

Interactive comment on “Developing the hertz art-science project to allow inaudible sounds of the Earth and Cosmos to be experienced” by Graeme J. Marlton and Juliet Robson

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Received and published: 22 June 2020

Referee 4: We thank the reviewer for their comments and respond to their comments below:

Anonymous Referee #4

Received and published: 14 April 2020

"General comments: This paper highlights a fascinating project that brings together science and art in a strong collaboration. It should prove interesting to scientists with an interest in public engagement with research, as well as artists looking to draw on

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science. However, I think there are some weaknesses in the paper as it is presented, which make it difficult to follow and detract from what is otherwise interesting work. It is lacking in clarity at times and I believe it would benefit from more detail at certain points. Specific comments: There are clear connections made to interesting and relevant science content through the early stages of the project, during design and prototyping. The connection between research and the final installation is less clear, aside from the use of infrasound. High-lighting the scientific research content and how it was expressed in the main installation would substantially strengthen the connection to scientific questions, I think. I would have appreciated an explication of the context of the project among related artworks. Have any other art installations used infrasound or is this the first? Are there other works that have used vibration in a similar or different way? How does this installation relate to other experiential works that incorporate scientific data? Similarly, explaining what other public engagement or artistic projects exist around infrasound or ARISE 2 would have helped site this work in the relevant landscape."

The introduction section is to be amended to include references to similar artworks and their artists, with aims to contextualise the artwork in a broader context.

"Together, these would make much clearer the extent to which this work is novel. Occasionally, the paper refers to 'playing the infrasound' (e.g. line 186, 187). I think this is a little disingenuous. The processing is quite carefully described, but my understanding of it from this is that what is actually played is synthetically generated pinknoise, which is then processed according to the infrasound data. If my understanding is not quite right, then perhaps the section on the signal processing needs to be revisited. I wonder to what extent artistic licence was employed when creating the infrasound-scapes. Phrases such as 'This produced an effect that we felt was relatable to infrasound if we could hear it' suggest quite a lot, which in turn suggests a move away from the science. Perhaps the phrase 'keeping translatable authenticity' needs unpacking to clarify to what extent the experienced signals relate to the original infrasound signals.

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Relatedly, a flow diagram of sorts might help here (e.g. aroundline 152), to make clear exactly what the inputs, processes and outputs were for the prototypes and also for the final installation. Even after multiple readings of the paper, I'm still not sure I understand the relationship between the signals fed to the subwoofer and transducer – are they just the same?"

The author is correct. The artificially generated pink noise amplitude is modulated by the amplitude of the band pass filtered infrasound. Scientific license is added by setting the band pass filter bands based on the frequency domain of the detected infrasound which is shown in figures 3 & 4. This ensures that only the band pass filtered signal is used to modulate the pink noise. The modulated pink noise was then low passed filtered to only enable the low frequency parts of pink noise to be played via the PCs sound card to the subwoofer and transducer. To clarify this we will adapt figure 5 to act as both a diagram and flowchart.

"The information on CTBTO stations and sensors is interesting, but I don't understand the connection between this and the project. Was data from these sensors used? Are the microbarometers used by CTBTO the same as the microbarometer used on this project? The connection needs to be made clear; or if there is not one, this (lines87-91) is probably extraneous and distracting information."

The inclusion of the CTBTO was to include some context as to why and how infrasound is monitored across the globe to give the reader some additional background. The data detected by our sensor is effectively the same kind of data collected by the CTBTO sensors, but isn't included in the project itself. This section will be reworded to clarify this.

"Likewise, the reference to playing Pink Floyd through the system is confusing – did Pink Floyd use infrasound? Or was Pink Floyd's music used somewhere in the project? If there isn't any further connection, then I would suggest it is a distracting detail. "

It was a sound file used as a to initially test the system. We will retract these lines

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"A point that is made in passing, but that I think deserves much more attention, is that 'you had to be physically present in order to sense the frequencies, making it an immersive and experiential artwork'. The fact that the artwork could not be reproduced through audio or video recording marks it out as something special in a world that seems increasingly focussed on engaging publics with research digitally. I think perhaps more could be made of this in the wider context of public engagement with research. On the other hand, Section 4.4 on Web and online presence comes across as rather weak. Simply stating the numbers of impressions gives no context and no conclusion. Can any analysis be done of who the Twitter followers were or who visited the website? Were they scientists? Artists? Funders? What were the most popular posts and why? How does this performance compare to similar websites or accounts? The weakness of simply stating figures is noted in the text, but if nothing further can be added to this section by way of analysis, I would consider removing it. As it stands, I think it detracts from the flow of the paper."

We will remove this and section 4 (the feedback section) will be refocused to look at all available feedback from across all venues to assess whether hertz met is aims to reconnect people with the Earth.

"The assessment of feedback from the tour was also somewhat underwhelming. It seems largely to consist of sharing positive comments. This section would be much stronger if this was better contextualised. How many comments were received? How many of those were positive / negative? Can the feedback be analysed in more detail? The word cloud seems like a good start, but are there themes to be drawn out? A clearer explanation of how this feedback impacted the project would also be beneficial. On a different note, I don't think the description of the installation as "scary" needs to be considered negative, especially if part of the goal was to "re-establish links with the natural environment" including events that are "both majestic and alarming".

Due to the nature of the tour the co-authors were only present at the first event and were not able to oversee the data collection at the other venues in person. Thus the

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feedback received was dependent on the venue in question, for example: At “We the Curious” the quality of the feedback received was quite good. However, Tramway’s feedback did not capture the public’s feedback and only that of the organisers. Further to this feedback from the participants was entirely optional and the feedback cards left had little in the way of prompts. In hindsight it may have been better to devise 2 or 3 well defined questions to be asked on the exit of the exhibits. Given the above highlighted issues with data quality we will rewrite the feedback section and perform a different analysis which would seek to answer, using the data available, Did participants feel more connected with the earth after interacting with the exhibits. This would be undertaken using a thematic approach as suggested by the reviewer

"Much is made of the artist-scientist relationship in this work, and to my mind this (Section 5) is the weakest section of the paper; I would consider substantially reducing or rewriting it with a much tighter focus. A substantial portion of the text is devoted to expounding stereotypes about the differences between how scientists work and how artists work. This struck me as rather lazy writing. There are no citations of studies or research that look at this question, and I wonder what the basis is for these wide-ranging assertions about what scientists “will” do. Furthermore, as this paragraph progresses, it seems to lose its line of argument, and it is not clear what point is intended. Moreover, I would be wary of suggesting that the different ways two particular people react to a particular event (see lines 305-309) is as a result of one being an artist and the other a scientist – this is not a strong conclusion. Finally, the overall conclusion suggests that this collaboration “is a good model for future art science collaborations”. To be more useful, I think the “model” in question needs further explanation. What was it they did that meant it worked especially well? What do other people need to know to be able to use the same model?"

We will rewrite this section with emphasis looking at other art-science collaborations such as those described in Leach (2005) and in Webster (2005) compare to the project described here. We will also compare how the approach used here differed from that of

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Tsoupikova et al (2013) We will also draw similarities from Eldred (2016) who demonstrated how art collaboration can benefit problem solving especially for scientists.

"There are a number of grammatical and punctuation errors throughout the text that need fixing. I think it could also do with the attention of a copy editor to re-phrase a few passages as some of the writing is a little stilted. Amending these would substantially improve the readability. Technical corrections: There were a couple of names and phrases that I think need explaining in the text. A few words of context would save me looking it up and give me a better frame of reference.- Line 99, 'LT' is not explained – is this 'local time'?-"

Yes we will add this

"Line 165, what is the Attenborough Centre – is it an art space, a science space, a community space or something else?"

It is, we will clarify this in the revised manuscript

"Line 211: What is 'We the Curious'?" It is an educational science gallery We will clarify this in the revised manuscript.

"There are some straightforward grammatical errors and misuses of punctuation- Line 32: 'science technology engineering and maths' needs some commas- Line 36: 'one of those was, co-author' – unnecessary comma- Line 41: '(Wilson 1969) see figure 1' – needs some punctuation- Line 58: 'the star in turn fluctuates in brightness, satellites like Kepler' – probably fullstop, not comma- Line 59: 'transiting exoplanet survey satellite' – this is the name of a particular satellite, treat it as such- Line 98-99: inconsistency with spaces before 'Hz'- Line 150: 'synthetic generated pink noise. to ensure' – capital T on 'to' Some sentences need re-phrasing, including- Line 25: 'Technology further isolates the modern human from the natural environment in which we evolved increasingly being used as a filter through which we view the natural world.-' Line 57: 'Sound waves move through sun stars gaseous interior because of temperature changes'-"

Line 106: 'The infrasonic signals produced by the Reading thunderstorms and the infrasonic signal from the aurora is 4 times smaller.' Four times smaller than what?- Line 107: 'This shows that different phenomena produce have different infrasound signatures' Line 113: 'Robson had a spare metal wheelchair made of metal that were good at transferring vibrations.' – intentional repetition of metal?"

These will be addressed and changed in the revised manuscript

References Eldred, S. M. (2016). Art–science collaborations: Change of perspective. *Nature*, 537(7618), 125-126. – How working on a art project changes your perceptions of your own work

Leach, J. (2005). 'Being in Between': Art-Science Collaborations and a Technological Culture. *Social Analysis*, 49(1), 141-162.

Webster, S. (2005). Art and science collaborations in the United Kingdom. *Nature Reviews Immunology*, 5(12), 965-969.

Tsoupikova, D., Kostis, H. N., & Sandin, D. (2013). A practical guide to art/science collaborations. In *ACM SIGGRAPH 2013 Courses* (pp. 1-55).

Interactive comment on Geosci. Commun. Discuss., <https://doi.org/10.5194/gc-2020-9>, 2020.

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