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Indoor environmental criteria for older adults: ageing means business

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Introduction

Europeans are living longer than ever in history, because of the economic growth and advances in hygiene and health care. Today, average life expectancy is over 80, and by 2020 around 25% of the population will be over 65. The increasing group of older people poses great challenges in terms of creating suitable living environments and appropriate housing facilities. The physical indoor environment plays an important role in creating fitting, comfortable and healthy domestic spaces. Our senses are the primary interface with the built environment. With biological ageing, a number of sensory changes occur as a result of the intrinsic ageing process in sensory organs and their association with the nervous system. These changes can in turn change the way we perceive the environment around us. It is important to understand these changes when designing for older occupants, for instance, care homes, hospitals and private homes, as well as office spaces given the developments in the domain of staying active at work until older age.

Within the domain of building sciences, the indoor environment is the realm of building physicists, environmental engineers and building services engineers. The indoor environment can be influenced or altered by building services: lighting systems can increase indoor light levels; and heating, ventilation and air-conditioning (HVAC) systems are used to control temperature and humidity. Therefore, it is the engineers who can help achieve fitting indoor environments for the ageing population. Many standards and models relating to indoor environmental quality focus on office situations, which are mainly populated by people roughly aged between 20 and 65 years old. It is, therefore, of the utmost importance to have a closer look at the effects of biological ageing on the perception of the indoor environment. The goal of this article is to present an overview of the effects of biological ageing on the perception of the indoor environment, in particular (1) the thermal environment, (2) air and odours, (3) light and lighting, and (4) the acoustical environment. Thereafter, we discuss the importance of these changes for design practice.

Ageing-related changes in thermal perception

Until recently, scholars supported the hypothesis that in relation to thermal comfort, older adults did not perceive thermal comfort differently from younger college-age adults. The effects of gender and age were accounted for by PMV-model parameters, such as activity and clothing level. The ability to regulate body temperature tends to decrease with age, and these changes vary widely among individuals and are related more to general health than age. Moreover, basal metabolism declines with advancing age leading to lower body temperatures. In recent studies by Schellen et al. (2010) and Schellen (2012) on moderate temperature drifts, it was found that the thermal sensation of older adults is in general 0.5 scale units on the 7-point ASHRAE scale of thermal sensation lower in comparison to younger adults under the same thermal conditions. According to Schellen (2012), older adults, thus, prefer higher ambient temperatures. In her words, mild thermal challenges can cause significant physiological responses. For instance, cold temperature exposures can results in increased systolic blood pressure levels. Older adults, should, therefore, be protected from even mild thermal disturbances.

Ageing-related changes in the perception of odours

There is strong evidence that smell perception declines markedly with age. Age-related losses of smell normally begin after the age of sixty. Age-related sensory changes to smell include a decrease in the number of olfactory cells. These changes may lead to decreased appetite and poor nutrition, as well as a decreased protection from noxious odours. The loss of cells in the olfactory bulb in the human forebrain can lead to changes in smell. In addition, a history of upper respiratory infections, exposure to tobacco smoke and other toxic agents, and changing levels of hormones negatively influence olfactory function (van Hoof et al., 2010a).

Ageing-related changes in vision and effects of light

Ageing negatively affects vision. In general, the performance of the human eye deteriorates at early age. Many people aged 45 and over wear glasses to compensate for impaired vision due to presbyopia, the significant loss of focusing power. Older people are known to have vision impairments stemming from the normal ageing process, which include an impaired ability to adapt to changes in light levels, extreme sensitivity to glare, reduced visual acuity, restricted field of vision and depth perception, reduced contrast sensitivity, and restricted colour recognition. Changes in vision do not happen overnight, and depend on the progress of age. After the age of 50, glare and low levels of light become increasingly problematic. People require more contrast for proper vision and have difficulty perceiving patterns. After the age of 70, fine details become harder to see, and colour and depth perception may be affected. Apart from the influence of ageing, there are pathological changes leading to low vision and eventual blindness, such as cataract, macular degeneration, glaucoma, and diabetic retinopathy (van Hoof et al., 2010a, Sinoo et al., 2012).

Apart from being indispensable for proper vision, light exposure is the most important stimulus for synchronising our day and night rhythm. Research by Aarts and Westerlaken (2005) in The Netherlands has shown that light levels that older adults are exposed to (due to their mainly indoor lives in general), even during daytime, are too low to allow for proper vision and biological effects. Nowadays, older people are being exposed to so-called ambient bright light from ceiling-mounted luminaires. This encompasses an increase of the general illuminance in rooms. There are several short-term and long-term effects such as lessened nocturnal unrest, a more stable sleep-wake cycle, possible improvement to restless and agitated behaviour as well as sleep, increased amplitude of the circadian body temperature cycle, and a lessening of cognitive decline (van Hoof et al., 2012).

Noise and room acoustics

In addition to sight, one of the first senses to be affected by age is hearing, and this begins to occur by the age of 40. High-frequency pitches are the first to become less audible, with a lesser sensitivity to lower frequency pitches. The ability to understand normal conversation is usually not disturbed at first, but when combined with the presence of background noise comprehension may be affected. A laboratory study by Sato (2005) involving 20 younger and 20 older subjects using various speech tests showed that speech recognition (intelligibility) scores of the older listeners were 25% lower than those of young adults for any kind of speech test. The effect of this difference is equal to the 5 dB increase of ambient noise.

Implication for design and practice

Given the demographic changes in our societies, it is very important to be aware that biological ageing may go together with different needs and preferences concerning the indoor environment. For designers, these criteria may be extra important when designing health care facilities or buildings that facilitate activities for older adults, such as day care centres or activity halls. For designers of work places it might be wise to have a second look at the controllability of the indoor environment given the trend that people have to work longer in relation to a postponed retirement. Being conscious of differences between younger adults, on whom most standards are based, and older adults, is the first step in improving your design.

At the same time, we need to be critical. There is still a lot we do not know. Of all the indoor environmental parameters treated above, light is the best understood, and even in that domain, gaps in our knowledge are plentiful. Novel lighting applications are developed by the industry and applied to improve cognition, mood and behaviour, sleep and vision, such as dynamic lighting systems. To date, we do not know if such expensive systems have better outcomes than static lighting systems, and how such systems interact with available daylight. Vision can be improved by raising general illuminance levels and glare control. When integrated in the building, light therapy solutions challenge the designer to come up with a design that on the one hand yields the right lighting to procure non visual effects and on the other hand does not hamper (through glare as a result of the high illuminances needed) the occupant while performing visual tasks.

The supply of fresh air, elimination of bad odours, reduction of background noise and other aspects of the acoustical environment are recognised as being important, but are not as well-studied as light and lighting. The economic benefits of accounting for these parameters are not yet clear. In terms of the acoustical environment, it is not possible to provide specific data and values of the ideal sound pressure levels and reverberation times for older persons. Recent findings in the realm of thermal comfort research suggest that older adults may have a need for slightly higher indoor temperatures. As long as there are many uncertainties, we suggest to allow for a maximum of user control in buildings. Apart from designing indoor environments that meet the needs of older adults, the accessibility of spaces and other human factors approaches should be considered to optimize a building for use by older occupants. ■