Audible Imagery: Creative Contemplations on the Sounds of Home

Marine Zorea
Kyoto Institute of Technology
Kyoto, Japan
marine.zorea@gmail.com

Katsuhiko Kushi
Kyoto Institute of Technology
Kyoto, Japan
kushi@kit.ac.jp

ABSTRACT

This pictorial paper explores domestic sounds' capacity to evoke imagery of everyday inhabited spaces. In recent decades, accelerated digitalization has been transforming our everyday sonic environment, and new interactive possibilities, such as multimodal and embodied interaction, draw attention to sound as a communicative medium. In that context, how can artificial product sounds integrate into the present ecology heard at home?

This pictorial includes visual impressions of domestic sounds as documented in Japan through a sound diary experiment, and those drawn by their listeners during a participatory exhibition in Tel-Aviv. The drawings offer insight into the creative sense-making strategies that listeners employ to situate acousmatic sounds within the interrelated composition of their everyday auditory experience. Furthermore, they demonstrate drawing as a unique research tool for constructing and sharing meaning during the product sound design process.

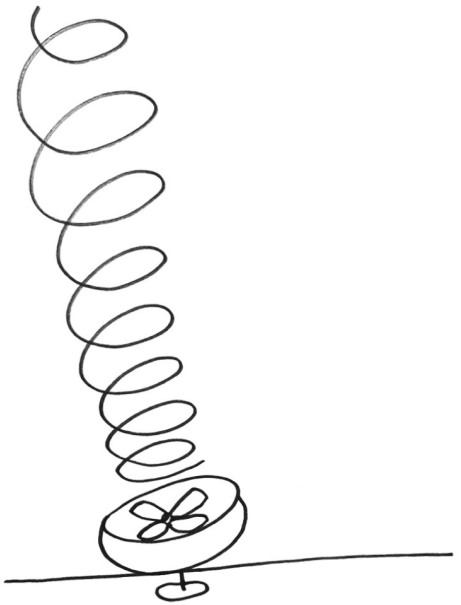
By contemplating drawing as a creative output and a reflective cognition process, this initial multimodal exploration highlights the participatory nature of domestic sound interactions and the opportunities posed by drawing for designing future home soundscapes.

Authors Keywords

drawing; home; soundscape; sound design; participatory design; multimodal

CCS Concepts

• Human-centered computing~Interaction Design



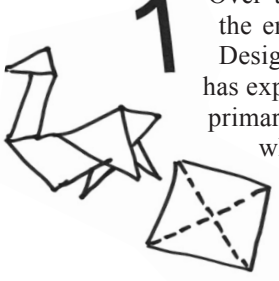
15

C&C '23, June 19–21, 2023, Virtual Event, USA

ACM ISBN 979-8-4007-0180-1/23/06.
https://doi.org/10.1145/3591196.3593366

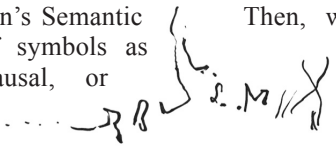
INTRODUCTION

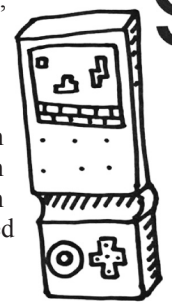
Sounds at home are intrinsic to our everyday experience. Composed of physical properties traveling throughout the inhabited space, their meeting with the ear produces the imagery of domestic objects, gestures, rhythmical occurrences and habits. In recent decades, the dispersion of domestic computational artifacts has transformed the sounds of home. Intentional sounds [17] artificially integrated into products populate our everyday auditory surroundings, and the field of sound design in HCI has been drawing attention. Notifications, feedback, and alerts attest to the field's continuous investigations into sound's capacity to convey information. Over the past decade and following the emergence of Sonic Interaction Design [7], product sound design has expanded to include sound as a primary interactive medium [16], which inspired numerous experimentations in embodied and multimodal sonic interactions. Whether through resounding tangible interfaces [2,3], sonification or interactive acoustic environments [8,12,27], sound design is becoming embedded within our everyday experience and home.

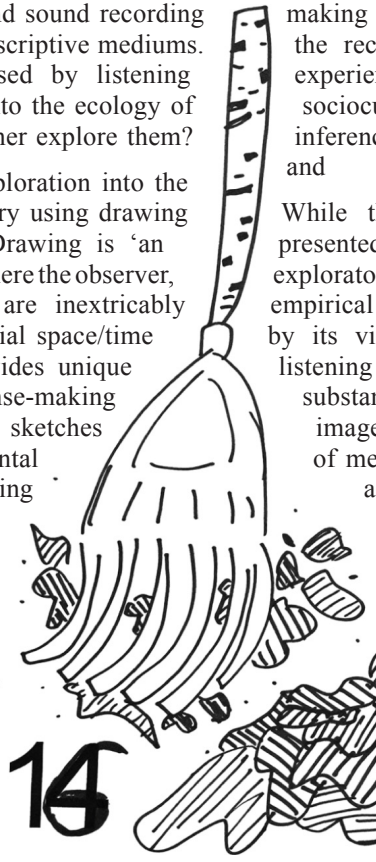


Over the years, ways of listening have intrigued sound designers, informing their practice with various musical and ecological frameworks. Developed in the 20th century amidst the revolutionary spread of recorded sounds, such frameworks conceptualize how people experience sound and extrapolate meaning from their auditory surroundings. Some concepts discuss listening as an experiential behavior (Schaeffer's influential concept of Sound Object, referring to the acoustic phenomenon without a source [24], Chion's Reduced Listening [5], and Gaver's Musical Listening [9]). Others describe listening as ecologically grounded, where sound infers its causing source and event (Chion's Causal Listening [5] and Gaver's Everyday Listening [9]). Schafer's concept of Soundscape contextualizes sounds within the locative arrangement of a particular geography [25], and Chion's Semantic Listening [5] within a system of symbols as language. Whether acoustic, causal, or contextual [3,5], listening hints at the participatory nature of product sound design: produced by the designer, listeners later interpret, imagine, and contextualize product sounds within their home. In HCI, a growing, multidisciplinary body of work elaborates the categorization, description, and mapping of everyday sounds using text [4,15], movement [2,3], vocalization [14], and sound recording and synthesis [2,3,14] as descriptive mediums. Given the opportunities posed by listening for weaving designed sounds into the ecology of sounds at home, how might we further explore them?

This pictorial presents an initial exploration into the production of domestic sonic imagery using drawing as a central medium of inquiry. Drawing is 'an exploratory, sense-making process where the observer, and the thing or idea observed, are inextricably bound together in a physical, material space/time relationship' [18]. As such, it provides unique access to people's thinking and sense-making processes. Moreover, self-generated sketches can serve as an extension of one's mental imagery, from which new meaning and insight emerge [11]. In recent times, researchers have gradually recognized drawing as a unique tool for researching creativity and cognition. Intending to capture the everyday experience of domestic sounds, their context, and subjective interpretations, we took a phenomenological approach and applied participatory methodologies in a two-phased process. First, we engaged participants in Japan with the Sound Diary Kit, where they documented their subjective impressions of the sounds of their homes through audio recordings, text, and drawings. Then, we held a participatory exhibition in Tel Aviv, where we presented drawings and audio recordings of 16 selected impressions. Visitors listened to the unfamiliar acousmatic sounds [24], independent from their originating context, and documented their subjective impressions through drawing. Contemplating the exhibition participants' drawings as a creative output and a reflective cognition process, we identified five sense-making strategies listeners employed to localize the recorded sounds within their everyday experience: episodic simulation, sociocultural imagery, sound source inference, artifact speculation, and experiential imagery.





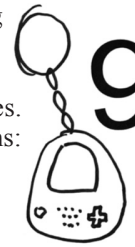


While the participatory exhibition presented here was intended as an exploratory action rather than an empirical study, the drawings produced by its visitors provide insight into listening as an active behavior [6,26] substantial to creating the interrelated imagery of home, and listeners as active creators of meaning. Along with pointing out functional, aesthetic, and critical considerations for product sound design implied by the emergent themes, this multimodal experiment illustrates the potential of drawing as a creative and engaging research tool enabling contemplation on concrete and tacit knowledge, creation of meanings and ideas, and their sharing in multidisciplinary

and multicultural contexts, all addressing current challenges in the field of sound design. By converging auditory and visual creative mediums, we hope the exploration described in this pictorial paper inspires future contributions on the future sounds of home.

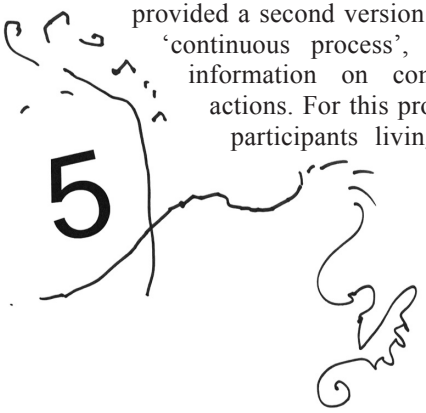
SOUND DIARY KIT

Seeking to engage participants both as observers and informants of their in-situ experience, we drew from the diary method for data collection [32] used for the real-time documentation of everyday events, actions, and experiences, and the participatory design method of Cultural Probes as documented by Gaver, Dunne, and Pacenti [10], where designerly skills are employed to create attractive mediums for data collection, such as maps, stickers, and postcards. Those mediums help designers to elicit valuable information about participants' everyday experiences. The 'Sound Diary Kit' is an original data collection tool designed to inspire reflection on domestic sound experiences. It comprises a Zoom H5 audio recorder device, instructions, and a designated worksheet encouraging responses over audio, textual, and visual mediums. The kit's open format was designed to accommodate participants' genuine responses. The worksheet includes the following columns:



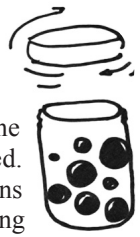
1. What did you hear?
2. Where did you hear it?
3. Information gained
4. Mood (emotions and bodily sensations)

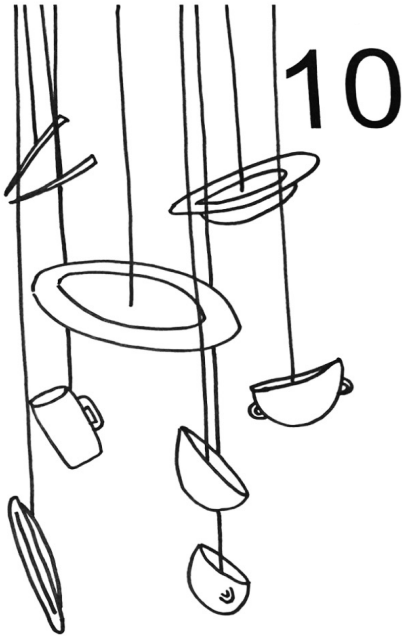
After completing the first worksheet, participants were provided a second version including the column 'continuous process', to gather additional information on continuous events and actions. For this project, we engaged five participants living in urban Japan in their 20s to 60s, who documented their domestic sound interactions in the diary over three to five days. Participants were recruited to represent a range of ages, household practices, and sonic expertise. Out of the documented data, we selected sixteen audio and visuals impressions of domestic sounds to be exhibited in a participatory exhibition that was held in Tel Aviv.



PARTICIPATORY EXHIBITION

The participatory exhibition was held for one week in November 2021, part of Tel Aviv Illustration Week, in collaboration with Felicja Blumental Music Center of Tel Aviv municipality. Participatory exhibitions invite visitors to add their contributions as inspired by the exhibited artifacts. By doing so, they can create and share meanings, as their contributions later become an extension of the exhibition to be experienced by subsequent visitors [28]. The exhibition included sixteen sound samples from the data documented in Japan through the Sound Diary Kit. It also included sixteen corresponding drawings made by its participants. The drawings were numbered, and the visitors could listen to the sounds they described by pressing the corresponding number on an interactive tablet interface. They could also hear those sounds through a soundtrack comprising all sixteen sound files, played in the background by speakers at the back of the gallery. By transposing the sounds from their material, regional, cultural, and subjective context of origin, we intended to create an acoustic experience to which visitors can contribute their genuine interpretations and original ideas. Most participatory exhibitions invite textual contributions, but in this exhibition we invited visitors to add visual interpretations of the recorded sounds. We instructed them to draw the sounds they heard. They used black markers on long paper rolls spread on tables near the gallery walls, where the Sound Diary Kit illustrations were featured. Visitors attached to their their contributions the number of the sound they had drawn using numbered stickers specifically for this purpose.





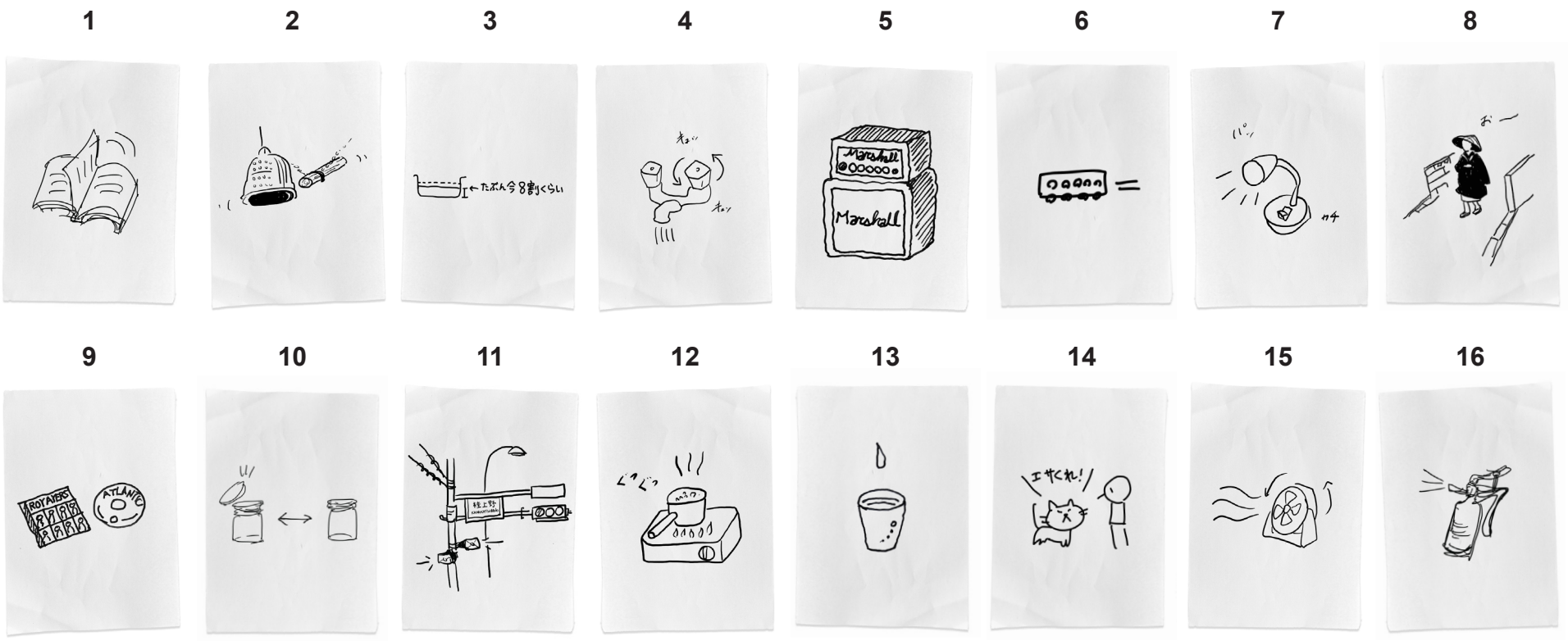
① Sound Diary participants document sounds in Japan

② 16 audio and visual impressions are selected

③ participatory exhibition visitors draw the sounds in Tel Aviv

④ inductive thematic analysis on visitors' drawings

Sound Diary Kit participants record sounds at their homes (left), visitors listen and draw the recorded sounds at the participatory exhibition (right). click to listen to hear the recorded sounds



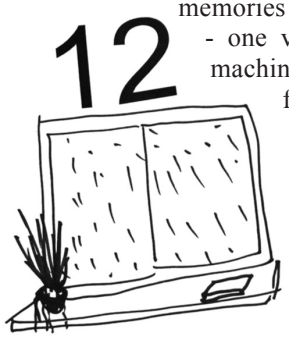
participants' drawings from the Sound Diary Kit, as exhibited in the participatory exhibition. click to listen to the corresponding sounds

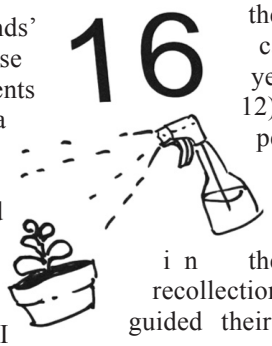
EMERGENT THEMES

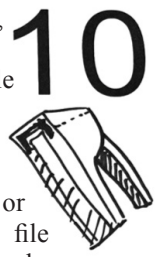
Visitors created ninety-eight drawings of the recorded sounds throughout the participatory exhibition. We performed inductive thematic analysis, where the data guided the analysis. We will thereby reflect upon listening and sense-making related themes that emerged from the drawings, arranged from actualization and concretization to imagination and abstraction.

Theme 1: Episodic Simulation

Many of the drawings reflected domestic sounds' capacity to conjure memories. Some of those memories are of autobiographical events - one visitor, for example, drew a machine from the factory his father used to work at during his childhood (sound file 16). Using sound to evoke autobiographical memories has been covered in multiple HCI research projects, with applications such as preserving personal sonic memories [20] or their deployment to improve dementia patients' quality of life [13]. Nevertheless, many drawings depicted recollections of daily repeated activities, such as house chores (sound files 4, 16), beauty and wellness routines (sound file 16), commuting to and from home (sound file 15), or everyday events, such as the crying neighborhood cat (sound file 14) or yesterday's rain (sound file 12). Episodic simulations, where people recall periodical procedures and occurrences, assist them in simulating and planning future ones [23]. Similarly, the sounds in the exhibition triggered visitors' recollections of daily events and activities and guided their simulation and recreation through drawing. Spreading on a temporal axis, sound's ability to elicit episodic simulations hints at opportunities for product sound design: domestic product sounds can be used not only to alert or notify on future events and activities but also to support their planning and execution.

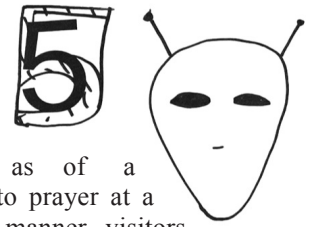


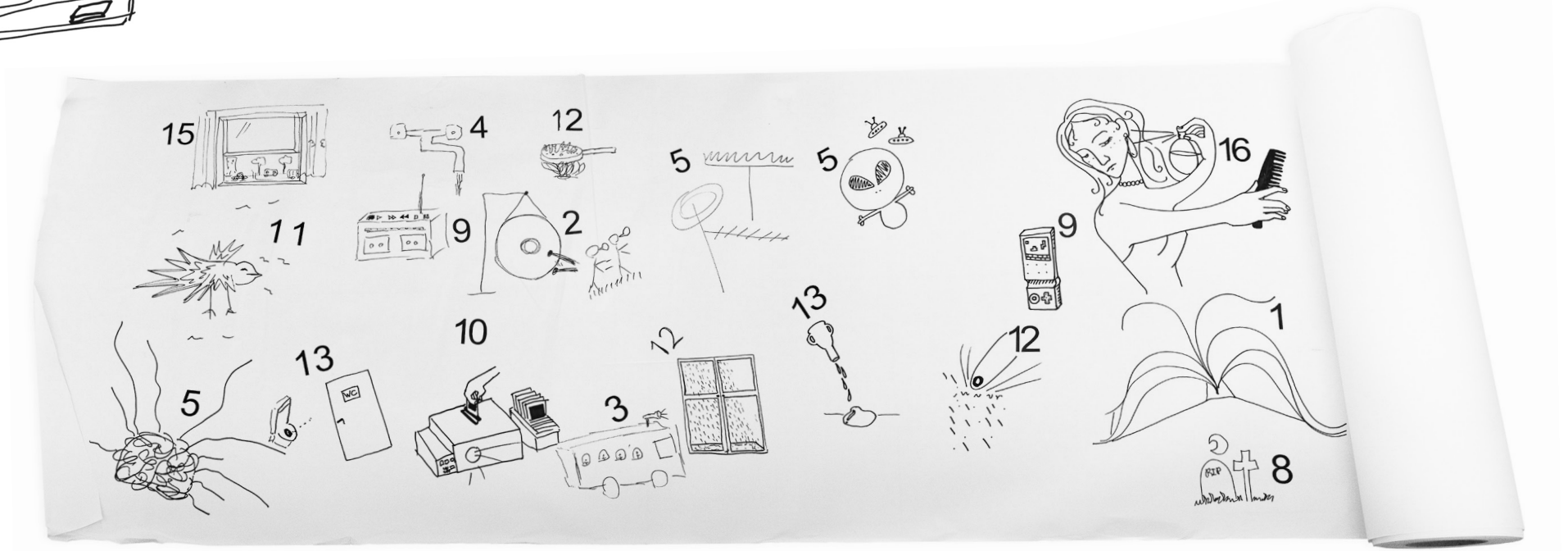




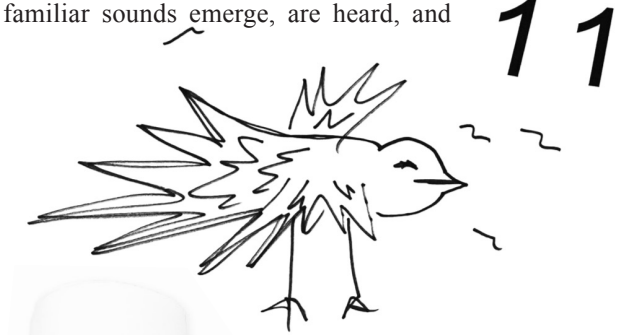
Theme 2: Sociocultural Imagery

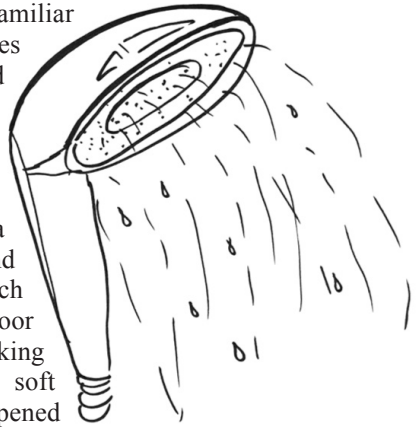
Visitors localized the recorded distant sounds within their everyday experience, transferring them into familiar sound cultures and soundscapes. For example, visitors situated the recorded sound of a Buddhist monk chanting in the streets of Kyoto within their local soundscape, drawing visual portrayals of local religious practices such as of a Christian cemetery or the call to prayer at a mosque (sound file 8). In that manner, visitors made the Japanese soundmark [25] into a local one. Several participants drew the sound of an AUX cable plugged into an amplifier (sound file 5) with the





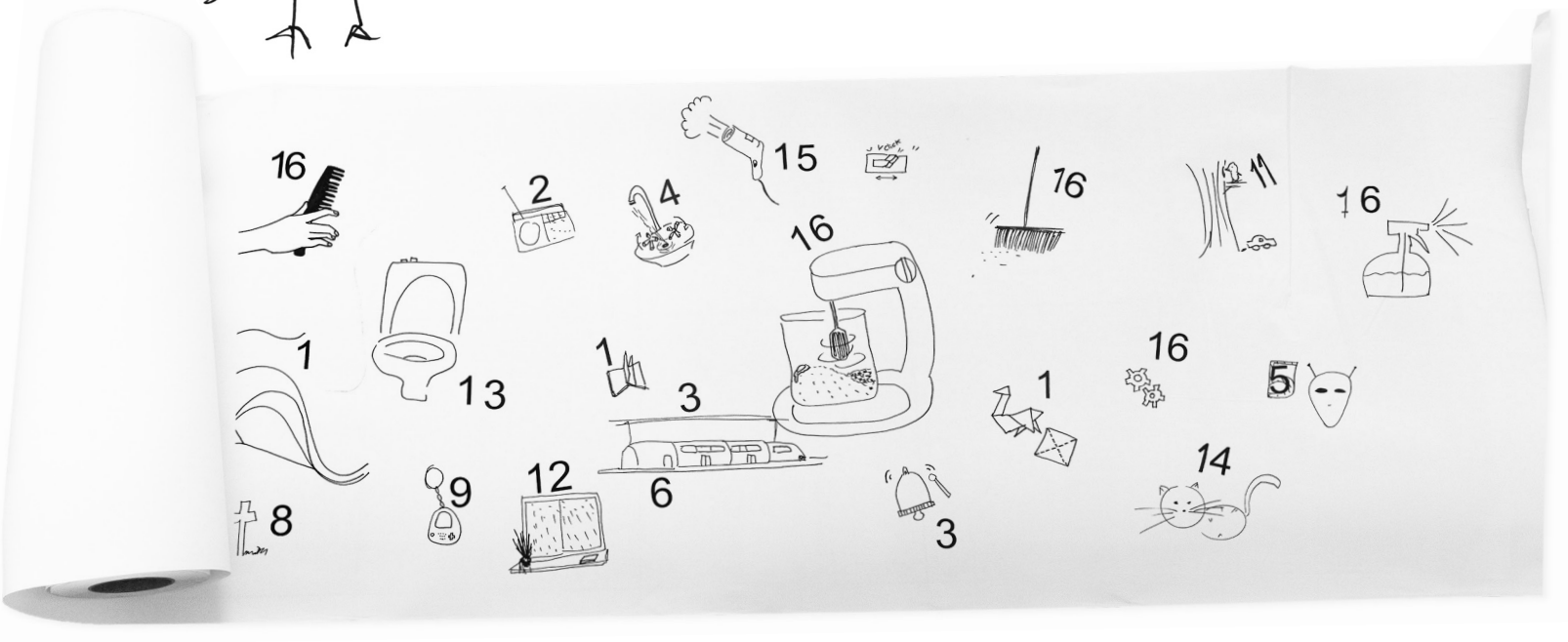
iconic portrayal of aliens due to its auditory similarity to early science fiction sound effects. While reflecting the developments of electronic music at the time of their production, those sound effects remain iconic to date. Similarly, visitors drew 1990's commercial handheld game consoles when they heard a CD played backward, apparently evoking the memorable sound image of early gaming culture (sound file 9). Whether grounded in local geography or distributed through various media outlets, visitors' sociocultural sonic imagery, exposed by the transposition of sounds from one region to another, emphasizes their willingness to reproduce the sound cultures within which familiar sounds emerge, are heard, and are practiced. In their framework for meaning-making in HCI, Mekler and Hornbæk suggest that our connection to the world we are in is vital for creating meaningful experiences [19]. Furthermore, voicing listeners' diverse sound cultures throughout the design process is critical, given European musical standards' historical influence and, more recently, techno-cultures have on the design and synthesis of new sound-related technologies [22]. Listeners interpret sounds in-situ within diverse soundscapes and sound cultures. The versatile and communicative qualities of drawing may be valuable for sharing and describing different meanings toward an inclusive product sound design process.



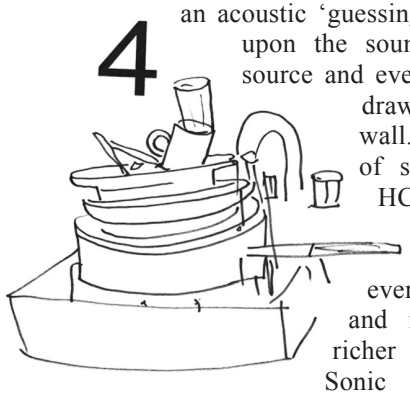


Theme 3: Sound-Source Inference

As observed in the seminal works of Gaver and multiple subsequent studies, people often perceive sound through causal listening, inferring its source of origin. It is therefore unsurprising that most of the exhibition drawings feature domestic objects in action. Visitors engaged in investigative listening behavior, seeking to retrieve sonic memories of domestic objects producing similar acoustic properties to the recorded sounds. They analyzed those properties, attempting to excavate acoustic details to identify the recorded sounds' source, making thus unfamiliar experiences coherent ones [19]. Some recorded sounds induced a wide range of drawn impressions. For example, several visitors drew the sizzling of a frying pan as rain (sound file 12), a light switch sound was drawn as a door lock and as tongue clicking (sound file 7), and the soft creak of a jar being opened and closed was drawn as a

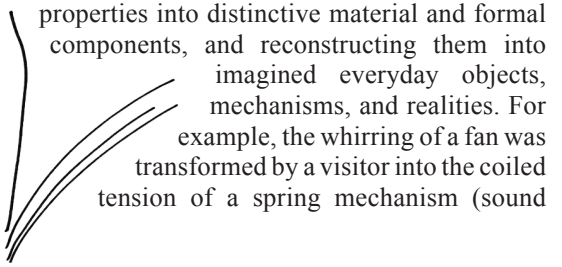


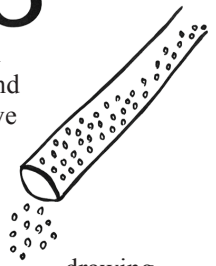
slide projector and as a stapler (sound file 10). Indeed, a simple look at the drawings on the gallery walls, drawn by the Japanese Sound Diary Kit participants, would have disclosed the identity of the objects producing the recorded sounds. Nonetheless, visitors often engaged in an acoustic 'guessing game': they reflected upon the sounds, drew the causing source and event, and compared their drawings to those on the wall. In their meta-analysis of soundscape research in HCI, Johansen et al. call attention to engaging participants in everyday sound description and recollection to design richer interactions [16]. In Sonic Interaction Design, participatory methodologies have long been endorsed for understanding everyday sound interactions and ideating new ones [7]. Visitors' enthusiastic analysis and description of everyday sounds' acoustic properties, achieved through hearing those sounds away from their context of origin and describing them in drawing, point out potential paths for engaging research methodologies for everyday sounds and product sound design.

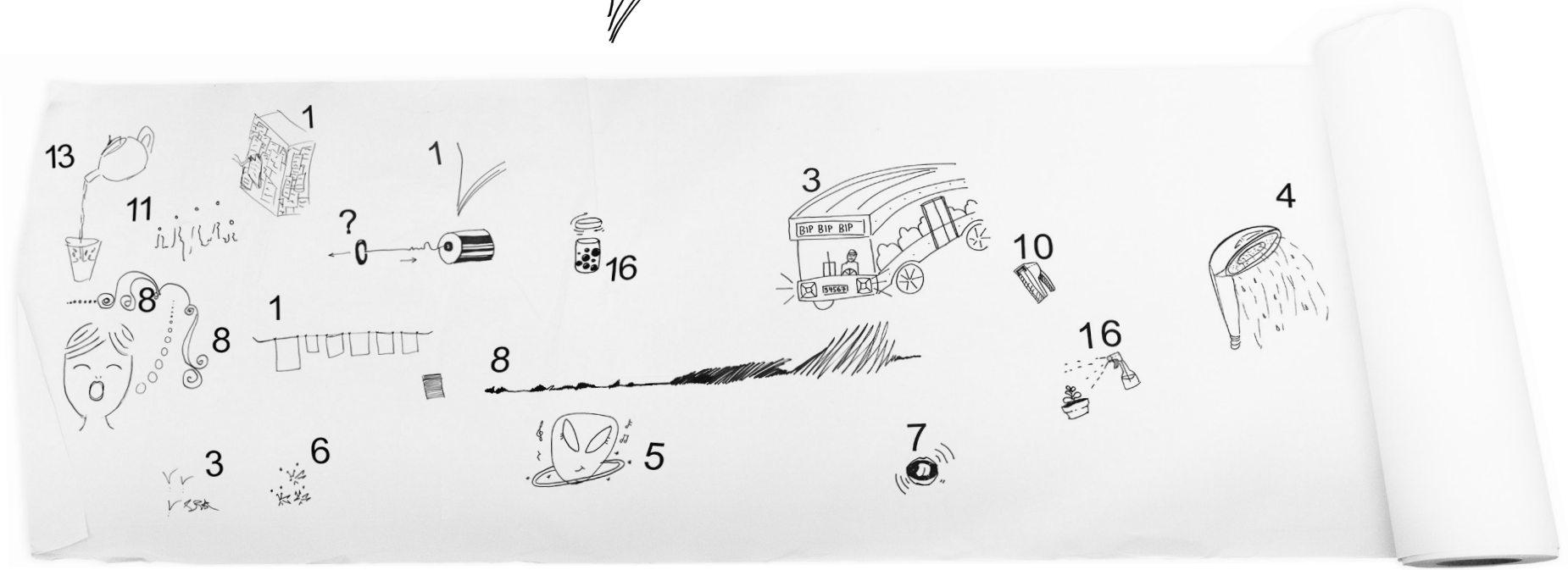


Theme 4: Artifact Speculation

Among some visitors, the attempt to identify the source of sounds developed into a speculative activity. Those visitors made their implicit process of sound identification visible by deconstructing the recorded sounds' acoustic properties into distinctive material and formal components, and reconstructing them into imagined everyday objects, mechanisms, and realities. For example, the whirring of a fan was transformed by a visitor into the coiled tension of a spring mechanism (sound file 15), and the sound of pouring water as a granular material poured from an elongated tube (sound file 13). The sound of a single light switch was imagined as its multiplicity (sound file 7). Drawings facilitated the inventive rematerialization of the sourceless recorded sounds, stretching their symbolic and acoustic affordances. The HCI research community gradually acknowledges drawing as a speculative medium of inquiry and interrogation [30,31], enabled by its imaginative yet materialized manifestation. As designed sounds are increasingly experimented with and integrated into emergent technologies such as mixed realities [12,27], in which novel experiences are created and through which existing ones are interrogated, drawing can be employed for speculating resounding artifacts, and the opportunities it offers for participatory ideation are manifold [21].

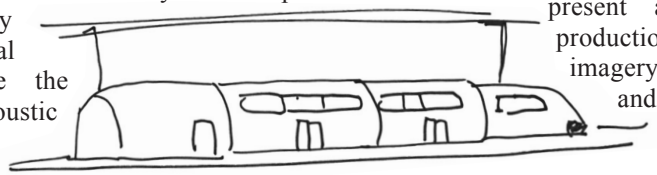






Theme 5: Experiential Imagery

Some visitors translated their auditory experience into visual expression. Those visitors expressed the experienced sounds' rhythm, pitch, and timbre using continuous and segmented lines, scattered dots, and imaginative shapes (sound files 5, 10, 16). Since the conceptualization of Sonic Interaction Design, multimodal and embodied interactions are increasingly being explored. While the coupling of sound and movement has been exercised in multiple research projects [2,3,14], drawing can be more thoroughly investigated as an expressive tool and contribute to multimodal auditory-visual interaction research. Furthermore, visuals can form a communicative tool for signification for describing implicit and subjective acoustic experiences. Denis Smalley's concept of Spectromorphology [29] provides a visual vocabulary to describe the 'sound-shapes' of acoustic events, creating a visual portrayal of sound's spectrum of pitches as it evolves through time. In a set of visual experimentations with sound-shapes, Blackburn demonstrates their potential to create shared understandings around implicit and abstract acoustic experiences [1]. Product sound design is a multidisciplinary process, including designers, engineers, musicians, and others describing sounds in different ways [4,6]. Given the multiple disciplines engaged in product sound design and the necessity for communicative description strategies during the design process, drawing can be further explored as a communication tool for product sound practitioners.



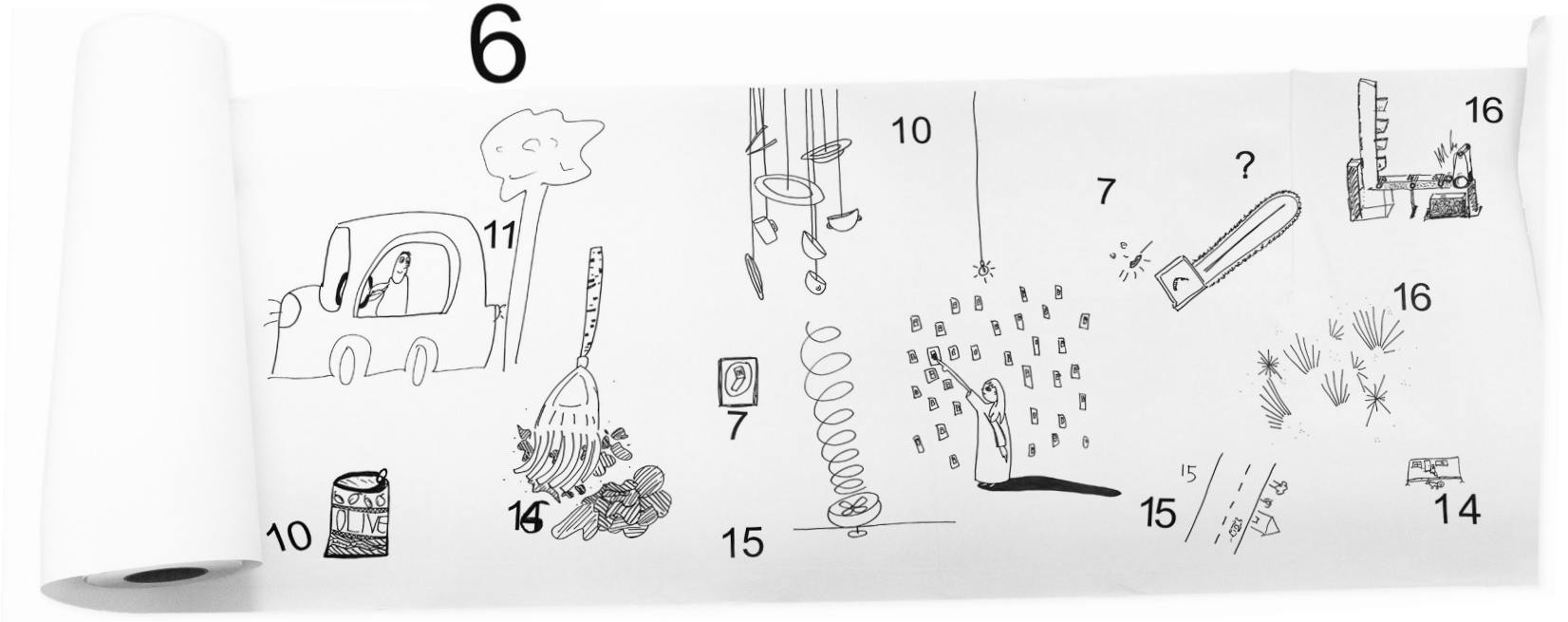
7

6

CONCLUDING THOUGHTS

The drawings generated in the participatory exhibition present a glimpse into listeners' production of everyday audible imagery, revealing the participatory and creative character of listening and highlighting the opportunities those qualities entail for future research and design of domestic product sounds. Listeners used the unfamiliar sounds to simulate recurring scenarios in their personal daily lives, voiced local soundscapes and collective sound cultures, analyzed acoustic properties to describe everyday objects, imagined those properties as speculative artifacts, and generated expressive multimodal transcriptions of implicit and embodied auditory sensations induced by the sounds. Those highly active listening behaviors indicate functional possibilities, aesthetic directions, and critical considerations for product sound design for current and emergent domestic technologies.

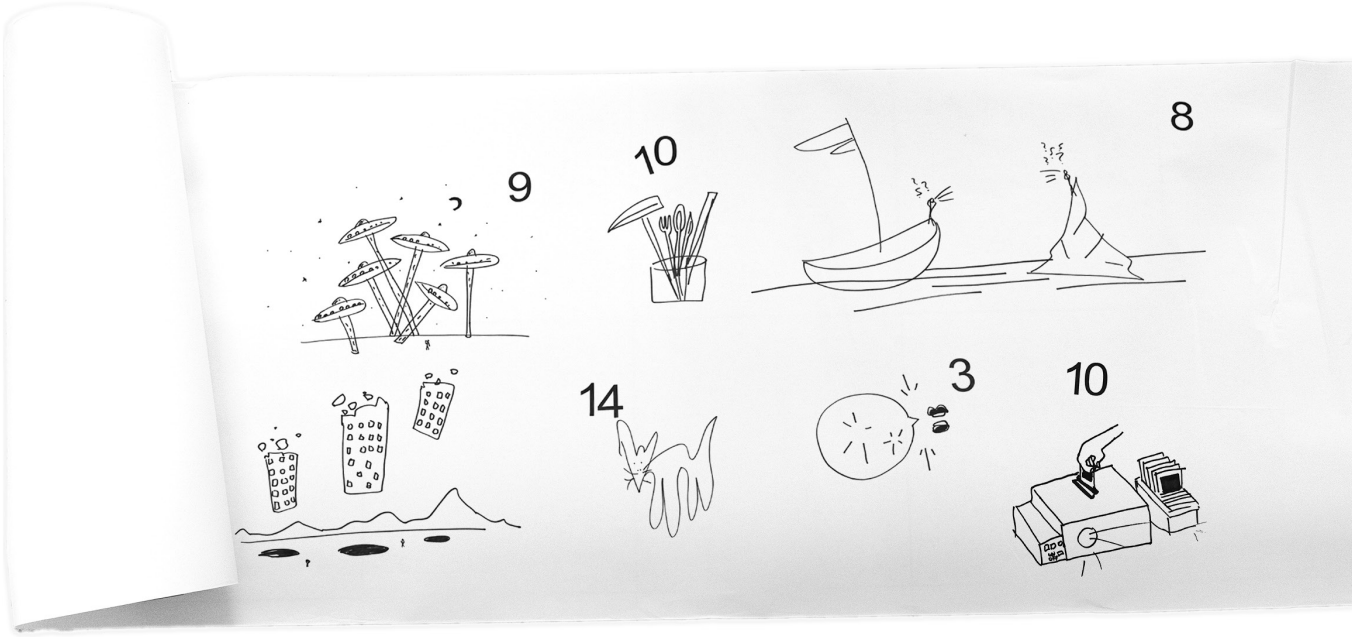
Further, the multimodal coupling of listening with drawing facilitated listeners' exploratory contemplation on their listening experience and the creation of meaning through recollection, contextualization, and imagination. Drawing supported the materialization of the acoustic experience, and its communicative and



expressive qualities enabled the sharing of explicit ideas and implicit impressions. Whether for engaging participants in research and design of domestic soundscapes, acknowledged as essential to the design process [16], for generating, interrogating, or sharing new design ideas, and for communicating meanings across the multiple disciplines [4,6] and cultures [22] involved in the product sound design process, drawing may be a valuable tool for addressing challenges currently faced by the field of sound design in HCI. This preliminary exploration aims to demonstrate its potential, toward designing the future sounds of home.

ACKNOWLEDGMENTS

The exhibition was facilitated by Tel Aviv Municipality and Felicja Blumental Music Center. We thank the participants in Tel Aviv and Japan for their creative contributions. Finally, we thank the pictorial committee, reviewers and team for their comments and support.



REFERENCES

[1] Manuella Blackburn. 2011. The Visual Sound-Shapes of Spectromorphology: an Illustrative Guide to Composition. Organised Sound 16, no. 1 (2011): 5–13. doi:10.1017/S1355771810000385.

[2] Baptiste Caramiaux, Alessandro Altavilla, Scott G. Pobiner, and Atau Tanaka. 2015. Form Follows Sound: Designing Interactions from Sonic Memories. In Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems (CHI '15). Association for Computing Machinery, New York, NY, USA, 3943–3952. https://doi.org/10.1145/2702123.2702515

[3] Baptiste Caramiaux, Norbert Schnell, Jules Françoise, Frédéric Bevilacqua, Norbert Schnell, and Frédéric Bevilacqua. 2014. Mapping through listening. Computer Music Journal 38, 34–48 (2014)

[4] Maxime Carron, Thomas Rotureau, Françoise Dubois, Nicolas Misdariis, and Patrick Susini. 2017. Speaking about sounds: a tool for communication on sound features. Journal of Design Research 15, 2 (2017), 85–109. https://doi.org/10.1504/JDR.2017.086749

[5] Michel Chion. 1990. Audio-vision: sound on screen/Michel Chion; edited and translated by Claudia Gorbman; with a foreword by Walter Murch. Columbia University Press, New York, NY

[6] Stefano Delle Monache, Nicolas Misdariis, and Elif Ozcan. 2021. Conceptualising sound-driven design: an exploratory discourse analysis. In Creativity and Cognition (C&C '21). Association for Computing Machinery, New York, NY, USA, Article 42, 1–8. https://doi.org/10.1145/3450741.3465258

[7] Karmen Franinovic and Stefania Serafin. 2013. Sonic interaction design. Mit Press.

[8] Emma Frid, Hans Lindetorp, Kjetil Falkenberg Hansen, Ludvig Elblaus, and Roberto Bresin. 2019. Sound Forest: Evaluation of an Accessible Multisensory Music Installation. In Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems (CHI '19). Association for Computing Machinery, New York, NY, USA, Paper 677, 1–12. https://doi.org/10.1145/3290605.3300907

[9] William W. Gaver. 1993. What in the world do we hear? An ecological approach to auditory source perception. Ecological Psychology 5, 1 (1993), 1–29.

[10] Bill Gaver, Tony Dunne, and Elena Pacenti. 1999. Design: Cultural probes. Interactions 6, 1 (Jan./Feb. 1999), 21–29. https://doi.org/10.1145/291224.291235

[11] Gabriela Goldschmidt. 2017. Manual sketching: Why is it still relevant?. In The active image: Architecture and engineering in the age of modelling. Springer International Publishing Editors: Sabine Ammon & Remei Capdevila-Werning.

[12] Gabriel Haas, Evgeny Stemasov, Michael Rietzler, and Enrico Rukzio. 2020. Interactive Auditory Mediated Reality: Towards User-defined Personal Soundscapes. In Proceedings of the 2020 ACM Designing Interactive Systems Conference (DIS '20). Association for Computing Machinery, New York, NY, USA, 2035–2050. https://doi.org/10.1145/3357236.3395493

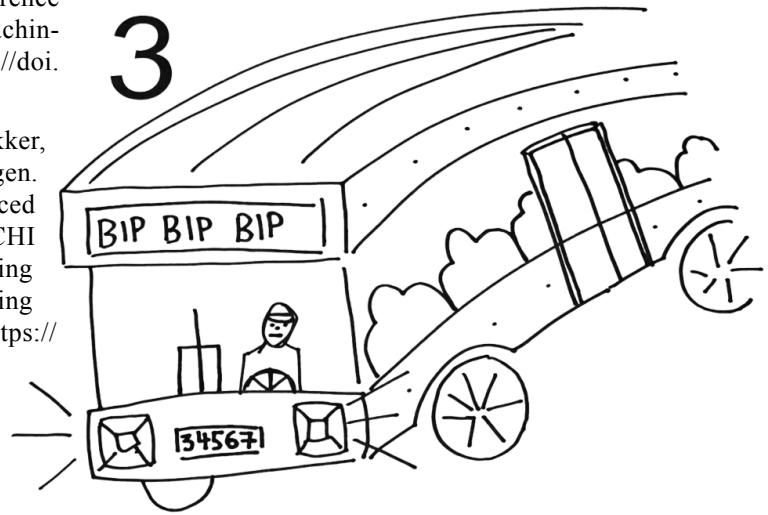
[13] Maarten Houben, Rens Brankaert, Saskia Bakker, Gail Kenning, Inge Bongers, and Berry Eggen. 2020. The Role of Everyday Sounds in Advanced Dementia Care. In Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems (CHI '20). Association for Computing Machinery, New York, NY, USA, 1–14. https://doi.org/10.1145/3313831.3376577

[14] Olivier Houix, Stefano Delle Monache, Hélène Lachambre, Frédéric Bevilacqua, Davide Rocchesso, and Guillaume Lemaitre. 2016. Innovative Tools for Sound Sketching Combining Vocalizations and Gestures. In Proceedings of the Audio Mostly 2016 (AM '16). Association for Computing Machinery, New York, NY, USA, 12–19. https://doi.org/10.1145/2986416.2986442

[15] Olivier Houix, Guillaume Lemaitre., Nicolas Misdariis, Patrick Susini, and Isabel Urdapilleta. 2012. A lexical analysis of environmental sound categories. Journal of Experimental Psychology: Applied 18, 1, 52–80.

[16] Stine S. Johansen, Niels van Berkel, and Jonas Fritsch. 2022. Characterising Soundscape Research in Human-Computer Interaction. In Designing Interactive Systems Conference (DIS '22). Association for Computing Machinery, New York, NY, USA, 1394–1417. https://doi.org/10.1145/3532106.3533458

[17] Lau Langeveld, René van Egmond, Reinier Jansen, and Elif Özcan. 2013. Product sound design: Intentional and consequential sounds. In Advances in industrial design engineering, Denis A. Coelho (Ed.). InTech Croatia, 45–73. https://doi.org/10.5772/55274



[18] Maarit Anna Mäkelä, Nithikul Nimkulrat, Tero Heikkinen. 2014. Drawing as a Research Tool: Making and understanding in art and design practice. Studies in Material Thinking. AUT University. Vol 10 (February 2014)

[19] Elisa D. Mekler and Kasper Hornbæk. 2019. A Framework for the Experience of Meaning in Human-Computer Interaction. In Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems (CHI '19). Association for Computing Machinery, New York, NY, USA, Paper 225, 1–15. https://doi.org/10.1145/3290605.3300455

[20] Gerard Oleksik, David Frohlich, Lorna M Brown, and Abigail Sellen. 2008. Sonic interventions: understanding and extending the domestic soundscape. In Proceedings of the SIGCHI conference on Human Factors in computing systems. 1419– 1428.

[21] Jeni Paay, Jesper Kjeldskov, Michael Bønnerup, Thulasika Rasenthiran. 2023. Sketching and context: Exploring creativity in idea generation groups. In Design Studies, Volume 84. https://doi.org/10.1016/j.destud.2022.101159.

[22] Laurel Pardue and S. M. Astrid Bin. 2022. The Other Hegemony: Effects of software development culture on music software, and what we can do about it. In NIME 2022. https://doi.org/10.21428/92fbeb44.0cc78aeb

[23] Daniel L Schacter, and Donna Rose Addis. 2007. The cognitive neuroscience of constructive memory: remembering the past and imagining the future. Phil. Trans. R. Soc. B362773–786 http://doi.org/10.1098/rstb.2007.2087

[24] Pierre Schaeffer. 1966. Traité des objets musicaux. Seuil, Paris.

[25] R Murray Schafer. 1993. The soundscape: Our sonic environment and the tuning of the world. Simon and Schuster.

[26] Mariana Seiça, Licínio Roque, Pedro Martins, and F. Amílcar Cardoso. 2022. Artefact, Participant and Interaction in Auditory Experiences. In Proceedings of the 27th International Conference on Auditory Display (ICAD 2022). Department of Computer and Information Sciences, Northumbria University.

[27] Marjan Sikora, Mladen Russo, Jurica Đerek, and Ante Jurčević. 2018. Soundscape of an Archaeological Site Recreated with Audio Augmented Reality. ACM Trans. Multimedia Comput. Commun. Appl. 14, 3, Article 74 (August 2018), 22 pages. https://doi.org/10.1145/3230652

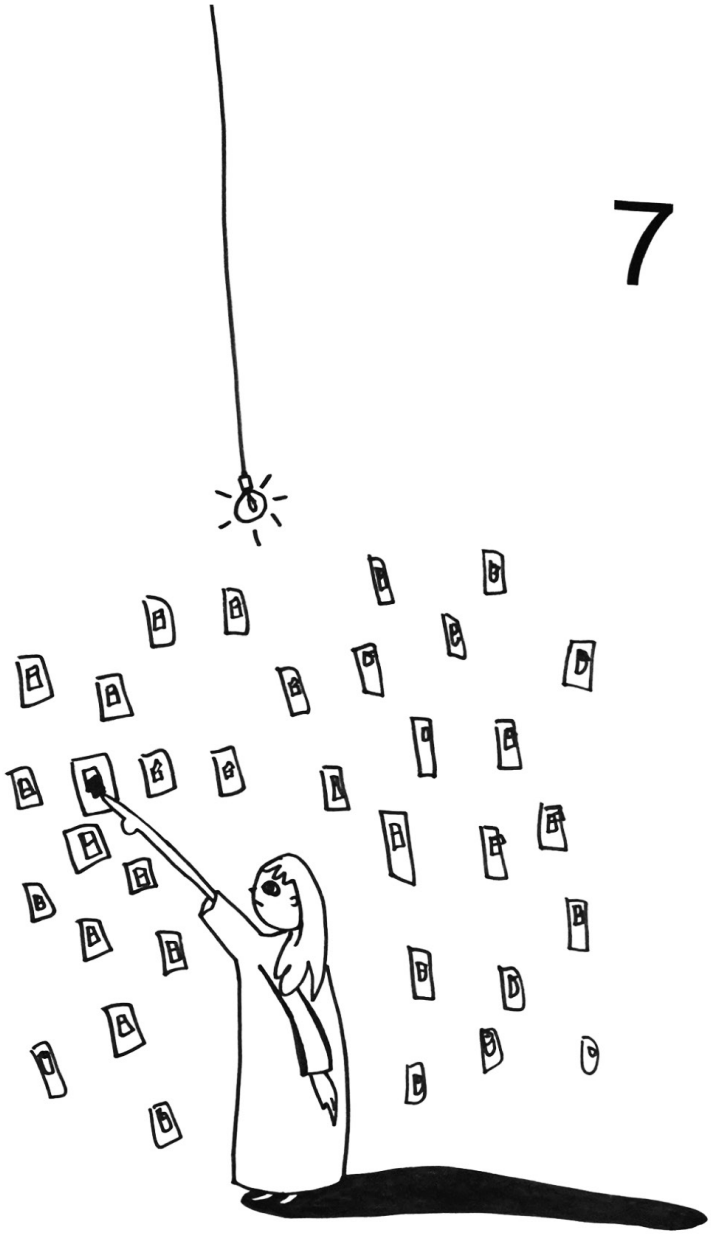
[28] Nina Simon. 2010. The Participatory Museum. Santa Cruz, California: Museum 2.0.

[29] Denis Smalley. 1997. Spectromorphology: explaining sound-shapes. Organised Sound 2, 2: 107–126. http://doi.org/10.1017/S1355771897009059

[30] Miriam Sturdee and Joseph Lindley. 2019. Sketching & Drawing as Future Inquiry in HCI. In Proceedings of the Halfway to the Future Symposium 2019 (HTTF 2019). Association for Computing Machinery, New York, NY, USA, Article 18, 1–10. https://doi.org/10.1145/3363384.3363402

[31] Paulina Yurman. 2021. Fluid Speculations: Drawing Artefacts in Watercolour as Experimentation in Research Through Design. In Creativity and Cognition (C&C '21). Association for Computing Machinery, New York, NY, USA, Article 38, 1–13. https://doi.org/10.1145/3450741.3466777

[32] Don H. Zimmerman and D. Lawrence Wieder. 1977. The Diary: "Diary-Interview Method". Urban Life; Newbury Park, Calif., Vol. 5, 4 (Jan. 1977), 479–498. http://search.proquest.com/docview/1292940175/citation/A16505C-65BA645C4PQ/1



7