Entangled Listening: Exploring Relational and Diverse Listening Practices for DMI Design

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Listening is fundamental to music practices and provides technical and cultural context to the design of musical instruments. Through various entanglement theories of human-technology relations, we can understand listening as a Baradian apparatus that motivates, propels, and evaluates the design of new musical instruments. Further, we can use listening practices as a method to de-center the human. We propose a workshop primed by emerging theories in sound studies to critically examine how listening appears, how it functions, and how it performs. Through guided mediations, hands-on exercises, and prompted discussion, we aim to integrate a plurality of listening experiences and suggest tuning our listening toward more entangled design practices.

Additional Key Words and Phrases: entanglement, apparatus, listening, aural diversity, workshop

1 Background

Listening itself is an entanglement in many ways. In considering sound as an event [6], it is a combination of the things that make vibrations, the medium that sound travels through, as well as the apparatus that measures and attends to sound. Salome Voegelin and other proponents of sonic materialism suggest listening as an attunement to a material reality [2, 16]. And this attunement is not just an involvement of ears but a multisensory experience by bodies. Thinking with sound reveals an 'alternative orientation to the visual' and suggests an entangled subjectivity that is relational, neither a completely inward nor outward disposition [12].

Karen Barad's formulation of the *apparatus* takes inspiration from Niels Bohr's quantum physics to describe a performative process of producing knowledge in which observer and observed are inseparable parts of the same phenomenon. "[A]pparatuses are the material conditions of possibility and impossibility of mattering; they enact what matters and what is excluded from mattering" [1]. We propose that the concept of the apparatus offers useful insight into listening, suggesting that the boundary between "listener" (possibly technologically-mediated) and "listened" (soundscape or other signals) can be redrawn according to context. Similar to how Reed et al. describe designing with data as constructing an apparatus [11], what we consider to be sound is inseparable from how we experience it.

This workshop notes affinities between the Deep Listening practices of Pauline Oliveros [10] and digital musical instrument design practices in NIME, each of which attends in its own way to the listening apparatus. Listening is an active engagement and a punctuation of sonic phenomena [15], and we find this is especially clear in music, design, and sound art installation contexts. These practices can be critically examined through aural diversity, which questions the notion of "normal" hearing, what parts of the body are necessary in listening, or listening as a fundamentally human experience [4]. Several technologies presented at NIME having explored access towards sonic phenomena, like audification [12], haptic instruments [8], and visual stimuli [17].

Listening devices have been explored through NIME before and demonstrate an ambiguity between making music and designing musical instrumentation. Examples include participatory design of haptic instruments with people of differing hearing abilities [8], augmented sound walks with various digital manipulations [13], and a fox-like head-mounted extrasensory listening device [7]. Still underexplored, however, are methods and methodologies around relating to other modes and realities of listening. Considering aural diversity, these methods and methodologies might differ from designer to designer [4]. Regardless, our listening will always be shaped by being human. Relationality includes both relating to an environment and as a means to relate to other beings. Morton et al. suggest a critical anthropomorphism, in that we may understand similarities between beings, but we must account for the differences and imperfections of attempting to put ourselves in another's shoes [9].

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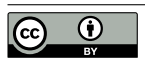

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Returning to the notion of entangled listening, we consider how to add accountability, responsibility, and ethics to our listening-making practices. In "Listening to the Leafblower", Flint traces resonances between technologies, higher education practices, and white supremacy, suggesting how listening can uncover what's not immediately seen, heard, or felt [5]. Damianakas uses methods of analogy and homology, appropriated from biology, to speculate an interspecies listening practice between humans and mollusks [3]. We are particularly interested in positioning listening as a somatic practice, and to investigate the norms of embodied practices. Spiel suggests a methodology that embraces pluralities, names norms, forgets intentions, and allows messes [14]. Listening, through this framing, is a kind of somatic practice that focuses on the temporal relationships between beings and things.

2 Key Concepts

- Listening practices, with or without technology, can actively shape and reshape imaginations, memories, and intra-actions with the world [10, 16]
- Listening as an apparatus presents an entangled subjectivity through an ongoing correspondence of thinking and doing with the material world [12]. This attentional disposition demonstrates an ambiguity between making music, exploring sound, and designing musical instruments.
- A tracing of accountabilities and responsibilities in designing musical instruments and building listening machines can begin to formulate in considering both an interdependency of beings and things in how sound is produced and a plurality of aural abilities in how sound is perceived [4].

3 Workshop Description

This workshop will run for a half day (3 hours in total). In the first part of the workshop the participants will be divided into three smaller groups. Each group will experience the follow three activites in turn. Each activity foregrounds entangled listening via a different technological configuation:

- **Ultrasonic demodulating headphones:** first created for a spatial sound installation [12], this device consists of closed-back headphones with a small microphone on the outside of each ear cup. The signal from the microphones is multiplied by a carrier frequency of 20.5kHz, creating a form of modulation that pushes ultrasonic signals down into the audible domain (and vice versa). Another curious property of the system is the way that the modulation exaggerates the Doppler effect so that every slight head or body movement perceptibly changes the frequency content of the sound. In the original installation, the headphones were paired with ultrasonic emitters playing precomposed material modulated up by a corresponding frequency. Here, we offer a reduced version of that with a small number of emitters playing simple tones, while also exploring curious phenomena discovered during the development of the installation in which certain sounds (e.g. footsteps on a hard surface, crinkling bags) produce interesting sonic experiences through the modulator. These tones are restricted to frequencies that can be played back through headphones.
- **Ultra-high sensitivity microphones:** this device consists of a pair of headphones and one or more electret microphone elements. The microphones will be deliberately set to an extremely high gain so that very soft sounds, electrical noise and interference are all boosted to audible levels. The signal will pass through a hard limiter that ensures the total amplitude never exceeds comfortable listening level, creating a situation of searching for places of quiet and solitude to be able to attune to micro-sounds amidst everyday noise. Anyone with hearing sensitivities or misophonia will be advised to proceed with caution. A byproduct of this sensitivity is that small body movements that cause the microphone or its cables to move may have audible consequences. These tones are restricted to frequencies that can be played back through headphones.
- **Earplugs and tactile listening:** many forms of listening are possible; it need not involve the ears and the auditory nerves, as d/Deaf musicians are aware. This exercise seeks to recentre the experience of listening to other parts of the body by attenuating cochlear hearing (especially high frequencies) through earplugs while increasing sensitivity in the body. A simple approach of holding an inflated balloon with the fingertips allows the perception of sound as tactile stimuli, though other membranes or surfaces could work equivalently. It is crucial to emphasise that this exercise is not presented as simulated disability; it claims no insight into d/Deaf experience. Instead, it offers a different approach to defamiliarising listening that doesn't presuppose the ears as the main locus of perception.

These three technological configurations are not exhaustive, and we will offer a variety of prompts that don't require electronics in place of headphone-based interactions. It is important to note that all three of these exercises are concerned with access. Technology as a mediation can provide access in some cases but not for all. In addition to granting access to sonic phenomena we highlight the ways in which these technologies do not.

Each group will receive a set of textual or graphic scores, that they will then explore on their own time. With any remaining time they will further explore and start to notice kinds of sonic and bodily phenomena that occur through the apparatus. Each of the prompts in some way will encourage a noticing of a particular kind of sound, and offer suggestions on how this sound could be transformed through bodily interactions, a mental reframing, or both. Each of these configurations explores defamiliarisation from everyday hearing to highlight how listening is constantly in flux.

The second part will be an integration of experience towards incorporating a plurality of listening towards design practices. After going through each of the three configurations, each participant will invent their own text or graphic prompt for entangled listening, which could be as literal as a recipe or as abstract as a graphic score. Participants will have the opportunity to explore the relationship between what they experienced and how their experience can be translated and interpreted.

We will demonstrate through this exercise that even though we are different people with our ways of experiencing the world, there are methods of relating to one another, and those methods are going to vary as well.

Finally, we will conduct a discussion of the experiences in trying to understand and translate listening experiences. By asking directed questions about similarities and differences we aim to have a productive conversation about aural diversity and what that means for design. What felt easy to communicate through score? What felt really difficult to translate as a somatic or listening experience? If you are someone who has a disability in hearing or mobility, what are ways that people in this room can better accommodate your experiences?

4 Schedule

Part 1	
Opening Presentation	15 minutes
Travel to Listening Environment	15 minutes
First Listening Exercise	20 minutes
Break	5 minutes
Second Listening Exercise	20 minutes
Break	5 minutes
Third Listening Exercise	20 minutes
Part 2	
Score Writing Exercise	10 minutes
Score Exchange Exercise	40 minutes
Discussion	25 minutes

5 Materials Brought by Organisers

- Ultrasonic installation technology including 6 headphone sets.
- 6 high-sensitivity microphone kits
- Large box of disposable earplugs
- Large bag of inflatable balloons
- Stationery materials for creating prompts and graphic scores

6 Media Links

The following two videos show sound installations by Nicole Robson using the ultrasonic listening devices used in part of this workshop. The workshop does not feature the compositional material of either installation; rather, these videos are provided to show some of the effects of moving around in space while wearing the ultrasonic demodulating headphones:

- *Being With the Waves*: https://www.youtube.com/watch?v=TSlTEDYbdAc
- *Sonographies*: https://www.youtube.com/watch?v=IAlXnZ37Vq8

7 Organisers

- **June Kuhn** is a PhD student at the Augmented Instruments Lab at Imperial College London. Her research incorporates entanglement theories towards musical instrument design, exploring listening practices, gender expressions, and live coding. She has previous experience leading listening workshops at the London LGBTQ+ Community Centre.
- **Nicole Robson** is a sound artist, musician and PhD researcher in Media and Arts Technology at Queen Mary University of London. Her research explores the experience of listening to sound installation art, entanglements of bodies and technologies with acoustic space, and interview methods for describing lived experience.

- **Brittney Allen** is a musician, music educator, and PhD student within the Augmented Instruments Lab at Imperial College London. Deeply interested in the socio-cultural implications of digital music instrument design, her research explores design philosophies and methodologies that are attentive to the expression of self, a "digital craftsmanship" approach to DMI design, and design artifacts that aid in the articulation of challenging issues by making the contributing aspects of the issues tangible.
- **Andrew McPherson** leads the Augmented Instruments Lab at Imperial College London. A composer, viola player and electronic engineer by training, his research brings together design, HCI and critical theory for the creation of new musical instruments. He is the creator of the magnetic resonator piano and TouchKeys, two augmented keyboards that have been used by hundreds of artists, and is a co-creator of Bela, the embedded platform for ultra-low-latency audio processing.

8 Requirements of the Space

The space should be large enough to accommodate 15 participants, and should meet accessibility guidelines (e.g. wheelchair access) similar to the rest of the conference. Power should be available in the space, and extension leads are requested to set up some simple audio equipment.

We also request, if available, a sign-language interpreter for any d/Deaf participants. Details of this provision can be discussed with the general chairs should it be needed.

9 Website

We will post references, resources, and schedule on a dedicated website before the workshop takes place.

10 Ethical Standards

This workshop builds in part on listening technologies developed by organisers Robson and McPherson for earlier studies which were reviewed and approved by the research ethics board at QMUL. All technologies will be tested for safety, including safe listening levels, prior to arrival at the workshop.

This workshop takes inspiration from the concept of Aural Diversity [4] which rejects a single normative notion of human hearing in favour of a broad spectrum of human and nonhuman ways of hearing. However, none of the four human organisers of this workshop are d/Deaf or significantly hearing impaired, even as our aural experiences may differ. We do not seek to use this workshop to advance a solutionist agenda toward disability or any other way of being, but instead seek to raise more general questions about what listening might mean in different contexts.

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