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Listening in the Absence of Sight: The Sound of Inclusive Environments

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Abstract
Sound provides information about our environment that is vital for social interaction, knowledge transfer and spatial orientation. Moreover, it has profound effects on our emotional responses to the world around us. Although a more conscious use of sound holds great potential to counteract the visual dominance in architecture, so far it received relatively little attention in designing inclusive environments. In exploring this potential, our study calls in the help of people with a visual impairment; forced to rely on non-visual senses, they learn to be more attentive to auditory information. After introducing Schafer's notion of soundscape and categorization of keynotes, signals and soundmarks, we cross analyse 22 in-depth interviews with visually impaired people, focusing on auditory qualities and constraints in the environment. The analysis yields interesting insights regarding the amount and kind of sounds heard, the different roles sounds may play, and the way the soundscape can be manipulated. In the absence of sight, several sounds that most people categorize under keynotes, are upgraded to soundmarks or signals. We conclude with suggestions on how architects could integrate these findings with an eye to designing more inclusive environments.

Keywords
sound experience, soundscape, user/experts, visual impairment

Introduction

Sound and silence provide information about our environment that is vital for social interaction and knowledge transfer, and essential for spatial orientation. Moreover, both have profound effects on our emotional responses to the world around us [1]. So far, however, sound received little attention in designing inclusive environments. Exceptions include a study of the acoustic qualities in dwellings with sensory impaired participants [2]; an exploration of acoustic comfort for all in auditoria [3]; and IDEO's TableTalk, a suite of bar furniture and disposable earpieces allowing people with unimpaired and impaired hearing to converse easily despite background noise [4]. This limited attention to the role of sound in inclusive design is highly regrettable, as a more conscious use of sound holds great potential to counteract the visual dominance that tends to characterise Western architecture [5,6].

Our study aims to make a first step towards exploring the potential of sound for designing inclusive environments. To this end, we call in the help of people who are visually impaired; forced to rely on non-visual senses they learn to be more attentive to auditory information [7,8,9,10]. Moreover, due to cerebral plasticity in early infancy, people can develop superior abilities in auditory perception related to spatial orientation, pitch change determination, verbal memory, speech discrimination and a striking accuracy in localisation of sound [11,12]. Several studies have indicated that the occipital area, known as vision centre of the human brain, has been recruited to carry out several auditory functions in early blind people [13,14]. As a result, they are ideally placed to expand our understanding of the role of sound. Many laboratory experiments related to the auditory function of early- and late-blind as well as sighted people have been performed. However, almost no information is available about the perception of the soundscape by visually impaired people. After introducing the notion of soundscape, we cross analyse 22 in-depth interviews with visually impaired people, focusing on auditory qualities and constraints in the environment. The analysis yields interesting insights regarding the amount and kind of sounds heard and the different roles sounds may play. Moreover, their interventions in the soundscape offer suggestions on how architects could integrate these findings with an eye to designing more inclusive environments.

Soundscape

In 1969 Raymond Murray Schafer [15] introduced the term "*soundscape*" to denote "*the sonic environment*". Like a landscape contains all visual cues, a soundscape contains all auditory cues, both from nature and made by people: "*The term may refer to actual environments, or to abstract constructions such as musical compositions and tape montages, particularly when considered as an environment*" [15]. Much like landscapes, soundscapes have their own reach. Their size and experience vary from place to place and throughout time. People influence and try to control their own soundscape as much as possible. Barry Blesser and Linda-Ruth Salter [16] contend that an environment always responds in an auditory way to human presence: "*In each case, the environment responds as if it were a partner in an auditory dialogue. Snap your fingers, and the space responds (…) Sing a song, and the space emphasizes particular pitches.*"

Designing the soundscape

Schafer regrets that consideration of the soundscape is often limited to what he calls a "*negative*" approach, *i.e.* to reducing and suppressing unwanted sounds and noise. Instead, Schafer wants to come to a "positive" approach of the soundscape, a "*positive*" use of sound: he wants to investigate which sounds we do want to hear [15]. Blesser and Salter refer in this respect to Japanese garden designers as good "*aural architects*":

> "*Japanese garden design, an ancient art form that stylizes and miniaturizes natural environments by creating the illusion of larger ones, includes the aural experience of spaces. Not only are objects and plants arranged for their visual pattern, but also for their ability to shadow and reflect sound from active sources. David A. Slawson (1987) mentions how muffling the sound of a waterfall makes it seem farther away, thereby enlarging the perceived size of the garden. By including the aural experience in its*

design, a Japanese garden becomes the artistic union of a landscape and a soundscape, and its designer a truly multisensory architect" [16].

Describing the soundscape

If designers are to consciously and creatively shape our soundscape, they need to understand the different sounds it contains: which sounds are important because they are so unique or numerous? Which sounds dominate our hearing and which fade to the background? Which sounds make a soundscape a pleasant place to stay in?

In addressing these questions, Schafer [15] divides the soundscape into three categories: "*keynote sounds*" include all sounds we hear so frequently that they form a background against which other sounds are heard (the sound of the sea or the traffic noise in the city); "*signals*" are foreground sounds we (need to) listen to consciously, *e.g.* because they are used as warning signs (whistles, bells or sirens); and finally "*soundmarks*" are the auditory counterpart of landmarks, sounds that are so unique that the people of the surrounding community consider them as something special (the sound of a nearby waterfall or the local carillon).

These categories can be interpreted in terms of how consciously sounds are perceived. Keynote sounds and signals respectively cover the unconsciously and consciously perceived sounds. Soundmarks are situated somewhere in between; depending on the situation and observer, they are perceived rather consciously or unconsciously. For instance, a carillon in a city may form a signal for tourists and visitors, but fade to the background as keynote sound for locals.

Interestingly, the volume of a sound seems not essential to hear it consciously. Think about the sound of a mosquito: the buzz is so quiet that one would expect it to be lost in the auditory background. Nevertheless, many people are cautious when they hear one, which suggests conscious perception.

Research set-up

The study reported here aims to expand our understanding of the (potential) role of sound for designing more inclusive environments by analysing interviews with and accounts of people living with visual impairments.

Data

Our study relies upon in-depth interviews with 22 people (15 men, 7 women) who are visually impaired. They were conducted by the first author in the context of her PhD research. Originally, the interviews aimed to probe into participants' experience of their home environment and the role of haptics therein [17]. However, they turn out to contain interesting information about sound experience as well. The interviews took place at the participants' home and were semi-structured along open questions, focussing on haptic perception in the home environment. Questions were asked on what is perceived haptically, how and why. Interviews were audio-recorded and transcribed word for word afterwards. These data are further supplemented with personal accounts of and writings by visually impaired people.

Participants

Participants are recruited in multiple ways: through personal contacts, a call on a forum for visually impaired people, e-mails to persons trained by the regional blind association, an article in the bimonthly journal of an association of visually impaired people, advertisements in schools for the blind, and acquaintances of visually impaired people.

Twenty-two people answer positively to our call and invite us to their home place. Although all 22 consider themselves as being born blind, some have seen longer than five years, which implies that they may have built up a visual reference system [18]. Four of them even have residual sight. Nine out of 22 did not have visual experience at all, which gives them a privileged position to talk about the role of non-visual aspects in their spatial experience. Most of them (15) can still recognize light. Coincidentally or not, several participants are somehow involved with music, professionally or in their spare time. Two have a recording studio, one makes piano's and, to our knowledge, at least five play the piano or organ. To guarantee anonymity, participants were assigned a code name.

The interviews were supplemented with personal accounts of visual impaired people, who were assigned a code name too. Lara is a student with low vision who studies at the authors' university. Stan is born with low vision and expects to become totally blind in a few years. The interviews were further supplemented with citations from two authors who have written about their experience as person with visual impairments: the late Jacques Lusseyran [19], a French author and political activist who became blind in a school accident at age eight, and John Hull [20,21], an Australian emeritus professor of religious education who became blind at the age of 45 after several eye operations.

Analysis

Prior to this study, the interview transcripts had been analysed in search for references to haptics in the spatial experience of visually impaired people [17]. For this study, the interview transcripts were analyzed again. First, a general picture of how people with visual impairments experience their environment was drawn. Secondly, interviews were colour coded with respect to four categories: general person-related information, information about the overall experience, information dealing with sound experience explicitly, and information that can be related to sound experience indirectly. Subsequently, interviews were processed again, by writing keywords in the margin and fine-tuning the colour coding where needed. In addition, the most important information for each interview was summarized. Finally, links were made with personal conversations and written accounts, and with concepts and findings from literature, and selected quotes from the interviews were translated from Dutch to English.

Findings

It is often assumed that visually impaired people have a better sense of hearing than other people. Several studies confirm that early-blind individuals benefit from involving the occipital cortex in auditory functions, but whether these plasticity changes also can happen later in life has not been confirmed yet [11]. In any case, it is found that visually impaired people learn to be more attentive to sound, because they are forced to rely on

non-visual senses [7]. The interviews confirm this: all participants mention to rely on hearing and touch. Some use both senses equally, others have an outspoken preference for one of both. However, even participants who contend to rely rather on touch, seem to pay explicit attention to the soundscape.

Consciously heard sounds

As a result of this explicit attention, people with visual impairments seem to (consciously) hear more sounds than other people. Lara articulates this as follows: "*you simply hear more and thus also all background noise full blast. If one person passes by, I also hear from where s/he is coming and in what direction, but if 10 pass by, that is a kind of flock… With reverberation in a space, I'm really not at ease if I cannot distinguish sounds*." Sam states that he is often "*auditorily very busy*". Too much unnecessary background noise and especially "*too much echo*" is experienced as irritating by all participants. Several sounds that would easily escape the attention of sighted people, are found disturbing. Aaron hears the dirt in the joints of the tiles in his kitchen. And when his dog starts eating during the interview, he asks whether it does not make too much noise ("*it crunches a little bit*"). Ralph mentions the "*rattling*" of metal stairs. Also too loud sounding footsteps are repeatedly mentioned as disturbing (Ralph, Simon, Sophia): "*well, if there is too much sound, I like to still hear some things, so a wooden floor that creaks and rattles everywhere… that might be charming sometimes, but if I like to get a move on somewhere, then I actually prefer that it does not … too much …that I still hear other things too*" (Simon). Several participants also seem to prefer "*quiet*" housing conditions. The rooms in the house where the least noise from the street gets through, are usually also the preferred ones (*e.g.* Aaron).

Role of sound

The role of sound in relation to people with visual impairments is often associated with echolocation, *i.e.* "*the ability to detect the reflective and reverberant characteristics of an environment using sound generated in the area*" [22]. The sound is typically generated by clicking with the tongue or ticking with a cane. Five participants contend to use echolocation regularly (Anna, Jack, Cara, Oliver, Sophia). Others do not mention the term explicitly, but do talk about using differences in echoes and reverberation for orientation (Roger, Tom, Sam, John). Still others seem to apply echolocation, but cannot name the phenomenon correctly (Aaron, Betty, Adam). Throughout the interviews, however, it becomes clear that echolocation is but one aspect of the participants' sound experience. For them, sound turns out to play multiple roles.

Sound discloses and bounds the world

According to Hull, the world discloses itself to him mainly through his sense of hearing and touch. Something or someone exists only when he can hear or feel it/him/her. His sense of the world is completely different. Most of the time, he seems to live in an almost endless space, only the ground under his feet offers a boundary. This may explain his great liking for thunder: "*I love thunder because it puts a ceiling on my world and prevents me from wandering in infinity which is frightening and disorientating*" [21].

Interestingly, Hull compares the role of sound with what "*turning on the light*" is for people without visual impairment. Sounds can be used to make the environment "*audible*": "*the first thing I do is get out my little portable radio set, which I carry with me almost always. And the first object I come to, (…) I lay my little radio down and I turn it on. That is my way of turning on the light*" [21]. This also relates to his great liking for rain, which allows him to perceive different silent objects from a distance. He hears the rain against the windows, but also in the driveway, on the bushes, on the street, … The rain causes on everything in the environment a slightly different sound. In summary, Hull contends: "*I don't study sound, I live in sound*" [16].

Sound informs about the world

Besides disclosing and bounding the world, sound also offers information about the world. Because visually impaired people cannot fall back on visual stimuli, they try to extract as much information as possible from auditory cues.

Through the sense of hearing, participants try to gain information about moving persons and vehicles. Lara uses hearing to localise moving people so as to avoid running into them. Also Simon and Nick use hearing to perceive pedestrians and automobiles. Yet, Simon notes, this works well only when there are not too many people, nor too many auditory cues, at once. He refers to big station halls, where people run criss-cross in disarray, which he finds very difficult.

In addition, sound offers information about buildings and objects. Especially through reverberation of sounds, people with visual impairments are able to obtain information about the shape and size of a room. But also passageways, openings, large obstacles and the like are perceived in an auditory way by most participants. In providing information on buildings and objects, hearing has a different reach than touch. While touch has a rather limited reach, what you can touch, can be felt in all its details. Through the sense of hearing, by contrast, information from a large distance can be taken in. Smaller objects and details are difficult to perceive in an auditory way, however. As Aaron formulates it, "*a blind person uses his ears to perceive obstacles, but not when they are small obstacles. For instance, it is difficult to perceive a post. But, you can perceive very easily a wall or a high surface, for instance; I will never run into that.*"

Two participants mention that they use touch and hearing for different things. At home Ralph uses touch only when he is "*busy with small things*", such as the dishes or his hobby. Yet, when moving through his house, he seldom uses touch. Similarly, Julia contends: "*in fact it is mainly based on the sense of hearing that I work … there are of course things you do by touch, but that is more about eating a bowl containing rice, containing other grain, you know, such things. But really in the house, I think I do most by hearing*." Inside the house, Sophia explains, she starts touching when something goes wrong, when she loses her orientation for a moment. However, when guiding the first author through her house, she surprisingly notices that she frequently touches walls, landmarks and other elements.

Finally, sound—and especially the voice—also provides information on people. Hull writes in this respect: "*The voice is a fingerprint of sound, in which the history of a person is encoded, just as sighted people say it is in the face*" [21]. After many years of practice, he can estimate a person's age based on the voice—not entirely faultless, but

sighted people cannot always do so faultless either. Also, he can assess people's emotions through their voice.

Sound makes a place (un)enjoyable

For visually impaired people, the interviews suggest, the sound experience plays a major role in assessing whether a place is enjoyable. Indoors as well as outdoors, local sounds influence their appreciation of space.

Some participants like to regularly open their windows (or doors), because "*enjoyable sounds*" can enter (Aaron, Ralph, Tom, Eric). When asked why he finds the kitchen the most pleasant room, the first reason he gives is that there is "*the least noise from the street*". More in general, the typical street sounds do not seem to be categorized under "*enjoyable sounds*": "*these big cities, there you have constantly noise and … traffic noise, I can't stand it anymore*" (Roger). This is also in line with the preference for living in "*quiet*" housing conditions (Aaron, Tom, Simon, Roger, Jack, Jill).

Sounds from nature are much appreciated: "*I find it enjoyable if you get up in the morning and the window is open and you hear that blackbird singing: oh, how fantastic that is*" (Ralph). Asked why he likes the terrace so much, Eric replies: "*the rustling of the trees here, there are a lot of birds here (…) the singing of the birds, that's also nice*." Lusseyran even hears a difference between different kinds of trees, they all have a different kind of "*auditory shadow*" [19]. Hull writes that the trees per season sound very differently: in winter they creak and groan, in spring the leaves sound soft and fluffy, in summer they rustle like waves on the sea and in autumn they sound metal-like: "*So in the autumn and the summer, when the sound of the trees is my raid, then I find it very beautiful to stand and listen*" [21]. Striking also is participants' great liking for the rain: we already referred to Hull's [21] soft spot for the sound of the rain. But also Ralph is fond about it: "*I find it so enjoyable when it rains that sometimes I just stand under my porch*."

For some participants, the favourite room in the house is the one where the music installation, radio, television and/or piano is located (Roger, Rob, Aaron, Betty, John): "*in this corner here, I sit close to the grand piano, close to my tapes, to my radio, the radio is very important*" (Roger). Rob finds a high-quality music installation very important: "*what I find very important, is that you have a good, high-quality [sound] installation in your house … For me, well, yes, for other people … who see, they don't have such an interest in it (…) but I do. (…) We live here in a house with music, I go to bed with it, I get up with it.*"

Shaping the soundscape

Interestingly, visually impaired people deliberately intervene in or shape the soundscape in a "*positive*" way. Some participants introduce sounds in their environment to facilitate orientation: "*when we arrived here*," Roger contends, "*we deliberately planted two trembling poplars at the extreme corners of the street side, that was with a view to coming home alone*." In addition, at the donkey's stable, he has partly excavated the soil and filled it with dolomite. Even though his intervention was meant mainly to provide a tactile reference when his sense of hearing is disturbed by say the wind, the difference in the ground is also perceivable in an auditory way.

Similarly, several participants put small mats in places where they have to pay extra attention. These mats signal a staircase or a small step, for instance (John, Simon, Roger, Julia, Oliver, Rob). They are often placed at the start or end of a staircase, or a stair carpet is used. In addition to a haptic cue, mats provide an auditory cue when one steps on them: one's footsteps sound more dull and muffled.

Yet, interventions in the soundscape may serve other purposes than orientation as well. Roger, for instance, planned to place in his sheep house a microphone (instead of a camera) so that he would be able to keep an "eye" on the animals, for instance when one has to give birth. When refurbishing his house, Hull wanted a "*rain room*", where he would be able to listen to the rain. When he asked the carpenter for a roof covering that lets the sound of the rain through, the latter did not know what to answer. Nobody had asked him that question before. In search for an answer, the carpenter put several samples of roof coverings under the shower [21]. Stan too paid a lot of attention to the soundscape in building and furnishing his house, made in a former public swimming pool. The living room is situated above the former swimming tub, which now serves as storage space. Yet, Stan did not want to lose the sense of space of the tub. In consultation with the interior architect, he came up with the idea to make an opening towards the volume of the tub. This opening works as a kind of sound box, such that the volume of the tub still can be perceived in an auditory way.

Discussion and Conclusion

The study presented in this paper fits into the growing attention for multisensoriality in architecture. In trying to counteract the visual dominance that tends to characterize Western architecture [5], our study focused on the auditory experience of spaces and environments, and aimed to broaden our understanding of the (potential) role of sound. The ultimate aim is to support architects in designing more inclusive environments by paying more attention to multisensory qualities.

In order to expand our understanding of sound experience, we called in the expertise by experience of visually impaired people. Interviews with and/or accounts of these people were subjected to a qualitative analysis. Major findings regarding sound experience relate to the amount and kind of consciously heard sounds and the different roles they play.

Judging from our analysis, people with visual impairments clearly pay more attention to the sonic environment, they deal more consciously with different sounds. Using Schafer's [11] categorization of keynote sounds, soundmarks and signals, we observe a shift in the soundscape. Sounds that other people seldom hear, are perceived much more consciously by visually impaired people. In their sound experience, many keynote sounds thus change into soundmarks or sound signals. Among the sounds that shift to another category, those used as auditory point of reference often become soundmarks; think, for instance, of Roger's trembling poplars. Other sounds shift to the category of sound signals. Examples include the sounds of walking people and vehicles. In summary, our analysis suggests that visually impaired people hear many more sounds consciously, probably (in part) because they want to obtain more information from the soundscape. In the absence of sight, several sounds that most people without visual impairment categorize under keynotes, are thus upgraded to soundmarks or signals.

This shift in the soundscape turns out to result in a surprisingly rich experience. For people with visual impairments, sound offers a lot of possibilities and plays multiple roles—possibilities and roles that are also relevant to other people's spatial experience.

First and foremost, sound discloses the world and, at the same time, provides some boundary to the world. For people without sight, something exists only when it can be heard or felt, smelled or tasted. Several spatial boundaries, such as walls and other obstacles, are perceived (amongst others) in an auditory way. Moreover, sound as such can provide a boundary in itself: thunder, for instance, is described as a sort of "*auditory ceiling*". In addition, the soundscape informs visually impaired persons about the world: through auditory cues they manage to obtain information about their environment and orient themselves. Finally, the sound experience has a major influence on the degree of cosiness visually impaired people attribute to an environment. Evident sounds (birds singing, music) as well as less evident ones (rain, trees rustling) contribute to the cosiness of a space. At home, the favourite room is often the one where the music installation, radio, piano stands and/or with the least street noise.

Striking is also how visually impaired people intervene in or shape the soundscape, *e.g.* by planting trembling poplars, making a "*rain room*", or preserving the sound experience of a swimming pool. These interventions demonstrate how spatial qualities that are relevant to all of us (recognition, cosiness, …) and which architects often address visually, may as well be addressed in an auditory way. As such, they may inspire architects to design environments with more explicit attention for sound and offer a step towards a more "*positive*" approach of the soundscape in architecture.

The step is but a first one, however. Further research is needed to confront the findings of our analysis with the visually impaired participants, and with sighted people. Meanwhile, however, the soundscape seems to hold great potential for inclusive design to be further explored. If we consider multisensory architecture as an ideal to strive towards, it is important to further expand architects' understanding of the soundscape. Our analysis strongly suggests that people with visual impairments, because of their heightened auditory attention, indeed are well chosen user/experts [23] to help in this expansion. Doing so, it has demonstrated the potential of disability (*c.q.* visual impairment) as a source of refreshing perspectives, which invite designers to perceive the material environment in novel ways, and challenge them to broaden their horizon. In other words, we have advanced disability as an opportunity to explore, rather than as a problem to be solved [4].

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