Colour in the environment for older adults

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Abstract: Demographic changes, the growing number of people with disabilities, and the demands on architecture and design are posing new challenges for designers. The space in which older adults live should be safe, not only from a legal point of view but especially to facilitate their daily activities. Modern society prioritizes the integration of older adults into everyday life so that as people grow older, they are not forced to abandon their daily routines because of obstacles in the space. It is said that a person is not handicapped because of their illness, but because society fails to prepare conditions for them to be able to move and live without restrictions. Moving in space is a multisensory experience. People use most of their senses such as sight, hearing, smell, and touch in addition to moving their bodies. How we feel indoors depends on the indoor climate, lighting, surface colours, air quality, floor plan, and furniture layout. Studies show that the materials and colour of products have an impact on how we navigate a space, how we feel and, in some cases, they can even have healing effects. The aim of our study is to investigate the association between colours in the environment and the orientation of people, especially older adults, in the space they live in. Several studies, experiments, and observations of foreign researchers serve as the basis of the paper. The analysis of case studies proved that colours in the environment have a significant impact on orientation in space and can be an effective tool for spatial orientation and drawing attention to a particular place. In surveys that have been conducted with older adults, warm colour tones such as yellow, orange, and red are preferred over cold ones. Red tones are some of the most easily recognizable for older adults who suffer from loss of colour recognition. They have lower cognitive abilities as a result of aging. Therefore, the achromatic environment does not sufficiently stimulate their brain function, leading to longer reaction times. Colour and contrast indoors play a big role in the perception of space and can help in drawing attention to a particular place.

Keywords: social inclusion, older adults, health, interior, furniture, colours

INTRODUCTION

A large part of public and residential interiors is not designed for or adapted to the needs of older people. The trend of aging population is a demographic phenomenon, but its consequences affect the entire society. "*According to European statistics, there are 127 million people in the European Union who have limited mobility, orientation or are unable to perform normal activities. In the context of projections of an aging population, the percentage of people with mobility and orientation impairments is set to increase. According to the European Statistical Office, the number of people over 65 in the EU countries is projected to rise from 17% today to 30% by 2050.*" (Rollová, Čerešňová, 2010) These facts prepare challenges for designers to suggest solutions for appropriate integration and to create an environment for the growing tendency. One of the priorities of the modern society is to address the issue of social integration of people with disabilities. Many professional articles and publications have been published, which have led to the development of guides and documents related to barrier-free accessibility. It should be a new standard to level the visiting opportunities for all types of people. Accessibility is an essential part of new buildings, but also of the renovation of older architecture. It is not only people with health, hearing, visual, or other disabilities who encounter problems in the public environment but social inclusion also concerns other vulnerable groups of the population – children, mothers with strollers, neglected people, and older adults. The vision is to improve the quality of life without discrimination. (Rollová, Čerešňová, 2010)

METHODOLOGY AND LITERATURE REVIEW

The purpose of this study is to find the relationship between colours and the perception of older adults, to understand the association and influence of colour choice in private and public settings through multiple studies and literature reviewed. The complexity of the situation required ongoing data collection. Firstly, the problems most encountered by older adults were observed and defined. Among health disadvantages, vision loss, visual impairment, and the resulting disorientation in the environment

were nominated as the connecting factors. A literature review was also conducted on this topic.

Secondly, a review of literature and scientific articles was conducted on the topic of colour, colour in the environment for older adults, colour in the environment in social service settings, colour from the perspective of environmental gerontology, studies on the impact of colour on humans, and the impact of colour and materials on humans in a broader spectrum. This basis for research included resources dealing with the aging population, the challenges older adults face in the indoor environment, and the adaptability of the indoor environment with respect to aging and physical health. In addition, a literature review was conducted to gather information on the role of colour and materials in influencing the well-being and safety of older adults. The cited studies were selected based on relevance to the topic. Preference was given to studies that dealt directly with colour and material in public and private settings in which the target group or the group involved in the experiment was composed of older adults.

Next, two different experiments were examined to provide specific insights into the impact of colour on older adults. The first experiment involved a survey of 150 older adults equally composed of men and women living in different settings. The purpose of the experiment was to assess their preferences and perceptions of colours and materials in interiors. The survey included a variety of scenarios that allowed participants to choose colours and materials that made them feel safe, comfortable, and independent. The second experiment used eye-tracking technology to investigate how colour affects older adults' visual attention and safety. A sample of 75 older adults was observed interacting with color-coded items within a simulated living environment. The aim of the experiment was to measure the speed of focus on different elements and their effect on perceived safety. Other experiments dealt with the topic of colour in conjunction with older adults, art therapy, and the perception of wood as a colour in the environment.

HUMAN-CENTRIC DESIGN

Inclusion of older adults and finding suitable accommodation and care is a challenge, at the outset of which we need to determine their needs, capacity, size, and standard of housing. At the same time, older adults are encouraged to fend for themselves and provide for their basic needs. A model where older adults still have responsibility for themselves but also professional help is available to them should their health suddenly deteriorate or where they have no relatives is an effective option that should be expanded in the future. Unlike living in a standard hospice, the older adult is still active, which also increases their prospects for mental and physical health. Deinstitutionalization is the transfer of citizens with disabilities or older adults from traditional social service settings, where they are often physically and mentally isolated from mainstream life, to services that create equal citizenship conditions similar to mainstream society. (Rollová, Čerešňová, 2015)

When designing nowadays, a designer has to be very careful about the versatility of their design. Just as a furniture designer is concerned with ergonomics and human anthropology, an architect must also consider the broader context, in the sense of the Design For All method – designing for all. In designing, the diversity of people, their needs, and constraints must be considered so that all users feel equal and have the same opportunities to be an active part of the community. Approaches to designing environments that address the diversity of people's needs and requirements are called human-centred design, which encompasses universal design, design for all, inclusive design, user-friendly design, design for all ages, and accessible design. (Rollová,

Čerešňová, 2015) Living in their own home for as long as possible is one of the most important requirements of aging people. Their desire is to be as self-sufficient as possible. The living space for older adults with mobility impairments needs to be adapted to allow sufficient room to manoeuvre and change directions. Their main need is for safety, functionality, and comfort. Furniture doors should be easy to open and all items should be reachable at arm's length. Fitting the bed, mattress, nightstand, or sofa is also important. (Beer, Olenska, Zbiec, 2017)

Fig. 1. Wooden Lotte armchair designed by Sarah Hossli helps people with age-related impairments rise and sit unassisted. (Photo: Severin Stark. Source: Griffiths, 2022)

Materials and colours for the interior of older adults

We are now seeing the connection of human-centred design to environmental psychology and neuroscience in architecture, which draws attention to the psycho-social aspects of design, the impact of the environment on people, their health, and their sense of well-being. For a wide range of people, physical, sensory, and informational accessibility, visitability, adaptability, and flexibility of the environment is also linked to the human-centred design. Humanizing the environment means an overall universally accessible design that manifests itself in kindness and can be likened to saying You are welcome here. (Čerešňová, 2017) People's affection for natural materials stems from man's natural environment and his affection for nature. Natural materials and biophilic elements are close to our nervous system. Thus, our body does not have to expend additional energy in recognizing and perceiving them.

On the contrary, it could be said that natural materials recharge us with energy. They are part of our traditional culture and it is appropriate to use them as they are timeless. In addition to the aforementioned advantages, wood also has haptic, olfactory, and acoustic qualities. The preference for the textures of natural materials is also justified by the fact that people's perception of black and white is better than that of colour. (Kotradyová, 2016) A 2022 study entitled Perception and Evaluation of (Modified) Wood by Older Adults from Slovenia and Norway, authored by Dean Lipovac, Solvi Wie, and Michael David Burnard confirmed that older adults prefer wood to other materials. One hundred older adults were involved in the workshop, and a number of samples of treated and raw wood and other materials were collected. The product tested was door handles. Wood was favoured over other materials in both the blind and visual tests. The study also showed that coated wood was preferred more than raw untreated wood. (Lipovac, Burnard, Wie, 2022)

"Environments created with natural materials, and wood in particular, have a regenerative effect on the nervous system, helping to

create a supportive environment for reducing stress and accelerating the healing process in patients, as evidenced by several global studies." (Kotradyová, 2016) The colour of the wood also plays an important role in the interior. The environment can make its texture more noticeable, or suppress it and accept it as just one of the shades. Different factors influence the wood colour, such as the type of wood species, climate, age, and finish. Wood studies show that the colour results of the forests studied are in the +a and +b quadrants, which correspond to red and yellow. Based on the results from the research, the colour corresponds to shades ranging from beige to dark brown and brown with the presence of saturation of yellow. (Ramírez, Fajardo, Escovar, Villamil, 2022) In addition to its visual qualities, wood is a quality and long-lasting material suitable for interior and exterior furniture. It is one of the most suitable materials for indoor use by older adults.

Visual perception

As we age, our visual perception changes, but so does our sensitivity to certain colours. Age-related changes in vision occur in all layers of the eye and can have different effects. First of all, the change in vision is caused by the tissues of the eyelids and the muscles around the eyes becoming flaccid. The biggest changes affect the lens of the eye, which hardens, thickens, and becomes less flexible. Changes to the lens allow less light to enter the eye and make it harder to recognize the environment a person is in. (Loredan, Sašek, 2023) The most common problems associated with vision loss are loss of central vision, which allows us to see fine details and colours, blurring of the eye, reduced sensitivity to contrast, reduced ability to see in low light or at night, difficulty seeing objects up close, loss of normal vision, and also increased sensitivity to glare. The most common eye diseases that affect older adults include macular degeneration, cataracts, diabetic retinopathy, dry eye, glaucoma, retinal detachment, and blindness. (American Optometric Association, 2021) Visual acuity alone is not the only indicator of a person's visual difficulties. Even a person with good visual acuity may have difficulty functioning and have trouble performing everyday tasks.

Adaptation of the interior

Whether it is adapting existing rooms in the home or designing a public service space, colour plays an important role in the space. When used purposefully, colour is a powerful tool that can not only enhance design aesthetics but also greatly help older adults feel independent and safe. Elements that can compromise our safety should be designed in contrasting colours. Moving through space is a multisensory experience. People use most of their senses such as sight, hearing, smell, and touch in addition to moving their bodies. Disorientation and unfamiliarity with the environment can increase fear in people and have a negative impact on their overall well-being. Flooring in areas designed for older adults should be designed in contrast to the walls and should be complemented with relief features such as artificial guidelines of different textures and colours. Older adults may be disoriented or feel unsafe if the space blends before their eyes and they cannot determine where they are walking. Alternating the colours of floor coverings, marking the purpose of rooms with embossed signs, or other wayfinding signs are helpful in helping older adults with orientation.

In circulation areas, there should be no obstacles on the ground that restrict the movement and safety of older adults. Safe floors should be solid, uniform, and protected against abrasion and slipping. The choice of solid floor coverings or tiles that do not shimmer is appropriate so as not to impair spatial orientation. If a carpet is used, it is advisable that it is low pile and passable by wheels. Carpeted floors have several major advantages. Carpets

transmit fewer pathogens to the hands than vinyl or rubber floors, and some serious pathogens survive for a shorter time. They reduce noise and glare, make walking easier, reduce the likelihood of falls and subsequent injuries, and prolong visits with family and friends (increasing social support). (Kotradyová, Lipovac, Hencová, 2023)

Fig. 2. Home for dependent elderly people and nursing home in Orbec, France. The red colour de-structures the space and adds dynamics. Architects Dominique Coulon & associés avoided using the conventional colours of the hospital environment. (Photo: Eugeni Pons. Source: Orbec, 2017)

Contrast and colours

The interior design of the apartment should be based on the contrasting design of the apartment's spaces or furniture elements. The colour scheme of the individual zones in the apartment can be a good aid to spatial orientation. Furniture elements or doors, for example, should have a contrasting colour to the wall on which they are mounted. Contrasting or different colours should also be used for elements or objects that may pose a safety risk to users. Warm and pleasant to the touch colours are preferred for furnishings. The interior should create a pleasant and welcoming atmosphere. Users should be able to furnish the interior with their own furniture; they can choose the wall colours so that their space receives a distinctive character. Several studies have shown the disadvantages of all-white architectural spaces. The monotony and lack of sensory stimuli in interiors can hinder users' orientation as they lack the visual cues needed to identify architectural elements. Colour contrasts in interiors need not be limited to walls and floors; the contrast between stair arms and walls, and colour-coded highlighting of important points and zones is also appropriate.

Other vital elements are switches and electrical plugs, which can be distinguished by graphic elements. Room entrances should be colour-coded, ideally at eye level. Aging eyes lose the ability to distinguish bright colours, making yellows and other pastel colours appear white. Shades of blue, green, and purple are classed as cool colours and can be seen as grey. People with colour deficiency are best able to perceive bright colours at the warm end of the spectrum, such as red and orange. (Moore, 2018) For cognitive reasons, colour is an essential cue for discriminating visual information. (Sloan, 1980) Equipment and furniture in the home designed in warm tones of the colour spectrum is more pleasant to the touch. The interior for older adults should have an open, welcoming feel. Older adults who live in facilities outside their homes should also be able to make their own living arrangements and adapt them to their own character. (Kotradyová, Lipovac, Hencová, 2023) A large number of colours can overstimulate our sensory perception. It is therefore important to review the choice of elements in our environment as we age.
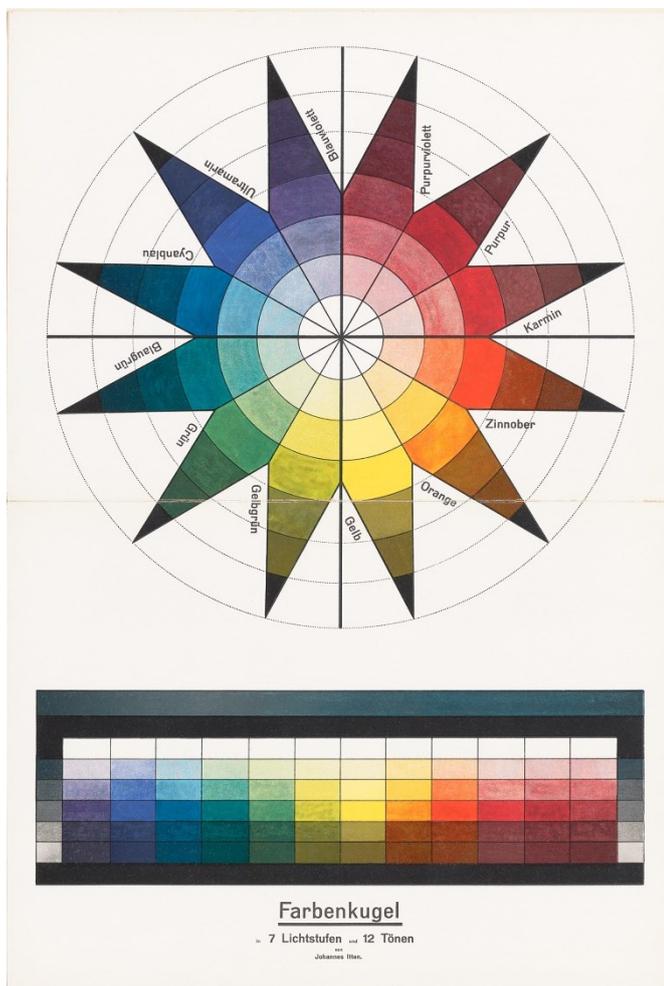

Fig. 3. *Farbenkugel in 7 Lichtstufen und 12 Tönen* (Colour sphere in 7 light values and 12 tones). (Source: Itten, 1921)

MATERIALS, DATA, AND METHODS

Colour in association with older adults was addressed by researcher Roswiyani in her dissertation. In her publication Older Adult's Well-being, Art Activity and Qigong Exercise in a Nursing Home in Indonesia, she writes about active aging and maintaining well-being. In her study, she mainly focuses on art therapy, which is also a form of self-presentation and expressing one's feelings. Art activities and working with colours present an opportunity for social communication with other people, establishing interpersonal relationships, and actively suppressing depression and feelings of loneliness. (Roswiyani, 2019) The topic of

anxiety in older adults has become a widespread health problem. Health institutes have estimated that the global prevalence of anxiety disorders in older adults occurs in up to 28.3% of the population. (Balsamo, Cataldi, Carlucci, Farfield, 2018) Other research conducted at a centre for older adults in Taiwan also investigated the effect of art therapy. The experiment involved randomly assigning four art activities to older adults and measuring their anxiety levels. At the end of a set amount of time, they were asked to write their most recent negative experience on an A4 sheet. Significantly lowest levels of anxiety were measured in the group that worked with paint and painted a pre-drawn mandala. Members of this group felt calm, safe, relaxed, and satisfied. (Koo, Chen, Yeh, 2020) Based on this study, it can be deduced that uncontrolled handling of colour can be disturbing for older adults. On the contrary, tidy, precise colour assignment within a defined framework improves their psychological and physical well-being. This important aspect can be regarded by the designer when designing their housing.

Colour can significantly help with spatial orientation, but it is the architect who addresses the core principles. Spaces for the elderly should be organized, clear, and allow natural movement. Orientation in space is also closely related to the navigation system integrated in it. A wayfinding system in spaces for older adults helps with spatial orientation and navigation. A good navigation system is clear, understandable, intuitive, and non-verbal. (Čerešňová, Filová, 2023) Many studies can now be found that examine the impact of physical elements on well-being in health care settings for older adults, but few are concerned with colour. These homes often have neutral to hospital-style facilities. Instead of institutional aesthetics, one should begin to think about adding more of a sense of home, and colour may be one of the most useful elements for this purpose. In addition, colour can be used to emphasize the difference between rooms designed for relaxation and those designed for activities. (Torres, Serra, Llopis, Delcampo, 2020)
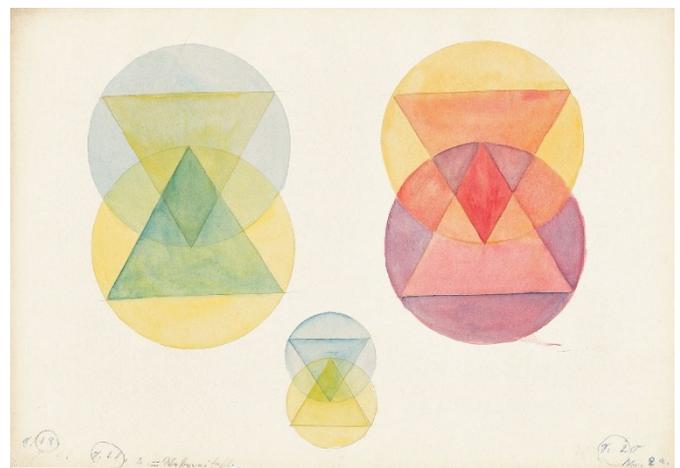

Fig. 4. *Farbenstudien* (Studies of colours). (Source: Willers, ca. 1922–1925)

Spanish researchers Ana Torres, Juan Serra, Jorge Llopis, and Anna Delcampo conducted two experiments with 134 older adults aged between 75 and 97 years in different activity rooms, during which they measured the level of arousal elicited by different colours. They conducted the first experiment in a nursing home and the second one in a laboratory using virtual reality. In both cases, they evaluated 6 colours in two groups: warm (red, orange, yellow) and cool (purple, blue, green). The conclusions of their study show that preferences depend on the type of room. In rooms used for social activities, people preferred warm to cool colours, with yellow – the shade in the middle of the colour spectrum – being the most preferred. For bedrooms and rooms designed for relaxation, older adults chose colours from the cool

visual spectrum, with green being the most preferred colour. The level of arousal by each colour was measured by the HRV instrument to measure the state of the autonomic nervous system. (Torres, Serra, Llopis, Delcampo, 2020) In publications and articles devoted to colours and emotions, the blue colour is usually cited for relaxation, peace, and tranquillity, while red tends to symbolize fire, activity, and excitement. Colour preferences may also differ between men and women, or between ethnic groups, but this was not confirmed in this study. The authors suggested that gender differences in colour preferences may also be due to biological differences in colour vision. However, this conjecture is also not confirmed.

The second experiment examined was conducted by researchers Ze-Yu Wang and Ji Young Cho from Korea using eye-tracking technology. In their study, they investigated whether the use of colour in residential environments affects the visual attention of older adults. In the first experiment, they observed the gaze behaviour of older adults when viewing images consisting of nine colour arrangements of door frames. Based on the results of the first part of the experiment, images of simulated environments with two door colours were created in the second experiment. Eye-tracking technology can conveniently capture eye behaviour without the participant being aware of it, so it does not cause any psychological or physical discomfort. The results show that participants paid more attention to pictures in which red or the red-black colour combination was used. In the experiment, the reaction time required to focus on a particular door was measured, with focusing on the white door being the slowest overall. (Wang, Cho, 2020) The results of this study confirm that colour can improve the visibility of features that can affect safety and improve their quality of life in older adults' living environments. Contrasting colours used in the environment makes the environment easier for older adults to remember. Older adults have lower cognitive abilities as a result of aging. Therefore, achromatic environments do not sufficiently stimulate their brain function, leading to longer reaction times.

Fig. 5. Experiment using virtual reality. Measuring stimuli and excitement while projecting three warm tones and three cold tones into the living space. (Source: Torres, Serra, Llopis, Delcampo, 2020, CC BY-NC-ND)
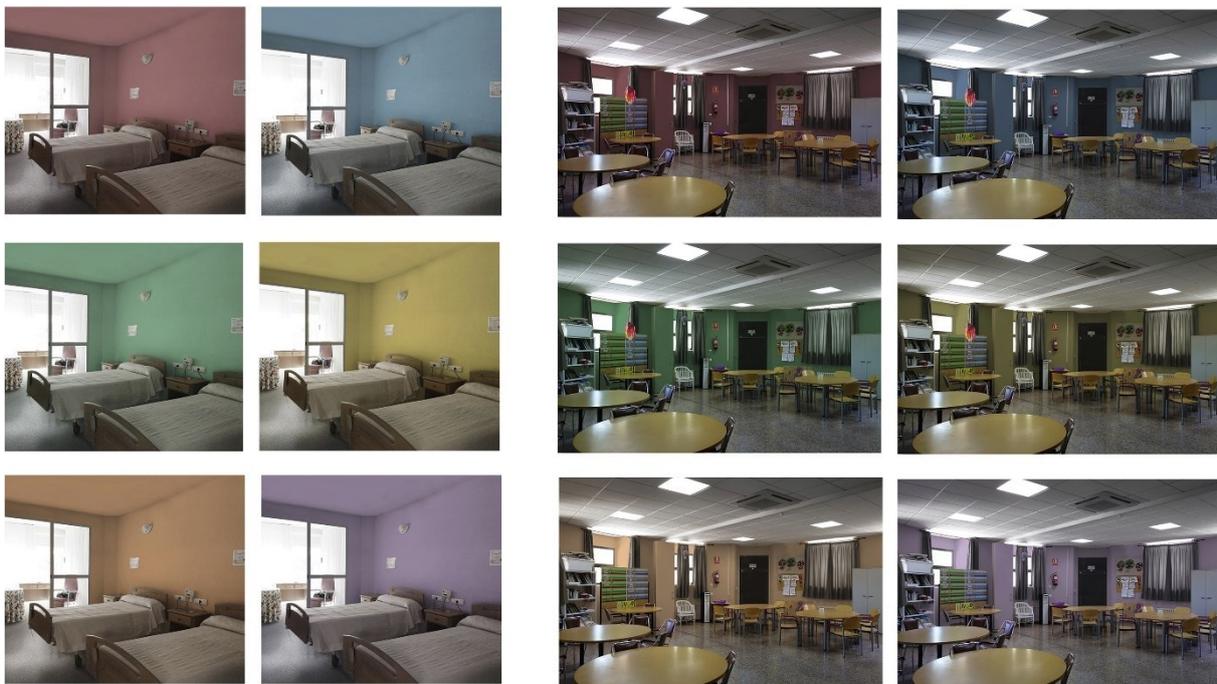

Fig. 6. Stimuli shown for (a) the bedroom and (b) the activity room, with the colours arranged from top to bottom and from left to right: red, blue, green, yellow, orange and purple. (Source: Torres, Serra, Llopis, Delcampo, 2020, CC BY-NC-ND)
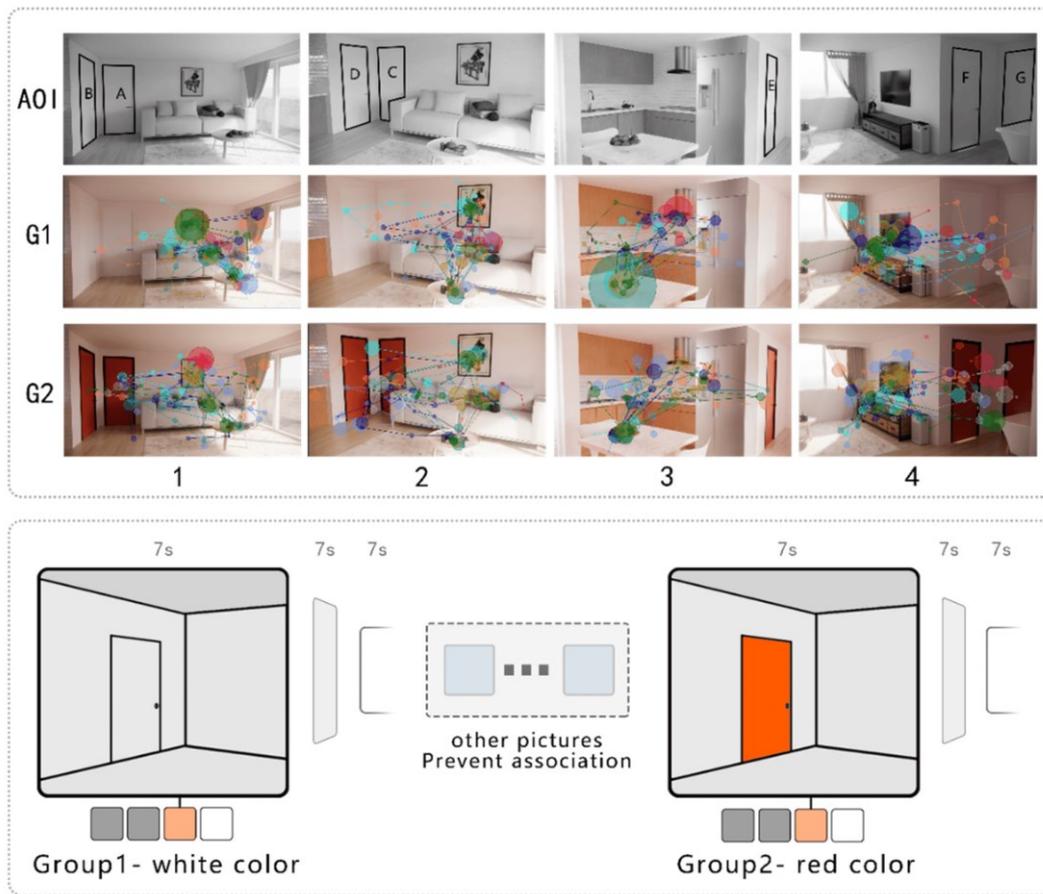
Fig. 7. Simulation of living environment and examining the older adults' gaze behaviour at the door colour with high visibility and with low visibility. In addition, it was intended to explore the differences in gaze behaviour between older adults with normal and low cognitive states. (Source: Wang, Cho, 2020, CC BY)

DISCUSSION AND CONCLUSION

The trend of aging population poses a major challenge to the modern society, requiring innovative solutions to address the needs and well-being of older people. The demographic shift is affecting various aspects of society, making social integration and accessibility essential priorities. In this context, human-centred design, which encompasses inclusive design, universal design, and user-friendly design, is crucial. It emphasizes the importance of considering the diverse needs and constraints of older adults and of promoting their active participation in society. People spend most of their free time indoors, the amount of which increases with age, making it even more necessary to be mindful of the environment in which we live. Sensory simulations in living spaces encourage the senses and motivate people to move and explore their surroundings. The choice of materials and colours plays an important role in creating an environment that supports the well-being of older adults. Natural materials, especially wood, are preferred for their restorative effect on the nervous system and timeless appeal. They play a role in cognitive stimulation, orientation, and emotional well-being, while warm colours promote relaxation.

Visual perception changes with age and sensitivity to certain colours may decrease. Common age-related visual problems, such as reduced sensitivity to contrast and difficulty distinguishing fine detail and colour, have important implications for design. Older people often face health problems, including various eye conditions, which need to be considered when planning accessible and inclusive environments. Adapting interior spaces is a critical factor in supporting the needs of older adults, and promoting their independence, safety, and comfort. Contrast and colour are essential tools to help orientation, enhance safety, and create an inclusive atmosphere. Designing spaces that are easy to navigate and that use contrasting colours where appropriate can reduce disorientation and improve overall well-being. Although the benefits of using colour when designing environments for older adults are obvious, there are some subtleties to consider.

Colour preferences may vary depending on the type of room and the activities being performed. Individual reactions to colour are complex and include emotional, cultural, and even gender factors. However, the use of colour can help older adults feel more relaxed, secure, and happy in their living environment. Despite the valuable insights gained from previous research, the impact of colour on older adults' well-being is still a developing area of study. Researchers continue to explore the complex relationships between colour, environment, and the mental and physical health of older adults. More research is needed to improve our understanding of the nuances of colour use in different settings and among different populations of older adults. Integrating the colour theory into the design process remains an important avenue for future research as it may lead to better-designed, safer, and more inclusive environments. Ultimately, the goal is to create living spaces that meet the specific needs and promote the well-being of the aging population, supporting their desire for self-sufficiency and continued active participation in society.

Incorporating colour sensations and natural materials in living spaces improves physiological and psychological indicators of human well-being. Human-centred design is also currently focusing on psychology and neuroscience in architecture, psycho-social aspects of design, and the impact of the environment on people, their health, and their sense of well-being. Creating a suitable environment for people to live in their housing from birth to old age is a transformation that the residential interior designer,

especially the designer, must grasp. Adaptability of space is a clear requirement of older adults. When designing, designers must be familiar with guidelines for adapting design and architecture for people with special needs and older adults. This includes interdisciplinary training with a focus on ergonomics, anthropology, gerontology, and sociology. Analyses show that architecture and design for people with disabilities and older adults is a market that will expand in the coming years to meet their needs. Whether it is adapting existing rooms in the home or designing public service spaces, colour plays an important role in space.

Colour contrasts do not have to be limited to floors and walls; they can draw attention to any important point of interest. When used purposefully, colour is a powerful tool that can not only enhance the aesthetics of a design but can greatly help older adults feel independent and safe. Vision impairment is not the only ailment of aging adults, but it can limit them in performing common tasks. Elements that can compromise our safety should be designed in contrasting colours. Shades of cool tones such as blue and green may be perceived as grey by the aging eye. Monotony and lack of sensory cues in interiors can hinder users' orientation as they lack the visual cues needed to identify architectural features. Warm tones at the warm end of the colour spectrum can still be seen even by people with colour deficiencies. In addition, these warm tones have a positive effect on their bodies, and feel warm and energizing. Studies show that furniture designed in warm tones is more pleasant to the touch. It can also be inferred from some studies that people perceive wood as a colour on the warm side of the colour spectrum. Shades of wood from beige to dark brown are mainly composed of a combination of shades of red and yellow. This may be one of the reasons why even older adults prefer wood in interiors over other different materials.

Tab. 1. Implications of Colour in Relation to Demographic Factors. (Source: Authors, 2023)

Demographic Factor	Implications of Colour in Interior Design for Older Adults
Age	Older adults may have reduced ability to perceive certain colours, making warm tones more preferable for improved visibility
Sex	Preferences for specific colours may vary between men and women, but further research is needed to confirm this variation
Type and Degree of Disability	Individuals with higher degree of disability may benefit from colours that enhance cognitive stimulation and orientation, such as contrasting colours
Health and Dependency	Colour choices can affect the mental state and well-being of individuals with health issues or dependencies, with warm colours promoting relaxation and cool colours aiding in a calming environment
Socioeconomic Level	Colour preferences may be influenced by socioeconomic factors, with further research required to understand the specific correlations
Other Environmental Factors	Colour choices should be adapted to the specific environmental conditions, taking into account lighting, noise levels, and the type of residence (urban or rural) to create a harmonious and visually appealing living environment

Tab. 2. Implications of Colour in Interior Design for Older Adults. (Source: Authors, 2023)

Aspect Analysed	Implications of Colour in Interior Design for Older Adults
Cognitive Well-Being	Use of warm colours can promote a calming and reassuring atmosphere Colour contrast can improve memory and orientation Cool colours can enhance relaxation spaces
Emotional Well-Being	Colours can influence emotions and mood Warm colours can promote a sense of warmth and energy Cool colours can create a soothing and tranquil environment
Physical Comfort and Safety	Contrasting colours on important elements enhance visibility Colour choices should consider potential safety risks
Orientation and Navigation	Colour aids in wayfinding and helps older adults in their orientation Colour coding can designate the purpose of rooms
Personalization and Adaptation	Colour choices should allow residents to personalize their living spaces Residents can choose colours that make their space distinctive

As our society continues to age, the design of living spaces for older adults is becoming an increasingly important aspect of social integration and well-being. The role of colour in this context is both an art and a science and if designers, architects, and researchers delve deeper into its potential, it can contribute to a brighter and more accessible future for older adults. By embracing the principles of human-centred design and harnessing the psychological and aesthetic power of colour, we can create living environments that are not only functional but also beautiful and supportive, enhancing the quality of life for older adults. Promoting inclusivity and ensuring that these environments are accessible to older adults is an important step towards a more equitable society. It is our shared responsibility to design with empathy, creativity, and a deep understanding of the needs and preferences of older adults. By embracing these principles, we can create living spaces in which every person, regardless of age, can feel truly welcome and thrive. Any biases identified in this research need to be further explored and addressed to ensure the findings are as objective and reliable as possible. In addition, the limitations of the study should be acknowledged. These may include factors such as sample size, demographic characteristics, or cultural aspects that could affect the generalisability of the results.

Identified biases and their impact on the results

A study may experience cultural bias in its results. Colour preferences, perceptions, and their impact on well-being may be influenced by cultural factors. The study does not explicitly address the diversity of cultural backgrounds and how this may affect the relationship between colour and well-being in older adults. This bias could lead to results that are not generally applicable.

Sampling bias: The study may not adequately represent the entire population of older adults. The impact of skin colour on well-being could vary based on factors such as age, gender, socioeconomic status, and health status. If the sample used for the study is not sufficiently diverse, the results may not be generalizable to all older adults.

Confirmation bias: There may be a bias in favour of positive findings. If researchers or designers have a preconceived notion that certain colours are beneficial to older adults, they may subconsciously interpret or present the results in a manner that confirms this belief. This could lead to overemphasizing the positive aspects of colour use and neglecting the potential drawbacks.

Publication bias: A study may be affected by publication bias when only studies with positive or significant results are published. This may lead to an overrepresentation of studies supporting the positive impact of colour on well-being, while studies with neutral or negative results may remain unpublished.

Cognitive bias: older adults' responses to colour stimuli may be affected by recall bias. Due to limited memory or other cognitive factors, they may not accurately recall or indicate their emotional or well-being responses to specific colours.

Future research could look at the intersection of colour psychology, neuroscience, and design for older adults to provide more comprehensive guidelines on and insights into how to use colour effectively. Studying the impact of colour in different cultural contexts and environments could also provide valuable insights into tailoring design approaches to different populations. In conclusion, the journey towards creating better living spaces for older people continues, and understanding the complex relationship between colour and design in this context is an important part of this process. It is an area ripe for exploration, innovation, and continuous improvement, with the ultimate goal of improving the well-being and quality of life of older adults worldwide.

Possible research directions

Longitudinal studies: Conducting a longitudinal study to understand how colour preferences and their impact on older adults' well-being evolve over time. This could provide insights into the changing needs of this demographic as they age in place.

Cross-cultural research: Exploring how colour preferences and their impact on wellbeing vary in different cultural contexts as this may inform more inclusive design practices.

Health-focused design: Focusing on designing living spaces that accommodate older people with specific health issues including dementia, visual impairment, and mobility problems.

Gender-focused studies: Exploring whether gender plays a role in older adults' colour preferences and responses, leading to gender-specific design recommendations.

Cognitive and psychological aspects: explore in more depth the cognitive and psychological aspects of colour perception and its relationship to well-being, possibly integrating findings from psychology and neuroscience.

Technology integration: Exploring how modern technologies, such as intelligent lighting systems, can be incorporated into the design to optimize the wellbeing of older adults.

As society continues to age, addressing the well-being of older adults through design remains a dynamic and evolving area. By expanding research along these lines, designers and researchers can contribute to more holistic and effective approaches to creating living spaces that truly enhance the quality of life for older adults.

Acknowledgements

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