

Cyborgutt: Exploring the body's fluid boundaries through a biosensor composition

First Author

Fotis Rovolis (φφ)
faux.tease@gmail.com
NKUA

Second Author

Areti Andreopoulou
aandreo@music.uoa.gr
NKUA

Third Author

Thanos Polymeneas-Liontiris
athpoli@gmail.com
NKUA

ABSTRACT

For Massumi the body has immaterial boundaries, being connected to space, time and movement. This paper presents an exploration of this notion through a creative-critical interactive music composition. The trajectories unfolded in this research meet in the cross over between queer politics and cyborg theory. The results of an initial theoretical research in this territory led into an interactive composition, a music work based on the practice of biomusic, of which the subject matter is the human body integrated into the current digital technological enhancements. The work explores the body and its sounds, through a genderless and fluid lens, to construct the soundscape of the body. Utilising biosensors and interactivity, the research highlights the way the body can be turned into an instrument for the making of its own soundscape. Acquiring breathing, heartbeat, and muscle sensors to modulate aspects of a body's soundscape, the experience of the performer is enhanced, by incorporating their somatic functions as modulators in the performance. Therefore, the research approaches the relationship between body and music through a creative-critical practice. It challenges certain stereotypical views on human nature, exploring a rather post-human narrative on the body. It observes it as an organism not strictly circumscribed inside flesh, but an organism of fluid boundaries and relations with its surroundings. The work aims to depict how interactive technologies used as tools in a cyborg art practice can contribute towards the desire to attain a cyborg identity. The paper describes the processes used in this creative-critical practice, its aesthetical aims and the bodily and technological challenges. Concluding, the research opens up a discussion on the experiential outcomes of the performance and proposes enhancements for a deeper exploration.

disappearance. According to Butler, gender is produced through a repetitive pattern of performed gestures and actions, a result of processes rather than something that predates, assigned at birth [1]. Within these processes, queer bodies that do not self-identify within the stereotypical gender binary spectrum (male - female) end up feeling invisible. This collective invisibility of existences leads to a series of temporally displaced experiences, creating alternative queer temporalities [2], a concept that responds to heteronormative standards and linear life milestones (such as adolescence, work, family), just as the broader concept of queer does: proposing constant fluidity, redefinition of boundaries, and recognising that queer bodies explore new relationships with time.

Stephen Connor and Joke Dame explore the role of the voice in gender attribution and performativity. Stephen Connor explains how every voice always implies a body, and correspondingly, every listening to the voice produces a "vocalic body" [3]. That is, as soon as one hears a voice, they immediately attribute it to a body, assigning the corresponding gender marker (figure 1). Thus, as Joke Dame suggests, the voice does not inherently possess any gender trace, but instead, it is the act of listening that attributes gender to each voice: perception operates within predetermined conventions. Therefore, she proposes that hearing should be reinvented every time one encounters a voice [3]. Additionally, for Jarman Ivens, the space in which gender boundaries can be deconstructed in the field of voice is the space between transmitter and receiver, what she calls *thirdspace*. It is the moment after the sound waves are transmitted from the body and before they are received by the hearing of another body, where the voice still contains infinite expressions, without yet acquiring a male or female signifier [4].

1. GENDER, VOICE AND BODY FLUIDITY

Judith Butler explains that gender is a social construct created by an exclusionary process that ends up trapping and oppressing bodies, and ultimately leading to their

Copyright: © 2024 First author et al. This is an open-access article distributed under the terms of the [Creative Commons Attribution License 3.0 Unported](https://creativecommons.org/licenses/by/3.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

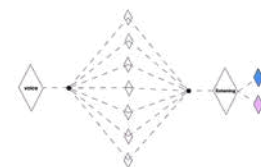


Figure 1. Attributing voices to bodies

Further on regarding body's boundaries and fluidity, the work of Brian Massumi challenges traditional perceptions that see the body as a stable, passive entity. Instead he advocates for a relational understanding of the body. From this perspective, the body is considered as a dynamic, constantly evolving organism shaped by its interactions with the world, a world that is actively participating in shaping [5]. Massumi distinguishes the body's fluidity into three aspects or systems, where the predetermined conventions under which it operates, as in previous fields, function in non-inclusive manners, thus trapping the body in finite forms [6]. Massumi's first aspect of body fluidity is summarised through the term "incipience," the intermediate moment after a state, movement, or action is completed and before its next occurrence [7], suggesting that the body constitutes a continuum set of shape, leading to motion and performance. Stern describes the body as a condition in a permanent potential position for activating new forms [6], similarly to gender and voice. A set of correlations, rather than an isolated shape, which is also part of a system of relationships among the bodies. Donna Haraway describes the relationality between bodies, through acquired tentacles [8] as multi sensory organs, contributing to a unified network where senses and boundaries are shared, translating into mutual care and responsibility among all. Finally, when this system of relations is understood as an integral element of space, one witnesses a structure being constantly created. According to Stern, the only way to learn about the body is by using it [6]. The experience and sensation of the body for its relative determination in space is proprioception and it is an essential component for the development of this relationality. Through proprioception, one perceives the body's location, balance, speed, and the position of its parts.

These qualities that contribute to a fluid understanding of the body and its relationships create the background for Stern's efforts to redefine the concept of "interactivity" as a condition strengthened through deeper qualities of sensory perception [6]. This means that each individual literally "interacts" through the process of movement-emotion-thought as a material bodily process, rather than being a technological informational entity that determines its actions. A digital work can only be "foolishly" interactive, offering limited computational capabilities, but this seems to diminish as technology gains more meaning than the actual experience itself. As Butler, Halberstam, and Massumi explain regarding the complexity of gender, time, and body, when placed in the context fragmentation of information, quantification, and segmentation of characteristics, they end up losing their overall substance and they only function as closed fields of deterministic connections and behaviours. On the contrary though, any relationship with digital technology should be deconstructed through the spatiotemporal kinetic duration of a body that literally "interacts" with it.

In line with the above considerations regarding the boundaries of the body, resides the reconsideration regarding the human condition in Donna Haraway's *Cyborg Manifesto* [8]. In this emblematic work, the notion of cyborg comes to challenge previous definitions of the human subject. Haraway explains how the fluidity of gender and nature manages to redefine social structures, deconstructing the rules and beliefs upon which human essence is built. Ultimately, the existence of the cyborg manages to dismantle all opposing systems, human-animal, organism-machine, man-woman, through the loss of pure human dimension, which is now problematised [8]. According to Haraway, 'Cyborgs are about remaking and reserving against reproduction and birth. [...] We have all been wounded, deeply. We do not need re-creation and rebirth, but rather remaking, and the possibilities of our reconstitution are contained in the utopian vision of a genderless monstrous world' [8, pp 67]. Furthermore, Gillian Haddow introduces the term "everyday cyborg" [9] explaining that the cyborg is not something distant found only in fiction but something we already are. The use of medical implants (pacemakers, prosthetic limbs) for curing medical conditions and enhancing humans is a process that creates informal cyborgs. Jaime del Val defines technology as a continuous self-organisation of motion, thus highlighting how biology and technology intersect at the level of continuous modification and production of infinite variations, whether in bodies or in the systems they shape [10]. The Cyborg Foundation and the Transpecies Society, two groups of contemporary cyborg artists, are currently expanding the idea of everyday cyborgs; they believe that cyborg identity is not about the stage at which each person's body is, whether they have implants or not, but primarily about how the individual feels. "If you feel like a cyborg, then you are a cyborg. It's more about the sense of identity than anything else" [11]. Artist Neil Harbisson, one of the first cyborgs and a founding member of the Cyborg Foundation, born with achromatopsia, manages to convert the colours he sees into frequencies through an implanted sensor in his head. As they describe, before undergoing the implantation, when he still used the device as an external attachment to their head, their brain had already "learned" to hear colours, so that from a certain point onwards, seeing colours produced frequencies. This new sense (exosense) had become connected to Harbisson's body, even without the completion of the sensor implantation procedure in their head. Another example is a recent member of the cyborg community, musician Kai Landre. Landre has assembled and attached to their hand a sensor system that detects cosmic radiation. The frequencies of that radiation are mapped to notes which are emitted as an auditory signal through a transmitter placed on their head. With this mechanism, Landre receives continuous auditory information that corresponds to the analysis and sonification of cosmic rays, and translates it into musical compositions. The exosense system may be the ultimate tool for redefining the relationship between the musical instrument and the musician. Interaction takes place on a

¹ The term cyborg emerged from Manfred Clynes and Nathan Kline in 1960, blending the words cyber and organism to refer to an enhanced form of human with simultaneous human and technological characteristics. The concept of enhanced existence, resulting from the augmentation of existing psychological, cognitive, and physical abilities or the addition of new ones, forms the basis for the development of exosenses.

multiplicity of different levels and interpretations, it becomes cognitive, and ultimately it concerns the dialogue between the subconscious mental, cognitive, and behavioural states of the musician with the system. It ends up being the instrument itself [12].

2. BIOPHYSICAL MUSIC

Biophysical music is a type of music produced using biological data and physiological signals, such as heart rate, respiratory rhythm, and muscle activity. Its goal is to create a direct connection between the performer's physical state and the music production. In this way, biophysical music aims to blur the boundaries between performer and instrument, making the performer's body the instrument itself. Marco Donnarumma approaches biophysical music by using his own body as a source of musical data, measuring and processing physiological signals such as heart rate, muscle activity, and respiration. He then maps these signals to musical parameters such as pitch, intensity, and rhythm to control the sound production in real-time. This way, he creates compositions that reflect his physical state at any given moment. By using technology to process and enhance his physiological signals, Donnarumma is able to create musical experiences that would not be possible without such type of technology [13]. In his performances, the audience can see the direct relationship between the performer's physical state and the musical output. Therefore the audience's perception and interpretation of the music are directly influenced by the performer's physical state and the observation of that state is part of the performance in itself. Donnarumma uses a range of technologies such as electromyography (EMG), electrocardiography (ECG), and respiratory monitoring devices to measure his physiological signals. He also employs signal processing techniques to extract information from raw data and map it to musical parameters. This way, he creates compositions that reflect his physical state at that particular moment. In his performances, Donnarumma explores the relationship between technology and the body and how the use of technology can enhance and extend human physical abilities, more specifically, how technology can shape the human experience and the way one perceives the world around us [13]. His works reside conceptually in the intersection between computational processes and the politics of the body. His body is used as a tool for exploration, creating hybrid and fluid performances that blur the boundaries between human and machine. Fluidity in all its manifestations is very characteristic in these works: the music develops and constantly changes, regardless if the body leads the processes or if technology does. In his work all the elements (body and technology) are presented as a unified ²system, unaffected by binary distinctions, they are part of the continuous production of space.

3. COMPOSITION / PERFORMANCE

3.1 Composition

The theoretical analysis described here lead the making of the interactive performance "Cyborgutt", composed by sound artist $\phi\phi$ (pronounced Faux, also known as Fotis Rovolis) in 2022. Cyborgutt is based on sound material generated by $\phi\phi$'s own body. The performance has two main elements; it consists of the live production of a sound environment from the performer's breathing and heartbeat, alongside the simultaneous playback of pre-recorded sound material also deriving from the performer's body. The two sound elements undergo live processing through biosensors placed on the composer's body.

During the composition stage of the fixed sound environment, a series of recordings took place in order to build a sound library. The recordings were divided into three categories based on the recording processes used, the qualities and the characteristics of the sounds: i) external sounds (sounds produced at the surface of the body p.ex. skin friction), ii) internal sounds (sounds produced by the internal organs of the body p.ex. bowel movements), and iii) intermediate sounds (such as voice and breathing). Subsequently, a series of processes took place, the sounds were modified using frequency modulation and granular synthesis, generating new textures, removing gender traces from the voice, aiming to explore new aural textures that are not bound to binary gender definitions and identifiers.

An important role in the recording process was the use of an electronic stethoscope, which was also used later in the live performance of the work. Through the stethoscope, one is able to hear sounds that the naked ear cannot perceive. Looking for the sounds of the internal body became a pivotal part of the composition because it enhanced the overall exploration of the performer's identity through contact with their body and sounds. Further on, based on the collected material, the sound artist created a fixed soundscape by over-stacking three layers of sound events: the rhythms of breathing cycles, the heartbeats, and the stomach and bowel movement sounds. These elements overlap during the composition, with their transitions and rhythms reinforced by the sound material of external sounds.

3.2 Rehearsals

For the live performance of the work, the use of bio-sensors plays a crucial role. A breath sensor, a heart rate sensor, and a muscle sensor linked to a Max/MSP patch are utilised to synchronise samples from the fixed-media soundscape. The breath sensor controls the playback speed of the sound event. The lower and higher values resulting from the lowest and highest points of inhalation and exhalation are mapped to the speed values of the sample. The heart rate sensor controls the duration of the grains. Any anxiety or tension occurring during the performance will alter the breath rate and consequently the heart rate. Therefore, any small

² Performances such as "Hyppo Chryssos" (2021)

variation in the range of the incoming values corresponds to a range capable of adjusting the size of the grains in the granular synthesis processes taking place in Max/MSP (figure 2). Finally, the muscle sensor controls the frequency range of the changes occurring in the grain frequency, with each contraction and relaxation being associated with a higher and a lower value of the pitchshift parameter. This layer is closely connected to the two layers of breathing and heart, so they all work together as the living organism of the piece, an organism with its internal processes that respond to the fix-media soundscape.

Rehearsing such a type of work is physically difficult, the performer may find it hard to exceed the duration of 10 minutes due to hyperventilation from the continuous repetitions of inhalation and exhalation. For best results with the breath sensor, one should hold their breath for several seconds while emptying the lungs completely and refilling them fully. Without the necessary preparation, this process may cause dizziness and fatigue in the body. These effects offered the possibility to explore methods for extending the physical endurance of the performer (p.ex. meditation), and yet influenced the final duration of the performance.

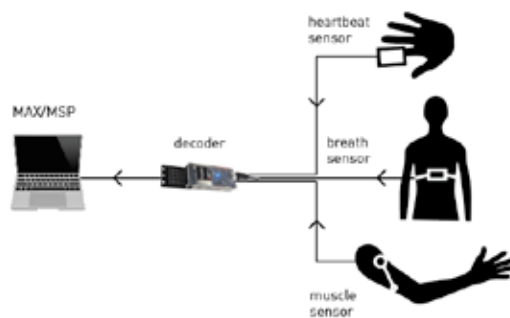


Figure 2. Signal flow

3.3 Performances

In the first performance the performer/sound artist positioned their body obliquely, they had the sensors placed on them, linked to a computer and a controller that were placed right in front of them, next to their head there was a microphone with a stand. The tension increased as the piece progressed, stemming from the combination of the performer's physical and emotional state because of the act of the performance itself as much as because of the hyperventilation. The performer's intention was to take as deep and long breaths as possible to make the sensor reach its extreme-most values.

The second performance (figure 3) was an attempt to make less obvious the relationship between the body and the computer. The aim was to shift the focus entirely on the performer's body. The computer was removed from the stage, and the controller was removed altogether from the process, any changes in the parameters that were previously made by the controller were automated. Likewise, the microphone placed on a

stand was replaced with a wireless head microphone, and an electronic stethoscope was added to the system reinforcing the sound of the heartbeat. With the addition of the stethoscope, the total duration of the piece was extended to 14 minutes. This version of the performance had an additional section, a moment where all other sounds went to the background offering space to the sounds of the live and pre-recorded heartbeats; these two elements offered a rhythmic variation to the piece. The changes in this second performance of the piece, although might seem minimal or insignificant, offered a strong impact to the overall experience. The only bodily movement in the second version of the performance was the chest and belly movement caused by the breath: the body therefore gained an even more central role.

The observations that emerged after the presentations span on different levels: from practical to conceptual aspects, creating space for further development, perhaps even a continuous reconfiguration of the project as a whole. A fundamental observation concerns the personal aspect of the work, it is a continuous exposure of the physical and emotional state of their body, giving also an ephemeral aspect to each presentation. What was noticed by the majority of the audience was the strong intensity of the performance. The sharing and presentation of sounds from within the artist's body, revealed an aspect of vulnerability. These sounds generate a sense of familiarity and ease the listeners to surrender and immerse into the flow of the soundscape. Further on regarding the content of the performance and the overall experience, the audience claimed that the work generated a sense of suspension and exploration, it fostered strong variations in emotions fluctuating from anxious moments to moments of calmness suggesting a sense of focus to the present.

In the practical aspect of the work, the observations that emerged relate to the end of the work and its overall structure and duration. Most of the audience members expressed their need for a longer duration of the work in order to become more perceivable (aurally and visually) the impact and the fatigue of the performance processes on the artist's body. Such a longer duration would offer space for a deeper understanding of the concepts dealt by the performance. By significantly increasing the performance duration and by extending the different sections of it, alternating silences with escalation of intensities, and adjusting the structure accordingly to maintain the performer's involvement increasingly, the work would become much more demanding taking on aspects of a long-duration performance. An extended duration of the work may allow experimentation on the endurance of the body, something that might contribute to the overall experience as the artist's complete physical exhaustion would become apparent. Another aspect that emerged as a potential field for exploration was the positioning of the audience. One suggestion was that the artist's body should be placed in the centre with the audience around it. Nonetheless, the work seems to demand exploration on alternative seating options.



Figure 3. “Cyborgutt” performance

4. CONCLUSIONS

The valuable feedback from the audience of both performances (in form of discussions that took place at the end of both events), and the personal reflections of the performer, informed the final conclusions of this paper.

Observing Masumi’s analysis of the body and his alternative perspective that moves away from the boundaries of the skin and elevates it to a system of relationships between bodies, time, and space, what becomes obvious, is the relativity of our perception and the fact of a constant variability that governs each body as part of a network. Therefore, the exploration of processes that examine, deconstruct, and potentially redefine traditional notions are important for our liberation from barren boundaries and misconceptions.

It becomes clear that fluidity as a framework for existence offers itself as a tool for understanding and exploration in different contexts. Every body and every sound is unique, their properties might be labeled in one or another way merely because they might operate within specific subjectively defined boundaries. The notion of non-binary identity of body sounds becomes the pivot for the making of an original sound art / performance, challenging conceptions, etiquette and taboos. The use of the electronic stethoscope in the music performance played exactly that fundamental role: it served as a means to challenge these misconceptions by establishing a nuclear connection with the sounds of the body by integrating them live into the sound landscape. Listening to these sounds, which carry rhythms and operate on a contemplative repetitive basis, induces tranquility and immersion in the present moment.

The sensors were crucial both for the visual and the conceptual aspect of the performance. They contributed in limiting the visual noise from the stage by removing all computers and controllers, and at the same time they gave the keys of control of the entire aural experience to the physical and mental capacities of the body, rendering the work much more conceptually integral. The experience of executing a piece without having a rational and physical control over it (by using midi controllers or similar) but having the body and the movements of its vital functions to be in charge of the development of the work makes the experience much stronger and much more personal overall. Throughout

the duration of the recordings and ultimately the performance, the body embarks on a feedback loop between the sounds it hears and the sounds it makes, bringing the processes of composition and execution into the discovery of new pathways of musical performance, musical expression and introspection.

The replacement of the conventional computer controllers with sensors that monitor physiological processes of the body, affect eventually the individual’s receptivity, as they allow the body to control different sound parameters, more than it is accustomed to, while simultaneously perceiving the sonic outcomes of this process and its internal state. This self-sustaining system approaches the essence of the synthetic sequence attempted in live presentations of cyborg artistic practices. Considering that the characteristics of cyborgs suggest the enhancement of the body capabilities and the production of new sensations, the critical approach implemented in this creative project suggests such a stance to a substantial degree. Following Haddow’s proposition about everyday cyborgs and the suggestions of Harbisson and Ribas regarding the cyborg’s characteristic as something independent of augmented bodily capabilities, but rather as a self-identification property, this performance showcases some of these notions and underlines aspects of the cyborg totality.

Regarding the cyborg experience, it is important to remember Stern’s observation about the confinement imposed on body and sound, confinement caused by digitality (Stern, 2018), the finite nature of interactive techniques and the use of sensors. These techniques inherently provide a control that parametrises movements, delimiting their outcomes and intensifying them within a predefined set of specific conditions. This trajectory however diverges from the concept of fluidity and deconstruction of predefined perceptions, allowing for some solutions but not leaving room for an infinite range of possibilities that may emerge after each action. Therefore, achieving increment in randomness is becoming a primary objective within the framework of such research paths, a process that could possibly be realised through the integration and experimentation with AI systems.

Last but not least, this performance constitutes an open segment of a continuous journey, still in development. The piece couldn’t be considered as an end, given that the journey’s attempt is to transcend finish lines, highlighting the importance for fluidity of every action. The work manages to create a temporal event, a framework of an aural coexistence, in which the audience and the performer explore sounds without limitations and come into contact with the body and the constant alternating sound intensities it creates. On a first level, by observing the fluid dynamics that define the conditions that make the sound work, one may say that the sound universe it creates is of a queer character. In a second instance though and by giving it a closer look, one may argue that the soundscape constitutes a queer substance, due to the content of the sounds from which it consisted. By collecting sounds that are considered taboo either in a musical context or in social conventions (stomach sounds, sounds of pleasure, breath, etc.), as well as sounds from marginal bodies, such as a non-binary body in this case, the composition is constituted as inherently queer.

Future variations could accommodate more

bodies creating a wider sonic fusion, as well as three-dimensional use of sound, given the relationship of space to body and sound. By including the audience in the system of sensors and incorporating multiple bodies at once, the possibility of greater immersion and inclusion of the audience arises. In a similar direction, by extending the time of the performance and pursuing a durational installation, a deeper immersive experience can be achieved. Meanwhile and lastly, expanding the time, the performer's fatigue and physical exhaustion emerges as a potential closure of the work, with the literal extinguishing of the body.

Acknowledgments

We would like to thank Thanos Vovolis for providing references and valuable information and M. Eugenia Demeglio for her help and overall support.

5. REFERENCES

1. J. Butler, *Bodies that matter*. New York: Routledge, 1993
2. J. Halberstam, "What's that smell?," *International Journal of Cultural Studies*, vol. 6, no. 3, pp. 313–333, Sep. 2003. doi:10.1177/13678779030063005
3. F. Jarman-Ivens, *Queer Voices Technologies, Vocalities, and the Musical Flaw*. New York: Palgrave Macmillan, 2011
4. C. A. Marchiselli, "Queer sonorities: Sound as persuasion in Gertrude Stein's *tender buttons*," *Women's Studies in Communication*, vol. 39, no. 1, pp. 69–85, Jan. 2016. doi:10.1080/07491409.2015.1127302
5. B. Massumi, *Parables for the Virtual: Movement, Affect, Sensation*. Durham: Duke University Press, 2022.
6. N. Stern, *Implicit Bodies Through Explicit Action. Perspectives: International Postgraduate Journal of Philosophy* 1 (1):64-87.
7. G. Thomas "SEX/SEXUALITY & SYLVIA WYNTER'S 'BEYOND...': ANTI-COLONIAL IDEAS IN 'BLACK RADICAL TRADITION'" *Journal of West Indian Literature* 10, no. 1/2 (2001): 92–118. <http://www.jstor.org/stable/23019781>.
8. D. J. Haraway, *Cyborg Manifesto*. Victoria, British Columbia: Camas Books, 2018.
9. G. Haddow, *Embodiment and Everyday Cyborgs: Technologies That Alter Subjectivity*. Manchester: Manchester University Press, 2021.
10. V. Michielon, "Becoming illegible. Jaime del Val: How to disrupt control society," *Digicult*, <https://digicult.it/news/becoming-illegible-jaime-del-val-how-to-disrupt-control-society/> (accessed Mar. 10, 2024).
11. "What it's like to be a cyborg, as explained by a Cyborg," *VICE*, <https://www.vice.com/en/article/gvv7dj/what-its-like-to-be-a-cyborg-as-explained-by-a-cyborg> (accessed Mar. 10, 2024).
12. J. C. Hu, "Sense hacking: The real-life cyborgs of the DIY augmentation scene," *How We Get To Next*, <https://www.howwegettonext.com/sense-hacking-the-real-life-cyborgs-of-the-diy-augmentation-scene/> (accessed Mar. 10, 2024).
13. E. R. Miranda, *Guide to Unconventional Computing for Music*. Cham: Springer International Publishing, 2018.