Designing for Elderly People-Ergonomics of Vision

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ABSTRACT

When designers need to develop communication, interior, signage or urban environment design projects for elderly people, their skills are enhanced with studies about normal aging process and anatomic changes. The same way, knowledge about vision, colour vision, vision loss and deficient colour perception of older people, must be taken into account, in order to improve design practice. These aspects of projectual practice are the key aspects to be addressed in this paper. In order to prevent dependency and exclusion, designers have to understand and account for the reduced functional capabilities of older adults in their designs. Achieving project goals for this target group will ensure better solutions for all users. We hope that this work will support design professionals in their goal for *'design for all'*. Bringing knowledge about colour vision deficits, and applying principles of visual ergonomics to projectual practice, will help people moving safely in urban environments, living comfortably in interior spaces, and reading all the visual printed information with minimum effort, which will improve their quality of life.

Keywords: Aged Vision, Colour, Lighting, Design.

INTRODUCTION

The aging process is characterized by progressive and multiple acquisitions of some deficiencies, predominantly related to vision, hearing, dexterity, mobility and cognition, which can lead to high levels of disability and dependency. This process includes physical degeneration, with reduction of the overall physical condition, reduction of agility, impaired vision and loss of hearing, memory faculties, and sense of direction. Deficits lead to changes in sensory perception and decreased sense of well-being, which often involves strong feelings of insecurity (Meerwein, Rodeck & Mahnke, 2007).

Designers and architects should design objects and environments that could be easily and completely used by older people, environments that should be easier to read by everyone's eyes and should consider ways to meet the visual needs of this growing population. Although the anatomic and physiologic processes of aging are distinct from the aging eye diseases, the vision changes they produce may be similar. Knowledge about these problems is essential to understand the mechanisms underlying age-related changes in visual function. Information about neuroanatomical changes in the visual system helps guide the development of strategies for compensating age-related deficits in visually-guided skills (Schieber, 1994). With the aging process, the gradual decline in the functioning of vision will affect performance of most daily visual tasks. Colour contrasts and colour combinations, with proper lighting, can make all the difference in the case of people, whose vision is impaired as a result of aging, reducing risks and increasing safety. The challenge will be to create environments that can help compensate for the most common types

of vision loss, improving the remaining vision with lighting and proper use of contrasts and colors.

AGED VISION AND COLOUR

With colour deficits due to normal ageing process, the ability to discriminate colors is reduced. The cornea remains clear but becomes thicker and more likely to scatter light. The yellowing of the lens, the progressive opacity and loss of transparency are the most important causes of decreased visual performance of the aging eye. The problems of aged vision, other than these anatomic changes are: loss of focusing capability “presbyopia” (incapacity of see correctly near objects, but can be corrected with glasses or lens); the diameter of pupil becomes smaller “senile miosis”; decreased visual field and depth perception; decreased visual acuity; loss of central vision; difficulties with light-dark adaptation; increased sensitivity to glare, dazzle with the brilliance; loss of contrast sensitivity, means they need sharper contrasts and sharper edges to discriminate between objects; reduced ability to discriminate colors, mostly blues and greens, because the yellowing of the lens causes a selective absorption of short wavelength light. Blue colour may appear dark and hard to distinguish from green, because the yellowish elderly lens absorbs blue light selectively.

With aging, other problems may interfere with vision and the ability to perceive colors by older adults: cataracts, ageing related macular degeneration, glaucoma, diabetic retinopathy and retinitis pigmentosa. As a consequence, colour vision, night vision, visual quality and lighting entering the eye decrease in this group; a 60 years old person receives only about 40% of the same amount of available light received by one of 20 years of age. The aging lens also scatters more light as one ages, adding a “luminous veil” over images on the retina, which reduces the distinctness (or contrast), sharpness of objects and the vividness of colors; colour perception improves after cataract surgery, “and most patients notice a brightening of colors at the blue end of the spectrum” (Marmor, 2007). Most people aged between 65 and 69 years (70%) sooner or later will develop a cataract; the percentage rises to 100% at 90 years, which means that studying vision of the elderly is to study vision with cataracts (Ikeda, 2009). Aspects or symptoms of cataracts are: Blurry vision, colors that seem faded, glare-headlights, lamps or sunlight may seem too bright, see a halo around lights, problems with night vision.

Light, Colour and Contrast

Light is essential for the perception of colour. The visual senses of human beings work with three dimensions in order to perceive space. Knowledge of light and colour interaction is the base for the understanding of a room, and the person’s innate or learned experiences are important when trying to interpret the surroundings and its spatial properties. Light and colour are important parts within the physical environment and can be used to support this highly frail group of people Nordin (2012).

In optimal conditions of light, normal vision is good. Under dim lighting or with changing levels of illumination, some individuals have difficulty to perform visual tasks. Increasing ambient light levels to about 50% more than is comfortable for a young, will increase vision. More light is required, because less light reaches the retina due to senil miosis. Aged and visually impaired people and some who are not recognized as visually impaired, may be unable to perceive some or all colors; however, they can perceive light and dark and since this is also a feature of colored surfaces their appearance can be influenced by the nature of the lighting condition. The large range of artificial light sources available have individual colour rendering properties. Their selection should be based on the need for colour recognition in the interior as well as energy efficiency. Where lamps with improved colour rendering are used then it is likely that all observers, including visually impaired people, may be more able to perceive contrast differences.

Some research from Reading University has shown that although there is some knowledge in medical areas about how perception of color is affected by eye problems such as macular degeneration, cataracts, glaucoma, retinitis pigmentosa (affecting about 80% of the population in the United UK), very little of this knowledge has been associated with the decisions taken within the building and architecture (Bright, Cook and Harris, n.d.).
Findings from Project Rainbow from same University (1997), suggest that visually impaired people can determine colour difference but there are areas where difficulties exist, mainly in differentiating blue toned green from green toned blue of similar lightness and chroma. Due to the declining vision following old age, very dark colors should not be situated next to each other since they seem to be difficult to distinguish, and the same goes for very light colors. Since colour preferences remain more or less stable throughout life and since colour and colour design are

highly appreciated among most people it is indicated that the colour scheme ought to take a greater advantage of this than is common today Wijk (2012).
Contrast and Glare sensitivity - Most of older individuals with loss of contrast sensitivity have more difficulty to see in dim light conditions, and they need sharper contrasts and sharper edges to discriminate between objects. They feel visual discomfort under bright light conditions, or at night with oncoming headlights. It's important to use colour contrasts to increase visibility, and a conscious colour scheme to make the environment attractive and safe for the elderly. Wijk (2012), propose a more frequent use of contrasting colors in order to accomplish visual distinction in the environment, to support depth and spatial perception and to simplify object recognition. In addition neutral colors and lack of contrast minimise attention contrary to strong colour cues, which seems to attract attention.

DESIGN PRACTICE

Interior and exterior environments

Visually comfortable environments, where *seeing well* is one effortless task, helps preserve sense of competence and independence of older people, improving their quality of life.

Good lighting can make the difference between seeing and not seeing for older adults with poor vision and between comfort and discomfort. Caregivers, allied medical professionals, and service providers can improve the quality of life of older people by recommending good lighting to mitigate some of the common problems associated with aging eyes (Figuero, 2001).

- Light colors on the walls and ceilings reflect more light in an indoor space, which is often useful. Doors, floors and furniture should have darker tones to contrast with the walls.

- The use of plain colors and matte finishes help prevent dazzle, reflections and glare. - Colors in contrasting shades are recommended to highlight furniture, equipment and potential dangerous objects and situations. A good color contrast can help locating emergency exits. Special attention should be given to location of mirrors to avoid confusion.

It is also suggested that colour could be used to attract attention of cues in the environment of the elderly. For example it is well known that orientation in the urban environment can be facilitated by way-finding cues, symbols and proper lighting to enhance visibility (Ulrich, 2006, apud Wijk 2012). Designers can help to compensate for these deficits by making colors differ more dramatically on the basis of all three characteristics- hue, lightness and saturation.

About lighting requirements

A good light pattern should be used. The illumination level throughout a building during the day and night should remain relatively constant. Should be given special attention to light position; for example, avoiding lights to eye level, because they can be blinding, even painful for people with specific ophthalmological problems.

- Should be used extra enlightenment to accentuate stairs, handrails, signage, lighting and important spots like phones; on the other hand, lighting levels should be uniform throughout the building.
- Always avoid creating situations of glare and brightness by adjusting the angle of lights, to direct the beam of light out of the eyes.
- Artificial lighting should be located so that we could avoid shadows or silhouettes. The same for bright light sources and windows, because sharp angle limits can produce relatively large and strong shadows.
- Matte finishes instead of glossy surfaces on walls, doors, furniture, handrails and floors can also help prevent glare and reflections. For example, if there is a window at the end of the corridor, the sunlight can make the floors look shiny and even wet. Glare can be mistaken for water on the floor that the person tries to step around.

Since many elderly lose some color sensitivity, good color-rendering lamps may enhance the color discrimination that remains. Incandescent lamps, including halogen, render colors very well. Many types of fluorescent lamps render colors nearly as well as incandescent lamps, and have much longer lives.

Graphic design and printing

Among all the visual design elements, graphics and texts are inseparable from colour performance. Aged people perceive less contrast between colors and perceived brightness is also different from people with normal vision. When selecting pairs of colors for typographic fonts and background, the contrasts of light against dark is preferable to emphasize the differences in hue or chromaticity. In other words, the lettering is perceived faster and more legible when there are substantial differences in brightness between letter colors and background colors. Thus, colors should be manipulated to maximize contrasts and facilitate perception. If we increase the contrast of brightness in a colour design project, it will increase its visibility.

Visocky O'Grady, (n.d.) recommends to accentuate the difference in 70% of brightness value between letter and background. Also Osborne (2005) refers to the same idea. The influence of contrast in reading is important not only because text of a wide range of contrasts is encountered in the environment but also because many ocular conditions lower the effective contrast of the reading stimulus. Most studies of the role of contrast in reading, however, have treated only the luminance dimension. In general, reading is found to be fastest when the luminance difference between text and background is maximal (Moreira da Silva, 2011).

In addition to biological changes, the differences in cognitive ability are also closely associated with aging. Heyl and Wahl (2003, apud Pettigrew, 2004) postulate that aging of the central nervous system, results in deterioration of the neural pathways to the brain, causing a slower cognitive processes including processing of visual stimuli. The ability of attention also decreases with age, meaning that cognitive processing becomes more demanding. It becomes more difficult to memorize new informations, especially if they conflict with other previously learned; nevertheless older people are able to conveniently process information if they are given enough time for that. Changes in visual acuity and cognitive processing related with age result in a need to modify presentation of texts, to maximize understanding by older people. The typographic characters should be slightly larger but not too large (Braus 1995, apud Pettigrew, 2004). We can't separate the chromatic relations from other aspects that contribute to effective communication, such as typographic composition, texts, shapes, proportions and scale of all elements that constitute the graphic design object. If one of the issues fails, the readability and the legibility get compromised. Printings in matte paper instead of glossy, presented in environments with minimal glare will improve readability and legibility (Braus 1995; Spotts and Schewe, 1989 apud Pettigrew, 2004).

CONCLUSIONS

The effective communication, legibility, readability and visibility of prints will depend not only of colour combinations, but on the interaction of many other factors such as: shape and design of typefaces, size type, the *x-height*, spaces between letters (kerning), words (tracking), lines (leading), colors and contrasts between text and background, page layout, form and weight of text, avoiding confusions between letters and numbers, reading distance, lighting conditions, surface of printing paper.

As we were studying legibility concepts and colour contrasts, we always had the aim to contribute with some principles to projectual practice. When including people who might normally be ignored in the design process, design objects interior spaces, urban environments, products, signage and all kinds of visually information will be effective and easier to read, not only for visually impaired people but also for all of us.

These areas of knowledge will improve the design process and contribute for an inclusive and efficient design practice. So, bringing to projectual practice this knowledge, i.e., aplying principles of visual ergonomics, we can help people to improve their quality of life, moving safely in urban environments, living comfortably on interior spaces, and reading all the visual printed information with minimum effort.

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