviate from their physical existence. These mechanisms construct cohesive auditory experiences, often fabricating timbral qualities to resolve ambiguity. Fales also points out that one of the

greatest ironies of perceptualisation is that it is tuned to convince the listener that this process doesn't exist and that the "virtual" timbre we perceive is the real version of the acoustic stimulus that causes it.

3. Methodology: "Or the Way We Perceive It, or Feel It."

To transform timbre from perception into external expression, we turn to art. If constructivism sees knowledge as actively built through interaction between the individual and his environment, (Cresswell 2014) art makes this process evident. Throughout history, artistic expressions like painting, sculpture, and even photography have externalized how artists capture and interpret the world. Like other forms of expression, art begins with perception. We are inspired by what we experience, expressing the way we perceive it, or feel it. In some ways, it could be considered a way of making our thoughts perceptible, both to ourselves and to others. In fact, Max Beckman speaks of painting as the fixing and transformation of those "immaterial" events of his own thoughts, feelings, memories and responses into something more material (Belting 1989).

This became the starting point for our methodological approach. A sound art piece where the immaterial events of timbral perception that colour our auditory realities—our own thoughts, feelings, memories—could be materialized.

Consider Vincent van Gogh's Starry Night. According to a scientific hypothesis, this painting is a very close visual representation of the principle of turbulence, a scientific theory that demonstrates the movement and flow of particles in conditions of high turbulence (Ma et al. 2023). In this case, it is argued that Van Gogh's painting could express, in an unconventional way, the complexity of this until-then intangible phenomenon, as if the artist had captured an essence not yet observable to the human eye, but present in the world. Whether intentional or not, the painting captures an essence previously unobservable, revealing the world through perception rather than objective analysis. Art, in this sense, makes the being manifest in a unique way, revealing internal correlations and meanings that construct the artist's perception of the world.

4. Sonic Iterations for Intangible Existences: Dark Matter

If *The Starry Night* could provide a glimpse into how Van Gogh conceived his reality through his visual representation of the invisible phenomenon of turbulence, then an audible representation of

an equally intangible phenomenon may similarly offer a glimpse into how we timbre our auditory realities individually. Dark matter, one of today's greatest mysteries in physics, emerges as the epitome of this intangibility: an existence, that despite constituting most our universe's mass-energy content, neither emits, reflects, nor absorbs light, remaining invisible by essence. Its form is unknown, nevertheless holds multiple possible representations in the mind of each person that studies and interprets it (Bertolami and Gomes 2017).

This became the concept that shaped the sound installation. Drawing inspiration from Kubisch's *Electronic Walks* (2003)—works that revealed the hidden electromagnetic dimensions of our world—I too intended to generate possible sonic representations for the elusive dark matter. However, instead of an electromagnetic sensor capturing and translating these dimensions into sound, as in the case of *Electronic Walks*, it is the internal structures and sensory processes of the mind that will generate the acoustic physiognomy.

In quantum physics, the principle of superposition demonstrates that a quantum system can exist in multiple states simultaneously—until it is observed (Caltech Science Exchange 2025). Timbre perception, to me, follows a similar principle: it holds multiple possibilities for representing the momentary state of some *thing*, but it is only when we establish a conceptual relationship with the sound event that we collapse all these possibilities into one—our own perception of that *thing*.

As corroborated by Orfeu Bertolami in a personal communication (October 27th, 2023):

"Timbre is our interpretation of matter, and its state as manifested through mechanical waves."

This concept was awarded in 2023 by Digitópia's Utopian Laboratory project and premiered in October 2024 in the west wing of Casa da Música during the Porto Electronic Music Symposium, with the attentive guidance of Óscar Rodrigues, Digitópia's curator and team leader, throughout its conceptual and technical development.

4.1. Strategies for Painting an Auditory Reality

To establish a conceptual foundation for approaching the enigmatic nature of dark matter, a series of meetings were conducted between October 2023 and July 2024 with Professor Orfeu Bertolami, a renowned theoretical physicist and dark matter specialist at the Faculty of Sciences of Porto University. While the physical inter-

action between sound and dark matter remains highly improbable, our discussions sought an equilibrium between speculation and physical possibility.

Through this process, we quickly realized a profound connection between theoretical physics and art: both disciplines rely on speculation, imagination, and creativity to grapple with the unknown and the inexplicable. In that spirit, we allowed theory and speculation to become our tools for sculpting the possible timbral behaviors that sound could acquire in dark matter.

Our initial strategies involved mimicking Bertolami's theoretical process—balancing objective data and established paradigms with mental speculation about how timbre might manifest in this elusive medium. This approach, however, confronted us with the stark reality of dark matter's mystery: most, if not all, of the quantitative data available is either tangential—failing to describe the substance itself—or, in many cases, merely measurement errors (Bertolami, personal communication, January 12th, 2024).

This realization forced us to reassess our approach. By attempting to rely on objective data, we were erratically pursuing a form of sonification, rather than exploring dark matter as a mental construct. In a way, dark matter itself redirected our course, reinforcing the necessity of embracing perceptual and speculative methods rather than attempting to impose a direct acoustic representation onto an inherently intangible phenomenon.

Comparing artificial intelligence to an advanced paintbrush, suggests that AI is not a substitute for human creativity but an extension of the creator's mind. Inspired by this idea, we turned our attention to the possibility of building an AI model capable of translating mental representations into acoustic physiognomies (Agüera y Arcas 2015).

However, as Jonathan Impett writtes, "an AI is essentially a memory machine", (Impett 2023, 225) and contemporary deep learning models rely almost entirely on vast datasets to train this memory. (Dobereiner and Pirro 2024) But how do we construct a memory of something that does not yet exist? What data could be used to train an AI designed to translate a mental representation that, by definition, has no prior instance? Here, we are speaking of the primordial moment of creation—the first act, where synapses establish possible timbral behaviors in a medium where no sound has ever been heard.

Speculation, as a philosophical and artistic exercise, enables us to form hypotheses about concepts that may not be empirically verifiable, venturing into realities that exist only in inference. (Goodman 1978) It bridges imagination and experience, placing the explorative mind at the center of knowledge creation. It is the moment of world-building, where we are coloring possible sonic realities, ones that may have no counterpart in another mind or any subsequent representation under measurable standards—precisely as Fales' paradox caution.

Thus, we found no database that made sense to train, nor any meaningful outcome from such an exercise. Artificial intelligence thus proved useless for the proposed artistic experience. However, does this suggest we have stumbled into a form of artistic expression that AI has yet to grasp? Or have we not yet discovered how to make this paintbrush a true extension of the artist's mind?

4.2. The source

Philosopher Thomas Kuhn (1962) argued that when a paradigm fails to accommodate new or anomalous data, it enters a state of crisis, often leading to a complete revolution of perspectives. Faced with the limitations of AI in translating the timbral speculations, we found ourselves at such a crossroads—requiring a step back to rethink our methodological approach.

Just as a painter develops fluency with the brushes that best express his vision, it became clear that, for this installation I too would have to take on the brushes with which I express myself best. Inspired by Alvin Lucier's *I Am Sitting in a Room* (1969), a recorded spoken voice became the central element—the original sound source from which my own timbral speculations would emerge.

To that end, a text was composed from fragmented thoughts reflecting the qualitative essence of dark matter, shaped through discussions with Professor Bertolami. Structured in collaboration with theatre director and performer Ana Lídia Pereira, part of this text unfolds as a poetic narrative, navigating dark matter's dual existence—as an abstract concept and as a subject of theoretical descriptions that attempt to concretize it.

Each syllable was meticulously crafted, not for traditional musicality, but for a precise vocal performance that, like in Lucier's piece, carried the potential to make space and matter resonate at their own fundamental frequencies. This recorded voice, then, was not merely a vehicle for language but a speculative instrument—provoking mental transformations of its existence in dark matter.

4.3. Transforming the source

To transform the source within a framework of physical possibility, I followed one of Professor Bertolami's proposals, which draws an analogy between dark matter and a gas. Recognizing the impossibility of describing it quantitatively with current data, we proposed an alternative approach: writing a qualitative equation of state to contrast the behavior of sound in air versus dark matter.

$$PV=nRT$$

Equation 1. The ideal gas law where P, V and T represent pressure, volume and temperature respectively; n is the quantity of substance; and R is the ideal gas constant.

While assigning numerical values to this equation within the context of dark matter is impossible, the purpose of this exercise was comparative—juxtaposing the pressure, volume, and temperature of air in the exhibition space against the speculative properties dark matter might exhibit if it behaved like a gas.

Bearing in mind the theory that dark matter should be vastly less dense than air and that interaction between its particles is minimal, we envisioned a gigantic compression of this matter within the space. This allowed us to think of dark matter as a medium with very little density, where, from the outset, the speed of sound propagation would drop incredibly comparing to air, but it would still retain a small capacity for acoustic propagation, with pockets of greater and lesser density scattered and wandering around the exhibition space.

To represent both the wandering presence of the dark matter that shapes our world and the timbral perception that shapes our reality beneath our conscious awareness, a sculpture was created in collaboration with sculptor Helder Maia, in a black metal mesh, designed to hang and be dispersed through the space (Fig. 1.). It's an amorphous sculpture if seen in motion, its defining lines are constantly redefined by the space's wavy acoustic glass that distort it and by the position that the visitor chooses to establish—a parallel to the fluid nature of both timbre perception and dark matter, which remain elusive until framed by individual experience (Fig. 2.).

It was now my turn to mentally speculate on the timbral behaviors resulting from the passage of this voice (the source) from one medium (air) to another (dark matter). This meant painting my own mental representations of the undulatory phenomena involved in such a transition—refraction, scattering, acoustic dispersion, interference, and beyond.

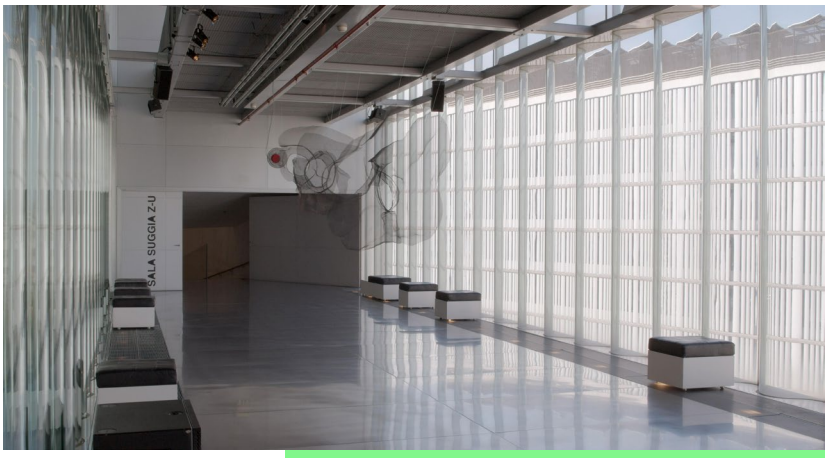

Fig. 1. *Sonic Iterations for Intangible Existences: Dark Matter* sound installation at Casa Da Música's west wing.

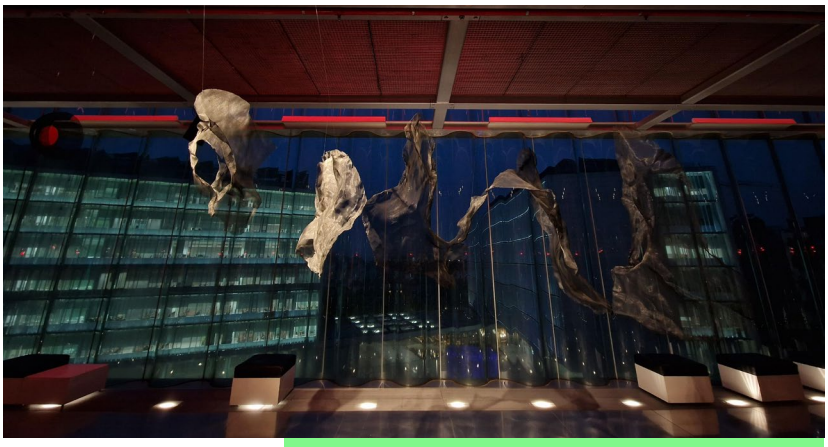

Fig. 2. Side View of the installation at night.

As electroacoustic manipulation is my most expressive brush, I turned to digital and analog tools that have accompanied me throughout my career. Through them, I sought to translate these mental representations into acoustic physiognomies, sculpting the imagined timbral transformations as precisely as possible.

To present the results of the timbral transformations without corrupting them, but at the same time be able to contextualize the visitors, it was necessary to create a bond with the original text that was being modulated. Here, Denis Smalley's (1997) concepts of Stability and Variability, central to his transformational discourse, became fundamental. Stability refers to acoustic elements that remain coherent, serving as perceptual anchors that bond the listener to the sound source, while Variability describes the elements that transform the sound, distancing the listener from identifying its origin. Smalley's framework provided a crucial method for managing the tension between these two forces—how much of the sound remains grounded in its source and how much departs into transformation.

To resolve this balance, I opted for a spatial approach. By creating two distinct sound spaces, I was able to segregate the original sound

source from its transformations, allowing for a clear contrast between stability and variability without compromising the integrity of the timbral metamorphoses.

4.4. Space A: The domain of variability

Covering the entire area surrounding the installation and extending into the west wing (Fig. 1.), Space A is dedicated to variability. Here, visitors hear only the transformed version of the original source, devoid of the acoustic cues that would reveal its origin. Timbre is liberated: It emerges purely as a construct of thought and cognition, allowing each visitor to give the sound their own version of a source, state and matter.

To enable this experience, six high-quality active tops are evenly distributed throughout the space, alongside one subwoofer on the upper floor. This spatialized acoustic design interacts with the acoustics of the room, creating the illusion that what is heard is not a playback system but an emergent response of the space itself.

4.5. Space B: The domain of Stability

In contrast, Space B serves as the point of stability within the transformational discourse. Here, the original text remains unchanged, acting as a perceptual anchor that resolves the surrounding abstract transformations. However, the text is only perceptible if the visitor precisely aligns with the red dot at the end of the sculpture. The sculpture was designed to create an optical and acoustic illusion—a single point of perspective convergence where all elements align, allowing an handcrafted ultrasonic directional speaker (Miura 2011) to transmit the unaltered text (Fig. 3.). At this point, and only at this point does the original sound become intelligible.

This creates a sonic focal point where the timbral behaviors of Spaces A and B converge into a unified transformational discourse—reminiscent of gravitational lensing, which reveals the presence of dark matter through its distortions of space-time (Fig. 3.). This configuration transforms the visitor into an active participant, navigating the tension between stability and transformation. As they move away from the focal point, the text dissolves into fragmented, diffuse, and modulated abstraction. This transition embodies Smalley's dynamic tension, where sound oscillates between recognizable form and perceptual flux.

The installation operates on eight independent audio channels, controlled via a MacBook connected to an audio interface, running a five-minute audio loop in Ableton Live 12. The timbral transformations were mapped across these channels, simulating the wandering pockets of higher and lower density, reinforcing the speculative presence of dark matter.[2]

5. Discussion: From Perception to Expression, to Perception

This installation set out to subvert traditional timbre research by redefining it not merely as a perceptual response but as an individual expression—one that externalizes the mental structures shaping auditory reality. Dark matter, as a speculative framework, proved particularly effective for this exploration. As an intangible entity, it can only be inferred rather than directly observed or heard. Consequently, the imagined timbral transformations in this installation were not influenced by external stimuli from the physical world. Instead, they emerged purely as internal perceptual events in the mind of the author.

Once these internal events where externalized as audible acoustic physiognomies, visitors navigated a space where its speculative presence was suggested through a series of timbral transformations, reinforcing the idea that the source we perceive is shaped more by individual interpretation than by its acoustic properties.

Unlike traditional timbral composition, where the acoustic result is iteratively refined between artistic intention and technical constraints, this process required a direct transposition of imagined timbral behaviors into acoustic physiognomies. However, translating mental timbral speculation into tangible sonic form revealed critical challenges. Speculation did not produce instant, fully formed mental timbral transformations, instead they evolved gradually, emerging as iterative mental exercises.

As Edwin Gordon's (2007) concept of audiation describes, the process of imagining timbral behaviors involved continuously recalling and refining previous mental versions, each iteration building upon the last. While the core character of the initial version remained intact, it gradually became richer and more complex until stabilizing at a point of perceptual resolution. This raises a key question: Could our auditory realities be no immediate perceptions but iterative constructions—where we progressively refine internal connections, generating virtual sonic versions that, as long as they remain functional, feel real to us?

Another key realization was that mental timbral representations were not governed solely by auditory perception—they also involved corporeal sensations, thus confirming an embodied understanding of timbre and suggesting a tactile dimension to Orfeus' definition of timbre as our interpretation of matter and its state as manifested through mechanical waves. To compensate for this sensory gap, a

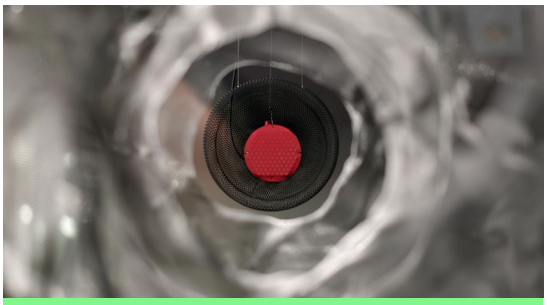

Fig. 3. Sonic focal point with a red ultrasonic directional speaker.

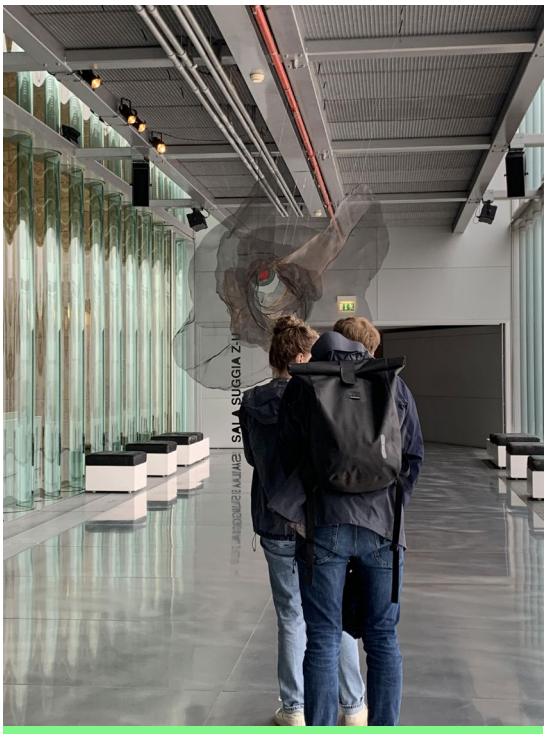

Fig. 4. Visitors listening at space B.

second subwoofer was introduced into the installation floor, reinforcing the physical impact of specific moments. Yet, even with this addition, it was not fully possible to bridge the gap between mental perception and its external acoustic representation.

Despite these challenges, the results remained remarkably faithful to the essence of the initial mental speculations. However, the final acoustic result carried an aesthetic layer seemingly inherent to the tools used. Nevertheless, in analogy with painting, the medium's constraints, do not invalidate the expression of how the artist constructs his own auditory reality.

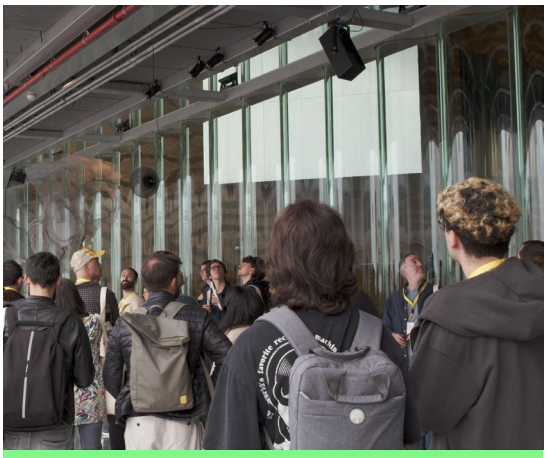

Fig. 5. Premier at Porto Electronic Music Symposium.

5.1. The Feedback Loop

One of the most unexpected outcomes of the installation was how the segregation of the transformed sound from its original source created a perceptual effect that contradicted my own mental experience. Internally, I perceived the voice (source) and its speculative timbral transformations as a single fused entity. However, within the installation, these elements were spatially separated, allowing the source and its transformations to be heard independently. This produced a perceptual anomaly closely related to Fales' anomaly by extraction—where isolated partials, or in this case, the timbral transformations, are removed from the original sound, yet when contextualized, the source remains perceptible.

In Space A (Variability), the timbral transformations took on an entirely new dimension. Positioned at the extreme end of Smalley's transformational discourse, these sounds became detached from their material anchor (the voice), acquiring an autonomous existence. Free discussions with visitors revealed a diverse range of emotional and perceptual responses—ranging from fear and intrigue to deeply visceral reactions, including chills and other bodily sensations.

Although the installation provided no specific instructions on visitor movement, the central placement of the sculpture naturally led most visitors to first engage with the transformed timbral behaviors (Fig. 5). This revealed interesting contrasts in perception:

- Visitors that where somehow familiar with the concept of the installation, immediately perceived the timbral transformations as emanating from a voice.
- Whereas visitors with no prior knowledge of the concept, engaged with the timbral transformations as independent entities, inferring a great variety of imagined sources. However, upon encountering Space B (Stability), all these possibilities could

not escape collapsing into a single perception: the voice being transformed. This seems to validate Fales' paradox, which asserts that timbre perception is ultimately a constructed version of reality—a cognitive resolution of sonic ambiguity, it further demonstrates how external acoustic stimuli can distort or even collapse these internal realities.

- A particularly striking realization occurred when Professor Bertolami, who had never heard the piece prior to the premiere, correctly identified specific timbral transformations as representations of specific physical phenomena he had theorized, such as acoustic dispersion, weak particle interaction, and density pockets. This strongly suggests that imagined and abstract timbral cues can still evoke concrete physical phenomena, concordant across different minds when bonded by the same conceptual framework.

In Space B (Stability), the installation served its function as a perceptual convergence point, where the ultrasonic directional speaker emphasized the parallel between internal audiation and externalized sound. The highly focused ultrasonic beam, interacting with the facial bones and tissue structures, created a strange perceptual effect, making the text feel as though it were resonating inside the listener's head. This experience mirrored the author's own perception of the timbral behaviors, allowing visitors to momentarily enter his auditory reality.

6. Conclusion: Timbre as a Contingent Expression of Auditory Reality

This installation aimed to challenge the conventional study of timbre by transforming it from a perceptual phenomenon into an expressive one, much like how visual art is capable of externalizing perception. While people may agree on the identification of timbre, each individual's internal perception differs. The objective was to reveal these personal, internal constructions of timbre—showing how we individually shape auditory reality. Through artistic exploration, the work made these mental constructs tangible.

To achieve this, speculative timbral behaviors were imagined in a space where sound had never existed before—dark matter. The installation space was divided into two perceptual domains: Space A (Variability), where only the transformed timbral behaviors were heard, and Space B (Stability), where the original source was revealed through an acoustic focal point using an ultrasonic directional speaker. The presentation of these timbral speculations followed

Denis Smalley's transformational discourse, carefully manipulating the balance between stability and variability to shape the visitor's perceptual experience.

However, much like in painting, where the medium inevitably imprints its own aesthetic, this transformation did not compromise the core expression of the imagined timbres. This raises an intriguing question: Could this form of timbral expression, which exposes internal frameworks, be used to train AI as a true extension of the individual mind—externalizing mental timbre without distortion from technical constraints or aesthetic biases?

The installation also directly demonstrated Fales' timbral anomalies: in Space A, detached timbral transformations led uninformed visitors to infer multiple imagined sources, constructing virtual versions of a source to resolve auditory ambiguity. In Space B, stability and variability converged into a fusion of the original source and its timbral transformations, collapsing these virtual interpretations into a single perceptual experience—a transformed voice. This validated Fales' paradox, reinforcing that timbre perception is a constructed version of auditory reality and that external acoustic stimuli can disrupt these internal constructs.

Space B (Stability) created an uncanny auditory lens through an ultrasonic directional speaker that caused visitors to perceive the sound as originating inside their own heads. This placed the listener momentarily inside of the author's head, experiencing the fusion of source and its transformations as a single identity.

Furthermore, the act of speculating timbral behaviors in dark matter, reinforced the idea that timbre is not always determined by physical phenomena but by our interpretation of them. This was most evident in the experience of Orfeu Bertolami, who, despite never hearing the work before the premier, was able to identify specific timbral transformations as corresponding to theorized and yet unheard physical phenomena in dark matter.

This exploration is part of a broader research project that rethinks timbre and, in later stages, will seek to address some of the questions raised here. Ultimately, it invites further investigation into the possibilities of exploring timbre as a contingent expression of how each individual constructs their own sonic reality. By proposing timbre as a speculative practice, this work demonstrated that the timbral world we inhabit is not merely given—it is constructed and continually reshaped by the way we engage with the world we live in. If timbre is a reflection of our cognitive framework, how might we further explore and externalize the sonic worlds that exist within us?

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Notes

1. "Timbrar" (Portuguese) Loosely translated as "Assigning a certain characteristic to" Definition from Infopédia – Dicionários de Língua Portuguesa, Porto Editora. Available at: https://www.infopedia.pt/dicionarios/lingua-portuguesa/timbrar (*accessed February 13, 2025*).

2. An audio document of the sound installation is available upon request. Please contact the author directly via email.

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