

Daylighting for people with sight loss

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Abstract

Around 3% of people have significant sight loss. Despite this, current daylighting design guides rarely mention people with sight loss. Daylight has a number of advantages for partially sighted people. It can give much higher illuminances than domestic electric lighting, aiding visual tasks. It is diffuse and lights a wide area, avoiding uncomfortable contrasts between task and background. Daylight has excellent colour rendering. The high illuminances from daylight, and its diurnal variation, can help maintain the body's circadian rhythms of sleep and alertness. For those with visual impairment, this is particularly valuable because their eyes are less effective at sending the required signals to the pineal gland, which controls these hormones.

The variation of daylight and sunlight adds interest to the visual environment. Windows provide contact with the outside and non-visual cues as changing conditions outside alter the acoustic and thermal environment, helping people orient themselves. However, daylight, and especially sunlight, can be a source of glare, and appropriate shading is needed. Contrast between bright areas near a window and the darker interior can also be uncomfortable or disabling. Even during the day, electric lighting may be required as well as daylight.

Introduction

This paper reviews the issue of daylighting in homes of people with sight loss. It is based on a comprehensive literature review of the topic¹. The work also included a small number of meetings with people with sight loss to discuss their attitudes to, and requirements for, daylight and sunlight.

Around 2 million people in the UK², 3% of the population, have sight loss affecting their everyday life. This covers a range of conditions, which differ in type and severity of sight loss. The most common include^{2,3}:

- Cataract (opacity and yellowing of the lens), reducing retinal illuminance and increasing light scattering.
- Glaucoma, where pressure in the eye kills retinal cells, resulting particularly in loss of peripheral vision.
- Macular degeneration, which results in loss of foveal (central) vision.
- Diabetic retinopathy, where areas of the visual field are lost. Usually this affects foveal (central) vision.
- Retinal detachment, which may cause part or all of the visual field to be lost in one eye.
- Loss of sight due to stroke, which typically results in hemianopia, loss of half the visual field.

Illumination

Those with visual impairment need higher illuminances to perform visual tasks, at least two or three times higher for older people in general³. For those with partial sight, even higher illuminances have been recommended. Often electric lighting in homes does not provide high illuminances. Silver et al⁴ measured median illuminance of 180 lux in the homes of a group of people with partial sight, compared to 1200 lux for optimum vision.

In a reasonably daylit room (average daylight factor 2%) in southern England, 100 lux of daylight alone is exceeded for 48% of typical occupied hours. 200 lux is exceeded 38%, and 500 lux 19% of the time. Near a window, illuminances three to five times these values could readily be achieved for the same periods of time.

Where higher illuminances are required, the use of daylight is often more pleasant than having bright electric lighting. Daylight is often more comfortable because it is more diffused and lights a wider area, avoiding uncomfortable contrasts between the task and its background. Daylight has excellent colour rendering and a high colour gamut, which means that objects appear in their vivid, true colours.

Hormones and circadian rhythms

The high illuminances due to daylight, coupled with the variation of daylight during the day, help to maintain the body's rhythms of sleep and alertness. They stop the body producing melatonin, a hormone that causes sleepiness, and stimulate the production of serotonin, which can reduce the symptoms of depression. For those

with visual impairment, high illuminances are particularly needed, because their eyes are less effective at sending the required signals to the pineal gland, which controls these hormones.

This can result in sleep disturbance at night. Tabandeh et al⁵ interviewed 388 subjects with either complete or partial sight loss. Almost half (189) reported sleep problems, compared with only 9% of the normally sighted group interviewed for comparison. They concluded that management of the sleep disturbance, perhaps via exposure to bright daylight during the day, may improve the quality of life in visually impaired people. The blue light content of daylight is effective at resetting circadian rhythms, and suppressing production of melatonin.

Variation of daylight

The variation of daylight and sunlight also adds interest to the visual environment. Even those with only the basic ability to resolve light and dark can detect changes in the weather and movement of the sun. This may be particularly important to those partially sighted people who are confined to their homes for long periods.

Daylight also varies spatially as one moves through an interior. This can lead to contrast variations which partially sighted people may find difficult to cope with. But a range of daylight provision may be helpful too. For key visual tasks very high levels of illumination are needed such as those provided near a window. But lower levels of daylight in a darker area are more restful and less glaring.

Windows can help people find their way around a larger building, particularly if the sun is shining. They also give non-visual cues as changing conditions outside alter the acoustic and thermal environment. The presence of a window, especially in circulation areas, can help people orient themselves within a room or building.

Light levels in transitional spaces such as hallways and entrance foyers should be balanced with those in the adjacent spaces, with intermediate levels of light³. These spaces should not be so dim that those entering from the bright outside find it hard to see. However, corridors and stairwells should not be so bright that dwellings leading off them are dark in comparison. Fully glazed stairwells and 'streets' should be avoided.

View out and contact with the outside

Contact with the outside is particularly important for those people who remain indoors during the day. Many people with sight loss, such as older people and those who are less mobile, fall into this category.

Some people can see larger objects such as trees or buses or other buildings, so that the view retains interesting visual content. However contact with the outside is not limited to visual aspects. Wyon and Nilsson⁶ found blind people were more positive towards windows because they appreciated being able to hear rain, wind, the activity outside windows and the smells sometimes admitted by windows. They used the acoustic and thermal asymmetry provided by windows to orientate themselves, and were more disorientated in windowless rooms.

Glare

Uncontrolled daylight and particularly sunlight can lead to glare, and this can be very uncomfortable or disabling to some partially sighted groups. Some eye conditions, such as cataract or retinitis pigmentosa, may give extreme sensitivity to disability glare. Effective, easily controlled solar shading is particularly important.

Conventional curtains do not always provide the right degree of control over incoming light. In their study of lighting levels in dwellings of elderly people in New York, Bakker et al⁷ reported that opaque shades were often drawn during the day, sometimes reducing daylight to very low levels.

Windows should have some means of excluding low angle sunlight⁸. A blind with vertical slats can be oriented to exclude the sun but allow daylight in from other directions. However it would require frequent adjustment during the course of the day to optimise incoming light. A blind with horizontal slats requires less adjustment but needs to be kept almost shut to control low angle sun. Incorrectly adjusted blinds can allow stripes of sunlight to penetrate. This can be distracting, especially in communal areas and circulation areas, as the pattern of stripes can be superimposed on the floor and walls. The stripes can be mistaken for the edges of surfaces.

If direct sunlight causes glare, loose weave fabrics or perforated venetian blinds often do not help because the sun is so bright. Opaque shading is best. Translucent shading, such as a thin light coloured fabric blind, gives some protection but may itself become uncomfortably bright under sunlight. One option may be a double shading system, with a net curtain for privacy supplemented by an opaque or nearly opaque blind.

Glossy room surfaces should be avoided as they can cause both disability and discomfort glare, and visual confusion⁸. Matt surfaces are preferable. Light coloured walls and window surrounds will help reflect light in the space and also reduce the contrast between the window and its surroundings, lessening glare. It is often more comfortable for partially sighted people to sit near to the window but facing away from it. Where someone can only read with one eye, that eye should be nearest to the window⁹.

Recommendations

Because of the benefits of daylight, homes for those with sight loss ought to be designed to higher levels of daylight provision than those for the general population. Those with partial sight need more light to perform visual tasks and maintain their body's daily rhythms, and may be in their homes for longer during the day. However there is no guidance on how much more light should be provided. Further research is recommended on the preferences of partially sighted people for the amount of daylight in their homes, including kitchens and bathrooms, which in some new housing may not have a window at all. Having big windows may cause privacy issues, and it would be useful to find out whether partially sighted people are more, or less, concerned about visual privacy than the general population.

Daylight and sunlight can also cause glare, so effective shading devices are important. Research is required to establish the type of blind that partially sighted people prefer, so as to give appropriate design guidance.

Even during the day, electric lighting may be required as well as daylight, so that partially sighted people can have extra light when they need it. Different people have different requirements for lighting, and good lighting control enables them to tailor supplementary lighting to their own individual needs and the time of day. Guidance is available on the best design of manual switching. However it is unclear whether automatic controls, which might be used in communal areas, are suitable for those with sight loss.

Finally, dissemination work is required so that future codes and standards on daylighting address the needs of partially sighted people.

Acknowledgment

This presentation describes research carried out for Thomas Pocklington Trust, a UK national charity dedicated to delivering positive change for people affected by sight loss. The Trust is shortly to publish a design guide¹⁰ on daylighting in the homes of people with sight loss.

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