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ESSAY

Future-making through eventing human-machine listening

[version 1; peer review: 2 approved, 2 approved with reservations]

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Abstract

Reverb-Resonate: Sounding the Affective Frequencies of Migration operates at the intersection of art, science, and technology to articulate an emotional landscape of migration and exile. Rooted in the methodology of research-creation (RC) and grounded in the interdisciplinary field of Art, Science, and Technology Studies (ASTS), the project transcends conventional disciplinary boundaries to offer speculative possibilities through human-machine listening. Drawing on the body is an already augmented site, the project makes audible physiological sensors that capture micro-level intricacies responsible for stress regulation. Listening, is, thus, foregrounded as the core public engagement strategy, creating a layered sound collage that interweaves somatic registers of recorded breathing samples and physiological sensor values with machine listening to recreate new forms of sound. Engagement with ASTS is, hence, in the form of a method that traverses transforming sensor application, generating technicized sound and composing an acoustic experience capable of affective engagement. Through machine learning—a subfield of artificial intelligence—the notion of 'machine listening' extends beyond human hearing limitations, introducing non-normative structures to challenge and expand habitual forms of human listening. *Reverb-Resonate*, hence, leverages artistic strategies and techno-augmentations to address the crisis of imagination that hinders opening up to realities far from the familiar and the personal to imagine 'what could be' as a way of future-making. It underscores the critical edge of RC and ASTS in addressing complex critical issues, proposing a speculative space where the human-machine hybrid puts forth a socio-technical assemblage of listening to understand 'otherly' experiences. The project, thus, advances a critical inquiry into the mediation and augmentation of listening to imagine new possibilities for embodied engagement with unfamiliar emotional spaces and experiences.

Open Peer Review

Approval Status ✓ ✓ ? ?

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Any reports and responses or comments on the article can be found at the end of the article.

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Acoustic Experience, Human-Machine Symbiosis, Machine Listening, Future-Making, Affective Attunement

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Context: From research-creation to art, science and technology studies

The following is a survey of theory and practice-based observations across the experiments I have and will conduct that fit within two rather peculiar orientations to scholarly work that stem from disrupting disciplinary boundaries. The grounding orientation is the one rooted in research-creation (RC) as a Canadian academic methodology that I situate my scholarly and artistic work within. As a close counterpart of the European framework of artistic research, RC does not separate research from practice but acknowledges that one necessarily informs the other as a way of making and disseminating new forms of knowledge. While as the name implies, RC maintains research and creative practice in a constant dialogue with one another, it tends to have an interventionist approach to conventional modes of knowledge production considering its focus on process-based and experimental inquiry.[1]

RC, thus, carries a dual impact as it has the capacity to analyze and comment on—in the tradition of social sciences and humanities—and to produce new forms of knowledge intertwined with the analysis and the critique using the generative methods of artistic practice in its wide definition. My alignment with this tradition is rooted in the speculative power it has to offer which is in line with fields that have a critical bent as "they speculate about different times/spaces from a particular time/space, and in so doing shape and co-compose what could be."[2] What could be, concretely in the case of my project, is building possibilities of experiencing forms of emotional space emanating from lived experiences that are unfamiliar through mobilizing the hybrid space of art-science-technology.

The latter construct, thus, touches upon the second orientation: the conglomeration of technoscience—an already hybrid of science and technology—and artistic inquiry as established within the interdisciplinary field of Science and Technology Studies (STS) as Art, Science and Technology Studies (ASTS).[3] The recent developments in technoscience, particularly intelligent machine systems and their agentive quality have further complexified the technological infrastructure, giving rise to the inclusion of these artefacts and processes as part of socio-political life.[4] In this sense, as machines become an indispensable part of human life, hence the term *socio*-technical systems, they allow for new ways of interacting with the world, at times as augmentations, and at other as amputations.[5]

Within ASTS, these augmentations and amputations can then be made tangible leveraging the practice-based nature of art which in conjunction with RC can engage with critical commentary. These hybrid spaces then reinsert the fact that "science has failed to produce anything like the public sphere of art to entertain the cultural and ethical arguments we need to have about our technoscience."[6] The way, thus, RC and ASTS imbricate allows for a new approach for a public-facing engagement and concretizes what is often hidden behind thick academic walls. Above all, these two orientations allow for machines and non-machines (here not only humans and machines but also agentive object-processes emanating from convergence of the two) to come together to be initially viscerally felt and consecutively critically processed thanks to the experience-building and event-making capacity of artistic practice. As this machine-nonmachine ensemble reorients the way the world is perceived, the capacity of mutual action brings attention to dimensions that humans could not have seen and hence could not have perceived to open up a critical capacity for better understanding of the self and the other. It is at this intersection that my ongoing project operates within, and my writing emanates from to put forth experimental, process-based work—streams of thinking and bursts of making—rather than reporting the outcome and findings after the fact. The goal behind such a sketching is to showcase the heterogenous coupling of sites of knowledge underpinning machine-nonmachine framework and their potential to produce speculative possibilities.

The project: From body to sound

My ongoing project entitled *Reverb-Resonate: Sounding the Affective Frequencies of Migration* that has gone through several iterations and experimentations as it continues to do so, focuses on leveraging sound to convey the affective and emotional tone of my lived experience as a migrant in exile to audiences. Framed as ineffable and hence notoriously difficult to convey, the project formulates migration and exile as embodied experience with the goal to collect corporeal-level information from my body to make these registers felt through acoustic experiences. I, hence, draw on augmentations of somatic phenomena using sensors fit to capture such information from the body that makes visible the micro-level intricacies in metabolic and biochemical processes involved in regulating stress. In this scenario, the technoscientific extension to the body allows for capture and augmentation of otherwise

[1] Chapman, Owen B., and Kim Sawchuk. "Research-Creation: Intervention, Analysis and 'Family Resemblances.'" *Canadian Journal of Communication* 37, no. 1 (April 13, 2012). https://doi.org/10.22230/cjc.2012v37n1a2489.

[2] Truman, Sarah E. *Feminist Speculations and the Practice of Research-Creation: Writing Pedagogies and Intertextual Affects*, 2022, 7.

[3] While there has been a number of inquiries to probe the intersection of art-science-technology (Borgdorff *et al*. 2020, Calvert & Schyfter 2017, Salter *et al*. 2017, Sormani *et al*. 2019), it was Rogers *et al*. (2021) that proposed the term ASTS as the intersection of artistic practice and STS.

[4] Braun, Bruce, and Sarah Whatmore, eds. *Political Matter: Technoscience, Democracy, and Public Life*. Minneapolis, Minn.: University of Minnesota Press, 2010; Crawford, Kate, and Jason Schultz. "AI Systems as State Actors." COLUMBIA LAW REVIEW 119, no. 7 (2019): 1941–72.

[5] McLuhan, Marshall. 2003. *Understanding Media: The Extensions of Man*. Edited by W. Terrence Gordon. Critical edition. Corte Madera, Calif: Gingko Press.

[6] Jones, Caroline A. "Foreword." In *Routledge Handbook of Art, Science, and Technology Studies*, edited by Hannah Star Rogers, Megan K. Halpern, Dehlia Hannah, and Kathryn de Ridder-Vignone, Abingdon, Oxon ; New York, NY: Routledge, Taylor & Francis Group, 2021, xix. https://doi.org/10.4324/9780429437069.

invisible bodily processes but not as an uncritical enhancement of the body in a transhumanist quest[7] for enhancing biological processes.[8] Instead, the project aims to open up the possibility to bring awareness to intricacies of affective response felt in the body, where complex experiences are felt, using the affective language of the sound. In doing so, listening is taken up as a sensory prompt as the biological signals are transformed into acoustic signals to take an audible form.

In this sense, as the sensor readings constantly reshape and reshuffle the acoustic qualities, a different level of physiological affective response, that of recorded breathing rhythms creates a foundation for listening. On a complementary level, sensor readings then sensitize the ears by shifting the qualities of the sound as their qualities change. The sound is, thus, composed as a 3-layered collage where direct recorded samples are interwoven with *machine listening* output—a concept within computer music to generate new forms of sound from already existing ones—along with sensor values that interlace these two levels. As the capacity—or rather agency—of machines to listen to and reproduce sound, machine listening in this case uses machine learning to create an expanded and non-normative form of listening. The goal behind complexifying the sound by foregrounding novel forms of sound objects is to create a new sensorial space where the unfamiliarity of my experience can be felt through the eccentric qualities of sound.

The project, thus, takes the contemporary body as an already augmented-amputated technoscientific site to activate an ASTS method that comprises transforming the application of sensor as a technoscientific object, generating technicized sound, and devising artistic strategies to compose an acoustic experience based on these augmentations to circle back to body. The attention to body on a larger scale is then meant to underscore the close coupling between bodily sensations, emotions and lived experiences. These dynamics then leverage creative production to comment on complexities of migration and exile, the body as a site for emotion regulation, and techno-augmentation and hence tap into the "hyphenation" of RC that allows the synthesis of research and creation.[9] However, beyond the frameworks that this project feels at home with—RC and ASTS—the framing of machine-nonmachine as a way to probe the technicized and the non-technicized under a rubric for exploration and assessment is especially apt. This orientation, thus, enables dealing with sound making sourced from the body that juxtaposes the unquestionable material nature of this type of sound, human operation to materialize and later consume it, with machine operation to augment the body and technicize the sound. To focus on one aspect of the project and engage with an analysis rooted in the frameworks discussed, what follows looks into the act of listening, its personal, social and machinic aspects and the way the project activates these dimensions to build transformative experiences.

Sociology of listening: The personal, the social, the technical

Analyzing the three levels of listening—personal, collective, and machinic—that the artistic process incorporates can elucidate how listening is central to the project. The first question that emerges is what is listening in the first place? As Jonathan Sterne aptly points out, listening ought to be differentiated from hearing as it is a learned capacity as opposed to a biological function. Hence, there is a level of entrainment already built into the experience of listening in the form of techniques culturally learned to attune the ear to sounds. With modern-day technicization of listening then specific practices were developed to assign logic and objectivity to listening that Sterne refers to as "the Audile technique."[10] Along the path of entrainment, different qualities of listening add layers of nuance into the formalized experience particularly evident in the two modes of *causal listening* and *reduced listening*. While causal listening intends to collect information about the source, reduced listening engages in exploring the sonic qualities and textures regardless of semantic qualities.[11] On a personal level and in the absence of linguistic communication and direct semantics, the listener, thus, still looks for cause-effect relationship as a historically conditioned reflex.[12] It is, thus, only in the process of loosening up causal listening with the intent to disrupt such patterns that the reduced listening come into play to open up the imagination.

Beyond the personal level, in the collective setting, listening becomes more of an interconnecting social experience when making personal-level deductions are challenged through reduced listening and attention is paid to qualities of sound and their impact on the body. However, collective listening does not require a radical transformation from personal to social to begin with as it seems to already have an inherent sociality built into it since the listening subject is already a social subject that socializes through the act of listening. In his book *Introduction to Music*, Theodor Adorono opens up by this provocation: "asked to say offhands what a sociology of music

[7] Transhumanism is the position that takes positively the accelerated technological advancements as a way to enhance the human mind and body to transcend bodily limitations. See for instance: Kurzweil, Ray. *The Singularity Is near: When Humans Transcend Biology*. New York, NY: Penguin Books, 2006.

[8] See Quantified Self movement that operates based on constant self-monitoring to log sensor data from the body as a way to constantly track and improve biological processes, for instance by regulating the heart rate, integrating enough exercise in a daily routine, managing sleep patterns and lowering stress level. See for instance: Lupton, Deborah. *The Quantified Self: A Sociology of Sel-Tracking*. Cambridge, UK: Polity, 2016.

[9] Stévance, Sophie. *Research-Creation in Music and the Arts: Towards a Collaborative Interdiscipline*. Revised and Updated translation. Abingdon, Oxfordshire: Routledge, Taylor & Francis Group, 2019.

[10] Sterne, Jonathan. *The Audible Past: Cultural Origins of Sound Reproduction*. Durham: Duke University Press, 2003, 23.

[11] Chion, Michel. "The Three Listening Modes." In *The Sound Studies Reader*, edited by Jonathan Sterne, 48–53. New York: Routledge, 2012.

[12] While causal listening is tied to an evolutionary drive for survival, this mode of listening has been formally sharpened and sensitized towards universal objectivity as a modern technique.

is, one would probably start by defining it as knowledge of the relation between music and the socially organised individuals who listen to it."[13] Thus, a listening experience in a public context—whether music, sound art, broadcast, or speech—assumes a social position superimposed over the personal experience. The sociology of listening within the framework of this project, thus, pays attention to the networked experience of listening beyond the individuation of the sound within a complex sphere of socio-technical assemblages that encompass the personal, the social and the technological.

Listening to machine listening: A speculative space

The latter structural element, the technological, touches upon the phenomenon of machine listening embedded in the history of technicization of listening, from techniques to apparatuses aimed at expanding the scope of listening. Within this domain, while numerous publications have addressed technical implementation of machine listening, in this context using machine learning for sound generation,[14] a dearth can be identified on the theoretical-critical level and how the phenomenon is figured into the human imaginary. I will, thus, touch upon machine listening as a strategy to get passed the human hearing limitation which concurrently then gets folded into vast socio-technical assemblages as an indispensable part of human listening practices. Machine listening, in this vein, addresses the deficit of human listening and sensemaking by way of recognizing machine to have a capacity "to listen more."[15] While listening has classically been bracketed as a solo experience where subjectivity is the cornerstone of listening, the transformation of human listening through technological mediation has already challenged the strict subjectivity associated with listening as a complementary stance to the sociology of listening argument. As Domenico Napolitano and Renato Grieco assert, machine listening further challenges the paradigm of listening as it operates on its own logic far different than that of the human logic of listening, "insofar as it is the materialization of nonhuman and desubjectivized listening."[16] By mobilizing the concept of the socio-technical—the one central to the STS epistemology highlighting the inseparability of the two phenomena—they then argue that the act of listening fundamentally occurs between the human and machine. This argument is not a simplification but an acknowledgement of the complexity of different layers and processes involved in technological listening that engages humans and their extended technological apparatuses which Napolitano and Grieco refer to as *the folded space*.[17] Thus, while machine listening holds fundamentally different qualities in relation to human listening, its output is meant to get folded into the human listening experience to form augmented listening as a distinct socio-technical imaginary.

This argument is in line with the concept of human-machine hybridities vastly discussed in the STS scholarship,[18] to reckon with the increased permeability of boundaries between humans and machines. More importantly these two distinct logics are negotiated in a mutual substrate to achieve a certain goal, highlighting a reciprocity that goes beyond machines or humans assuming a submissive role. In the particular case of art produced using machine learning, the level of autonomy that the machine assumes can be shockingly lively in comparison with classic artistic media as it appears "strange, surprising, indeterminate, unfathomable, uncanny, unexpected, unpredictable, unexplainable, and unknowable."[19] In this sense, machine listening assumes an 'animate' quality where the phenomenon of listening more teases the human listening habits and the audible techniques sharpened historically. The folded space then becomes a space of a new audile technique to be developed where these novel qualities of listening become part of the human listening spectrum.

Machine listening operating at the intersection of machine learning[20] and artistic practice then leverages the capacity of machines to tap into the already ubiquitous remix culture brought about by the legacy of computer art to recycle existing forms and create new recombinations as a way to speculate the future.[21] In this process the human and machine action are

[13] Adorno, Theodor W. *Introduction to the Sociology of Music*. Translated by E. B. Ashton. New York: Continuum, The Seabury Press, 1976, 1.

[14] Collins, Nick. "Automatic Composition of Electroacoustic Art Music Utilizing Machine Listening." *Computer Music Journal* 36, no. 3 (September 2012): 8–23. https://doi.org/10.1162/COMJ_a_00135; Meza, Gerardo. "Exploring the Potential of Interactive Machine Learning for Sound Generation: A Preliminary Study with Sound Artists." In *Proceedings of the 2023 New Interfaces for Musical Expression Conference*, 604–7. Mexico City, Mexico, 2023; Smith, Benjamin, and Guy Garnett. "Machine Listening: Acoustic Interface with ART." In *IUI '12: 17th International Conference on Intelligent User Interfaces*, 293–96. Lisbon, Portugal, 2012. https://doi.org/10.1145/2166966.2167021.

[15] Parker, James E K, and Sean Dockray. "'All Possible Sounds': Speech, Music, and the Emergence of Machine Listening." *Sound Studies* 9, no. 2 (July 3, 2023): 253–81. https://doi.org/10.1080/20551940.2023.2195057.

[16] Napolitano, Domenico, and Renato Grieco. "Folded Space of Machine Listening." *SoundEffects - An Interdisciplinary Journal of Sound and Sound Experience* 10, no. 1 (January 15, 2021): 176. https://doi.org/10.7146/se.v10i1.124205.

[17] Ibid, 182.

[18] Haraway, Donna. "A Manifesto for Cyborgs: Science, Technology, and Socialist Feminism in the 1980s." In *The Postmodern Turn: New Perspectives on Social Theory*, edited by Steven Seidman. Cambridge; New York: Cambridge University Press, 1994; Hayles, N. Katherine. *How We Became Posthuman: Virtual Bodies in Cybernetics, Literature, and Informatics*. Chicago, Ill: University of Chicago Press, 1999; Suchman, Lucille Alice. *Human-Machine Reconfigurations: Plans and Situated Actions*. 2nd ed. Cambridge; New York: Cambridge University Press, 2007.

[19] Audry, Sofian. *Art in the Age of Machine Learning*. Cambridge, Massachusetts: The MIT Press, 2021, 161.

[20] Machine learning is a subfield of Artificial Intelligence heavily reliant on principles of statistics where algorithms learn from existing datasets to make predictions about the future patterns. Recent generative models operate autonomously, without direct supervision, and iteratively learn from data with the goal to generate new sets of data similar to the training set.

[21] See Lev Manovich's wide scholarship (e.g., 2003, 2005, 2007, 2023) on the concept of remixability that taps into the cultural practice of modularity and remix in creative practices from a historical perspective.

inseparably fused together to create a hybrid where both exert agency to reach a common goal. In this sense, as during the training process machines develop new behaviors in an adaptive manner over which the artist have only an indirect control, the autonomy of the machine means the desired result may only be achieved through a process of trial and error,[22] in order to achieve a common ground of mutual intelligibility.[23] In the context of machine listening, this degree of autonomy then allows for true improvisational tones to come through, creating forms that at times can be radically different from human-centered synthesis logic. As a result, different pathways of speculation can become activated through phases of reduced listening that underlines formal qualities over familiar sonic maneuvers in the cause-effect chain of causal listening. The new space of audile techniques then goes beyond the crisis of imagination that hinders opening up to realities far from familiar and personal narratives to imagine *what could be*.

Machine-nonmachine assemblage: Expanding senses

On a pragmatic level, to highlight the critical perspective of the project, machine listening is a strategy to tap into the speculative possibilities of listening as a way to bring awareness to emotional tones unfamiliar to the listener. As the recorded breathing rhythms create the material for the machine listening, the reproductions captured as the result illustrate what listening more can mean. From the perspective of habitual human-centered listening, the machine listening operation in this project can appear as operating on a warped scale as it confuses and conflates that which is close with that which reverberates at a distance, exaggerates the frequency and the repetition, and sharpens some textures while muffling others. The slightly awkward quality of these reproduced sounds that make sense while they do not then bring further attention to the experience of listening that falls between causal and reduced listening. The project, hence, puts forth a further expanded acoustic collage that integrates the machine listening result along with my selection of some of the original recorded rhythms of breath to underscore the differences in sonic qualities and sharpen the sense perception.

In this vein, the machine-nonmachine assemblage involves multiple actors: human (and its micro and macro materiality) and machine (as hardware and software—computer, sensor, and their circuitry, software and code including algorithms) along with their products as biological and acoustic signals. This assemblage can then make felt the affective intricacies that take up a shape, that of listening, as an embodied experience. This level of feeding the somatic intricacies—biological signals from sensors and breathing rhythms—back into the body for a transformative emotional impact through human sense perception then makes use of the technoscientific, the artistic, and the critical to create a space for embodied understanding of unfamiliar lived experiences. This new assemblage of listening that occurs between the machine and nonmachine foregrounds audition to tap into the future-making qualities of technicized sound reproduction, laying down experiences and possibilities beyond the quotidian firsthand personal experience. Future-making in this sense, goes beyond the linear temporal construct of past, present, and future to instead tap into *futures* as multiplicity of possibilities taken shape as "imaginary 'others' outside the ordinary" to open up towards alternative pathways.[24]

As the project iteratively takes different shapes through experimentations, it makes use of already-established frameworks discussed to design various acoustic collages and adjust the codes of interaction with audience in different performative settings. The goal is then to rehearse different ways of future-making to transduce affective resonances tied to my experience towards creating the conditions for affection, i.e., the quality of being attuned to an affective and emotional space, that of mine. As the project posits technicized listening as an active site for expanding sensory capacities, it imagines the possibility to tap into unknown emotional spaces and by extension unfamiliar experiences. In this vein, the project becomes a critical inquiry into the ways machines can mediate and augment our capacity for understanding 'otherly' experiences by expanding the universalized and habitual forms of navigating the world. It suggests that through the creative application of machine listening and integration of biological and acoustic signals, new pathways for comprehending the nuanced intricacies of experiences that might otherwise remain inaccessible can be opened. In this manner, *Curves & Reverbs* remains faithful to the urge for experimentation, the drive for subversion and heterogenous recombination as the crux of practices that grapple with the uncomfortable task of conducting research under the rubric of art-science-technology to highlight critical and problem-oriented perspectives.

Ethics and consent

Ethical approval and consent were not required.

Data availability

No data are associated with this article.

[22] Audry, *Art in the Age of Machine Learning*.

[23] The concept of mutual intelligibility (see Suchman 2007) implies a symbiotic relationship where human and machine learn to understand each other within the confines of their operational paradigms. In this context, the artist requires recognizing patterns and potentials inherent in learning algorithms, while the machine adapts to artist's inputs and adjustments.

[24] Kjærsgaard, Mette Gislev, Joachim Hales, Rachel Charlotte Smith, Kasper Tang Vangkilde, Thomas Binder, and Ton Otto. "Introduction." In *Design Anthropological Futures*, edited by Rachel Charlotte Smith, Kasper Tang Vangkilde, Mette Gislev Kjærsgaard, and Ton Otto, London New York: Bloomsbury Academic, 2016, 2.

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Alexander Refsum Jensenius
University of Oslo, Oslo, Norway

This exciting manuscript describes the ongoing research-creation project "Reverb-Resonate: Sounding the Affective Frequencies of Migration." I found the opening contextualization and reflection helpful and the theoretical discussion interesting. One challenge is that the article aims to incorporate many terms from different disciplines, which makes it somewhat challenging to follow some of the arguments (see details below).

My most significant criticism relates to the article's lack of a description of the actual research project it discusses. After reading the article, I still do not understand much about what the research-creation process has entailed or the artistic, experiential, and exploratory products it has produced. What types of sensing have been used? How has the data been sonified? What types of machine learning have been employed? Have others than the author been involved in the process? Where have the results been displayed?

In sum, while I am highly sympathetic to the topic and approach, I would request the following changes to be made to accept the manuscript:

1. Clarify (and perhaps simplify) some of the terminology used and present it in a way that makes it welcoming to read for researchers and practitioners from neighboring (inter)disciplines.
2. Present (at least briefly) the actual project so that the theoretical discussion is understandable.

Here are some more specific comments:

- I find the abstract too long for such a short article. I suggest shortening it slightly and presenting it in only one paragraph.
- Can you explain what you mean by "disrupting disciplinary boundaries"?
- It may be that "research-creation (RC) as a Canadian academic methodology". However, this approach is also outside of Canada, so writing this piece in a larger international context would be better.
- I do not understand what you mean by "nonmachines (here not only humans and machines

but also agentive object-processes emanating from convergence of the two)". I would think that your pairing of "machine-nonmachine" describes the convergence between the two. But what, then, is the nonmachine?
- Word pairs like "machine-nonmachine" should use an en-dash (instead of a hyphen) to denote the connection.
- As far as I can see, physiological sensors have been used, but no details are given. If so, I don't think you actually measure "metabolic and biochemical processes", so this should be corrected or explained.
- I don't understand the sentence "listening is taken up as a sensory prompt as the biological signals are transformed into acoustic signals to take an audible form." What is a sensory prompt? I guess you mean perception? How are tbe biological signals transformed?
- What do you mean by "contemporary body as an already augmented-amputated technoscientific site". What is a "contemporary body," and how does it differ from other (non-contemporary) bodies? What is a "technoscientific site"?
- I like the term "technicized sound", although I have never heard it before. I guess it is more common to use "mediated sound", but is that different from what you mean?
- How do you define "entrainment"? I think of it as the process leading to synchronization (typically to rhythms), but how does that work when you write "there is a level of entrainment already built into the experience of listening"?
- What do you mean by "socio-technical assemblage"?

Is the topic of the essay discussed accurately in the context of the current literature?
Yes

Is the work clearly and cogently presented?
Partly

Is the argument persuasive and supported by appropriate evidence?
Partly

Does the essay contribute to the cultural, historical, social understanding of the field?
Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Music technology, sound and music computing, embodied music cognition

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Author Response 21 Aug 2024

Mona Hedayati

I would like to thank Alexander Refsum Jensenius for taking time to review this essay. As I have responded to the previous review, I would like to highlight the fact that this is not a

research paper but an essay. To clarify as I did in the previous response, this is an arts and humanities contribution, not a technical one, and it is a proceeding of a conference that is visible under the collection section. As such, it naturally responds to its thematic prompt and hence its essential to be contextualized. Questions like what “non-machines” are refer to the need for such contextualization. To respond to specific questions: - I took time explaining what I mean by RC and ASTS so that it is understandable for the general audience, however, RC is a term that is internationally used, widely written about and hence not a “local” term even though its inception was in Canada. -

I responded to nonmachine inquiry above: it is the thematic prompt of the conference that can be browsed over in the collection section. -

Thank you for pointing out the missing dash between non and machines. -
Biosignals are a result of metabolic and biochemical reactions and my argument is that they withhold the granularity and vibrance of such processes: art and humanities analysis and not technical. - I do not discuss “the how” in the essay. This is an analysis from art and humanities perspective and not a research paper (types of contributions are firmly differentiated with one another under the ORE framework) and certainly not a technical one. Indeed, while I do mention that I transform the biosignals into acoustic ones, I do not elaborate on the methods and techniques used as this is a short analysis matching the conference contribution and not a research paper where such details are tackled. But maybe referencing contributions where I go over technical details (how sensor data is mapped to sound) in the footnote could be a way to provide such details. -

Contemporary body is the one that is already hybridized with technologies; cf. Agre (1994), Hayles (2017), Viseu & Suchman (2010). -

Coining terms to draw attention to arguments is a common practice in arts and humanities. -

Again, entrainment is taken up in its social science’s embodiment. For intersection with music cf. Kim et al. 2019. -

Socio-technocal assemblage is a term derived from science and technology studies where the inseparability of social and technical systems is emphasized. Looking up the term will return many results but maybe Bijker et al. (1987) can be a good start. Finally, I would like to express my gratitude for writing a detailed review, while recentering the review criteria for essays in arts and humanities: “essays are analytic or interpretive compositions on a single topic. This could include articles outlining an argument or personal point of view. The peer review focuses on whether the research methods used are appropriate, and the claims in the paper are sound and have academic merit, not on the perceived impact of the work. Open Research **Europe encourages any reflective arguments and personal points of view in the arts and humanities.**” While this contribution has already been approved by two reviewers, I continue to meticulously study and eagerly learn from every single review, drawing from relevant and constructive points made to revise this contribution. Note: it seems from my long correspondence with ORE that they do not provide the necessary information so that reviewers already know what they are reviewing and while they mandate suggesting reviewers, they do not ask for further suggestions once the potential reviewer declined and instead go ahead and open the review process. This results in receiving reviews from experts in fields that are less (or in some cases not at all) familiar with the subject matter and their recommendations for

improvement then prove to be less relevant than not. In the case of my contribution, while ORE staff apologized for mismatch in the expertise for such reviews, they did not open the review to further reviewers suggested by me.

Competing Interests: No competing interests were disclosed.

Reviewer Report 13 July 2024

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Michele Geronazzo
Department of Engineering and Management, University of Padova, Vicenza, Italy
Andrea Gulli
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Mona Hedayati's essay "Future-making through eventing human-machine listening" proposes a theoretical framework at the intersection of art, science, and technology studies (ASTS). It treats the integration of human and machine listening as a possible vehicle to deliver affective attunement regarding the migration topic, creating possible future interactions and shared sensitivities via the Research-Creation (RC) methodology.

The author takes as an illustrative implementation the ongoing artistic (?) project entitled “Reverb-Resonate: Sounding the Affective Frequencies of Migration.” The work presented is at the intersection of different theoretical schools of thought: McLuhan's media studies, Adorno's studies on the sociology of music, and Donna Haraway's more recent works on cyborgs that criticize anthropocentrism. This background provides a solid theoretical framework for the project's intent of possible future social interactions and affective engagement through listening.

Although such interdisciplinary studies are very welcome among academic works, and such cross-knowledge can inspire different scientific fields, the essay seems to be out of focus and confusing for three main reasons.

1. First, the project referred to is never clearly explained, nor is a reference given to allow the reader to gather more information about it.
2. The concept of machine listening is never explained in depth; the opportunities and capabilities attributed to it by the author could be the same as those of the more traditional digital signal processing techniques, and no elements are provided to distinguish between the two. Machine listening can easily be confused with the computer science discipline dedicated to modeling the action of listening and its fundamental components, e.g., sound source identification, localization, and diarisation.
3. Some theoretical concepts need clarification. In several sections, a listener's personal

experience is considered as historically acquired knowledge and belief, e.g., the evolutionary concept of reduced listening, the biased identification of machine listening with machine learning approaches, the framework of embodied mind and sound-based practice for stress reduction, to name but a few.

It is fundamental for the scientific validity of this essay to take care of the three aspects highlighted, in particular the technical aspects of "Reverb-Resonance: probing the affective frequencies of migration": which sensors the author employed, which automatic listening techniques the author used, which results led to the hypotheses of the essay.

Furthermore, some ideas are taken for granted, without references, explanations, or results to support them: the crisis of imagination, the link between the remix culture and computer art (the conceptual relocation of an object dates back at least to Duchamp's ready-made), the idea that biofeedback can lead to an affective and emotional relationship. What is the relationship with the scientific literature in the field of research through design (RtD)?

Finally, the language must be revised; the sentences are too long, some terms need to be replaced with synonyms, and there are typos ("Adorono").
Does non-machine assemblage mean the involvement of animals or plants?

Some suggestions for revision:

- A reduction of the introduction, disambiguating personal ideas from established schools of thought.
- The inclusion of a section dedicated to the project "Reverb-Resonate: Sounding the Affective Frequencies of Migration" (or at least a figure explaining its workflow), and another for the topic of migration, which is completely overlooked.
- A stronger focus on the sociological aspects of listening related to this specific subject.

Is the topic of the essay discussed accurately in the context of the current literature?
Partly

Is the work clearly and cogently presented?
No

Is the argument persuasive and supported by appropriate evidence?
No

Does the essay contribute to the cultural, historical, social understanding of the field?
Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Human-computer interaction, sonic interaction design, spatial hearing and computational acoustics

We confirm that we have read this submission and believe that we have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however we have

significant reservations, as outlined above.

Author Response 14 Jul 2024

Mona Hedayati

I would like to thank Michele Geronazzo and Andrea Gulli for taking time to write a comprehensive review on my contribution. Please see my response to the points made, numbered according to reviewers' remarks:

1- The project was specifically mentioned to get at the concept of "machine listening" and the analysis behind it and not as a case study to be analyzed. But perhaps it is indeed a good idea to clearly describe this intention in my revision while further expanding on relevant aspects of the project to the concept of machine listening. Please note that there are different contribution types under Open Research Europe (ORE) framework and reviewers in general conflate these differences in their remarks, concretely between a research paper, a case study and an essay. The current contribution being a conference proceeding is supposed to reflect the content of the conference presentation and hence was suggested by ORE editors to either go under an essay or an open letter, article types radically different than those the reviewers tend to push this contribution towards. Please note that under arts and humanities, the field I have chosen to see the relevant article guidelines under, there are 9 different article types, essay being one of those.

2- I discuss machine listening "as the capacity—or rather agency—of machines to listen to and reproduce sound, machine listening in this case uses machine learning to create an expanded and non-normative form of listening." This definition clearly identifies that machine listening is intersected with machine learning in the essay. However, further down I clearly explain that the whole point to bring this intersection up is to construct an "imaginary" to go beyond human listening and in fact I do draw a spectrum purposefully. My point is not to distinguish between different ways the term can be interpreted technically, even though my citations clearly point to what I define. This is evident in the opening of the passage "Listening to Machines Listening": "the latter structural element, the technological, touches upon the phenomenon of machine listening embedded in the history of technicization of listening, from techniques to apparatuses aimed at expanding the scope of listening. Within this domain, while numerous publications have addressed technical implementation of machine listening, in this context using machine learning for sound generation, a dearth can be identified on the theoretical-critical level and how the phenomenon is figured into the human imaginary. I will, thus, touch upon machine listening as a strategy to get passed the human hearing limitation which concurrently then gets folded into vast socio-technical assemblages as an indispensable part of human listening practices. Machine listening, in this vein, addresses the deficit of human listening and sensemaking by way of recognizing machine to have a capacity to listen more."

3- I am unsure of what the reviewers mean by "a listener's personal experience is considered as historically acquired knowledge and belief." In any case, I believe that while reviewers have clearly identified this contribution to operate across disciplines, they still assume a strict disciplinary position, specifically from engineering and computer science, and in fact most comments demonstrate this point. This contribution is far from a "technical paper": in fact, it is neither technical, nor a paper. This "essay" is classified under the

collection “Non-Machines: Playground of Perspectives,” visibly marked above the contribution. A quick glance over the description of the collection will shine a light on the fact that the essay is the proceeding of an “artistic” conference and hence there need not be a “(?)” in opening of the review, of whether or not this is an artistic contribution. This is above and beyond the fact that I dedicated an entire section as the introduction to situate my work within the academic tradition of “research-creation” as well as “art, science, and technology studies” with relevant references. On the last remark regarding reviewers’ comment on the “scientific validity,” please see the above point on the positioning of this contribution, neither being a technical nor a scientific paper. This is an artistic contribution, classified as an “essay” vs. a “research paper” or a “case study” under the collection of an artistic conference and arts & humanities article type (not even natural or social sciences). The fact that I do borrow across disciplines does not position this contribution as an engineering or CS contribution and in fact there is no rational justification on why it has to be treated as a scientific contribution, other than the fact that the disciplinary lineage of the reviewers dictates so. Regarding why there is no mention of “research through design,” I underline the fact that I situated this essay as a contribution to “research-creation” and “art, science, and technology studies” and not “research through design” and I wrote an entire section on the relevance of these lineages. On the question of supporting arguments, I do not see the reason why there is a necessity to go back all the way to Duchamp here to explain the concept of remix culture while I do cite Manovich’s scholarship. I have not committed myself to drawing a comprehensive genealogy of the term or a lit review on the topic anywhere in the contribution. On the remark that “the language must be revised,” while I understand that within the disciplinary value system of the reviewers the use of “must” might be acceptable, it is indeed less so in arts and humanities, the field that I have chosen and committed to its guidelines as outlined by ORE. While, in order to solve a particular engineering problem there “must” be certain protocols that need to be followed, in the case of arts and humanities, using “must” can come across as jarring, particularly in a review scenario. Moreover, while this essay does operate across disciplines, its contribution remains in the disciplinary tradition of arts and humanities within which long sentences are not uncommon. I cannot, however, be sure what the reviewers intend by “some terms need to be replaced with synonyms.” Final points: thank you indeed for pointing out the misspelling of “Adorno.” To respond to “does non-machine assemblage mean the involvement of animals or plants?” I would encourage the reviewers to read the collection description “Non-Machines: Playground of Perspectives” to grasp how the conference organizers define the term and also to refer to my description where I refer to the term as “machines and non-machines (here not only humans and machines but also agentive object-processes emanating from convergence of the two).” Finally, I would like to sincerely thank both reviewers again for taking time to write a detailed review, while recentering the review criteria for essays in arts and humanities: “essays are analytic or interpretive compositions on a single topic. This could include articles outlining an argument or personal point of view. The peer review focuses on whether the research methods used are appropriate, and the claims in the paper are sound and have academic merit, not on the perceived impact of the work. Open Research Europe encourages any reflective arguments and personal points of view in the arts and humanities.” While this contribution has already been approved by two reviewers, I continue to meticulously study and eagerly learn from every single review, drawing from relevant and constructive points made to revise this contribution.

Competing Interests: No competing interests were disclosed.

Reviewer Report 26 June 2024

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Eunseob Kim
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The essay "Future-making through eventing human-machine listening" by Mona Hedayati explores the integration of human and machine listening to create speculative futures, particularly focusing on the affective frequencies of migration. The project, "Reverb-Resonate," leverages the methodology of Research-Creation (RC) within the interdisciplinary framework of Art, Science, and Technology Studies (ASTS). It utilizes physiological sensors to capture stress-related data from the body, transforming these biological signals into acoustic experiences. By foregrounding listening as a public engagement strategy, the project aims to create a layered sound collage that interweaves somatic registers with machine-generated sound. This hybrid approach seeks to address the limitations of human listening, introduce non-normative listening structures, and imagine new possibilities for understanding unfamiliar emotional experiences.

The essay is well-situated within the context of current literature, drawing on recent developments in ASTS and RC. The author references a wide range of sources, including foundational texts in technoscience, human-machine symbiosis, and the socio-technical dimensions of listening. This grounding provides a solid theoretical framework for the project's exploration of speculative futures and affective engagement through sound.

While the essay presents an innovative and compelling exploration of human-machine listening, its clarity can be improved. The abstract, in particular, is dense and challenging to penetrate. Simplifying the language and breaking down complex concepts into more digestible parts would greatly enhance readability. Additionally, more structured explanations and clearer transitions between sections would help the reader follow the author's line of reasoning more easily.
My suggestions are below:
1. Simplify the abstract to clearly convey the main objectives, methods, and findings of the project. Avoid overly technical jargon and ensure the abstract provides a concise summary of the essay.
2. Use subheadings to organize the content better and provide clear transitions between sections. This will help guide the reader through the essay's arguments and evidence.
3. Provide more detailed explanations of key concepts, such as "machine listening" and "affective frequencies," to ensure that readers from diverse backgrounds can understand the discussion.

The argument is intriguing and supported by relevant literature, but certain aspects require

further development to be fully persuasive. While the essay effectively draws on existing research to support its claims, it would benefit from more concrete examples and detailed descriptions of the project's implementation and outcomes.
My suggestions are below:
1. Include specific examples of how the physiological sensors capture stress-related data and how this data is transformed into acoustic experiences. This will help illustrate the project's process and impact more clearly.
2. Elaborate on the results of the project's experimental iterations. Discuss any observed changes in audience perception or engagement with the sound collages.
3. Where possible, include empirical data or case studies that demonstrate the effectiveness of the proposed human-machine listening approach in achieving its stated goals.

The essay makes a significant contribution to the cultural, historical, and social understanding of the field by exploring the intersection of art, science, and technology in addressing complex emotional and social issues. The project's focus on migration and exile through the lens of human-machine listening offers a novel perspective that enriches the discourse on socio-technical assemblages and the role of artistic practices in speculative future-making.

The essay presents an innovative and interdisciplinary approach to understanding migration and exile through human-machine listening. While the presentation and clarity can be improved, the work's theoretical grounding and potential contributions to the field are significant. With revisions to enhance readability and provide more concrete evidence, this essay will be a valuable addition to the literature.
Additional comments are below.
1. Although the author states that ethical approval and consent were not required, it would be helpful to briefly discuss any ethical considerations related to the use of physiological sensors and the transformation of personal data into public acoustic experiences.
2. Consider including a section on potential future directions for the project, such as expanding the scope to include diverse populations or integrating additional sensory modalities.

Overall, this essay is a commendable effort that bridges multiple disciplines to explore important socio-technical issues. With the suggested revisions, it has the potential to make a substantial impact on the field.

Is the topic of the essay discussed accurately in the context of the current literature?
Yes

Is the work clearly and cogently presented?
Partly

Is the argument persuasive and supported by appropriate evidence?
Partly

Does the essay contribute to the cultural, historical, social understanding of the field?
Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Human-Machine Interaction, Acoustic Ecology, Sound Art and Sonic Practices

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Reviewer Report 21 June 2024

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Eleni Ikoniadou
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The essay draws on the artistic project Reverb-Resonate: Sounding the Affective Frequencies of Migration, which centers listening by making use of technical and scientific means to bring attention to the experience of migration and exile. Relying on recent literature in Art, Science and Technology studies (ASTS) and the practice-based method of Research-Creation, the author proposes new connections between human and non-human (machines and object-processes) ensembles, as activated by their artistic project. This essay offers an analysis of these possibilities, particularly through the act of listening, which is opened up to include machine listening in the age of AI. The argument is at its most convincing listening is posited as an activity that fundamentally occurs *between* human and machine as opposed to belonging to either. Such an approach moves the conversation from the trite oppositional debate on humans versus machines to the more complex “assemblage”, “hybrid”, “merging” relations or our socio-technical reality. This project and its analysis are part of a much-needed ongoing shift in literature and methodological and philosophical approach, whereby the speculative potential offered by practice-based experiments can bring awareness to the unfamiliar and unknown states of being and feeling of the ‘other’, away from the ignorant and limiting perspective of those who own the dominant narratives. As the author explains, “Future-making in this sense, goes beyond the linear temporal construct of past, present, and future to instead tap into *futures* as multiplicity of possibilities taken shape as “imaginary ‘others’ outside the ordinary” to open up towards alternative pathways.”
My only suggestion would be to revisit the abstract, if possible, as it stands it’s a little difficult to penetrate and doesn’t do the more sufficient analysis that follows any justice.

Is the topic of the essay discussed accurately in the context of the current literature?
Yes

Is the work clearly and cogently presented?
Yes

Is the argument persuasive and supported by appropriate evidence?
Yes

Does the essay contribute to the cultural, historical, social understanding of the field?
Yes

Competing Interests: No competing interests were disclosed.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.