Aural Diversity Toolkit

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Introduction

Arup and the Aural Diversity Network have developed this toolkit to aid designers in creating spaces and environments. It is a tool for designing acoustically inclusive environments.

Our toolkit captures lived experiences of real people. We asked participants to complete a questionnaire, and then held several follow-up interviews with these individuals. We have used these lived experiences to develop anonymised, aurally divergent personas.

The need for this toolkit

Many acoustic design standards are based on 'optimised' hearing. Designers who follow these standards alone may overlook the range of needs of an aurally divergent population. Limitations of the existing acoustic design standards include:

– Design Standards: Very few acoustic standards mention differing hearing needs. Very few reference inclusive design standards.

– Acoustic criteria: Acoustic criteria are typically based on dBA which is inherently not inclusive. This metric was derived from listening tests on 'healthy' 18-25 year olds[1]. As a result it doesn't reflect the range of hearing experience across an aurally diverse population.

Limitations of the existing inclusive design standards include:

– Lack of technical detail: Inclusive design standards currently lack technical knowledge and level of detail on acoustics.

The focus of the toolkit is primarily on indoor environments in public and commercial buildings e.g. offices, shopping centres, restaurants, hospitals, airports etc. Outdoor environments are occasionally discussed in this toolkit however they are not the primary focus. This is because the standards and guidance documents reviewed as part of the scope of this research were primarily for the design of buildings and our questionnaire focused on the participants' experience in buildings.

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The aim of the toolkit

Each of us is unique.

We all need flexibility and choice when we interact with the built environment. Often these requirements are not met when the design of the built environment is based on criteria for ‘average’ human beings. This is particularly apparent when we consider the needs of an aurally diverse population.

Public buildings should be environments which are inclusive of the widest number of people possible. They should be adaptable to individual needs when required.

This Aural Diversity Toolkit is a reference for architects, designers and other practitioners who shape the built environment. The first part provides examples of aural experiences from an aurally diverse population. The second part provides guidance and recommendations, for the design of public buildings for an aurally diverse population.

A group of aurally divergent people

Image showing illustrations of a group of aurally divergent people

How to use this toolkit

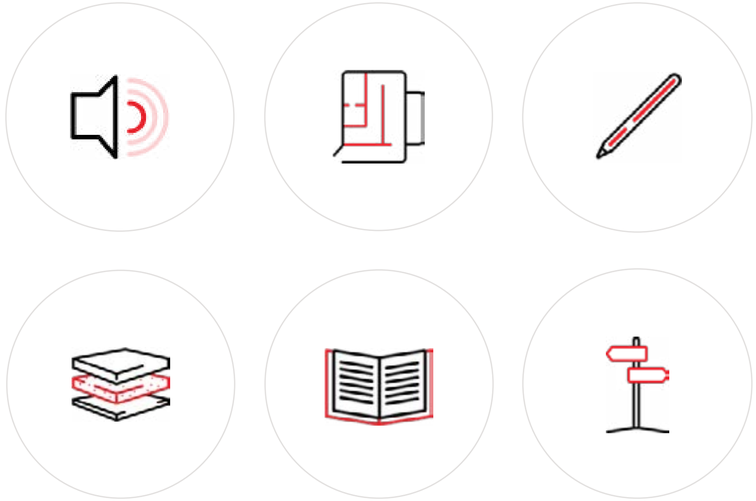
This Aural Diversity Toolkit is in two parts:

– Part 1. Personas.

– Part 2. Recommendations.

Designers should consider the personas and recommendations in this toolkit as early in the design as possible. This will maximize the opportunity to embed these recommendations in the design.

Users should read it alongside relevant standards and guidance.



Part 1.

Personas:

The purpose of the personas is to introduce empathy into design and encourage designers to consider a wider variety of aural experiences. The personas in this toolkit illustrate different user's perspective to consider in the design. The personas can be used to engage with stakeholders and with the design team, and to encourage discussion about how different users will experience the design.

Part 2.

Recommendations:

Provides recommendations and considerations for acoustics, wayfinding, multi-sensory environments, choice of environments, prior information, sound systems and assistive devices. These recommendations can be considered at each stage of the design process.

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Aural diversity

What is Aural Diversity?

The term ‘aural diversity’ refers to the wide range of different hearing experiences in the human population[2]. Aural diversity impacts everyone to some degree, due to minor differences in physiology like the shape of our ears, temporary changes in hearing due to infections, or the change in our hearing range as we get older. The context, situation and listening environment will all have an impact on a person’s hearing experience.

For some individuals and groups of people who are aurally divergent, the spaces and environments in which they live, work and play can have a great impact on their wellbeing. This can include people who are unable to hear certain sounds or frequencies, are particularly sensitive to some types of sound, who experience sound in a different way, are more reliant on hearing (e.G. To compensate for the loss of another sense) or who have no hearing at all. There is a limitless range of individual aurally divergent experiences, and we provide some examples of common categories on the in the diagram to the right.

The Aural Diversity Network provides a more thorough exploration of aural diversity in this infographic.[3]

This toolkit provides a reference for designing for aural diversity in the built environment. It aims to help designers identify barriers that could disadvantage aurally diverse populations.

Examples of aural diversity experiences

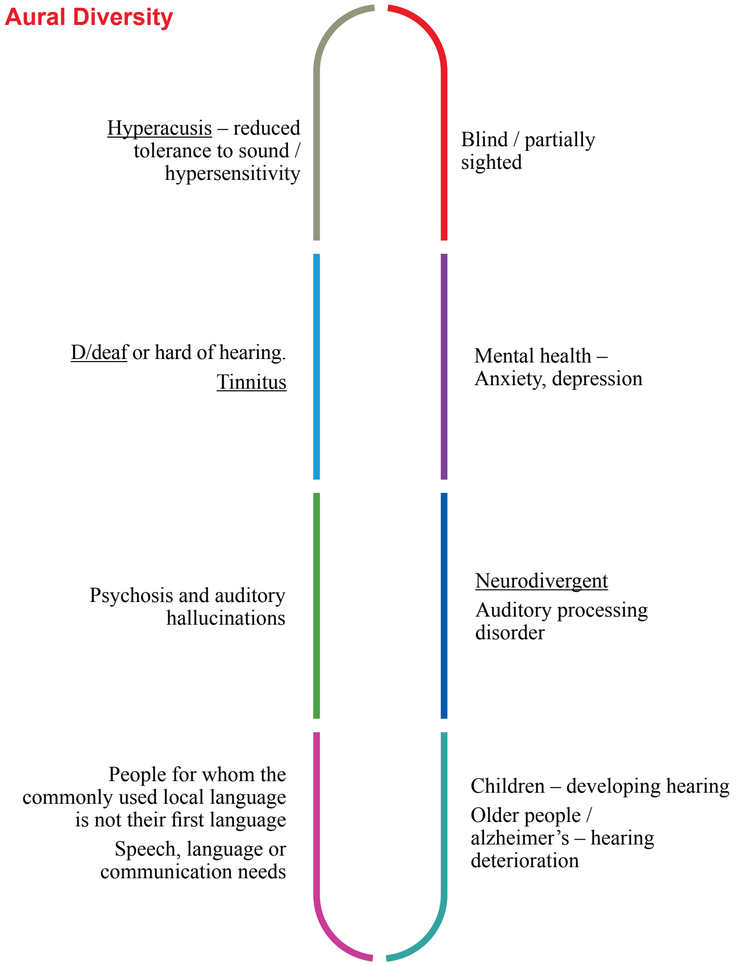
People are complex individuals with multifaceted experiences often falling into more than one way of being aurally divergent. This can make a one size fits all solution difficult or impossible. A solution that can help one individual can hinder another. Therefore, design solutions often require a balance of different criteria and flexibility /adaptability in use.

Aural Diversity Network

It’s a research network founded by Andrew Hugill. A multi-authored book titled Aural Diversity [4] has been published bringing together contributors from the arts, humanities and sciences, edited by Andrew Hugill and John Levack Drever.

Find out more >

Aural Diversity



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Results of the questionnaire

Arup and the Aural Diversity Network designed a questionnaire for people who are aurally divergent to capture their requirements and challenges.

A total of 49 participants completed the questionnaire. The questionnaire included several opportunities for people to write about their experience in their own words as well as more quantitative questions to gain an understanding of the participants and their experiences in a more unified way. Following this arup conducted follow-up interviews with a number of participants to discuss their experiences in more detail.

The questionnaire intentionally avoided asking about clinical diagnoses or asking people to categorise their condition, instead focusing on the experiences themselves, taking a plain english approach and allowing participants to identify with their own categories if they chose to do so.

The questionnaire captured a wide range of aural diversity. The following percentage of participants reported that they...

33% Use lip reading.

4% Have a cochlear implant.

22% Use a hearing aid.

24% Consider themselves to be D/deaf.

These varieties in aural experience are reflected in the six personas in this toolkit.

When asked which types of sounds (out of a set list) they find challenging, participants most commonly included:

– Loud sounds.

– Background noise.

– High pitched sounds.

– “Echoey” (reverberant) spaces.

When participants were asked to rate their confidence in terms of acoustic comfort when attending a set list of locations, all types of spaces received a range of answers on both sides of the scale between ‘not confident at all’ and ‘totally confident’, showing a diversity of experiences and needs in terms of acoustics within an aurally diverse population.

Not confident at all: Restaurant, Airport, Bar, Railway station and Supermarket.

Totally confident: Bank Branch, Theatre /concert hall, Museum, Library.

When participants were asked how important the acoustic environment is when considering visiting a public place:

96% Said that they give at least some consideration.

57% Said that it is quite or very important.

When participants were asked to list any technology, assistive devices and techniques that they use, commonly in loud scenarios or whilst trying to sleep:

20% Use noise-cancelling earphones or headphones.

22% Use ear plugs.

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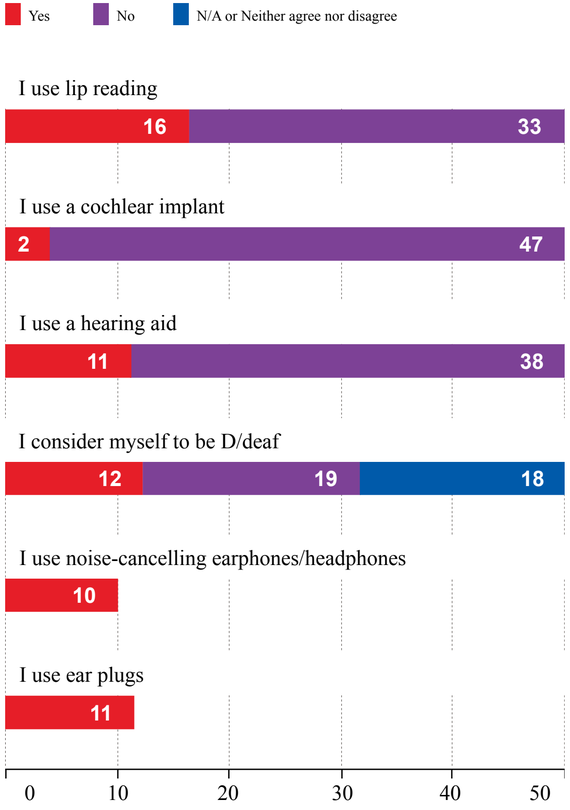
Results of the questionnaire

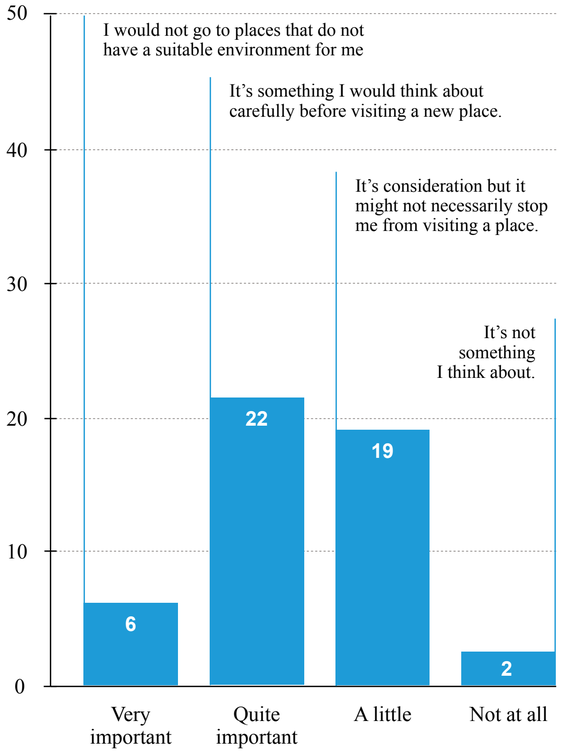
Reposes to a questionnaire

Graph showing the number of participants who responded as agreeing with the statement



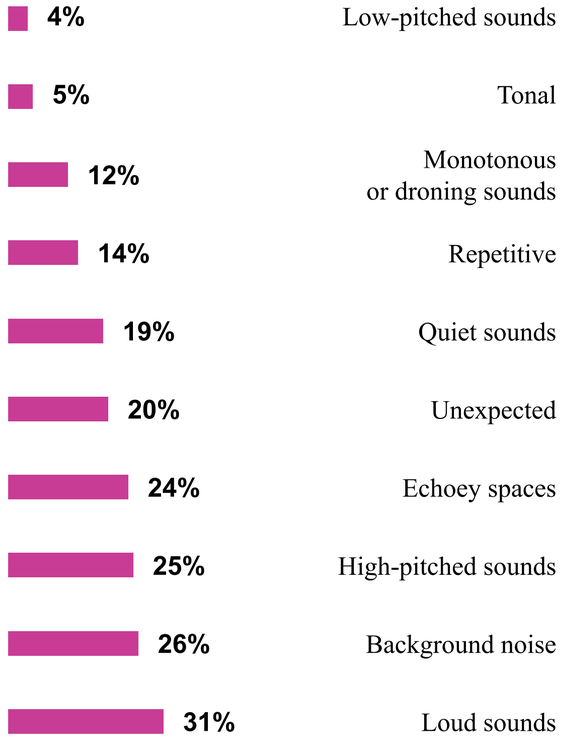
Acoustic environment

When you're considering visiting a public place, how important is the acoustic environment in making your decision?



Sound challenges

Graphs showing the number of participants



Confident Spaces

Table showing the number of participants how they felt on different Spaces:

	Totally confident		Don't know		Not at all confident
Bar	*1*	*13*	*+4, -4*	*23*	*4*
Café	*7*	*24*	*+3.5,- 3,5*	*1*	*0*
Office building	*14*	*18*	*+4.5,- 4.5*	*6*	*2*
Restaurant	*5*	*24*	*+2, -2*	*16*	*0*
Library	*31*	*13*	*0*	*2*	*2*
Supermarket / Shopping centre	*13*	*14*	*+3, -3*	*10*	*6*
Bank branch	*17*	*21*	*+2.5, -2.5*	*6*	*0*
Theatre / concert hall	*12*	*27*	*+1, -1*	*5*	*8*
Open public space	*23*	*22*	*+1.5, -1.5*	*1*	*0*
Museum	*27*	*15*	*+1.5, -1.5*	*3*	*1*
Railway station	*6*	*19*	*+2.5, -2.5*	*16*	*3*
Airport	*9*	*17*	*2, -2*	*14*	*5*

Quite confident — Not very confident

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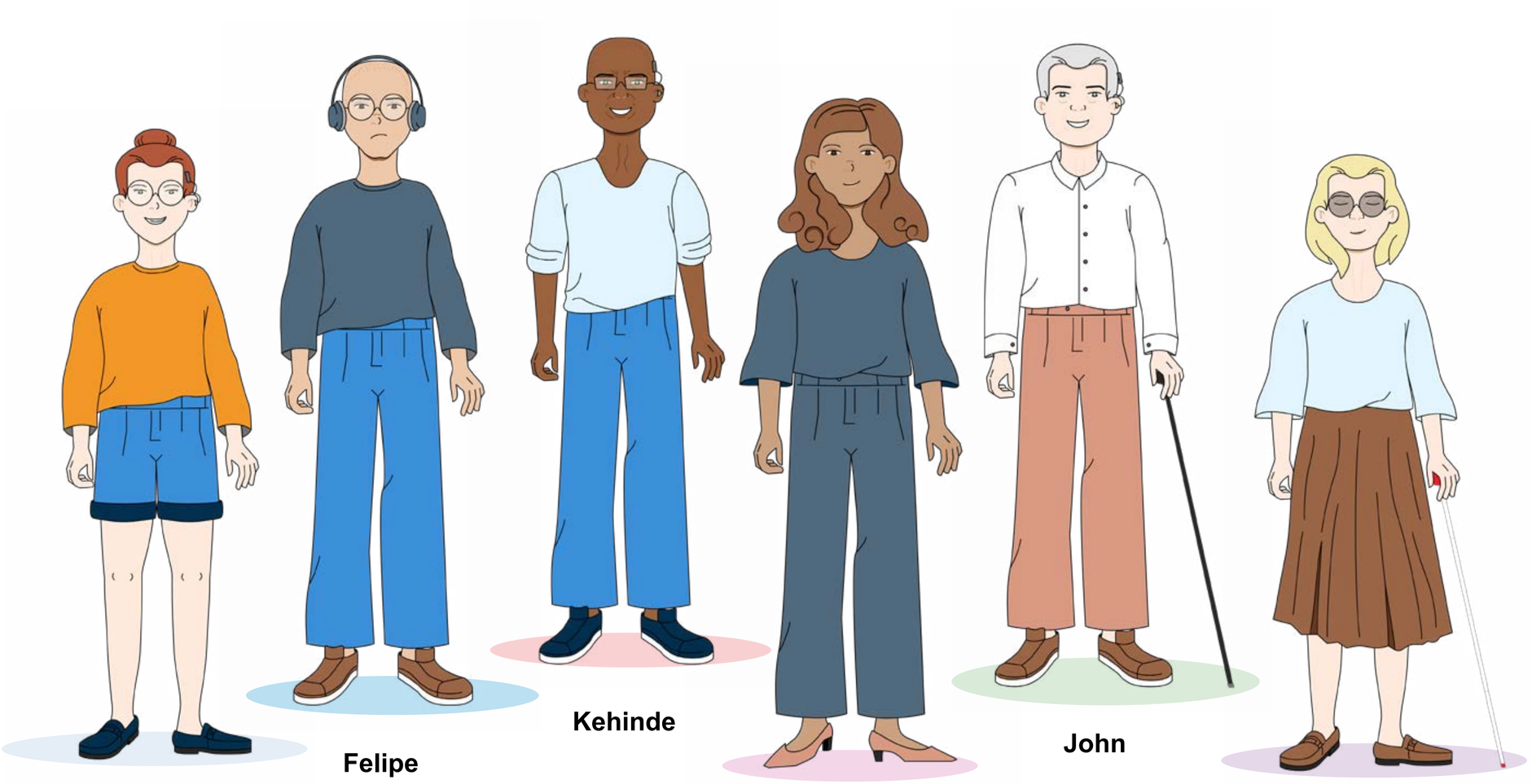
Part 1:

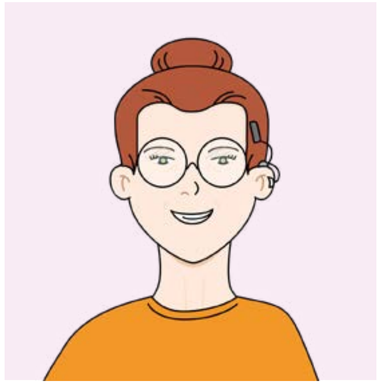
Personas

We have created six personas to illustrate some of the experiences, challenges and needs of an aurally diverse group of people.

They provide understanding and empathy to the designer in considering how designs may be experienced. The personas are based on lived experiences. They reflect the preferences and feedback of real people who we consulted. These personas are intended to facilitate a design dialogue to and broaden the thinking about inclusive acoustic design.

Whilst the personas are based on extracts from actual responses, we have amalgamated and anonymized the personas so that none can be attributed to any single individual. We have taken care when amalgamating these to note where there are common themes, or where there is a logical thread between experiences.





Tracey O.

41 years old

About her:

– Oral deaf
– Lip reading
– Speech-to-text
– Cochlear implants

About Tracey

She identifies as oral deaf. She has been hard of hearing since birth but is now able to hear using cochlear implants. She also makes use of lip reading and speech-to-text translation technology, such as transcribing apps.

At work

Tracey works in marketing and enjoys the creative and collaborative aspects of her work, though she struggles to hear speech over background noise in the office due to the open-plan layout. She can also find conversation tiring, and enjoys being able to escape to a calm green space during her lunch break to enjoy the sounds of nature. There's a small public garden a short walk from her office that is a hidden gem – never too busy, and sheltered from traffic noise.

Lifestyle

Tracey is a creature of habit as she is not confident in new spaces where she doesn't know what to expect, such as shopping centres and cafes that she hasn't been to before. It helps when spaces aren't too busy or there are quiet areas, when there is clear visual signage and when audiovisual content has captions.

When she does switch up her routine, Tracey enjoys going to the theatre – but only when she is able to sit close to the stage so that she can lip read. When the accessible seating isn't close enough, she needs to splash out on the expensive seats, which she can't always afford. She appreciates it when the theatre can provide her with access to the script so that she can read along.

Challenges

Noise
- Background noise
- Unexpected or out-of-context noises

Space
- Open plan or reverberant spaces

Traffic
- Traffic/vehicle noise

High pitch
- High-pitched noises e.g. babies crying.

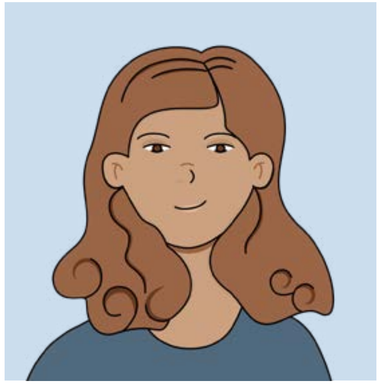
Helpful factors

Quiet areas
- A quiet environment or quiet areas/meeting places.

Acoustic
- Being able to understand the acoustic environment and how busy a space is before going.

Lip reading
- Context to be able to follow conversations using lip reading.

Signage
- Visual signage so she doesn't have to rely on hearing.



Shruthi S.

50 years old

About her:

– Sensitive to Noise
– Noise cancelling headphones
– Stuggles with high-pitched noises

About Shruthi

She is sensitive to noise. Loud and high-pitched sounds tend to evoke a feeling of anxiety and can also lead to sensory overload. This is heightened by experiences of synaesthesia, which she describes as experiencing sounds with her entire body. Noise can also affect her other senses, such as causing visual disturbances.

At Work

Shruthi works in banking in the city. She avoids getting the underground to work because she doesn't like the harsh lighting or the echoey/ reverberant passages. Instead, she takes a bus – which takes longer – but she can always get a seat which allows her to relax, and she enjoys the journey whilst listening to a podcast through her noise cancelling headphones.

Lifestyle

She isn't confident in bars or clubs and tends to avoid them. Music gigs aren't her thing either – due to the flashing lights, high noise levels and crowds. She's also more aware of her hearing than others and is keen to protect her hearing from damage by avoiding overly noisy events.

When Shruthi goes to a shopping centre she makes sure to go with her partner or a close friend, as these environments can be noisy and overwhelming when they are busy. She particularly struggles with the clashing music emanating from different stores as she passes.

Challenges

Noise
- Being overwhelmed or struggling to navigate in noisy environments

Space
- Trying to concentrate on a task or a conversation in a noisy space.

Wellbeing
- Struggling to sleep due to sensitivity to noises whilst trying to sleep.

High pitch
- Loud and high-pitched sounds.

Helpful factors

Quiet areas
- Venues or areas in venues without loud music.

Lighting
- Soft artificial lighting/daylight.

Space
- A quiet and calm environment
- Ability to move in a space away from noise sources affecting her.

Signage
- Clear and thoughtful signage

John H.

82 years old

About him:

– Hearing loss

– Hyperacusis recruitment

– Bone-conducting headphones

About John

He is retired and has age-related hearing loss. Sounds are trickier to hear and to distinguish from background noise now – especially at high frequencies, and he has hyperacusis (things can sound louder than they do to other people). Because he lived most of his life with optimum hearing, he finds this change in his hearing frustrating. He wears hearing aids to help him hear.

Listening to music doesn't bring him the same joy as it used to as he misses a lot of the high frequency information in the sound, but using bone-conducting headphones helps slightly.

Lifestyle

John is determined to not let his hearing prevent him from going anywhere, or doing the things he wants to do. He has connected his hearing aids to his phone via bluetooth so that it is easier for him to understand phone conversations for him to understand phone conversations. Although he gets anxious going to the bank due to the prominence of verbal communication there and the legibility of this through the glass partitions between him and the cashiers, he doesn't trust online banking. As his wife would have said in exasperation: he is undeniably stubborn. To make things easier, he asks for an appointment so that he can sit down and it is easier to focus on the person he is speaking to. Being able to clearly see their face, without being obstructed by a glass screen, also makes it easier for him to lip read.

John is sometimes lonely and he enjoys chatting to people when he can, although engaging in conversation can be tiring for him as he struggles to process and understand the speech sounds that he hears, especially when there is loud background noise. Therefore john avoids coffee shops and restaurants – he prefers quieter meeting places such as parks or his local community hall where he attends a book club.

Challenges

Echoey & Noise
- Background noise or echoey/reverberant spaces and any distractions

Hearing Aids
- Sounds that cause feedback in the hearing aids

Quiet areas
- Hearing quiet sounds

Speaking
- Loud background music
- Processing conversation
- Understanding announcements in airports, railway stations and similar.

Helpful factors

Quiet areas
- A quiet environment or quiet areas/meeting places

Space
- Spaces where it is easy to focus on the person he is speaking to without speech masking
- Predictable noise environment that he can prepare for

Signage
- Visual cues e.g. signs at a train station, so he doesn't have to rely on hearing announcements or speaking to people.

Felipe M.

25 years old

About him:

– Sensitive to Noise

– Speaks quietly

– Misophonia

About Felipe

He is sensitive to noise to the extent that loud noise can be uncomfortable or even painful. He also has misophonia, where certain common sounds such as breathing and chewing can trigger emotional discomfort or pain.

At work

Felipe works as an engineer and in general, his hearing doesn't really impact his job. His office has great zoning for speech privacy and individual work. At quiet, focused times, he listens to music through earphones to mask his tinnitus so that he can focus. However, he is sometimes self-conscious when his co-workers struggle to hear him; he speaks quietly so that his voice is not too loud for himself.

Lifestyle

Over the past year Felipe has also developed tinnitus. It might have been due to going to loud club nights and raves when he was a bit younger, but he's not sure. He can always hear the high-pitched ringing in his ears, but being in a loud space for over half an hour makes it louder when he's trying to sleep that night. He still likes to go out with his mates and is grateful for socially acceptable ways of going somewhere quieter, like the outside smoking area of a bar.

Felipe struggles with particular noises, but he has figured out what triggers him and what to avoid. He tries not to go to restaurants because the noise ruins the experience of the food – he prefers getting a delivery instead. When he does go to restaurants or cafes, he likes ones with background music playing to mask the sounds of clinking cutlery. Felipe also avoids public toilets due to the loud noise from high-speed hand dryers, and makes sure to wear his noise cancelling headphones when he's getting the train so that he doesn't hear the squeaking of brakes, and when he's at the gym so he doesn't hear the weights and machines (or the grunts!).

Challenges

High pitch
- Physical pain from loud and/or high-pitched sounds

Speaks quietly
- People struggling to hear him when he speaks quietly in a noisy environment

Wellbeing
- Struggling to sleep due to sensitivity to noises whilst trying to sleep

Repetitive noise
- Repetitive noises like clinking or machinery

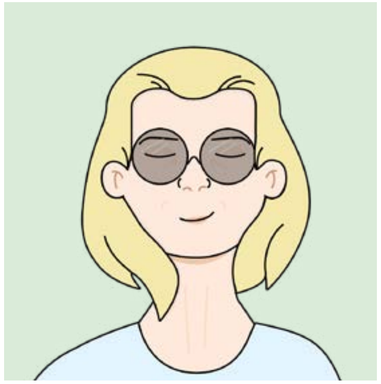
Helpful factors

Quiet areas
- Areas that are quiet with low reverberance
- The ability to navigate a city via quieter streets and alleys away from heavy traffic noise.

Ear plugs
- Ear plugs or noise cancelling headphones to mask tinnitus

Music
- Background music in cafes and restaurants to mask eating and other distressing or repetitive sounds such as cutlery clinking

Natural sounds
- Natural sounds rather than mechanical/artificial sounds



Jessica B.

64 years old

About her:

– Sensitive to Noise

– Blind

About Jessica

She describes herself as blind and uses a white cane to navigate independently. She started losing her vision from her teenage years and has lost all vision since her early twenties.

At Work

Jessica is a freelance writer. She enjoys background music playing in a space – she finds it soothing and it helps with contextualizing her surroundings. She has a few favorite coffee shops near her where she is familiar with the layout. She often spends an afternoon in one of them, working on her next novel.

Lifestyle

Jessica relies on her hearing more than most people to navigate. For example, one of her favorite coffee shops is in a large shopping center. The hard floor and high ceilings of the shopping centre, compared to the soft furnishings or the coffee shop and open space of her walking route help her intuitively navigate between different spaces. Noise coming from different shopfronts and a primary school she walks past help her understand her position in her journey.

Conversely, she finds pa announcements in airports and train stations very confusing. The additional auditory information makes it harder for her to position herself relative to aural ‘landmarks’ or sounds reflecting from nearby surfaces. She accesses this kind of information herself via headphones connected to her smartphone, so finds that public information systems, alarms or audible advertising really just get in her way.

Challenges

Noise
- Directionless background noise

Signage
- Public address systems

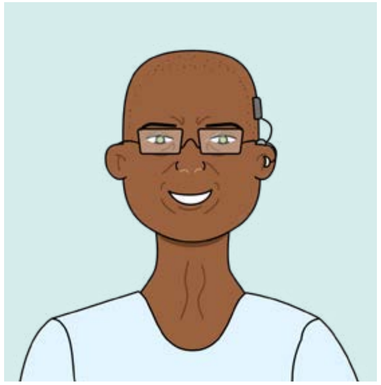
Crowds
- Crowds e.g. football matches, demonstrations

Helpful factors

Assistive technology
- Information that allows her to use her own assistive technology – e.g., tactile indicators showing a QR code she can scan with her phone to access audible informatio

Space
- Transitional spaces to help her senses adapt and communicate a change in location

Navigation
- Changes between acoustic environments to help her navigate



Kehinde L.

36 years old

About him:

– Hearing loss

– Lip reading

About Kehinde

He has moderately severe hearing loss in his right ear with some hearing loss in the left. It developed from excessive noise exposure from being in a band when he was a teenager and in his 20s. He is not able to locate sounds as he mainly hears out of one ear. He has learnt to use lip reading to help him understand speech.

At work

Kehinde is a teacher and sometimes struggles to hear his students. He has rearranged the layout of his classroom so that he teaches from the corner. This means that he can see all his students to be able to lip read, tell who's talking and hear everyone. The only problem is that the whiteboard is in the centre of the room against the widest wall, which would make orienting his left ear to the audience difficult.
He tends to avoid using it. His students understand that they have to speak louder and might have to repeat their question for Kehinde, but he sometimes has to be strict to prevent them from being noisy and all talking at once.

Lifestyle

Kehinde is consciously punctual to social events and gatherings so that he is able to choose where he is sat. This allows him to deliberately locate his right ear towards the wall and his left ear towards the rest of the room. He prefers meeting his friends in groups of 3 or fewer to be able to always maintain eye contact and lip read.

Kehinde struggles to block out unwanted noise and so struggles to concentrate when there's any background noise. He has to mark his students' homework in a study at home, away from the noise of his children playing or watching television. He also likes marking and lesson planning in his local library.

Kehinde is acutely aware of how his past actions have led to his current hearing problems and so does not want to further damage his hearing. He avoids night clubs and rock concerts and makes sure to carry ear plugs with him in case he goes somewhere noisy.

Challenges

Noise
- Background noise

Space
- Wide rooms which can make orienting his "good" ear in the optimum direction difficult e.g. presenting in seminar rooms at work;
- Geometrically complex places e.g. stairwells make it very difficult to keep up with conversation.

Echoey spaces
- Echoey/reverberant spaces and more than one person talking at once

Helpful factors

Space
- Being able to choose where he is sat so he can have his bad ear to the wall

Noise
- Predictable noise environment that he can prepare for

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Part 2:

Recommendations

This section of the toolkit gives recommendations and considerations for designing acoustically inclusive environments. Our recommendations are informed by:

– Hearing about the lived experiences and recommendations of people who are aurally divergent;
– Acoustic and inclusive design standards and guidance documents (see "Standards and Guidance Documents");
– Previous research and work at Arup.

The recommendations are primarily focused on design considerations, since this toolkit is intended for use by built environment practitioners. However, we also provide some operational considerations, for information, where relevant.

The recommendations are organized into the following themes:

Acoustics

Wayfinding

Multi-sensory environments

Choice of environments

Prior information

Sound systems

Assistive devices

Acoustics

About Acoustics

The acoustic environment of a space is key for enabling communication. It affects a person's experience in a space. Different sounds can affect people in different ways. It is not simply the level of sound that can create problems: the character of the sound, the context of the listener situation and the nature of the sound source all have an effect. The need to concentrate on or filter out sounds can add to cognitive load and increase fatigue and tiredness.

Spaces with high levels of background sound and a long reverberation time can make it particularly difficult for users to communicate. Some users may be unable to raise the level of their voice to compete with the background sound. The natural tone or the level of their voice might make it more difficult for others to understand them. Some users may find it difficult to discriminate between multiple sources of sound in an environment.

Hearing aid and cochlear implant users can find high levels of background sound and overly reverberant spaces disturbing and confusing. Noise can be overwhelming and confusing for a person with dementia and a hearing impairment (as stated in the Kirklees Dementia Friendly Design Toolkit). These users benefit from additional control of background noise and reverberation.

Recommendations:

Quiet areas

Provide spaces which are quiet and calm to provide an acoustic respite.

Choice of environments for more details >

Space Planning

- Use acoustic zoning to signify different spaces. To avoid a sudden transition which could result in a sensory overload, consider designing for a gradual transition of sound between each space.
- In the early stages of design of a new or renovated building, undertake a space planning exercise to locate spaces for activity which is sensitive to sound away from spaces which are likely to generate high sound levels or have high levels of footfall.

Soundscape

Consider the soundscape of an environment alongside the acoustics of that environment[5] introducing sounds which are perceived by users as more pleasant e.g. natural sounds. Consider which sounds they will perceive as negative and whether they can be reduced, removed or masked.

Surface finishes

- Design rooms to have a suitable balance of surface finishes that provide an acoustic suitable for the purpose
- Include adequate sound absorbing finishes and soft furnishings in spaces where listening and communication are important, to allow speech to be more clearly interpretated. These can be arranged to allow for some reinforcement of direct sound from speaker positions whilst controlling reverberation. Note that there is a balance required in room acoustic design. "Use of materials with very high absorbencies can give rise to spaces that have muffled, lifeless character which is uncomfortable and unpleasant for some people."[6]. Some people make use of acoustic reflections in their wayfinding to help them navigate between spaces.

Enhanced criteria

- Consider targeting the enhanced acoustic criteria in BB93 - Acoustic design of schools: performance standards and PAS 6463:2022 Design for the mind – Neurodiversity and the built environment – Guide to provide a range of acoustic environments in a building that are accessible to users.
- Consider going beyond the standard performance requirements set out in the standards and guidance where possible

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Acoustics

Recommendations:

– + Noise control

– Reduce background sound levels through good design of building services, and good design of sound insulation to reduce intrusion from surrounding spaces (both external and internal). Note that it is not as simple as making spaces as quiet as possible. Background sound can enhance privacy or mask unwanted or annoying sounds, including those audible only by that person e.g. tinnitus:

– In the early stages of design of a new or renovated building, undertake a space planning exercise to locate spaces for activity which is sensitive to sound away from spaces which are likely to generate high sound levels or have high levels of footfall.

What Aural Personas think:

"I feel like I'm working so much harder than other people [in conversation] and that they are coping better than I am."

"I can move towards my good ear towards the noise and without even necessarily anyone noticing that I'm doing it."

Kehinde

"Sometimes I have to get someone else to repeat what they've said because the tonality is wrong or you know the person is just really quiet."

John

"If there's a lot of background noise, it's difficult."

Tracey

"I can't see [tell] where the noise is coming from so I really struggle to focus on that."

Shruthi

"I can't stay here because the noise is just too much."

Felipe

Operational considerations

– Consider how to reduce or avoid noise from furniture or equipment in the space through selection or adjustments. Problematic examples include chairs dragging across a hard floor and beeping from entry systems.

– Inform building users of the intended use of any acoustic zones within a building and monitor the actual usage in case the approach needs to be adapted over time as the use evolves. E.g. in the case of zones within an office where some places are intended for more collaborative working whilst others for quiet independent working.

Wayfinding

About Wayfinding

The acoustics of space can aid building users with navigation and wayfinding. This is the case for all users but can be particularly critical for those users who are blind or partially sighted. Some of the interventions in this section were informed by Arup's work on designing the acoustics for the Lighthouse for the blind building in San Francisco.

Recommendations:

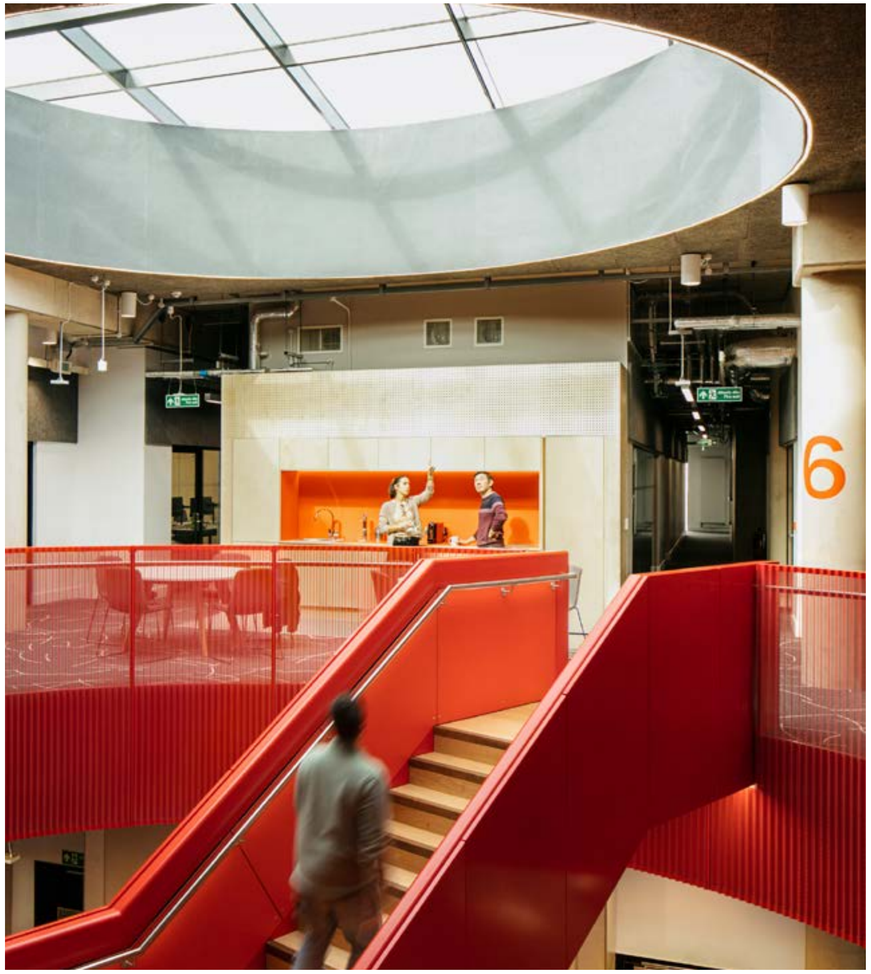
Colour

– Consider the use of colour to assist with wayfinding e.g. the use of a red door, green door etc. which has been found to work well for some neurodiverse users.

Signage

– Include clear signage placed in appropriate locations and consider multiple means for communicating this information, e.g., icons and pictograms for people who have difficulty reading English or tactile information for people with different levels of vision.

– To assist with users who are D/deaf or hard of hearing, include a visual display. This can be particularly key in the case of waiting room settings where a D/deaf or hard of hearing user may not hear their name being called.



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Wayfinding

Recommendations:

Surface Finishes

– Design spaces to have a variety of acoustic reflection sequences and reverberation levels to signify different spaces. Network Rail Design Manual – Inclusive Design states that “areas that have distinctive acoustic qualities can be more easily interpreted and memorized, by partially sighted and blind people helping them to navigate the building”.

– Use differing floor finishes to signify different spaces:

  – e.g. a different floor finish in the primary circulation routes and areas that serve other functions.

  – Note that deep carpet offers less feedback for cane users and can create barriers for people using mobility equipment.

– Use differing ceiling finishes to signify different spaces.

– Consider leaving the soffit of a space acoustically untreated (i.e. no sound absorption) to help give a sense of how large a space is vertically.

  – Note this should be balanced with the need for controlling the reverberation time of a space (e.g. as mentioned in the ‘Acoustics’ section of this document on the previous page).

– Vary the local acoustic environment around circulation routes e.g. install thick sound-absorbing finishes at corners as a learned acoustic cue for blind and partially sighted users.

What Aural Personas think:

“I’m really careful around crossing the road, like to the point where my husband kind of laughs at me a bit because he’ll be across the road and waiting for me for ages because I just really want to be sure that I’m safe. Because I know that I can’t completely depend on my senses to be feeding back in a reliable way.”

Shruthi

“Having visual support e.g. digital signage screens [makes environments easier for me]. In a shop I rely on having the total displayed at the checkout till.”

John

Operational considerations

– Consider how fittings, furniture and equipment could be arranged to provide audio cues to help a blind or partially sighted user to navigate a space.

Multi-sensory environments

About Multi-sensory environments

It is important to consider all the senses in an environment to design for good health and wellbeing. We experience the world as an interpretation of the multi-sensory environment that we are in. An improvement to one or more of sensory design aspects can make the difference of a space being bearable or not for aurally divergent users.

By designing though a multisensory lens, designers can mitigate some of the impacts felt by built environment users with extra sensory requirements. Additionally, this can lead to a more pleasant and relaxed experience as the cognitive load is reduced.

Cognitive load is typically increased when unnecessary demands are imposed on people, for example by requiring them to process a multi-sensory disturbance whilst listing to speech. This in turn makes the task of processing information overly complex, demanding and stressful.

Arup's Neuro-include guidance[7] researched design for multisensory environments and found that:

- 70% of neurodivergent people consider lighting the most upsetting feature in the built environment (fluorescent lighting in particular).
- Fluorescent, flickering lights, loud noise and crowds can have a significant impact, causing sensory overload. A cluttered environment, with strong fluorescent lights, noise, strong smells can make some people feel overwhelmed. This can cause anxiety and even panic attacks, or feelings of claustrophobia and dizziness.
- Particularly bright, visually busy or particularly dark wall colours may be distressing for individuals. A visually busy environment (walls/patterned or shiny floors) can create a sense of anxiety and claustrophobia.

Recommendations:

Space Planning

- Design for the cognitive tasks that users will need to complete when using a space. Provide focus on these and aim to reduce distraction from objects that do not have any sensory purpose for the user
- Allow sufficiently wide corridors and spaces to allow clear visual communication space between D/deaf or hard of hearing user and a guide.

Signage

- Use clear and consistent signage to direct users to a space. Design elements such as furniture and planters can also be used to guide people through spaces, these interventions may reduce the reliance on auditory interactions to seek guidance on navigation.

Holistic design

- Design holistically considering acoustics, noise, lighting, temperature and material finishes

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Multi-sensory environments

Recommendations:

Holistic design

Visuals

– Avoid particularly bright or visually busy patterns on surface finishes as they can be distracting for people who use sign language or lip reading

– Design floor, wall and ceiling surfaces to achieve a good level of visual contrast (minimum 30pts difference in Light Reflectance Value)*. This helps a wide variety of users to locate themselves within the room, improving levels of comfort and wayfinding.

– Provide clear visual information as an alternative to auditory information and announcements so that users of the space have a variety of access choices.

What Aural Personas think:

" I have to leave noisy environments, especially shopping environments, because I can't handle the sound. [Synaesthesia] starts to kind of cloud my ability to separate out all the different sensory input."

Shruthi

"It's a stress indicator for me.... So if I sleep poorly or I'm simply stressed, I would perceive [my sensitivity to noise] much more."

Felipe

Operational considerations

– Consider how any potentially "annoying" sounds can impact users of the space (e.g. alarms, beeping, tonal, repetitive, impulsive sounds)

– Consider how prior information can be especially helpful to enable people to research a venue before visiting to help with cognitive load during their visit. See the 'prior information' section).

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Choice of environments

About Choice of environments

Not all people with aurally divergent requirements will experience spaces in the same way. It is important that designers of the built environment provide a choice of acoustics to provide equity of experience.

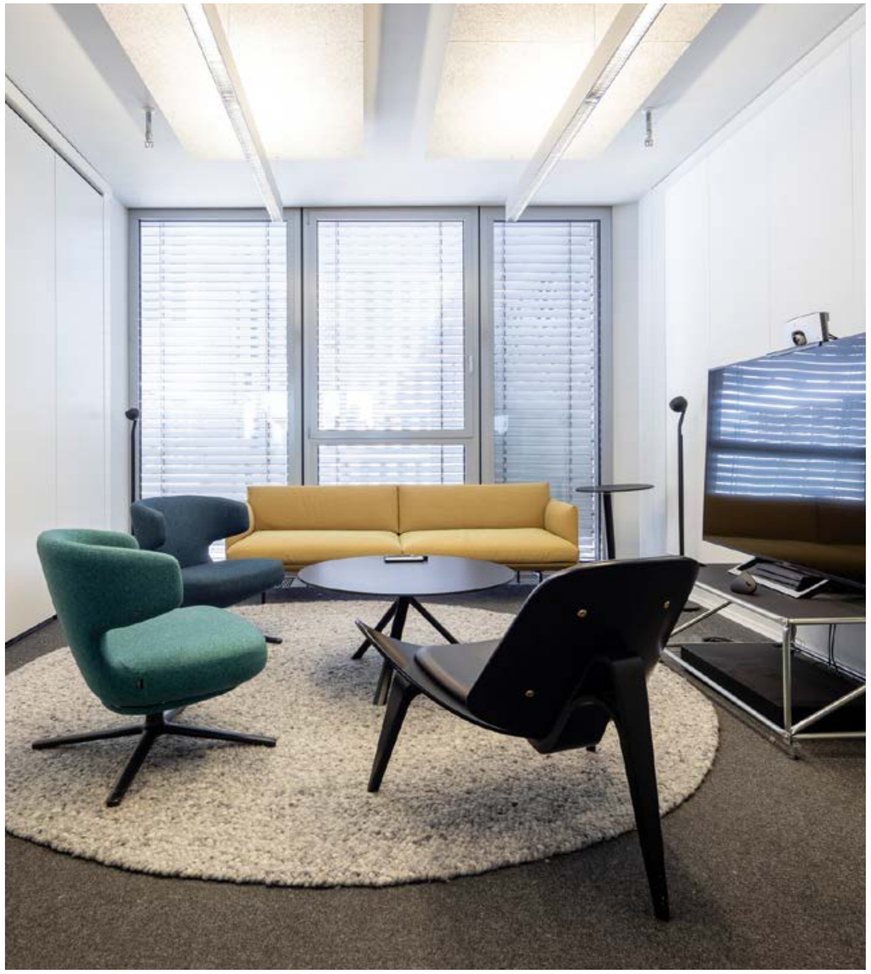
For example, in an office, a user may require a hearing loop to take part in a meeting or presentation or may require a quieter room to be able to lip read with the person that they are talking to. In these instances, a choice of activity-based environments should be provided.

Concentrating on sounds, or filtering unwanted sounds, can add to cognitive load and increase fatigue and tiredness, and decrease the enjoyment of a space and associated activities.

Providing users with a degree of control over their environment can help them to manage their aural experience, and also increase their sense of ownership and belonging.

PAS 6463:2022 Design for the mind – Neurodiversity and the built environment – Guide describes how an individual should be able to control the noise that they are exposed to. This could include control measures such as;

- the ability to switch an extractor fan on or off;
- the option to close a window or ventilator panel when noise comes from the street;
- the option to use a variety of spaces including access to a quiet room;
- the option to choose the level of noise (e.g. between using paper towel and hand dryers).



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Choice of environments

Recommendations:

Quiet areas

– Provide quiet spaces to allow acoustic respite. Locate these rooms in an appropriate location away from noisy activity.

Choice

– Provide users of the built environment with a choice of acoustic environments where possible. Include spaces with less acoustic reflections to enable aurally divergent users to be able to hear with increased clarity.

Adjustable Design

– Provide ways of adjusting the internal acoustics to accommodate different activities, for example the use of curtains, freestanding sound absorbing panels, moveable furniture, mechanical sound absorbing wall panels to alter the reverberation time

What Aural Personas think:

"For me it's all about being able to choose and to know that there are acoustically "safe" spaces to retreat to if needed. Bars often work[….], because it is not as (socially) difficult to just go outside for a breather... "

Kehinde

"Everybody is different and works in different ways […] Establishing quiet for people who need quiet. That's really tricky."

Tracey

"I find that offices do a very poor job at supporting people's needs from a sound perspective […] not enough zoning to carry out focused individual work."

Shruthi

"The ability to move in the space and away from any audio sources that affect me [makes environments easier for me]."

Felipe

Operational considerations

– Is it possible to give users control of noise generating equipment in the space? Can you offer alternative spaces which are isolated from building noise? Can facilities teams supply less noisy alternatives hand dryers, alarms and other noisy systems?

– Provide an option to experience a space in a quieter setting e.g. by organizing quiet sessions where the volume of amplified audio is reduced.

Prior information

About Prior information

Planning ahead and prior information is often important for people with diverse physical requirements. It allows users or people unfamiliar with a building the ability to pre-plan and ensure that the venue has adequate facilities to support them.

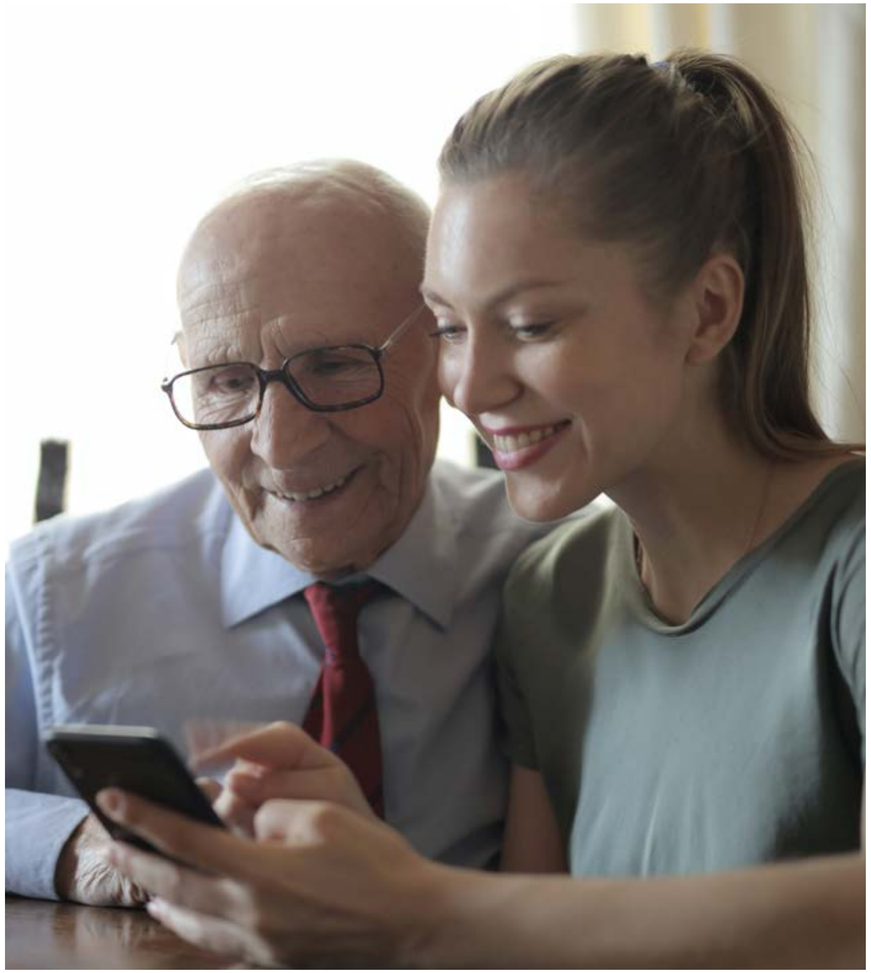
Many venues share details about the things people can expect before and during their visit, especially in transport, arts buildings, and increasingly commercial buildings and retail. This can include information about the user's journey through a building, what sort of times they might wait, and the distances people may need to travel. This could be via print or digital platforms.

People with diverse aural requirements may find information such as busier/louder times to be useful, if (for example) they require an acoustically calmer environment. Details of a venue's technology provision could also be beneficial as it would allow users with aurally divergent requirements to make informed decisions about any assistive technology they may need to bring to the venue or ask for adjustments if needed.

With the advent of connected devices, it is possible to understand the acoustic profile of a space, even relaying live sound levels to a website dashboard or providing real-time information to displays within the same facility (e.g., a shopping centre or transport hub).

The ability to understand more about the acoustic experience of an environment before visiting allows individuals to prepare for the visit and anticipate what they might need.

Immersive technology (e.g. XR, VR, AR) and virtual tours can allow designers and users to experience a space before they visit it or even before it has been built.



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Prior information

Recommendations:

Information

– Understand the environment's acoustic profile including the acoustics, the nature of typical sounds in the environment and any potentially disturbing noises. Make this information available to the users. Identify any technology or support interventions that might be required by users. Be mindful of how this acoustic profile may change depending on the time of the day or year.
  – Information regarding the acoustic profile and other accessibility considerations of an environment could be made available to the users on the environment's own website under accessibility features. To supplement this, submit this information to numerous apps and online search engines that provide accessibility information.
  – When users have access to this information, they can make informed choices about the time they may wish to visit, to access a particular sound profile, have information about any technology they may be able to access and have a clear understanding of any technology or support mechanisms they may wish to bring with them during their visit.

What Aural Personas think:

"I can mentally prepare for a coffee shop to have background chatter, whereas a bar is very unpredictable. "

Jessica

"Now you tend to get pinged on your phone if your booked train's changed." (On the topic of hearing train announcements)"

Tracey

Operational considerations

– Keep users of the space updated with any changes to the environment e.g. building works and any other potentially noise generating activities so that they can make an informed choice about their visit.
– Provide users of a space with prior information and consider how you can enable them to gage the nature of the acoustic environment and typical noisiness before they visit to enable them to plan their visit e.g. in an office building with a where users can choose their work environment, facilities and building users could observe the typical uses and noisiness of each zone and give an indication of this to assist in a user choosing the zone most suitable for them or the type of work they are planning to undertake.
– In entertainment venues consider providing relaxed performances with lower sound levels, simpler lighting etc.

Sound systems

About Sound systems

Sound systems in buildings are used for public address (making announcements of information), evacuation purposes (e.g. for fire) and playing audio/music. The acoustics of a space have an impact on the quality of sound perceived from these systems within the space. In the case of communicating information through announcements, the acoustics have a direct impact on the speech intelligibility.

Better speech intelligibility improves comprehension for everyone. Aurally-diverse users (e.g. with hearing loss or with a different first language), particularly benefit from better speech intelligibility.

Recommendations:

Surface Finishes

For public address sound systems, include adequate sound absorbing finishes to help control the reverberation time and background noise of a space to assist with providing a good signal to noise ratio for the sound system.

Enhanced criteria

– Design public address sound systems to meet an enhanced speech transmission index (STI) criteria to improve intelligibility for age-related hearing loss as well as for people for whom the commonly used local language is not their first.

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Sound systems

Recommendations:

Visuals display

– Use visual display panels / lights as an alternative and additional way to communicate an announcement. This is especially critical in the case of alarms for evacuation where a hard of hearing person may not be able to detect the alarm.

What Aural Personas think:

"If I wear fully noise cancelling headphones I can miss all sorts of things… fire alarms, you name it, we don't have any flashing lights in my office."

Kehinde

"In the [supermarket]... They're playing music from when i was a teenager, and like all of a sudden i'm buying my groceries to pulp – common people, and it is the most ironic experience, but that puts me in a kind of comfort zone. […] The other thing is that the people who work in there have headsets... Instead of the customers having to listen to [announcements] intended for the staff."

Felipe

Operational considerations

– Consider the use of music in the space. BS EN 17210:2021 states that it should be at a comfortable noise level for the majority of people. Consider that background music can hinder communication for people with hearing impairments. This should be balanced with the consideration that background music can provide useful masking and can be found soothing by others.

– Consider that some users will be unable to hear public announcements over a speaker system e.G. In a train station or airport setting, so may miss key information. Consider multiple means for communicating this information

– Consider how any tones or audio for the testing of sound systems can be annoying or upsetting for some users. Inform users that the test is taking place so that they can be aware.

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Assistive devices

About Assistive devices

People with diverse aural requirements may use assistive technologies to help them when in aurally challenging environments, including hearing aids and cochlear implants.

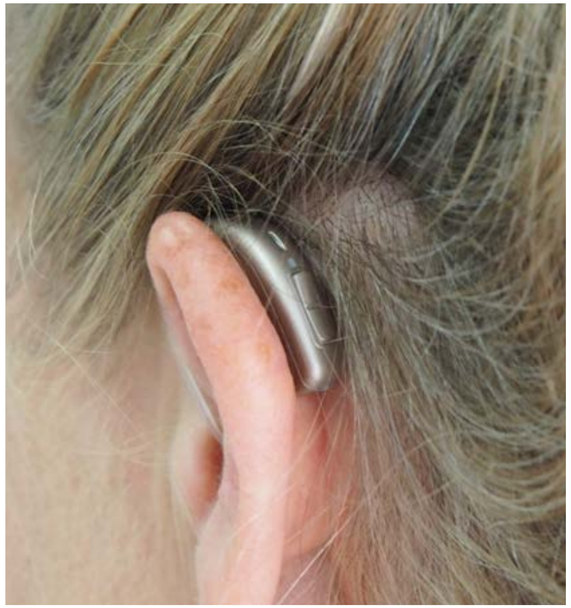
Hearing aids:

– Hearing aids do not give users optimum hearing, but they make can make sounds louder and clearer, reducing the impact of hearing loss.

– Hearing aids can assist wearers to hear everyday sounds such as doorbells and phones, improve the clarity and understanding of speech, and make it easier to follow conversations in different environments.

– Hearing aids also boost loudness so that the user being able to listen to sounds, such as tv and music, at a volume comfortable to others around them.

– Some users find that hearing aids do not assist them in hearing more clearly.



Cochlear implants:

– Cochlear implants are an electronic device, which is surgically implanted and gives a sense of sound to a person who has profound hearing loss. A cochlear implant does not cure deafness or hearing loss, and instead is a substitute to external hearing aids which directly stimulates the cochlea.

– The implant's electrodes stimulate the cochlea's hearing nerve fibers, which relay the sound signals to the brain to produce hearing sensations.

Many people who use hearing aids or cochlear implants will adjust, remove or turn off their devices for comfort in some situations. For example, a user may switch off their cochlear implant to help them concentrate in an open office, and therefore be unable to hear an alarm or other auditory information.

Assistive devices for aural diversity are available from a range of manufacturers, and broadly fall into these categories:

– *Assistive listening devices (ALDs)* which help to amplify the sounds their users want to hear, particularly where there is a lot of background noise. ALDs can be used with a hearing aid or cochlear implant to help a wearer hear certain sounds better. Types of ALDs include;

  – hearing loops and induction systems;

  – FM systems;

  – infrared systems;

  – personal amplifiers.

– *Augmentative and alternative communication (AAC)* devices help people with communication disorders to express themselves. These devices can range from a simple picture board to a computer program that synthesizes speech from text.

– *Alerting devices* connect to a doorbell, telephone, or alarm that emits a loud sound or blinking light or vibrates to let someone with hearing loss know that an event is taking place.

– *Ear plugs, ear defenders or noise cancelling headphones* are widely used for different purposes.

– *Bluetooth beacons* can also be used to assist with navigation. These are usually used in conjunction with an app on a smartphone and provide directional information within a building. They work by triangulating a user's location within a space, and providing auditory information via headphones explaining the user's location and/or navigational instructions.

– *Hotel alarm systems* additionally have specific assistive technologies that can increase their ease of use and provide information to aurally divergent users. Vibrating pillows, often used in conjunction with red in-room strobe lights can alert users to fire alarms. Similarly a flashing light can be linked to doorbells to alert users who cannot hear door knocks that a user has arrived.

Assistive devices

It is worth noting however that many technologies have drawbacks as well as benefits, and the advantages of implementing each should be considered.

- Hearing loops for example have the advantage of working with most hearing aids internationally, which makes them a simple solution in public buildings with an uncontrolled population. However, they afford very poor confidentiality and can interfere with each other, so are often not appropriate for private meeting rooms or when discussing private transactions (e.g., in a bank).
- Infrared systems are commonplace in cinemas, theatre and lecture halls where it is desirable to restrict the signal to the same room. They provide a better degree of privacy, as the signal can only be intercepted by people with a line of sight to the transmitter (similar to a TV remote). However, they require additional equipment, typically a ‘dongle’ worn around the individual’s neck, which is not always practical or desirable.
- Portable hearing loops are not always practical as they have a very narrow range (designed for 1-on-1 conversations) and require a degree of training for the user.
- Bring your own device (BYOD) systems typically use a mobile app receiving data from an existing wifi network. This can offer a higher degree of security and better audio quality than other systems, but rely on having a known and controlled group of users e.g., an office / university, or in performance venues where users can be briefed in advance. Wi-fi based systems often have increased latency which can be problematic.

It is important to consider how the audio is fed into the system: typically they rely on audio being picked up via a microphone or as an output from a sound mixing console. For example, within a lecture hall, a hearing assistance device may pick up audio from a microphone being used by the presenter, but depending on the system it may not pick up questions from the audience or sound content from videos.

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Assistive devices

Recommendations:

Technologies

– Implement a range of inclusive technologies. These technologies can be embedded within the design phase to provide easier access for users with diverse auditory requirements. These technologies could include hearing loops, subtitles on video information and staff who are able to communicate via sign language.

Noise control

– Assistive devices do not replace good design, and designers of spaces should consider implementing good design practice before implementing assistive technologies. For example, designing spaces which have less background noises, such as ventilation noise, designing to avoid congested areas where users congregate and designing to avoid other confusing sounds, will help both hearing aid and cochlear implant users to distinguish speech from background noise.

Choice

– Designing in areas that provide choice and flexibility in where someone can sit is also of benefit as many hearing aid users will prefer to sit in corners or in positions where they can align their ears to capture the sounds as effectively as possible.

What Aural Personas think:

"I still struggle to understand human speech in crowded or loud places even with hearing aids, and, as a musician, I'm aware that my experience of music is missing out a lot."

"I am able to hear most sounds when wearing my BTEC hearing aids. When I take my hearing aids off I feel very calm and able to concentrate better."

John

"People [located] behind me talking, I can't hear at all"

Tracey

On using ear plugs:
"It tends to be when I'm in an environment when I have to be there. […] So, to buffer against [noise] in environments I don't have control over."

Shruthi

Operational considerations

– Temporary interventions, such as Perspex screening used around reception areas during the Covid-19 outbreak can add a layer of complexity to users interacting with reception facilities, as they can muffle sounds and lower overall volumes, in these instances an amplified system may be appropriate.

– Facecoverings can affect a user's ability to lip read, is it possible to use masks with lip reading windows, or clear full-face shields as an alternative?

– Approved Document M: Access to and use of buildings – Volume 2: Buildings other than dwellings states that door entry systems should be accessible to people with no hearing.

– The quality of sound on hearing loops can change over time (e.g. if new interference is introduced). Regularly check the quality of hearing loops using a loop test receiver.

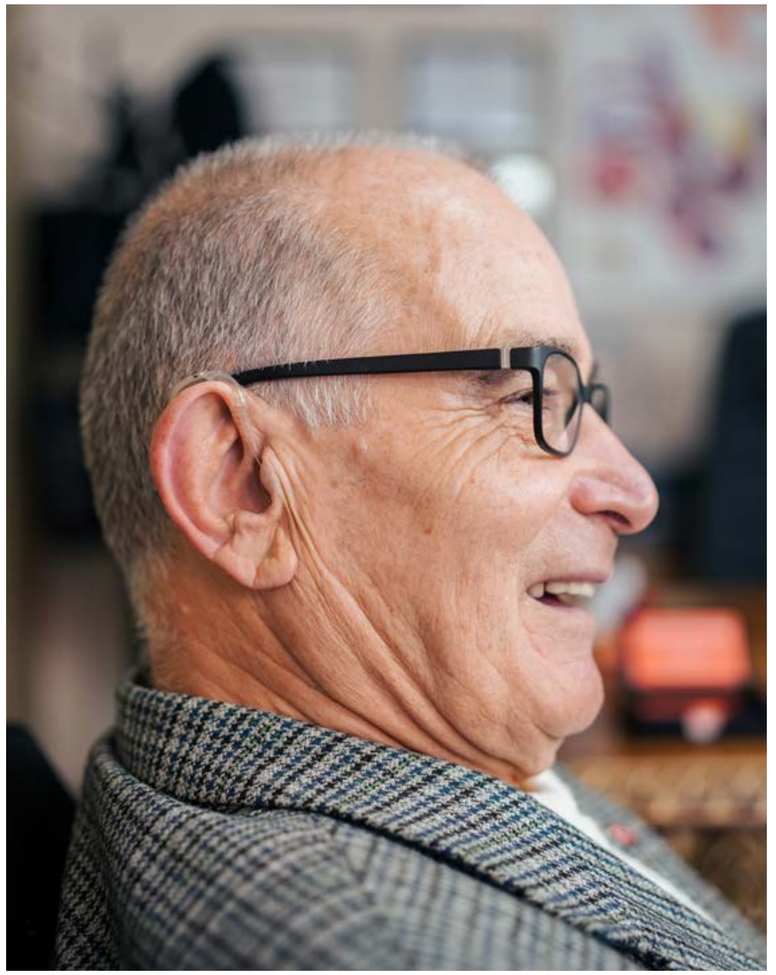
Next steps

In this toolkit we have made recommendations based on information contained in acoustic and inclusive design standards/guidance documents, and guidance from the lived experiences of those who are aurally divergent.

There is still further research to be done in understanding acoustic interventions and requirements to aid in designing built environments suitable for an aurally diverse population.

The following areas would benefit from further research:

- Define enhanced acoustic standards for aurally divergent users in various spaces:
  - Acceptable internal noise limits;
  - Desirable reverberation times;
  - Appropriate sound insulation criteria.
- Explore the role of music in aiding or hindering an acoustic environment / soundscape;
- Explore the role of acoustic zoning within buildings and cities to help aurally divergent users;
- Explore the usefulness of partially separate acoustic ‘pods’. Do they need to be fully acoustically separated, such as a small room in order to be beneficial?;
- Undertake a similar exercise to the approach in this toolkit with a focus on the acoustics and sound in external environments (e.g. Urban environments);
- Further research how aurally divergent people experience soundscapes, and how designers can better consider this in their practice.



Standards and Guidance Documents

This list is not intended to be exhaustive. It signposts the most relevant standards and guidance documents we have considered in the making of this Toolkit

Acoustic standards/guidance

- Building Bulletin 93 - Acoustic design of schools: performance standards, February 2015
- Acoustics of Schools: a design guide, November 2015
- BS EN 60268-16:2020 – Sound system equipment – Part 16: Objective rating of speech intelligibility by speech transmission index
- BS EN 50849:2017 - Sound systems for emergency purposes
- BS 6259:2015 - Code of practice for the design, planning, installation, testing and maintenance of sound systems
- Health Technical Memorandum 01-08: Acoustics, 2013
- BS 8233:2014 – Guidance on sound insulation and noise reduction for buildings
- BS 4142:2014 – Noise from industrial sources
- British Council for Offices – 2019 Guide to specification – Best practice for offices
- World Report on Hearing (who.int)

Inclusive design standards/guidance

- BS 8300:2018 (parts 1 and 2): Design of an accessible and inclusive built environment
- BS EN 17210:2021 Accessibility and usability of the built environment – Functional requirements
- PAS 6463:2022 Design for the mind – Neurodiversity and the built environment – Guide
- Health Building Note 23 – Hospital accommodation for children and young people, 2004
- Network Rail Design Manual – Inclusive Design, 2020
- Dementia Friendly Design Tool, Kirklees Council & Dementia Services Development Centre, 2021
- Approved Document M: Access to and use of buildings – Volume 2: Buildings other than dwellings, 2021

References and Further Reading

References

1 BS ISO 226:2003 - Acoustics – Normal equal-loudness level contours

2 Drever, J. L. (2017) 'The Case For Auraldiversity In Acoustic Regulations And Practice: The Hand Dryer Noise Story'. In: 24th International Congress on Sound and Vibration (ICSV24). Westminster, London, United Kingdom. 23-27 July 2017.
Available at https://research.gold.ac.uk/id/eprint/20814/

3 Hugill, A. (2022) 'Aural Diversity Infographic'.
Available at http://auraldiversity.org/infographic.html

4 Drever, J. L. and Hugill, A. (2022) 'Aural Diversity'.
Abingdon: Routledge. ISBN 9781032025001

5 ISO 12913-1:2014 Acoustics — Soundscape — Part 1: Definition and conceptual framework

6 BS 8300-2:2018 - Design of an accessible and inclusive built environment

7 Arup. (2020) 'Neuro-Include – A Toolkit for Organisations'.
Available at: Mental Health & Neurodiversity in the Built Environment: (sharepoint.com)

Further Reading

The following documents were not explicitly referenced in this Aural Diversity Toolkit however are relevant to the topic of Aural Diversity:

– Renel, W. (2018) '"Auraldiversity": Defining a Hearing-Centred Perspective to Socially Equitable Design of the Built Environment'. Built Environment. 44(1), 36–51.

– Rosas-Pérez, C. (2022) 'Human diversity in acoustics. Towards a more inclusive sound environment'. Internoise. Glasgow. Available at: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-inconference-public/5990841e8e854964867d013c69ebc1aa

– Davies, B. (2022) 'Can acoustic design accommodate aural diversity?'. Internoise. Glasgow. Available at: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-inconference-public/9b30a53ac7854f93ba3d3a71adb5ec2a

– Hugill, A. (2022) 'Aural Diversity: noise control and a sustainable future.' Internoise. Glasgow. Available at: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-inconference-public/310b8ec590784196992c8ca649b2807d

– Drever, J. (2022) 'Auraltypical acoustics? A critical review of key standards and practices'. Internoise. Glasgow. Available at: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-inconference-public/dabbc40e9a2b4cffbf349aec63ebe02a

– Renel, W. (2022) 'Non-normative sonic space: exploring the divergent capacities of soundscape design in the built environment'. Internoise. Glasgow. Available at: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-inconference-public/7d90119886eb484286dfd77b96c239

Glossary

A.

Airborne sound: Airborne sound is energy that is transmitted through the air, whereas structure-borne sound is transmitted through solid objects such as walls.

C.

Cochlear implant: provide a sensation of hearing to people who have permanent, severe to profound deafness, and cannot hear the full range of speech sounds with standard hearing aids. A Cochlear Implant is different from a hearing aid. It has two parts: one is worn like a hearing aid, behind the ear or clipped on to clothing, and the other is surgically implanted. A Cochlear Implant turns sound into electrical signals. Instead of simply making sounds louder, like a conventional hearing aid would, the Cochlear Implant provides a sensation of hearing by directly stimulating the auditory nerve using electrical signals.

Find out more >

D.

dBA: The unit used to define a weighted sound pressure level, which has been found to correlate well with the subjective response to sound for those with optimum hearing.

Deafness:

- **Sensorineural deafness:** or nerve deafness as it's sometimes called, is a hearing loss in the inner ear. This usually means that the cochlea isn't working effectively. Sensorineural deafness is permanent.
- **Conductive deafness:** Means that sound can't pass efficiently through the outer and middle ear into the inner ear. This is often caused by blockages such as wax in the outer ear, or fluid in the middle ear (glue ear). Glue ear is a very common condition, especially in pre-school children. Conductive deafness is usually temporary, but it can be permanent in some cases.

Find out more >

F.

Frequency: is the rate of repetition of a sound wave. The subjective equivalent in music is pitch. The unit of frequency is the hertz (Hz), which is identical to cycles per second. A 1000Hz is often denoted as 1kHz, e.g. 2kHz = 2000Hz. Human hearing ranges approximately from 20Hz to 20kHz. For design purposes frequencies grouped into 'octave bands' between 63Hz to 8kHz are generally used.

H.

Hearing aid: are electronic devices which make it easier to hear sounds and speech. They are programmed to the individual's hearing level and are specific to that person.

Find out more >

Hearing loss: Degrees of hearing loss refer to the severity of the loss and are generally described as mild, moderate, severe, or profound.

Find out more >

Hyperacusis: (Pronounced hyper-a-queue-siss) is a condition when people experience some sounds of everyday life as intrusively loud or uncomfortable or even painful.

Find out more >

L.

LRV or Light Reflectance Value: is a measure of how much visible light is reflected from a surface. This expressed on a scale of 0-100, where '0' is a surface from which no light is reflected (pure black) and '100' is a surface where all light is reflected (pure white). A difference in LRV between two surfaces of at least 30pts is commonly used to define an adequate level of visual contrast under different lighting conditions and/or for people who may see colour differently.

M.

Misophonia: is a condition where a person has a severe sensitivity to specific soft sounds and visual images. When a person hears the sounds, the person has a very strong emotional reaction such as hate, anger, anxiety, rage, and resentment and physiological distress.

Find out more >

N.

Neurodiverse / neurodivergent: The unit used to define a weighted sound pressure level, which has 'Neurodiversity' is, ultimately, a biological fact of the infinite variety of human neurocognition. Neurodivergence includes, but is not limited to: Attention Deficient Disorders, Autism, Dyslexia, Dyspraxia, Dyscalculia, Tourettes Syndrome, and others.

O.

Oral D/deaf: People who identify as oral D/deaf or D/deaf oral were born deaf or became deaf before learning to speak, but learn to communicate via auditory and verbal skills.

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R.

Recruitment: is a specific form of altered sound tolerance in people who have a hearing loss. In recruitment, the auditory system goes from too little, to too much very quickly.

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Reverberation time: is the time it takes for the sound in a space to decay. It is commonly measured by the time (in seconds) it takes for the sound energy in a space to decrease by 60dB after the sound source is switched off.

S.

Signal to noise ratio: The ratio between the strength of the desired signal or sound source and any unwanted signal or the background noise.

Sound level meter: A sound level meter is an instrument that measures sound pressure.

Soundscape: Acoustic environment as perceived or experienced and/or understood by a person or people, in context.

Speech transmission index (STI): A measure of intelligibility between 0 (bad intelligibility) and 1 (excellent intelligibility) based on the frequency and temporal content of speech and the transmission function between the sound source and the receiver/listener.

Synaesthesia: In its simplest form it is best described as a "union of the senses" whereby two or more of the five main senses that are normally experienced separately are involuntarily and automatically joined together. Some synaesthetes experience colour when they hear sounds or read words. Others experience tastes, smells, shapes or touches in almost any combination. These sensations are automatic and cannot be turned on or off.

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T.

Tinnitus: is unique to the person experiencing it. But ultimately it is the sensation of hearing a sound when there is no external source for that sound. Someone with tinnitus may hear ringing, buzzing, hissing, whistling or other noises. Tinnitus can be there all the time or come and go. The volume of someone's tinnitus can vary from one episode to the next.

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