Effects of Ageing on Atmosphere Perception

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Introduction

The advent of LED technology radically increased the potential of lighting for improving human well-being. Light of various colors and intensities can be created at any place and time, allowing a variety of decorative and ambience lighting effects. When combined with functional lighting, these effects can be used to create affective ambiences that can more easily address the needs of occupants in the room.

Lighting-based ambiences can be exploited to the benefit of the (growing) elderly population accommodated in care centers. Especially at the moment of relocation, elderly can experience anxiety, because they realize that they are in the last stage of their life, or sadness, because they miss family, friends or pets (Lee, Woo, & Mackenzie, 2002). Reducing these negative feelings through the action of positive ambiences in the room (e.g., a pleasant high arousing ambience to compensate sadness, and a pleasant low arousing ambience to decrease anxiety) could improve the elderly quality of life and might reduce the demands on the nursing staff. This solution has already been shown to have some potential for patients affected by dementia (Riemersma et al, 2008).

The first step towards our goal is to determine how elderly experience the affective meaning of ambiences. We refer here to this experience as atmosphere perception. Atmosphere differs from mood; it does not represent the affective state of a person, but rather the affective state of an environment (Vogels, 2008). As such, an atmosphere describes the potency of an ambience to change a person's mood. Independent of a person's affective state when entering a room with a specific atmosphere, the affective state of the ambience can be almost immediately recognized (Vogels, 2008). This atmosphere should have, on the longer term, a positive influence on the affective state of the people that are immersed in the ambience.

Ageing effects on the visual system can influence the experience of the ambience. The absolute sensitivity to light declines approximately threefold over the course of a lifetime, because of a reduction of the pupil size and increased lens absorption (Johnson, 2005). Also color perception declines from the age of twenty; especially the perception of short wavelengths (blue) are affected by age related effects as yellowing of the lens and the selective loss of short-wavelength sensitivity cones (Johnson, 2005). In line with these age related visual impairments, Knez and Kers (2000) found that older people judge the room illumination as less bright and as warmer compared to younger people, regardless of color temperature of the light.

Several researchers argue that different age groups have different attitudes towards colored lighting. Yildirim and colleagues (2007) revealed that older customers had more negative atmosphere perceptions of colored interiors. They argue that as age and experience increase, a more critical attitude is displayed. Also Knez and Kers (2000) argue that different age group share different conceptions about the indoor lighting.

For our purposes, we need to understand how elderly perceive the affective meaning of ambiences, and to do so we compare their atmosphere perceptions with that of younger people. We begin our research starting from ambiences created by light designers. Designers were asked to create two pleasant low arousing ambiences (i.e., cozy and relaxing) and two pleasant high arousing ambiences (i.e. activating and exciting) for a modern living room and with younger people

in mind (Seuntiëns & Vogels, 2008). By means of Vogels' Atmosphere questionnaire (2008) the ambiences are first evaluated by younger people to check the light designers' input. Thereafter, a group of elderly participants also evaluates the ambiences with the same methodology. We report here the results of this experiment, highlighting similarities and differences in atmosphere perception between elderly and younger people.

Experimental Design

Two separate experiments were conducted; one with younger participants and one with elderly. Both experiments had the same within-subject design; with the four ambiences (cozy, activating, relaxing and exciting) as independent variables and the scores of the Atmosphere questionnaire as dependent variables.

Our participants were immersed in the ambience and then asked to fill in the Atmosphere questionnaire. The questionnaire measures perceived atmosphere on four dimensions: coziness, liveliness, detachment, and tenseness. It uses seven-point Likert scales, ranging from totally not applicable (-3) to totally applicable (3). Participants were asked to base their scores on the atmosphere of the complete room. The ambiences were shown for as long as it took the participants to rate them and were randomized between participants, with a neutral ambience in between. On average, it took the participants around four minutes to complete the questionnaire.

Participants

In the first experiment fifteen participants were involved (8 females and 7 males), aged between 19 and 30 years. In the second experiment twenty-one elderly participated; 12 females and 9 males. Their age ranged between 65 and 88 years. All participants were native Dutch speakers and had no colorblindness.

Experimental room

The experimental room was located at the Philips ExperienceLab and furnished as a living room. The room size was 6x4x3 meters. The color of the walls was white and

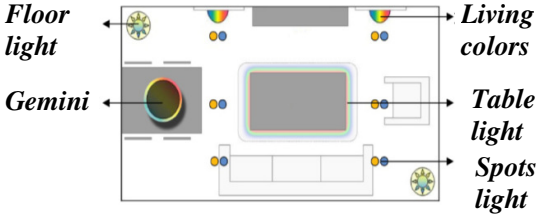

Fig. 1: An overview of the installed luminaires in the experimental room

the ceiling had an off-white (i.e. ivory white) color. The floor consisted of dark grey carpet patches. The windows were blinded from the outside in order to prevent influences of natural light during the experiments. On the inside, the windows were covered by low chromatic curtains. Furthermore, a black coffee table, white sofa and a white chair were set around the center of the room. Underneath the coffee table an off-white carpet was placed, and a black television cabinet with a black 42" television was placed on the wall against the sofa. Finally, a black dinner table with four chairs was placed against the wall on the left-hand side of the sofa.

Installed luminaires

Figure 1 gives an overview of the luminaires installed in the experimental room. Functional white lighting was provided by two cylindrical floor lights consisting of four fluorescent lamps; two lamps with a warm white color temperature (CT) of 2700K (Philips Master TL5 HE 28W/827) and two lamps with a cold white CT of 6500K (Philips Master TL5 HE 28W/865 lamps). Accent white lighting was provided by six pairs of halogen spot lights; each pair consisted of one spot with a warm white CT of 3000K (Philips HR Dichroic 50W GU5.3 12V 36D) and one spot with a cool white CT of 4700K (Philips Diamondline 50W GU5.3 12V 36D 1CT).

Decorative lighting was provided by three Philips Living Color lamps. Two were placed on each side of the television cabinet and one in the lower left corner. A table light consisting of red, green and blue LED strips was mounted underneath the coffee table and illuminated the floor underneath the coffee table. Finally, a Gemini table lamp,

consisting of red, green and blue LEDs illuminated the ceiling above the dinner table.

Stimuli

Four different ambiances were created by light designers reflecting a cozy, relaxing, activating and exciting ambiance (see Figure 2). For details on the light characteristic of the four ambiences see Table 1 and (Seuntiëns & Vogels, 2008).

Table 1:The illuminance level, color temperature and the use of hues in the ambiences

Ambience	Illum [lx]	CT [K]	Hue pairs
Cozy	Low	2700	Orange, blue
Activating	High	4000	Cyan, blue
Relaxing	Low	2700	Green, blue
Exciting	High	4000	Random colors
Neutral	Medium	3400	Only white

Results

Quantitative data

The inter-rater reliabilities were determined by computing Cronbach's alpha for each atmosphere dimension.

For both groups of participants we obtained acceptable to good reliabilities (values ranging between .67 and .89 for elderly, values ranging between .75 and .89 for younger participants).

Figure 3 presents the average atmosphere scores on the four ambiences for both the younger people and the elderly; separated for each of the four atmosphere dimensions.

For the younger people the 'cozy' ambience received the highest coziness scores, followed by the 'relaxing' ambience. The 'activating' and 'exciting' ambiences received the lowest coziness scores. The Wilcoxon signed-rank test on the coziness dimension revealed a significant difference between the 'cozy' ambience and the three other ambiences: 'relaxing' (z=-3.02, p=.003), 'activating' (z=-3.35, p=.001), and 'exciting' (z=-3.42, p=.001). In addition, also the difference between the 'relaxing' ambience and both the 'activating' (z=-2.50, p=.012) and 'exciting' (z=-2.11, p=.035) ambience was significant for the coziness dimension. For the elderly the 'cozy' ambience received the highest coziness scores in line with the results of the younger

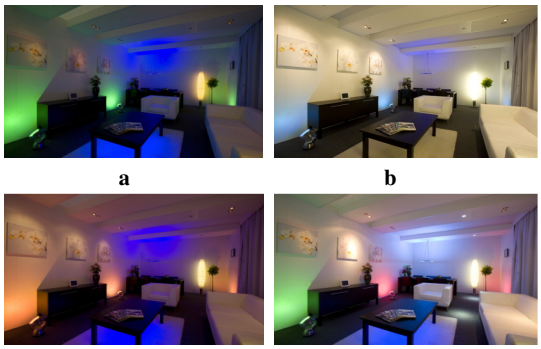

Fig. 2: Ambiances created by light designers; reflecting a relaxing (a), activating (b), cozy (c) and exciting (d) ambiance

people, but the scores were just above neutral. Only the differences between the 'cozy' ambience and both the 'relaxing' (z=-2.44, p=.015) and 'exciting' (z=-2.58, p=.010) ambience were significant for the coziness dimension assessed by the elderly.

Both the 'activating' and 'exciting' ambiences were scored high on liveliness by the younger participants; the 'cozy' and 'relaxing' ambience received low liveliness scores. For the liveliness dimension a significant difference was found between the 'activating' ambience and both the 'relaxing' (z=-3.01, p=.003) and 'cozy' ambience (z=-2.98, p=.003). Furthermore, a significant difference between the 'exciting' ambience and both the 'relaxing' (z=-3.21, p=.001) and 'cozy' (z=-2.48, p=.013) ambience was found.

Similar results were found for the elderly; the 'activating' ambience received the highest liveliness scores followed by the 'exciting' ambience. The scores were however lower than those obtained by the younger people. The 'activating' ambience was rated significantly different from both the 'cozy' (z=-2.77, p=.006) and 'relaxing' (z=-2.94, p=.003) ambience on the liveliness dimension. Also the liveliness of the 'exciting' ambience was scored significantly different from both the 'cozy' (z=-2.33, p=.020) and 'relaxing' (z=-2.16, p=.031) ambience.

All four ambiences were scored below neutral on the tenseness dimension by the younger participants; the exciting ambience received the highest scores. Only the

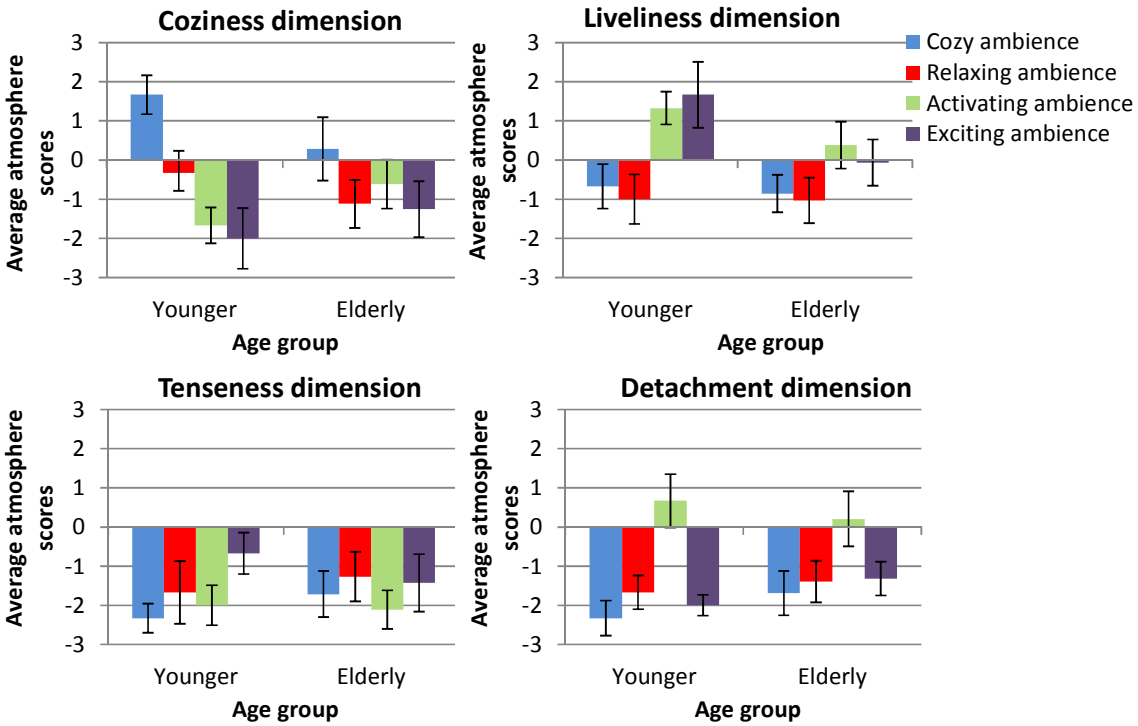

Figure 3. Average atmosphere scores on the four ambiences for both age groups separated for the four atmosphere dimensions

difference between the 'exciting' ambience and both the 'cozy' (z=-3.31, p=.001) and 'activating' (z=-2.29, p=.022) ambience were significant.

Also for the elderly all ambiences were scored below neutral on tenseness. No significant differences were found.

The activating ambience received the highest detachment scores from both age groups. The analysis revealed a significant difference between the 'activating' ambience and three other ambiences for both younger people: 'cozy' (z=-3.30, p=.001), 'relaxing' (z=-3.17, p=.002), and 'exciting' (z=-3.31, p=.001), and elderly: 'cozy' (z=-3.55, p < .001) 'relaxing' (z=- 3.01, p=.003), and 'exciting' (z=-3.30, p=.001).

Significant differences between the scores of the younger people and the elderly were investigated with the Mann-Whitney test. The coziness scores for the 'cozy' ambience were significantly different between the younger and elderly participants (z=-2.11, p=.035). For the exciting ambience a significant difference was found between the scores on the liveliness dimension (z=-2.36, p=.018). All other differences were found to be non-significant.

Qualitative data

After the experiment, the elderly were allowed to comment on the ambiences presented. Most elderly reported that the 'relaxing' ambience was too dark and they disliked the green blue color combination. Several elderly commented that the use of different colors in the 'cozy' and 'relaxing' ambiences gave them a restless feeling. Also the blue light above the table in both ambiences was perceived as cold and uncomfortable. Another remark of the elderly concerned the 'exciting' ambience; they found the ambience to be unsuited for the elderly population.

Discussion

The ambiences, with the exception of the relaxing ambience, were well recognized by the younger people. The 'cozy' ambience received high scores on the coziness dimension, while the 'activating' and 'exciting' ambience received high liveliness scores.

The ambiences were, however, less well recognized by the elderly population. The 'cozy' ambience received the highest coziness scores; the scores were however just

above neutral and significantly lower than the scores of the younger participants. The liveliness scores of both the 'activating' and 'exciting' ambience were lower compared to those of the younger people; for the 'exciting' ambience this difference was found to be significant.

The qualitative data gave some insights why the ambiences were less well recognized by the elderly. The relaxing ambience was perceived as too dark. This might be caused by a decline in the sensitivity to light in the elderly population (Johnson, 2005). Also the use of more than one color in the relaxing, cozy and especially in the exciting ambience was perceived as restless and unsuited for the elderly population. This conclusion is in line with Knez and Kers (2000), who found that different age groups have different conceptions about the room light, and with the findings of Yildirim et al. (2007), who showed that older customers have more negative atmosphere perceptions of colorful interiors. Determining the reasons behind this discrepancy and precise design guidelines for the design of lighting atmospheres for elderly are still open research topics and will be addressed in future research.

References

Johnson, M. L. (Ed.). (2005). *The Cambridge Handbook of Age and Ageing*. New York: Cambridge University Press.

Knez, I., & Kers, C. (2000). Effects of indoor lighting, gender, and age on mood and cognitive performance. *Environment and Behavior, 32*(6), 817-831.

Lee, D. T. F., Woo, J., & Mackenzie, A. E. (2002). A review of older people's experiences with residential care placement. *Journal of Advanced Nursing, 37*(1), 19-27.

Riemersma-van der Lek R. F., Swaab D. F., Twisk J., Hol E. M., Hoogendijk W. G, Van Someren E. W. Effect of Bright Light and Melatonin on Cognitive and Noncognitive Function in Elderly Residents of Group Care Facilities: A Randomized Controlled Trial. JAMA. 2008;299(22):2642-2655.

Seuntiëns, P. J. H., & Vogels, I. M. L. C. (2008). Atmosphere creation: Atmosphere and light characteristics *Internal report*. Eindhoven: Philips Research.

Vogels, I. M. L. C. (2008). Atmoshere metrics. In *Probing Experiece: From Assessment of User Emotions and Behaviour to Development of Products* (Vol. Philips Research Book Series). The Netherlands: Springer.

Yildirim, K., Akalin-Baskaya, A., & Hidayetoglu, M. L. (2007). Effects of indoor color on mood and cognitive performance. *Building and Environment, 42*, 3233-3240.