How can the architectural design of public buildings be improved for Visually Impaired people?

vision impairment
public buildings
accessibility
qualitative research

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The aim of this paper is to identify issues that visually impaired (VI) people face in public buildings and, where possible, suggest design solutions. Research methods involved interviewing VI individuals with varying levels of vision, to gain first-hand insight into their experiences within public buildings.

Several discussed issues included the importance of multi-sensory design and the observation that acoustic features can lead to disorientation. The paper considers use of lighting, importance of design consistency, and benefits of natural light and hindrance of glare. It emphasises the importance of contrast, to distinguish between features, around doorframes and on the nosing of stairs, and use of staircase tactile indicators and extended handrails, to improve safety.

The paper also highlights the importance of consulting VI individuals to make use of their embodied expertise in a co-design process, to hopefully help make public buildings more accessible to VI people.

1 INTRODUCTION

How do Visually Impaired (VI) people experience public buildings? This paper investigates their experiences, both good and bad, after considering a number of design interventions and examples of best practice, to provide reflection, inspiration and some uplift or relief from participants' frustrations. The argument developed is that processes which produce buildings presenting obstructions to a socio-economically and socio-culturally disadvantaged demographic constitute an important barrier to good design. The paper will move from reviewing VI people's experiences of public buildings to suggesting that an adapted, inclusive design process could potentially help improve designs and produce more socially inclusive spaces. It is important to note, however, that the paper is based upon a small study-sample, and so should be considered a pilot to prompt further research.

In the UK, since 2006, instead of being classed as blind and partially blind, the terminology has shifted to referring to the sight impaired (SI) and severely sight impaired (SSI); in this paper, for simplicity and clarity, the phrase Vision Impaired (VI) will be used as an umbrella term for all those affected by poor vision, as it is more commonly understood UK public parlance. In order to be registered SI or SSI, one must meet certain set criteria (Fig.1). Most VI people have some level of vision (Fig.2), and most of those who do not are likely to have had some previously in life, meaning that "98.5% would most likely have a visual memory and could understand visual concepts" (RNIB, 2022).

This paper will hopefully help encourage more thinking around inclusive public building design through sharing insight into the VI world. There would appear to be a weakness in the literature surrounding access needs for people who are partially sighted and those with no sight. A survey of the literature using Scopus, a widely respected database of peer-reviewed journal publications, for example, using the search terms "vision impair*", and "visual impair*" AND "building*" under title, abstract and keywords, brought up 363 results. However, on reviewing paper abstracts, most were not relevant to the paper's research focus, looking instead at the public built environment (the spaces between buildings) (Laurìa, Secchi & Vessella, 2019), travel (Trop et al. 2023), technology (Jeamwatthanachai, Wald & Wills, 2019) and the effectiveness of aids such as tactile paving and white canes (Demirkan, 2013). In the end, less than 10 papers were found to be useful from this particular search, many of these around the importance of strong contrast (Feigusch, Stefan & Ossberger, 2021; Lukman et al., 2020; Fallatah, et al., 2020). "Sight impair*" brought fewer results and "blind" an unmanageable number due to the many different meanings of 'blind'. "Visual impair*" AND "built environment" brought up a similar number of much the same results, and so on. This paper will provide additional knowledge that can assist in prompting thinking around designing more inclusive spaces. To produce accessible designs, there are many aspects to consider, such as how to get to, enter, use and then understand instructions in buildings. Within these categories, it would appear to be commonly understood that specific thought should be given to creating clutter and barrier-free spaces, accounting for lighting, colour, contrast, surface texture, sounds, scents, etc. (Arch20, 2020; UK coaching team, 2021). Although some literature is available, there is seemingly, from the review conducted for this paper, still a "lack of design evidence in relation to what enables and disables people with visual impairment" (McIntyre & Hanson, 2014, 59). The Social Model of Disability states that it is the barriers that buildings and society create that disable people, rather than impairments themselves (Shakespeare, 2006), meaning it is vital to produce accessible designs allowing people to function to the best of their ability; accessible design "can cost as little as 1% more" (Badaway, 2020, 9). It is affordable, entirely feasible and officially required, to meet legal requirements, to provide spaces accessible to all (Badaway, 2020; McIntyre & Hanson, 2014; RTF, 2022).

	Sight Impaired	Severely Sight Impaired
Full visual field	3 / 60 - 6 / 60	3 / 60
Reduction of field of vision	6 / 24	3 / 60 - 6 / 60
Very reduced field of vision	6 / 18	6 / 60

Fig.1 - A table showing the level of visual activity needed to qualify as SI or SSI. 6/60 means that the level of detail the VI person can see at 6m away, a healthy eye sees from 60m (RNIB, 2022).

By studying existing literature and research papers and interviewing VI respondents who kindly gave their time to talk about their experiences, this paper aims to provide new insight into improving the accessibility of public buildings for the VI.

2 LITERATURE REVIEW

When talking about designing more accessible buildings for VI, it is important to consider all the literature currently available. As previously noted in the introduction, there remains something of a paucity of published peer-reviewed work in this area focused specifically upon the experiences of VI within public buildings. The aim of this paper is to help progress the discourse and practice a little; it is a small study, conducted unfunded by an undergraduate student, but the hope is that findings from the 14 interviews considered could help provide the grounds to justify further research funding, scaling up and out from the pilot work presented here.

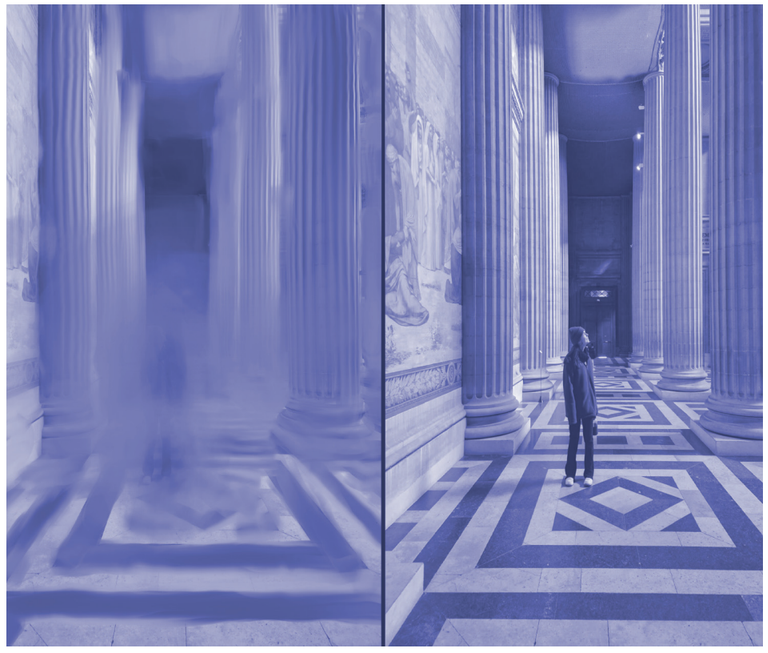

Fig.2 - A representation of what the primary author can see as a severely sight impaired person with a form of macular degeneration.

2.1 VI Simulation and Design

Before talking about solutions, it would be useful to begin to try to understand the problem and consider some examples of best practice. Back in 2008, Banks and McCrindle produced a visual eye disease simulator tailored for architects and designers to replicate several different VI views of the world.

This was potentially very useful, as it is not easy to design for something you have no direct experience of, and so do not understand. It is important to consider design from a VI point of view, or lack of, "for reasons of social inclusion, legislation and increased personal safety" (Banks & McCrindle, 2008, 167).

This could encourage production of more inclusive designs, especially if adapted and embedded within Computer Aided Design programmes, then made available as training tools for promoting more thinking around accessibility. This could potentially be game-changing, as it is key to at least try to understand the world from a VI perspective, in order to seek to improve it (Lopez, 2005). The work has thus far been picked up by a small coterie of other academics, although the majority from a medical perspective and a few with a specific focus upon developments in the design process (Yamauchi, Aoyama & Oya, 2013; Wu et al., 2018). Encouragingly, McCrindle is still researching and publishing in the field (Stewart & McCrindle, 2017).

2.2 The Importance of Multi-Sensory Design

Secondly, when designing for VI, it is important to design for all senses rather than just to be visually appealing. Chris Downey, a recently blind architect, noticed that when walking around he now notices a "symphony of subtle sounds" (Downey, 2013) that weren't as prominent beforehand, that help him to navigate through familiar places. The Centre for the Blind and Visually Impaired in Mexico sits as an example of best practice design, using a retaining wall that functions as a sound barrier, and inserting channels of water running alongside pathways, allowing the VI to be guided by these sounds to the building's entrance (Fig.3). This technique is not very widely used, however, it has received significant praise when it has (RTF, 2020).

Sense of smell is also important for creating atmosphere in and around public buildings; several buildings designed specifically for the VI and others have implemented sensory aromatic gardens to stimulate the sense of smell. Plants such as lemon, rosemary, jasmine and lavender have strong, pleasant aromas and so are widely used in such gardens, providing another method of sensory wayfinding in addition to creating clear landmarks (Jenkins, Vogtle & Yuan, 2015; RTF, 2022).

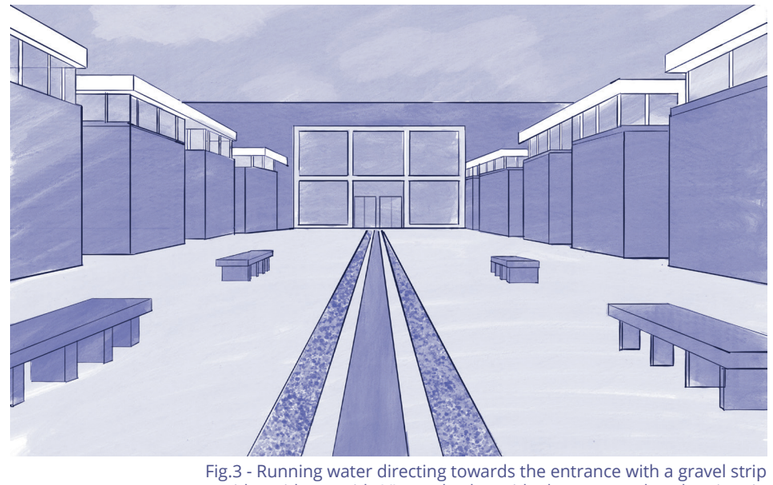

Fig.3 - Running water directing towards the entrance with a gravel strip either side to guide VI people alongside the water rather than into it.

2.3 How much is too much?

On the other hand, extreme sensory overload can be overwhelming; sound, being the most common culprit, can distract from useful audible indicators, hindering the VI person's ability to effectively navigate (such as noisy hand-dryers). Similarly, large open spaces can be disorienting as there is nowhere close-by for sounds to reverberate off, leaving no useful audible cues. A more desired outcome would increase useful sounds like footsteps, but reduce disturbing mechanical sounds (Jenkins, 2012; Ormerod, 2005; RTF, 2022).

2.4 Vitality of Contrast and Colour

Dalke, et al. (2006) speak about the importance and legal requirement for good colour contrast in buildings for the VI. The specific colours tend to matter less, so long as shades have big enough distinctions between them on the Light Reflectance Value (LRV) scale. However, it is important to note that neon colours can be distressing to people with colour and light sensitivity. Fallatah, et al. (2020, p.8) note that many previous studies had approached the topic from the perspective of printed text; these are much less relevant, they argue, but such studies are nonetheless included in their work because of the 'lack of research in the environmental design field' concerning preferences over dark to light values.

Colour-coding different types of spaces can be a good method of "wayfinding, orientation and providing key landmarks" (Dalke et al., 2006, 347); using such on signage can make places more user-friendly for all, and by carrying the contrast on throughout the design of floors or walls can produce easy-to-follow trails for VI people. Further, using bold, contrasting colours for receptions can make these points easier to find when entering buildings, aiding in locating key support provision (Fig.4, Dalke, et al., 2006; RTF, 2022). Jenkins, Vogtle and Yuan (2015) further suggest using interesting 'contrasting textures to define different areas … surface materials that provide distinct tactile and auditory feedback for cane-tapping'.

2.5 Tactile Indicators

Creating a multi-sensory design can not only make it more accessible to VI and neuro-diverse people but also create a "more inclusive, equitable, just city for all" (Downey, 2013, 11:07). Further, using contrasting materiality to distinguish between stationary areas and walkways with laminate flooring and carpet, simply but effectively helps to guide someone VI through a building – as long as this is consistent throughout. It is important that floor surfaces are firm and level but also not slippery. Tactile tiles can also be used, most commonly outside, but they are a useful tool for highlighting staircases; lined tiles signal to go forwards whereas dotted signify to stop or turn. These can allow VI people to navigate to and in-between public buildings and find entrances more easily through the use of a cane or feeling through their feet. (Badaway, 2020; RTF, 2022). Finally, tonal detailing can help VI people identify the shape of a space. For example, Victorian detailing can help orientate the VI "due to shadow detail on mouldings" (Dalke et al., 2006, 352) as it provides definition to the edges of spaces.

2.6 What about lighting?

Good lighting is essential for those with VI; poor lighting can hinder eyesight further, disorientate and cause headaches. Many people struggle with extremes, going from bright sunlight to dimly lit areas. Where artificial light is necessary, as it will often be, daylight bulbs or, as Karyono, et al. (2020) suggest, a smart lighting system made up of LEDs, could allow users to adapt the light to the surrounding conditions and task at hand; they could also use previous experiences to predict preferred lighting conditions. This could therefore reduce the effects of moving from one area to another (Fig.4). Natural light is preferable, however this is often not possible, and glare from windows can also be an issue. Blinds could be a useful tool here, slanted to let diffused natural light in, preventing glare. Another technique used at the National Institute for the Blind in Budapest is the placement of large sheets of perforated metal over windows, which prevent harsh

Fig.4 - The use of a bold colour on reception can aid VI to identify it.

Fig.5 - Daylight effect smart bulbs.

direct sunlight coming in and instead allow for a softer, kinder light, causing less discomfort (Dalke et al., 2006; RTF, 2022), (Fig.5).

2.7 Indoor Mapping

There are several proposed methods to use mobile devices to navigate routes inside buildings for the VI (e.g. Anken et al., 2022; Upadhyay et al., 2022; Engel & Weber, 2022). Some public buildings have already produced visual online maps, however these are often not VI friendly. Instead, projects have inserted sensors into buildings' rooms and corridors that connect via Bluetooth to a mobile app and can provide directions to specific rooms (e.g. Guerrero, Vasquez & Ochoa, 2012). Such devices would allow people to plan routes in advance and save previous routes. Although this is a particularly effective modern tool, it is not the focus of this paper, as these are not a design feature in the makeup of the building, but instead potentially useful guidance tools (McIntyre & Hanso, 2014; Jain, 2014).

2.8 Participants in the Design Process

One very effective way of improving public buildings for VI, is to include VI users in the design process, to ensure disabling features such as obstacles, glare or poor surfaces are designed out and positive features like good colour contrast, diffuse natural lighting and multi-sensory stimulation are included. This is usually included in Stages 1-3 of the RIBA Plan of Works 2020 (in the UK) and would hopefully help ensure more accessible designs (Badaway, 2020; Boys, 2014; RIBA, 2020).

However, clients have been argued to frequently view accessible design as something that must be done for legal reasons, but that hinders design processes and outcomes, leading to many designers doing the bare minimum, and mostly for mobility impairments, rather than hearing, neurological divergence and the VI (Boys, 2014). Additionally, many designers have also been argued to believe that access consultancy and co-design will stifle creativity in the design process, having to include a plethora of access components (Boys, 2014). However, a growing number of other researchers and writers argue that accessible design can be stylish and innovative, when well carried-out (Badaway, 2020; Boys, 2014).

3 Methodology

In order to develop techniques to improve public buildings for VI people, more primary research is needed, this, it is argued, by the authors and research respondents, should directly involve VI individuals, recognising the value of their lived experience and embodied expertise (Hetherington, 2003). The valuable research published in the field of visual contrast now needs broadening out to other areas outlined in this paper, around, for example, more accessible stairway and door design, more optimal office and kitchen layout, improved noise attenuation, and so forth. This, it is argued, should involve research with VI people as well as, post-occupancy evaluations of existing buildings, to assess what could be improved.

A mixture of primary and secondary research was undertaken for this paper; firstly, a literature review. This comprised reviewing sources discovered from search terms including: VI, blind, partially sighted, architecture, public buildings, accessibility, wayfinding, multi-sensory and inclusive design. This provided a range of academic sources covering many aspects of VI in the built environment, although, as mentioned, a more restricted sample specifically looking at access within public buildings.

Secondly, primary research was pursued using qualitative methods, due to the exploratory nature of the research. As the literature suggests, it is important to ask the opinions and experiences of the demographic concerned (Naoum, 2019). Therefore, attitudinal research; was carried out to "subjectively evaluate the opinion, view or the perception"

(Naoum, 2019, 58) of respondents. Because of the lack of existing data in the scholarly literature, it was felt more appropriate to investigate in an qualitative manner, rather than providing questions with a limited range of pre-set answers, which could stifle participants' voices, cause frustration and impact negatively upon engagement and so findings.

There are several forms of attitudinal research, the most appropriate here being semi-structured interviews (SSI), an effective way of collecting both facts and opinions. The research purpose, to explore ways to improve public buildings for VI people, required explanation and examples rather than simple yes/no answers or agree-disagree scales, meaning the exploratory interview was more suitable than surveys. In addition, respondents being either VI or totally blind made verbal interviews much more accessible than written surveys.

After consulting the literature and using the first-named author's personal experiences as a VI individual, an interview script was developed and a manual qualitative discourse analysis (QDA) approach employed in analysing results. QDA is a good method for analysing qualitative data, involving the repeated in-depth scrutiny of transcribed texts; keeping an open mind about discovering new or contrasting information to the literature (Naoum, 2019).

There are both strengths and weaknesses to these methods, the positive including the collection of in-depth responses due to the informal aspect of SSIs, leading to a deeper understanding of each respondent's experiences, whilst keeping the conversation topical. However, choosing an interview approach rather than a questionnaire did result in fewer participants, simply due to the time- and labour-intensiveness of arranging, conducting, transcribing and then analysing in-person interviews, so a smaller number and therefore possibly variety of experiences was gathered.

Although this would have had some restricting implications, the interviewees had a range of eye conditions, and different levels of sight and demographics, and therefore provided a diverse and interesting range of views. The interview process continued until a point of saturation was reached and no new findings were emerging from each successive interview; 14 interviews were conducted, and so this sits comfortably within the range outlined in Hennink and Kaiser's (2022) systematic review of sample sizes for saturation in qualitative research. This is not to argue that further new findings might not have emerged from additional interviews, but on reaching saturation in a small unfunded pilot study, it was felt appropriate to stop collecting primary data. A thematic analysis was then carried out using the themes identified and indicated under sub-headers in the literature review.

4 Findings and Discussion

The research sample consisted of 14 volunteers with various levels of VI, including no vision, light perception, identifying shapes, light sensitivity and various levels of very poor, but useable, vision. This diversity in levels of vision meant that the sample was able to represent most of the VI population. Many core issues arose from this work; lots have been addressed in the literature, however, unique findings would also appear to have been noted and these analysed, around energy-saving bulbs, colour-contrasting indication of zones of purpose and barriers, and the need for more tactile markings around and on staircases. It is important to note that as a small qualitative study, the strength of any claims must be measured, however, the work can hopefully offer insight into areas of worthwhile future research.

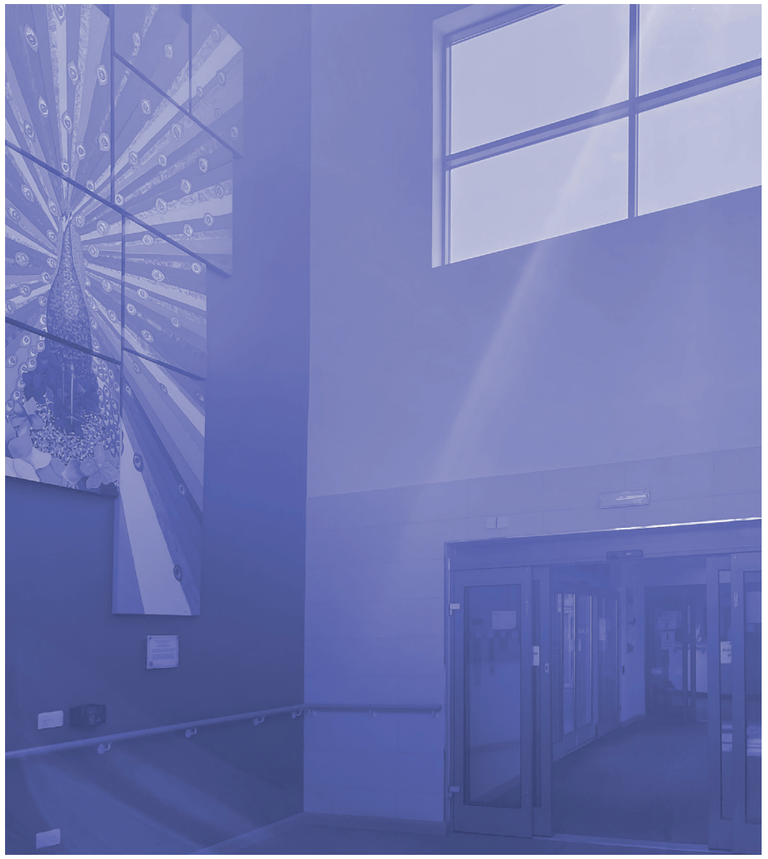

Fig.6 - Natural lighting coming in from above to provide a diffuse light.

4.1 Natural Lighting

Lighting was the most common issue to arise, firstly natural and secondly artificial. There was a consensus (amongst everyone who could perceive light) that natural lighting was preferred, however, it was also noted by many respondents that direct sunlight can cause discomfort and pain, particularly to those with light sensitivity (Fig.6).

Another issue identified was glare – both from screens and surfaces, and the eye itself – caused by bright direct sunlight hitting the surface in question. This is particularly problematic with partially sighted participants who need to see a computer screen at work or home, as when light hits the screen it can make it extremely difficult to effectively carry out tasks due to even further impairment of vision. In addition to this, one participant mentioned her experience at hotels abroad which have white floors and walls to reduce heat absorption; this produces higher levels or glare, meaning that even with sunglasses on, walking around the grounds can be particularly painful.

Other participants agreed that this is a difficulty they have experienced, even in day-to-day life. For example, white tables and desks have been criticised for attracting glare and making it more difficult to function due to the discomfort caused.

One solution proposed was the addition of linear blinds to guide natural light more evenly. Another effective way of creating more diffuse light is to let it in from above either through skylights and roof lanterns, clerestory windows, sawtooth roofs, atriums (although these can be problematic for VI people), remote distribution, light reflectors, daylight-reflecting window film and fibre optic concrete walls (Lowe, 2016).

This would allow for a more even spread of gentler natural lighting, which is also said to provide visual comfort and wellbeing, for all users (Sylvester & Konstantinou, 2010).

4.2 Artificial Lighting

Good lighting is essential throughout the entirety of any building, but often there are spaces that natural lighting doesn't reach effectively, as well as seasons where natural lighting can be scarce, and therefore artificial lighting is an unavoidable and important consideration. Findings from interviews unearthed new issues to do with lighting and the transition between differently lit zones not found much in the literature. This is valuable information that could be used to create much more visually comforting spaces for those with VI. Lighting is difficult to get right, and most participants said that if lighting is too dim, it is hard to function but at the same time, if it is too bright, it can cause headaches and discomfort.

It was mentioned several times that very warm lighting can be disorientating, as hues are so different to natural daylight; daylight bulbs or smart lighting systems are preferable, as they ease the passage from outside to inside. This means that people with light sensitivity won't struggle as much passing through spaces, as for many, their "pupils take longer to adjust to light changes" (interview F). Schneck and Haegerstromportnoy (2003) similarly recommend avoiding large changes in light levels wherever possible with regard to VI.

Spaces such as kitchens and desks need optimum lighting, as tasks which need high levels of focus occur here; stairs and toilets are arguably something of an afterthought, with lighting too often either dim or very bright and targeted. Four participants spoke of discomfort in these situations, mostly due to light sensitivity and difficulties adjusting to quick brightness changes. In addition to this, automated energy-saving lighting systems were mentioned by participant H; these can start to dim with no warning and then brighten back up to different light levels with the slightest movement, which can be difficult to adjust to and can cause pain and eye fatigue (similarly, interviews D, H, N).

Motion sensors, although good in theory, can prompt drastic changes in light levels; if one remains still for too long, the lighting changes again, causing cycles of readjustment and eye fatigue (interviews D, N). Importantly, this is something that was not found within the published literature. Karyono, et al. (2020) have proposed a smart lighting system that allows users to adapt colour and brightness levels manually, using memory to predict levels for certain times of day. However, for this to be effective, there would need to be very slow lighting change fades over a period of five or ten minutes, so as to not shock the eyes. This could simulate the evening dusk as it becomes darker outside, slowly changing to a warmer softer light, a gentle contrast against the dark sky and warm streetlamps (interviews D, J, N).

This rings true with the literature reviewed, which, as noted, is as yet rather sparse. Karyono, et al. (2020, p.1) note that 'the design of the workplace currently is still lacking in compliance with [the needs of VI employees]', due to the lack of building regulations' attention to differing levels of visual impairment. Lewis and Torrington' (2013, 345) similarly observe that 'there is scope for additional guidance on aspect and daylight … [l]ittle of this specialist guidance is included in mainstream design guidance'. Finally, Feigusch, Steffan & Ossberger (2021, p.7) do at least optimistically note that 'considering the needs of people with visual impairments … by means of adequate lighting and visual contrast of building elements, is growing in importance and in interest by stakeholders'.

4.3 Contrast

Another important issue noted was contrast of colours and materials; everything should be contrasting (A, C, F, H, I, L, M, N). It is important that desks are not white (M) as this can cause too much glare, but also that they are a significantly different colour to the floor, walls and chairs, so they are easier to find and less of

a trip-hazard. One idea proposed by an interviewee was to have a contrasting floor to identify each type of area; for example, wet-rooms like kitchens and bathrooms one flooring type, waiting spaces like reception or seating areas another type, and a third for circulation zones. Contrasts in materiality are textural cues that a cane or guide dog can pick up on, colour changes ones that people with some vision can identify, but these need to be consistent throughout any building (H, L, M).

The literature (Badaway, 2020; RTF, 2022) backs up all these points, including the drastic contrast needed for the nosing on the edge of steps. However, participant I suggested that having a bold contrast around door frames would further help, such as using bright paint or tape to highlight openings in existing buildings. Figueiro, et al. (2012) also note this point in their discussions around Improving night-lighting to enhance contrast around door frames in an effort to improve the safety of older people (Fig.7).

In terms of décor, colours tend currently to match rather than contrast (C), however it would be possible to have "appealing, comfortable and calming colours which are still contrasting" (M). Another contrast issue mentioned, and not noted in the literature, was that of barriers indicating where to queue; if these blend with the floor,

Fig.7 - Contrast in doors, trim, walls and floor.

they can can be disorientating and cause one to get lost in a place one goes to weekly if they are moved around (M).

Finally, participant M mentioned that "rain is nice as it causes more contrast"; this prompts the question of whether shiny floor surfaces could be used to the same effect, enhancing contrast with surrounding furniture. It would appear that there is no literature surrounding this idea, so it is suggested that this could be a matter worthy of further investigation; one potential negative could of course be glare, if a surface is reflective, so considerable primary research would be necessary before any formal advice could be developed.

Approved Document M (HM Gov, 2015), the most current UK building regulations, does specify the need for visual contrast with doors, nosing on steps and handrails of 30 light reflectance value (LRV) points at 100 lux luminance; however, a variety of authors have since argued from their research with VI participants that contrast needs to be considerably stronger (Lukman et al., 2020).

4.4 Stairs

Steps and stairs can be a major issue; several interviewees specified the importance of high-contrasting nosing at the edges of stairs. This can help more when descending, as "it's harder going downstairs than up, as the stairs get further away rather than closer to me" (N). If stairs can be avoided with a ramp or lift alternative, several participants said they would choose that option instead.

When stairs are necessary, it was felt by interviewees to be vital that there were tactile markings signifying the stairs' top and bottom, to reduce chances of falling, and markings needed to be a universal indicator (B, C, D, E, F, G ,H, I, J, K, L, M, N). Foster et al. (2014, p.156) note that 'a high-contrast tread edge highlighter present on steps and stairs and positioned flush with the edge of the tread should improve stairs safety', observing that whilst UK British standards (BS 8300-2:2018) and regulations (HM Gov, 2015) advise on the width and the location of the strip (55mm), practice can vary on whether this is flush or set back from the stair edge.

It was felt important by several respondents that handrails should extend 2ft past the end of stairs as an indicator that stairs are there, a point also asserted by Wood-Nartker, Beuschel and Guerin (2019). Furthermore, these respondents felt that if the bannister is made of glass, the handrail should be a bold contrasting colour such that it is more easily visible (B, D, F, L). Handrails were mentioned much more in the academic literature covering older adults, rather than the broader VI population, for some reason (Fang, Liang & Liang, 2023; Wang & Leung 2023). In addition, several different respondents stressed that stairs should be a smooth, even surface rather than a rough stone, so they remain predictable and reduce the likelihood of tripping. Stairs of different heights and spiral staircases were also noted to be a hinderance, due to their uneven nature (G, H, M, N). Overall, as a mix of new findings and ones confirmed by the literature, the important things to remember were the importance of tactile markings, extended contrasting handrails, even stairs and contrasting nosing to make using stairs safer and less scary for VI people (M, N).

4.5 Clear signage

In buildings such as hotels, offices and universities, it is important to clearly identify room numbers; this can be very challenging to a VI person. Interviewee N, who has usable vision, said "I can never find the correct room without someone taking me there", and B, "It is helpful to have staff around in the lobby, especially in the GP". It is also important to have good signage, which should be located at eye-level, in an easy-to-read font, such as Calibri, Helvetica or Arial (Macular Society 2023). A large font-

Fig.8 - Clear signage with braille and colour contrast.

size with highly contrasting colours was said to make things easier to read, and it was noted that this should also feature either braille or tactile indicators, that signage should be positioned uniformly and numbering systems be consistent throughout any building, to assist VI users with identifying (see Fig.7, A, B, C, D, H, M, N). Thoughts here concur with the advice of the Macular Society (2023) cited above.

Wayfinding can be difficult – "where is the door?!" (E). The literature suggests using multi-sensory design methods to help VI people find their way to doors and around buildings; paths can be created with scented plants, water-trails and use of colour, as noted with the example of the Centre for the Blind and Visually Impaired in Mexico (Dalke et al., 2006; Jenkins, Vogtle & Yuan, 2015; RTF, 2022). K suggested that public buildings create tactile maps to help VI people navigate new places, as was noted in the literature review (Demirkan, 2013). Another problematic design feature is large open spaces like atriums, where useful sounds can get lost with no structures for them to bounce off (Fig.8).

4.6 Desks

Desks and workspaces could usefully be adapted to better suit the needs of the VI; limited reference was found to this in the literature covered. Four participants mentioned that adjustable desks and chairs would be ideal as "I have to lean a lot closer to the desk to work, causing back and neck pain" (D), meaning that higher desks and lower chairs could be a good combination for partially sighted people. Interviewee M suggested that rounding the corners of desks could prevent some injuries, as reducing the sharp-edged hazards in a room that might be walked into.

4.7 Noise Levels

Loud or sudden noises can be problematic. Both participants H and M stated that Dyson-style hand dryers in public toilets can be disorientating, as they are so loud they can warp sense of place. In addition, crowded rooms or rooms with an echo can also cause disorientation (B), making it harder to navigate even familiar buildings. Participant M suggested that buildings be acoustically divided, so sounds do not leak between spaces. Fire-drills can be more alarming to the VI as some can be more sensitive to noise (D, N); therefore, verbal warnings about planned fire-drills would be useful; currently, written warnings are common but VI people tend not to know about these. Although the literature recognises the potential sensory overload these matters can produce, there were not many suggested solutions.

4.8 Kitchens and Clutter

A lot of interviewees mentioned clutter as a problem due to limited vision, as it is easy to miss obstacles on the floor and trip; corridors and walkways need to be clear so there is no safety hazard. In addition to this, cluttered kitchens can hinder a VI person; everything needs to be put back in the correct place to be able to find it again (H, L, N). Kitchen appliances can also be inaccessible; several interviewees mentioned liquid-level indicators that sit in the top of a cup and alert you when the liquid is near the top, accessible tactile or talking microwaves to allow VI people to independently reheat their food in a public kitchen, and indicators on taps to identify which is hot and cold, as very enabling technology they wished were more widely used (B, D, H, L, M).

4.9 Public Toilets

Public toilets can be problematic for the VI; although toilets were not covered in the literature review due to limited time and are an intended subject of future research, respondents mentioned several issues. As previously discussed, dryers can be unpleasantly loud, resulting in disorientation; mixed with a complex layout, this can mean "it's almost impossible to find my way out again!" (N). A straightforward layout is clearly preferable, so that wayfinding is less confusing (H). Furthermore, a couple of participants mentioned that it is difficult to tell if toilets are locked or not, which has resulted in opening doors onto cubicles in use; clearer signage would evidently help. Accessible or self-contained cubicles containing toilet, sink and dryer, would be beneficial, allowing users to find everything without needing to consider other users. Participant L suggested that talking accessible toilets would be preferred; on entrance, these

inform the user of bathroom layout, allowing them to understand where everything is located.

4.10 Doors

Manual doors can cause issues if they are left half-open, as a cane may miss them and cause injury. However, automatic doors can cause issues too, particularly if they require a button-press to open, as locating the button can be tricky unless very clearly signposted, with contrasting colours (H). When automatic doors open towards the user, this can cause those with VI to walk into them; sliding automatic doors were felt to be preferable, as they cause fewer obstacles. (Fig.9.)

4.11 Communication

Finally, and arguably the most important point, "companies should engage with the VI before designing buildings, to understand what is and isn't accessible" (A). Several participants agreed with some of the literature and suggested that employing at least one VI consultant for each project would allow design teams to consider VI accessibility more effectively (Badaway, 2020; Boys, 2014). Another suggestion was to educate architecture students more thoroughly on all aspects of accessible design, which would increase awareness, in turn hopefully leading to more outcomes accessible to the VI and other disabled users (F, I). This is important for all minority groups, not just VI, and has been expertly articulated in the book Doing Disability Differently (Boys, 2014); Boys' work stresses that inclusive design should not be seen as a limiting or restrictive imposition, but rather as opening the design process up to other creative and innovative skills and methodologies.

5 Conclusion

VI people face many barriers in day-to-day life, many coming from poor design of public buildings. Through a literature review and set of semi-structured interviews with 14 participants, the paper collected information and viewpoints that can hopefully assist in developing research programmes to investigate the mentioned matters in more detail, as a step towards assisting the design community to produce more accessible public, and other, buildings.

The research highlighted the effects a range of issues can have on the VI. Lighting consistency, speed of luminance change and transition between different building zones were found to have a very significant effect, especially for those with light sensitivity; consistent and diffuse lighting was felt to be best throughout buildings, to minimise discomfort. Contrasts in colour and tone were found to be essential to help people distinguish between zones of purpose (e.g. queueing), objects, and the floor, and needed especially on the nosing of stairs, for safety, and around doorframes to help with wayfinding. To provide more warning that the individual is approaching a staircase, universal tactile floor markings were advised to be fitted and extended handrails used. The use of different materials to define different spaces was suggested as an effective way of helping building-users know where they were.

Fig.9 - Automatic sliding doors to reduce obstacles, with contrasting trim.

Multi-sensory design came through from the research as an evident potential advance encouraging more accessible design; it is advised that this consideration should be carried into future research and design work. Ensuring public kitchens and bathrooms have simplistic layouts with accessible features, such as talking toilets/microwaves, could make things much easier to find and use. Beyond building design and into matters of facilities maintenance and day-to-day building management, minimisation of clutter was noted to be essential. It is much easier to carry out tasks if everything is where it should be, and there are no unnecessary obstacles in pathways.

Importantly, one argument coming strongly from the interviews conducted for this paper was that the best way to avoid bad design and design more accessible public buildings for VI people is to include them at the consulting stage, as only the VI can truly understand what is needed to accommodate for the VI successfully. This in turn would provide insight towards each of the highlighted issues, so that architects can work towards practical solutions. This point aligns very strongly with the consistent theme coming from Boys' (2014) work covering all forms of impairment; that we need to involve the lived experience and embodied expertise of disabled people as early as possible in the design process and then consistently throughout, to produce more truly accessible design.

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