Colour, Typography and Aged Vision: An Inclusive Design approach

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ABSTRACT
This paper presents a PhD Research Project - Visual Communication and Inclusive Design: Colour, Legibility and Aged Vision, developed at FAULTL, Lisbon. The research aimed to determine specific design principles to be applied to visual communication design (printed) objects, in order they could be easily read and perceived by all. We overlapped different areas of study such as colour, vision, typography and legibility in an inclusive design perspective, bringing the knowledge to the design community, in an accessible and simple language. When designers apply colour to visual communication design projects, they must assume that the anatomic changes occurred in the normal aging process, vision loss, and deficient colour perception of older people must be taken into account. This study target group consisted on a selection of socially active individuals aged between 67 and 77 years. We developed a qualitative mixed methodology, using Focus Groups and direct observation. In the end, it was produced a manual with guidelines and recommendations to be applied to visual communication design printed objects, in order to improve the design process and to contribute for a conscious, informed, inclusive and efficient design projectual practice.

1. INTRODUCTION
In this study we have overlapped the knowledge about colour, aged vision, typography and legibility in an inclusive design perspective. We defend a less intuitive approach to colour application, and design projects based on scientific knowledge in all these selected areas of study.

Colour is a tool that communicates in a different way from typography or images; has the function to focus attention, creates contrasts, and helps objects to become understood and memorable. Colour conveys messages, has symbolic content, causes emotional reactions and enlivens our perception of surrounding environments. Colour communicates, attracts attention, informs, highlights, signals, identifies and symbolizes. Colour belongs to the structure of the visual message, taking part in their language and communication process. The language of colour derives from the physical process of light energy, which is transformed into a visual perceptual process in order to have communication.

In this study we've focused only on the perceptual aspects of colour and readability of texts. When designers apply colour on design projects, they must assume that knowledge about vision, colour vision, perception, interaction and harmony of colours, chromatic contrasts, psycho physiological reactions, symbolism, psychology, and semiotics of colour should always be present on the design process. But knowledge about vision, vision loss and deficient colour perception of older people must be introduced in the design projectual practice. So, Inclusive Design, should help people and communities to prepare themselves for future, as well as should improve quality of life in the present. Designers need to create envi-
environments and objects that are easier on everyone's eyes with or without visual impairments.

1.1 Colour and Aged Vision

The aging process is characterized by progressive and multiple acquisitions of minor deficiencies, predominantly related to vision, hearing, dexterity, mobility and cognition, which can lead to high levels of disability and dependency. The aging process includes physical degeneration, with a reduction of the overall physical condition, 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).

The aging lens and cornea causes glare by light scattering, especially for shorter wavelengths; the yellowing of the lens causes a selective absorption of short wavelength light (blues and greens), and becomes increasingly dense. Blue colour may appear dark and hard to distinguish from green, because the yellowish elderly lens absorbs blue light selectively; the colour perception improves after cataract surgery, "and most patients notice a brightening of colours at the blue end of the spectrum" (Marmor, 2007). Most people (70%), aged between 65 and 69 years, sooner or later will develop a cataract; the percentage rises to 100% at 90 years, which means that studying the vision of the elderly is to study vision with cataracts (Ikeda, 2009).

The fog or blurring of the lens, besides affecting colour perception of objects also decreases its saturation; this aspect has been neglected in the research of colour perception of the elderly, by the tendency to consider only the colour of yellowed lens (Ikeda, 2009).

![Figure 1: The superior range of colours in these examples shows the difference between colour perception of normal and aged vision. ©Jill Morton.](image)

Although retinal stimulus and neural signals are strongly affected by age related changes (such as the reduction of pupil size, density of the lens, reduction of photon absorption efficiency of cones and losses of retinal ganglion cells), colour appearance is stable throughout the life-span. There is, however, a loss of sensitivity in colour discrimination; although colour appearance changes little with age, the ability to discriminate colours is significantly reduced with age under certain conditions Shinomori (2005).

As colour vision, the contrast sensitivity is affected in the aging process. "Two colours that contrast sharply to someone with normal vision may be far less distinguishable to someone with a visual disorder. It is important to appreciate that it is the contrast of colours one against another that makes them more or less discernible rather than the individual colours themselves" (Arditi 1999).

As Greem Arntyte points out (2009), further studies will be needed to establish more precise legibility scores for different colour combinations; his article called "Hues that dis-
appear”, describes the influence of the phenomenon on legibility, which has implications for designers, that should be wary of acting on assumptions, take note of the phenomenon of and consider the different ways in which colours can be manipulated to improve legibility.

In the same way, type design can improve legibility. Many studies have defined letter groups as more or less legible; although the structure and shape of the letters are important in the recognition, there are details in the design that can minimize confusion among them, especially if they are read under poor visibility conditions.

![Comparison between Helvetica (orange) and Wayfinding Sans Pro (blue)](image)

*Figure 2: Comparison between Helvetica (orange) and Wayfinding Sans Pro (blue) (Pinheiro 2012).*

We can summarize the main changes in vision with the aging process: loss of focusing ability (presbyopia), senile miosis, decreased visual field, decreased visual acuity, loss of central vision, difficulties with the light-dark adaptation, increased sensitivity to glare and dazzle with the brilliance, decrease in contrast sensitivity, depth perception and reduced ability to discriminate colors. Other problems may interfere with vision and the ability to perceive colors: these are Cataracts, Ageing Related Macular Degeneration, Glaucoma, Diabetic retinopathy and Retinitis pigmentosa, as the most frequent situations among older adults.

2. METHOD

This project was developed using a qualitative mixed methodology. After the literature review, we started an active research using posters of different sizes, from cultural events, as a pretext for the study and as observation objects. The information was summarized in identification forms, previously designed by the author, with colour coding of text and background colours in CMYK, RGB and Pantone System; we used the Colour Munki Design colorimeter by Pantone to colours codification.

The second step of the research methodology was supported by the use of Focus Groups. The target group of this study consisted on a selection of socially active individuals aged between 67 and 77 years. To support the process of viewing and analyzing posters at different distances of observation, a tool in the form of worksheet was created for each observed poster. All the results were synthesized in charts and tables.

3. RESULTS AND DISCUSSION

As a result of this work, we produce a manual with guidelines to be applied in the design projectual practice, in the visual comunication design area. Among all the visual design elements, graphics and texts are inseparable from colour performance. We can’t separate the chromatic relations from other aspects that contribute to effective communication, such as the typographic composition, texts, shapes, proportions and scale of all the elements that constitute the graphic design object. If one of the issues fails the readability and legibility gets compromised.
4. 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), colours 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 and readability concepts and colour contrasts, we always had the aim and intent to bring inclusiveness to projectual practice. These areas of knowledge will improve the design process and contribute for an inclusive and efficient design practice. When principles of universal graphic design are applied, including people who might normally be ignored in the design process, printed design objects, (or 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.

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