

Interaction with sound for participatory systems and data sonification

Liu, D.

Citation

Liu, D. (2023, November 21). *Interaction with sound for participatory systems and data sonification*. Retrieved from https://hdl.handle.net/1887/3663195

Version:	Publisher's Version
License:	Licence agreement concerning inclusion of doctoral thesis in the Institutional Repository of the University of Leiden
Downloaded from:	https://hdl.handle.net/1887/3663195

Note: To cite this publication please use the final published version (if applicable).

Appendix \mathbf{A}

Supplementary materials for Chapter 4

Expert Review Checklist

Checklist

	Poor	Fair	Average	Good	Excellent		
Learnablity							
I can recognize the similarities and dissimilarities among the sounds without introduction.							
After a brief introduction I can understand it and repeat it.							
Immediacy							
I am able to recognize one sound fast. (within 2 seconds)							
I do not have to remember each sound intentionally.							
Segregation							
I can easily separate one sound from other sounds when played in parallel.							
The sound is clearly heard when there are four same sounds from four directions.							
Localization							
The sound is easy to be localized from all directions.							
The sound is easy to be localized on all layers.							

${}_{\rm APPENDIX}\,B$

Supplementary materials for Chapter 5

Instructions for Experiment I

Experiment Instructions

Thank you for agreeing to participate in our sonification study. The experiment will take you approximately 25-30 minutes. There are four speakers around you, which will play sounds during the experiment. You are free to change your head orientation, but please do not move the chair. The experiment consists of four phases:

Phase 1 Introduction (~ 2 minutes)

We designed four different sounds representing four chemical elements H, C, N, O. You can press the keys of h, c, n, o on the keyboard to playback the corresponding sounds, and press ESC to stop playing.

Phase 2 Pre-test (~ 7 minutes)

You will hear 28 sound samples, the duration of each sample will be 4 or 8 seconds. The sounds may come from four different directions (speakers) around you. Each direction will contain up to one sound source. You can use mouse (left click) to choose corresponding elements from each direction as you hear. You can change your head orientation during the test. You are allowed to leave uncertain part blank. You can press ENTER to start, each time when you finish answering please press ENTER again to go to the next question.

Phase3 Practice with feedback (~ 5 minutes)

You may have already found the differences among sounds. In this phase, you will hear several sound samples and be asked several questions as practice to get familiar with the sound design. Feedback will be provided on your answers.

Phase 4 Post-test (~ 7 minutes)

You will hear 28 sound samples, the duration of each sample will be 4 or 8 seconds. The sounds may come from four different directions (speakers) around you. Each direction will contain up to one sound source. You can use mouse (left click) to choose corresponding elements from each direction as you hear. You can change your head orientation during the test. You are allowed to leave uncertain part blank. You can press ENTER to start, each time when you finish answering please press ENTER again to go to the next question.

Training Session in Experiment I

No.____ Date_____

Practice with feedback

- 1) There are two sound sources around you. It is C from left, and what do you hear from right?
- 2) There are two sound sources around you. It is O from left, and what do you hear from right?
- 3) There are two sound sources around you. It is H from left, and what do you hear from right?
- 4) There are two sound sources around you. It is N from left, and what do you hear from right?

$$C - C_{Q1} - C$$
 $O - C_{Q2} - N$ $H - C_{Q3} - O$ $N - C_{Q4} - C$

- 5) There are four sound sources around you. How many nitrogen atoms can you hear? Please point them out (direction).
- 6) There are three sound sources around you. How many hydrogen atoms can you hear? Please point them out (direction).
- There are four sound sources around you. How many carbon atoms can you hear? Please point them out (direction).
- 8) There are four sound sources around you. How many oxygen atoms can you hear? Please point them out (direction).

- 9) There is a carbon atom in front of you, what are the other three atoms around you? Please point out their directions and name them.
- 10) There is a hydrogen atom from your left, what are the other three atoms around you? Please point out their directions and name them.
- There is an oxygen atom from your back, what are the other three atoms around you? Please point out their directions and name them.
- 12) There is a nitrogen atom from your right, what are the other three atoms around you? Please point out their directions and name them.

13) You will hear three sound sources, please point their directions and name each atom.

14) You will hear three sound sources, please point their directions and name each atom.

15) You will hear three sound sources, please point their directions and name each atom.

$$\begin{array}{ccccccc} C & X & H \\ | & & | \\ X - \begin{array}{c} C \\ Q 13 - \end{array} & N & O - \begin{array}{c} C \\ C \\ Q 14 - \end{array} & N & C - \begin{array}{c} H \\ | \\ C \\ Q 15 - \end{array} & X \\ | \\ H \end{array}$$

16) You will hear four sound sources, please point their directions and name each atom.17) You will hear four sound sources, please point their directions and name each atom.18) You will hear four sound sources, please point their directions and name each atom.

$$\begin{array}{cccccccc} O & N & C \\ | & | \\ C - C_{Q16} - C & H - C_{Q17} - H & O - C_{Q18} - H \\ | & | \\ N & C & O \end{array}$$

Appendix \mathbf{C}

Supplementary materials for Chapter 6

Instructions for Experiment II

Experiment Instructions

Thank you for agreeing to participate in our sonification study. There are four speakers around you, which will play sounds during the experiment. You are free to change your head orientation, but please do not move the chair.

Phase 1 Introduction (~ 3 minutes)

Element: We designed four different sounds representing four chemical elements H, C, N, O. We used pitch and density as two main features for the sound design in accordance with the weight differences of the four elements.

Layer: If you are standing on C₂ (please see the figure right beside):
a) First layer: only sonifying the atoms directly connected to the current carbon position (marked as yellow ones).
b) Second layer: also sonifying atoms behind the directly connected atoms (marked as light blue ones).



Example: Now you are standing on C_0 (see the figure below), you will hear three sounds adding one by one from your right. C_1 is on the first layer, C_2 is on the second layer and H is on the third layer. On one hand, the distance determines the loudness and the sound of C_1 is the loudest. On the other hand, C_2 has slightly higher pitch and more resonance, which becomes less sharp and intensive. Reverb is employed to enhance the sensation of distance of atoms in the second layer.

 $C_0 - C_1 - C_2$

Phase 2 Training (~10 minutes)

You may have already found the differences among sounds. In this phase, you will hear several sound samples and be asked several questions as practice to get familiar with the sound design. Feedback will be provided on your answers.

Phase 3 Test - Condition 1 (~ 5 minutes)

You will hear 8 set of sounds. In each set there will be maximally 8 sound positioned around you. The first layer of sounds will be played first. After 10 seconds, the second layer of sounds will be played. Each layer will contain up to 4 sounds from four directions. Please use mouse (left click) to choose corresponding elements from each direction and layer as you hear. You can change your head orientation during the test. Please choose "-" if there is no sound heard.





Phase 4 Test - Condition 2 (~ 5 minutes)

You will hear 8 sound samples, the duration of each sample will be 20 seconds. The sounds may come from four different directions (speakers) around you. Each direction will contain up to two layers of sound sources. You can use mouse (left click) to choose corresponding elements from each direction as you hear. You can change your head orientation during the test. Please choose "-" if there is no sound heard.

Training Session in Experiment II

No.____ Date_____

 \cap

Training

- 1) There is a nitrogen atom on the second layer. Now a new sound is added, which layer is this sound object on?
- 2) There is an oxygen atom on the first layer. Now a new sound is added, which layer is this sound object on?
- 3) There is a hydrogen atom on the second layer. Now a new sound is added, which layer is this sound object on?
- 4) There is a carbon atom on the first layer. Now a new sound is added, which layer is this sound object on?



- 5) There are several sounds around you. How many nitrogen atoms are positioned on the first layer? Please point them out (direction).
- 6) There are several sounds around you. How many oxygen atoms are positioned on the first layer? Please point them out (direction).
- There are several sounds around you. How many hydrogen atoms are positioned on the second layer? Please point them out (direction).
- 8) There are several sounds around you. How many carbon atoms are positioned on the second layer? Please point them out (direction).

$$\begin{array}{cccccc} C & N & H & x \\ | & C_{05} - N & C_{06} - C - O & H - x - C_{07} & C - C_{08} - x - C \\ | & | & | & | \\ C & O & C & C \\ | & | & | & | \\ H & H & H & H & O \end{array}$$

- 9) There is a carbon atom in front of you, four atoms will be added around you one by one? Please point out their directions, layers and element name.
- 10) There is a hydrogen atom from your left, four atoms will be added around you one by one? Please point out their directions, layers and element name.
- 11) There is an oxygen atom from your back, five atoms will be added around you one by one Please point out their directions, layers and element name.
- 12) There is a nitrogen atom from your right, six atoms will be added around you one by one? Please point out their directions, layers and element name.



- 13) You will hear seven sound sources, please point out their directions, layers and name each atom.
- You will hear six sound sources, please point out their directions, layers and name each atom.
- 15) You will hear seven sound sources, please point out their directions, layers and name each atom.
- 16) You will hear seven sound sources, please point out their directions, layers and name each atom.

References

- Alkemade, R., Verbeek, F. J., & Lukosch, S. G. (2017). On the efficiency of a vr hand gesture-based interface for 3d object manipulations in conceptual design. *International Journal of Human-Computer Interaction*, 33(11), 882–901.
- Bayliss, A., Lock, S., Sheridan, J. G., & Campus, B. H. (2004). Augmenting expectation in playful arena performances with ubiquitous intimate technologies. *Pixel Raiders*, 2, 6–8.
- Bilda, Z., Edmonds, E., & Candy, L. (2008). Designing for creative engagement. Design Studies, 29(6), 525–540.
- Brungart, D. S., Simpson, B. D., & Kordik, A. J. (2005). Localization in the presence of multiple simultaneous sounds. Acta Acustica united with Acustica, 91(3), 471–479.
- Carlile, S. (2011). Psychoacoustics. The sonification handbook, 41–61.
- Cipriani, A., & Giri, M. (2010). *Electronic music and sound design* (Vol. 1). Contemponet.
- Dahl, L., Herrera, J., & Wilkerson, C. (2011). Tweetdreams: Making music with the audience and the world using real-time twitter data. In *Proceedings of the international conference on new interfaces for musical expression* (p. 272-275). Oslo.
- Dahl, L., & Wang, G. (2010). Sound bounce: Physical metaphors in designing mobile music performance. In Proceedings of the international conference on new interfaces for musical expression (p. 178-181). Sydney.
- Divenyi, P. L., & Oliver, S. K. (1989). Resolution of steady-state sounds in simulated auditory space. The Journal of the Acoustical Society of America, 85(5), 2042– 2052.
- Dix, A., Finlay, J., Abowd, G. D., & Beale, R. (2003). Human-computer interaction. Pearson Education.
- Freeman, J. (2012). Saxophone etudes: for solo saxophone (any voice) with audience

participation via mobile phones. Retrieved from http://distributedmusic .gatech.edu/jason/music/saxophone-etudes-2011-solo/materials/ saxophone-etudes-score.pdf (Accessed: Feb. 27, 2021)

- Freeman, J., Chen, Y., Shen, W., Weitzner, N., & Xie, S. (2013). Sketching: for 5-7 improvising musicians with audience participation via mobile phone. Retrieved from http://distributedmusic.gatech.edu/jason/music/sketching-2013 -for-improvis/materials/sketching-score.pdf (Accessed: Feb. 26, 2021)
- Freeman, J., Xie, S., Tsuchiya, T., Shen, W., Chen, Y., & Weitzner, N. (2015). Using massmobile, a flexible, scalable, rapid prototyping audience participation framework, in large-scale live musical performances. *Digital Creativity*, 26(3-4), 228–244.
- Gamma, E., Johnson, R., Vlissides, J., & Helm, R. (1995). Design patterns: elements of reusable object-oriented software (Vol. 49) (No. 120). Addison-Wesley.
- Gelfand, S. A. (2016). Hearing: An introduction to psychological and physiological acoustics. CRC Press.
- Grand, F., & Dall Antonia, F. (2008). Sumo. a sonification utility for molecules.
- Grond, F., Janssen, S., Schirmer, S., & Hermann, T. (2010). Browsing rna structures by interactive sonification. In *Proceedings of the 3rd interactive sonification* workshop.
- Hartmann, W. M. (1983). Localization of sound in rooms. The Journal of the Acoustical Society of America, 74(5), 1380–1391.
- Hermann, T., Hunt, A., & Neuhoff, J. G. (2011). The sonification handbook. Logos Verlag Berlin, Germany.
- Hindle, A. (2013). Swarmed: Captive portals, mobile devices, and audience participation in multi-user music performance. In *Proceedings of the international* conference on new interfaces for musical expression (p. 174-179). Daejeon.
- Ibrahim, A. A. A., Yassin, F. M., Sura, S., & Andrias, R. M. (2011). Overview of design issues and evaluation of sonification applications. In 2011 international conference on user science and engineering (i-user) (pp. 77–82).
- Kato, M., Uematsu, H., Kashino, M., & Hirahara, T. (2003). The effect of head motion on the accuracy of sound localization. Acoustical science and technology, 24(5), 315–317.
- Kim, H. (2011). Moori: interactive audience participatory audio-visual performance. In Proceedings of the 8th acm conference on creativity and cognition (p. 437-438). Atlanta.
- Lane, D. M., Scott, D., Hebl, M., Guerra, R., Osherson, D., & Zimmer, H. (2017).

Introduction to statistics. Citeseer.

- Lee, S., & Freeman, J. (2013). echobo : Audience participation using the mobile music instrument. In Proceedings of the international conference on new interfaces for musical expression (p. 450–455). Daejeon.
- Letowski, T. R., & Letowski, S. T. (2012). Auditory spatial perception: Auditory localization (Tech. Rep.). Army Research Lab Aberdeen Proving Ground MD.
- Levin, G. (2001). Dialtones: A telesymphony. Retrieved from https://www .fondation-langlois.org/html/e/page.php?NumPage=229 (Accessed: Mar. 03, 2021)
- Ligna, & Röhm, J. (2003). Dial the signals! radio concert for 144 mobile phones. Retrieved from http://ligna.blogspot.nl/2009/07/dial-signals -radio-concert-for-144.html (Accessed: Mar. 03, 2021)
- Liu, D. (2016). Navigation in an audio maze game with quadraphonic and octophonic speaker set-ups (Master Thesis, Leiden University).
- Livingstone, D., & Miranda, E. R. (2004). Composition for ubiquitous responsive sound environments. In *Icmc*.
- Lokki, T., Grohn, M., Savioja, L., & Takala, T. (2000). A case study of auditory navigation in virtual acoustic environments..
- Malikova, E., Adzhiev, V., Fryazinov, O., & Pasko, A. A. (2020). Visual-auditory volume rendering of dynamic quantum chemistry molecular fields.
- Mast, D., de Vries, S. I., Broekens, J., & Verbeek, F. J. (2021). The participant journey map: Understanding the design of interactive augmented play spaces. *Frontiers in computer science*, 45.
- Mazuryk, T., & Gervautz, M. (1996). Virtual reality-history, applications, technology and future.
- Miletto, E. M., Pimenta, M. S., Bouchet, F., Sansonnet, J.-P., & Keller, D. (2011). Principles for music creation by novices in networked music environments. *Journal of New Music Research*, 40(3), 205–216.
- Monahan, G. (1982). Speaker swinging. Retrieved from http://www.gordonmonahan .com/pages/speaker_swinging.html (Accessed: May. 17, 2018)

Munakata, N., & Hayashi, K. (1984). Basically musical. Nature, 310, 96.

- Neuhoff, J. G. (2011). Perception, cognition and action in auditory displays. The sonification handbook, 63–85.
- Novo, P. (2005). Auditory virtual environments. In *Communication acoustics* (pp. 277–297). Springer.

- Popper, A. N., Fay, R. R., & Popper, A. N. (2005). Sound source localization. , 272–316.
- Rau, B., Frieß, F., Krone, M., Muller, C., & Ertl, T. (2015). Enhancing visualization of molecular simulations using sonification. In 2015 ieee 1st international workshop on virtual and augmented reality for molecular science (varms@ ieeevr) (pp. 25– 30).
- Reich, S. (1968). Pendulum music. Retrieved from http://www.ubu.com/aspen/ aspen8/leadPendulum.html (Accessed: May. 17, 2018)
- Schraffenberger, H., & van der Heide, E. (2015). Audience-artwork interaction. International Journal of Arts and Technology, 8(2), 91–114.
- Shepard, M. (2006). Tactical sound garden [tsg] toolkit. In 3rd international workshop on mobile music technology. Brighton.
- Shi, X., Cai, Y., & Chan, C. (2007). Electronic music for bio-molecules using short music phrases. Leonardo, 40(2), 137–141.
- Stevens, S. S., & Newman, E. B. (1936). The localization of actual sources of sound. The American journal of psychology.
- Tanaka, A. (2006). Net_dérive locative music for 3 mobile telephones and gps. Retrieved from http://www.ataut.net/site/Net-Derive (Accessed: Jan. 3, 2017)
- Tek, A., Chavent, M., Baaden, M., Delalande, O., Bourdot, P., & Ferey, N. (2012). Advances in human-protein interaction-interactive and immersive molecular simulations. In *Protein-protein interactions-computational and experimental tools*. IntechOpen.
- Temple, M. D. (2017). An auditory display tool for dna sequence analysis. BMC bioinformatics, 18(1), 221.
- Thurlow, W. R., & Runge, P. S. (1967). Effect of induced head movements on localization of direction of sounds. The Journal of the Acoustical Society of America, 42(2), 480–488.
- Valentine, J. C., & Cooper, H. (2003). Effect size substantive interpretation guidelines: Issues in the interpretation of effect sizes. Washington, DC: What Works Clearinghouse, 1–7.
- van der Heide, E. (2010). Spatial sounds (100db at 100km/h) in the context of human robot personal relationships. In International conference on human-robot personal relationship (pp. 27–33).
- Van Troyer, A. (2012). Hyperaudience: designing performance systems for audience inclusion (Unpublished doctoral dissertation). Massachusetts Institute of Tech-

nology.

- Walker, B. N., & Nees, M. A. (2005). Brief training for performance of a point estimation sonification task. In *Proceedings of the 25th international conference* on auditory display. (icad2005). Limerick.
- Weitzner, N., Freeman, J., Garrett, S., & Chen, Y. (2012). massmobile an audience participation framework. In *Proceedings of the international conference on new* interfaces for musical expression (p. 21-23). Michigan.
- York, R. O. (2016). Statistics for human service evaluation. SAGE Publications.
- Zhang, L., Wu, Y., & Barthet, M. (2016). A web application for audience participation in live music performance: The open symphony use case. In *Proceedings of the international conference on new interfaces for musical expression* (p. 170-175). Brisbane.