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Color preferences for four different types of spaces

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Keywords
color preferences, space, personal characteristics, consciousness, white

Abstract

Purpose - Studies on color preferences for different types of spaces are scarce and show ambiguous results. This paper presents data about preferred colors for two work environments: the office and a meeting room, and two residential spaces: the living room and the bed room. Furthermore correlations are explored with personal characteristics such as gender, age and education, and type of person, and what factors might explain different color preferences.
Method - The data were collected by means of a questionnaire that was distributed among 1077 Dutch persons.
Findings - The color white was most frequently mentioned as the preferred color, by 32-44% of all male respondents and 28-38% of all female respondents, dependent on type of space. The choice 'no color preference' rated high as well: by men 11-22%, by women 7-22%. Significant correlations were found between preferred colors for different types of spaces and gender, age, education and type of person.
Research limitations - Only Dutch people completed the questionnaires. Due to the many influencing factors, only a selection of the conceptual model could be empirically tested.
Practical implications - Information about color preferences for different types of spaces can support clients, end users and (interior) architects to create environments that people like, which may influence peoples' wellbeing in a positive way. It is suggested to apply colors in the built environment more like nature shows.
Originality/value - Up till now, no information was available   about color preferences for different types of spaces in connection to different types of persons.
Type of paper - Research paper.

Introduction

People have various color preferences. Next to a general favorite color without any connection to a particular topic, many individuals prefer a particular color for clothes (Kundel, 1976; Radeloff, 1991; Lind, 1993; Schloss et al, 2012), toys (Jadva et al, 2010) and products such as cars (Schloss, 2012; Holmes and Buchanan, 1984; Funk and Ndubisi, 2006, Hanss, 2012). Because people spend much time in buildings, it is interesting and relevant to know whether individuals have different color preferences for different types of spaces, and their preferred color per type of space. Knowledge about preferred colors for different rooms could be helpful for architects and designers to match their design with user preferences. Previous research showed that individuals are not always aware of the characteristics of the physical environment (Schneider, 1987; Dijksterhuis, 2007). Often they do not know on a conscious level which colors are applied or which furnishing and decoration exactly is present in the room (Weinberg, 1922, Bakker et al, 2013). At a conscious level, many individuals

respond that color is not important. Other environmental cues get higher scores on level of importance, such as air quality and temperature (Bakker et al, 2013a, 2013b). Dul et al (2007) showed that respondents find the application of inspiring colors not very relevant. However, this does not mean that color has no impact on peoples' appraisal of the built environment, behavior, performance or wellbeing.

Individuals look for a matching atmosphere for a particular space (Manav, 2007; de Destefani and Whitfield, 2008). Because colors have an affective meaning the chosen colors contribute to the atmosphere of a particular place (Guilford, 1934, Hofstätter and Lübbert, 1958, Adams and Osgood, 1973). As a consequence it is expected that color preferences for particular spaces are directly related to the desired atmosphere and that color plays an essential role in the perceived quality of the built environment (Schneider, 1987; Weinberg, 1922; Bellizzi et al, 1983; Bellizzi and Hite, 1992; Crowley, 1993; Turley and Milliman, 2000). This assumption is confirmed by Countryman and Jang (2006), who investigated which aspects of the built environment influence the overall atmosphere of a hotel lobby. Their study showed that in comparison to lighting, layout, furnishing and style, color showed to be most important in the evaluation of the atmosphere. In a study by Bakker et al (2013a) the appraisal of a meeting room during the meeting itself was correlated most strongly with the appraisal of the wall color and lowest with air quality and temperature. However, when the respondents were asked again to give their opinion a couple of days after the test, being at their own workplace, subjects rated the importance of air quality and temperature highest and color lower than during the test. Apparently consciously responding to a color questionnaire during a test results in different responses than responding to a former situation in current work circumstances.

Because color plays a prominent role in creating a particular atmosphere, and responses to colors showed to be ambivalent, it was decided to further explore color preferences for different types of places. The next section of this paper presents the findings from a literature review on former research into color preferences for different spaces. These findings are summarized and visualized in a conceptual model. The third section presents the research findings from a survey into the color preferences of 1077 Dutch respondents, to test parts of this conceptual model. The paper ends with the overall conclusions and a discussion with reflections on the findings and practical implications.

Findings from former research into color preferences for different types of places

Nature
Because man is part of nature and throughout our evolution nature is our teacher (Kaplan, 1995; Kaplan and Kaplan, 1989; Fjeld, 2000; Van den Berg, 2007), color preferences partly depend on the appearances of color in nature (Miller and Schlitt, 1985; Scott, 1993). Researchers such as Humphrey (1976), Janssens (2001) and Palmer and Schloss (2010) suggest that color preferences have an innate character. By means of the mirror neurons that were discovered in 1996 persons mirror themselves continuously to their environment (Oberman et al, 2007). As such persons and their physical environment continuously interact. How color appears in nature may influence how individuals perceive color and their color preferences in other environments as well. People also connect different colors to different meanings. Blue is associated with the ocean and the sky and stands for openness and tranquility (Mahnke, 1996; Mehta and Zhu, 2009). Brown is the color of earth and is associated with stability, safety and earthy (Mahnke, 1996). Regarding color preferences for the

physical environment, Mahnke supposed blue to be connected to spaces that require a soothing atmosphere, and brown to the floor and to a lesser extent to the ceiling.

Culture and time spirit
In spaces one can observe that colors are applied according to cultural norms and habits (Gage, 1995). The Netherlands have their typical brown pubs, Sweden their wooden cottages and barns that are often painted in typical red falu (Fridel Anter, 2000). Individuals are accustomed to these phenomena, which may influence their color preferences for the physical environment. Not surprisingly, many researchers found color preferences to be depending on culture (Janssens, 2001; Choungourian, 1968; Saito, 1996; Madden et al, 2000; Park and Guerin, 2002; Baniani and Yamamoto, 2014). Time dependency was also found regarding trends in color preferences (Janssens, 2001; Birren, 1955) and time related construction and interior design styles (Slatter and Whitfield, 1977).

Context
Within the same culture and time, different color applications can be found depending on the context: in a neighborhood with bright colored exteriors of Victorian houses a pink colored front door may be acceptable, whereas the same pink color will not be accepted in a suburban community (Sivik, 1974). According to Janssens (2001), regarding color preferences the relationship between the colored facade of buildings and its surroundings is more important than the color itself. In addition Hårleman (2012) indicated that the environment is experienced as a whole. The same counts for products. Minato (1977) showed the risks of applying context-free chips such as colored cards to establish the color preferences for products and also indicated the importance of totality. The perception of colors is not only dependent on the overall image but also on variables such as the changing daylight. In sunlight all colors seem to be more chromatic whereas in sky light pale yellow looks less yellow and greenish blue changes towards elementary blue (Hårleman, 2012). Taft (1997) investigated color preferences by presenting colored chips and colored objects, which were rated differently. He also showed that the impact of context varies per color.

Personal characteristics and type of person
Color preferences for different physical spaces depend on personal characteristics such as age (Bakker et al, 2013c; Huang and Xu, 2009), gender (Bakker et al, 2013c; Huang and Xu, 2009; McManus et al, 1982; Hurlbert and Ling, 2007), type of person e.g. being a soloist or being rational or more emotional (Bakker et al., 2013c), personality (Götz and Götz, 1975; Rosenbloom, 2006), family income (Huang and Xu, 2009) and life style (Saito, 1996). Stalker (1956) also showed differences in color preferences depending on the price of a home and thus probably of income. Birren (1955) explains this phenomenon due to the fact that high-income persons have more freedom to choose, whereas low-income persons are more bound to current styles and trends.

Learnt associations and personal experiences
Because individuals do not primarily search for a particular color in a room, but mainly strive to create a nice atmosphere (Manav, 2007) they focus primarily on a color that evokes this atmosphere. Learned associations play a role here as well and are reinforced by personal experiences. According to Manav (2007), persons prefer light colors for a calm space, and white to create a space that evokes a sense of hygiene and pureness. Color associations and color preferences may be affected by

physiological reactions on color that directly occur within the interference of the amygdala, the visual cortex and the reticular activation system in the brain stem (Bakker, 2014). Mahnke (1996) also refers to this influence in his color experience pyramid. In addition, color preferences are linked to colors of objects to which persons are accustomed (Davidoff, 1991).

Type of space
Slatter and Whitfield (1977) showed that color preferences also depend of the function of the space. Subjects preferred different colors for a living room and a bed room. Inui (1966, 1969) found different color preferences for a waiting room and wards in hospitals and the exterior of buildings such as hospitals or hotels. Stalker (1956) found that most residents preferred beige and brown for the living room and had a tendency to choose warm colors. Manav (2007) found light blue as the most frequently preferred color for the living room. This may be caused by the type of the light blue that he used in his test. In his paper the exact coding of the color is missing; looking at his pictures it appears like warm yellowish light blue. For the bedroom Manav found pink as the most frequently preferred color, which is associated with romanticism, enjoyment and warmness. Kaya and Epps (2004) found that the bed room is associated with red purple. In research by Stalker (1956) respondents preferred blue.

Different buildings and spaces evoke different associations as well. Kaya and Crosby (2006) asked 98 students about their color associations regarding ten types of buildings. For each presented picture of a building the respondents were asked to mark 1 out of 9 presented colors they think off when looking at this building. 71% of the students linked factory buildings to grey , 42% linked restaurants to red and 31% linked restaurants to green; 57% linked official buildings also to grey. Regarding housing 20% chose red and 22% chose blue. Apparently different functions evoke different color associations. This may have an impact on color preferences as individuals develop their color preferences related to appearances they are accustomed to.

Saturation, brightness and hue
Former studies showed that it is not the hue that is predominant for color preferences, but other aspects such as a low contrast (Birren, 1955, Goldstein and Goldstein, 1940) or the degree of saturation and brightness (Acking and Küller, 1972; Sivik, 1970). Camgöz et al (2002) showed that colors with the highest saturation and the highest brightness levels are most valued. Smets showed that saturation is the best predictor of pleasantness (explaining 88.4% of the variance of scores on pleasantness) followed by brightness (11.5%). Hue explained less than 1%. In addition Crozier (1996) found that variation in saturation significantly influenced the perceived pleasantness of colors. This phenomenon concerns not only European countries. Taylor et al (2013) showed the importance of saturation in a different population, inter alia among the Himba adults in rural Namibia.

Research methods
The methods used to measure color preferences influences the results (Norman and Scott, 1952). Sivik (1974) showed for instance that the color preferences for buildings in reality was beige and yellow and that the respondents disapproved the color violet, which was contradictory to the results when colored chips were presented. Taft (1997) also showed differences in semantic ratings of real objects and colored chips. In addition, the preferred degree of saturation and lightness is different for colored chips versus real life products such as cars (Schloss et al , 2012). Acking en Küller (1972)

found similar results when using drawings and colored slides. They doubt whether colored slides represent color experience in a real life situation. This shows that it is important to select appropriate test methods and to be careful to transfer conclusions based on tests in artificial settings to real life settings.

Figure 1 summarizes the mentioned influencing factors on color preferences for the built environment in a conceptual model.
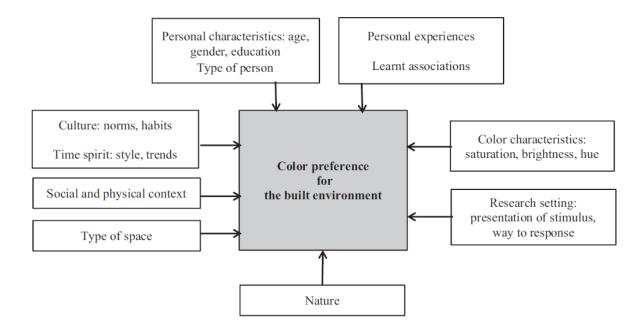

Figure 1: Influencing factors on color preferences for different physical environments

Empirical research: research questions, methods and findings

Research questions
This conceptual model shows that many factors may influence color preferences for the built environment. Because only a limited amount of literature focusses on color preferences for different types of spaces and no clear insight exists in preferred colors in connection to personal characteristics, type of person, and various other factors, a research study was conducted to get answers to two research questions:
1. What are the color preferences for different types of spaces?
2. Which factors may have influenced these color preferences?

Research methods
In order to improve our understanding of individual color preferences a questionnaire has been developed, based on the literature and additional experts' opinions. To completely test the conceptual model would require a very long and complex questionnaire that should be applied in different contexts. For this reason we focused on the impact of personal characteristics and type of person. In order to exclude the impact of the context in which the colors appear and specific color characteristics such as brightness, saturation and hue , the respondents subjects were asked to

complete a color preference questionnaire (see Figure 2) in which colors were presented in words, to mark their favorite color (not connected to a particular topic), to mark their preferred colors regarding four different rooms (two work environments i.e., the office and the meeting room, and two residential places i.e., the living room and the bed room) and clothing, , and to mark which colors evoke particular moods. In order to exclude the impact of (national) culture, only Dutch people filled out the questionnaire, as such representing a European western culture. In total 1095 people filled out the questionnaire. Eighteen subjects were excluded due to color blindness, leaving data of 1077 subjects to be analyzed. The respondents were asked to mark the name of the preferred color i.e. white, lilac, violet, dark blue, blue, light blue, turquois, green light green, yellow, orange, pink, red, dark red, brown, grey and black, or 'no preference'. Because it is the affective quality that individuals are looking for when choosing colors for their physical environment and color names are associated with these affective qualities, it is assumed that the color names represent the preferred color. The demographics include age, gender, and education level. The respondents were also asked to make clear what type of person they are by marking on a seven point 'Likert' scale whether they consider themselves to be technical, artistic, rational, emotional, a soloist, like to be alone, a team player, messy, tidy, happy, how strongly they prefer colors and if they require much light. Finally various other variables were included, such as the living area of the respondents and the type and size of the company where one works. The questionnaires were partly collected by email and partly distributed on-site after lectures at different higher education institutes. All data was processed using SPSS 16 to analyze the percentages of respondents that preferred particular colors and to explore significant correlations.

date:																	
personal characteristics *(please complete or mark)*		lives in the area *(please mark the right option)*															
date of birth:		NH		Limburg		Friesland											
gender	M/F	ZH		Gelderland		Groningen											
are you color blind	yes/no	Utrecht		Overijssel		Flevoland											
do you use eye correction (lenses/glasses)	yes/no	Nrd Brabant		Drenthe		Zeeland											

color preferences *(one cross per line)*	no preference	white	lilac	violet	dark blue	blue	light blue	turquoise	green	light green	yellow	orange	pink	red	dark red	brown	grey	black
what is your favourite color?																		
what is your favourite color for clothing?																		
what is your favourite color for the living room?																		
what is your favourite color for the bedroom?																		
what is your favourite color or the office?																		
what is your favourite color for the meeting room?																		
what is your favourite color combination (max. 3)																		

color and mood (one cross per line)	no preference	white	lilac	violet	dark blue	blue	light blue	turquoise	green	light green	yellow	orange	pink	red	dark red	brown	grey	black
what color makes you feel calm?																		
what color makes you feel energized?																		
what color helps you focus?																		
what color makes you most creative?																		

general questions *(one cross per line)*	not at all			average			very much								
	1	2	3	4	5	6	7	*(please mark the right option)*		
are you technical?								**school/education**	**work**	
are you artistic?								last received education	**type of company**	
are you rational?								primary school	government	
are you emotional?								level	semi public	
are you a soloist?								lower vocational	public	
do you like to be alone?								higher vocational	**size company**	
are you a team player?								university	1-3 persons	
are you messy?									4-9 persons	
are you tidy?									10-49 persons	
are you happy?									50-99 persons	
do you prefer many colors around you?									100-199 persons	
do you prefer much day or artificial light around you?									200 or more	

Figure 2: Research questionnaire used in this study

The findings on percentages of favorite colors in general, not connected to a particular object, and preferred colors for clothing have been published earlier (Bakker et al., 2013c) .The current paper focuses on color preferences for the office and the meeting room, the living room and the bedroom,

and the impact of personal characteristics, type of person, the living and work situation, and the need for (much) light.

Characteristics of the study sample
Table 1 shows the characteristics of the study sample. The numbers of men and women are nearly the same. The age range is mainly 19 to 65 years. Most subjects are educated at the higher vocational level and most subjects are working in a business environment.

Table 1: Characteristics of the study sample regarding gender, age, education and work situation

	Number	%
Gender		
male	548	51
female	524	49
missing	5	0
total	1077	100
Age		
till 18	11	1
19 till 25 incl.	279	26
26 till 35 incl.	185	17
36 till 45 incl.	228	21
46 till 55 incl.	204	19
56 till 65 incl.	111	10
66 and older	5	1
missing	54	5
total	1077	100

	Number	%
Education		
university level	262	24
higher vocational level	644	60
lower vocational level	164	15
missing	7	1
total	1077	100

	Number	%
Work environment		
government	164	15
semi-government	185	17
business	583	54
other	145	14
missing	0	0
Total	1077	100

Research findings: Color preferences for four types of places

Table 2 shows the percentages of preferred colors for the living room, the bedroom, the office, and meeting rooms. Table 3 and 4 present the most frequently preferred colors per type of space and significant relationships.

Table 2: Color preferences of females and males concerning four types of rooms, in percentages

	Office			Meeting room			Living room			Bed room		
	males	females	all	males	females	all	males	females	all	males	females	all
no preference	17	14	16	22	22	22	11	9	10	13	7	10
white	43	38	40	32	28	30	44	35	40	32	29	30
lilac	1	1	1	1	1	1	0	0	0	2	3	3
violet	2	2	2	1	1	1	3	2	2	3	4	4
dark blue	1	1	1	1	2	2	1	1	1	2	2	2
blue	3	7	5	5	4	4	2	1	1	3	4	4
light blue	4	6	5	7	5	6	1	0	1	5	5	5
turquoise	1	1	1	1	2	1	1	2	1	1	3	2
green	4	6	5	4	6	5	3	4	4	3	5	4
light green	4	5	5	4	8	6	2	4	3	3	3	3
yellow	4	7	6	5	5	5	5	4	4	7	4	6
orange	2	3	3	4	4	4	2	3	3	2	2	2
pink	0	1	0	0	0	0	0	1	0	1	3	2
red	3	2	2	3	3	3	4	6	5	6	7	7
dark red	1	1	1	2	2	2	4	5	5	5	5	5
brown	3	2	2	4	3	3	11	15	13	6	6	6
grey	5	4	4	5	3	4	5	6	6	4	5	4
black	1	0	1	1	0	1	1	1	1	1	1	1
Total	100	100	100	100	100	100	100	100	100	100	100	100

Table 3: Most frequently preferred colors per type of space

		office	meeting room	living room	bed room
males	1	white	white	white	white
	2	no preference	no preference	brown	no preference
	3	grey	light blue	no preference	yellow
females	1	white	white	white	white
	2	no preference	no preference	no preference	no preference
	3	blue/ yellow	light green	brown	red

For all four spaces, white shows to be most frequently preferred. Dependent on the function of the space, 32-44% of all male respondents prefer white, versus 28-38% of all women. For all four spaces, males prefer the color white a little more often than females. The color white was most preferred for offices by 43% of all male respondents and 38% of all female respondents. For the meeting room these percentages were 32 % and 28% respectively. Concerning the living room 44% of the male respondents and 36% of the female respondents chose white. Concerning the bed room the percentages were 32 % and 29% respectively. Only for the living room was a particular color – brown – substantially more often preferred than other colors, in particular by men. All other percentages regarding particular colors are quite low and no prominent preferred color came to the fore, apart from white. The percentage of 'no preference' is relatively high as well, both for males (11-22%) and females (7-22%). 'No color preference' ranks a striking second position, except for the living room, where brown gained the second position (overall sample: 12,7 %).

Significant individual differences
The color preferences for the four types of spaces were significantly related to gender concerning the bed room ($\chi2=40.76$, $p=0.001$, $\alpha=0.05$) and the office ($\chi2=28.81$; $p= 0.036$; $\alpha= 0.05$). Females are more concerned about the color and used the option 'no preference' less frequently. Regarding age a

significant correlation was found with preferred colors concerning the living room ($\chi 2$= 87.54; p= 0.000; α=0.05): the younger the respondent, the more respondents preferred brown. For the bedroom a significant difference was found as well ($\chi 2$= 101.83; p= 0.001; α=0.05): the higher the age the higher the percentages 'no preference'. Young persons (19 till 25 years) mostly marked red and dark red colors as the preferred color for the bed room. Concerning the office, there is also a significant relationship with age ($\chi 2$ office space = 49.47; p= 0.007; α=0.05): young persons (19 till 25) prefer more often a white office and marked 'no preference' less frequently. Concerning education significant relationships were found for the living room ($\chi 2$= 42.08; p= 0.000; α=0.05) and the meeting room ($\chi 2$ =35.41; p= 0.018; α=0.05). Regarding the living room the data showed that a higher education corresponds with a lower percentage of 'no preference'. In addition, the lower the education, the more persons prefer brown. Both for the living room and the meeting room subjects of university level more often choose yellow. Concerning the meeting room it was found that the higher the education level, the more subjects prefer white.

Table 4: Significant relationships

	office	meeting room	living room	bed room
gender	X			X
age	X		X	X
education		X	X	
Type of person	being artistic	being artistic	being a soloist	

In addition type of person plays a role. The color preferences for the office space (One Way ANOVA F=3.56; p= 0.001; α=0.05) and the meeting room (One Way ANOVA F= 2.23; p= 0.03; α=0.05) were statistically significantly different for subjects that perceive themselves more or less as 'being artistic'. For the living the color preferences were significantly correlated with yes or no 'being a soloist' (One Way ANOVA: F=3.37; p= 0.003; α=0.05). No significant correlations were found between color preferences and other types of person and with the living area, type of company and size of the company.

Females preferred significantly more color in their environment than males (One Way ANOVA: F=5.40; p= 0.02; α=0.05). Younger persons preferred more colors around them than older ones (One Way ANOVA: F=2,82; P= 0.010; α=0.05).

The preference for a colorful environment is compared with the preference for the amount of light in the rooms. About one out of four respondents (26%) prefer many or very many colors around them. Almost two third of the respondents (63%) like much or very much light %), more than twice as many respondents that like to be surrounded by many colors. Females preferred significantly more light than males (One Way ANOVA : F= 19,728; p=0,00; α-0,05).

Conclusion and discussion
The current study shows that white is the most frequently preferred color. This percentage ranges from 30-40%, dependent on the type of space and gender and – to a lesser extent – also on the type of person. Men and women don't differ very much: for men the percentages that prefer white range

from 32-44%, for women from 28-38%. Of all respondents, 10-22% did not mark any preference at all, dependent of the type of space; among men this percentage ranges from 11-22%, among women from 7-22%, so again almost an equal range. In particular the relatively high percentages of marking no particular color preference is remarkable, as this option is seldom mentioned in color preference research. For less private spaces such as offices and meeting rooms 15-22% of the overall sample marked "no preference". For more private spaces such as the living room and bedroom still a substantial percentage of the sample (10-12%) did not express any color preference. These findings correspond with the findings of Rice (1953), who found no color preferences for classrooms. A reason could be that people often experience their physical environment at an unconscious level and are less aware about the influences of color.

All other respondents marked a preference for a particular color. However, preferred colors show a huge variety. Apart from brown for the living room (preferred by 11% of all male respondents and 15% of all female respondents), no single color was preferred by more than 10% of the respondents, nor for the office and meeting rooms, nor for the living room and bedroom. The data confirm that the preferred color for different types of spaces depends on the personal characteristics as age, gender, education and on type of person.

There may be various reasons why such a remarkable high percentage of people prefer white, both for business environments such as the office and meeting rooms and for private environment such as the living room and the bed room. In earlier times of the old Greek and the old Hebrew, people were not focused on colors but primarily on the amount of light (Bakker, 2014). Yellow and blue were perceived as light and dark (Bakker, 2014). It was the light quantity that counted. It is possible that nowadays, too, persons focus on light, and for this reason prefer the color with the highest reflection, namely white. This explanation is supported by the high appreciation of the presence of (much) light and a much lower l appreciation of the presence of many colors. This phenomenon also came to the fore in the study of Kwallek et al. (1990) among 675 office workers, which showed that light colors such as white or beige are most frequently preferred for offices. In the BOSTI study of Brill et al. (1985) in which 1,000 employees were asked about their color preference, the preferred colors for walls in offices were low chroma colors such as light blue, light aqua green and off-white.

Another explanation for a rather high percentage of people that prefer white could be that people are not really interested in the color of the physical environment. They allocate a low value of importance to color (Bakker et al, 2013a).

A third reason may be that people are afraid to apply color because they are afraid to make the wrong decisions. Hellman (1952) indicates this lack of confidence. White is a more safe color and easy to apply in combination with colored attributes. Finally, habituation may play a role as well. Individuals are daily affected by their environment, partly due to the operation of the mirror neurons. In current environments they will be often confronted with the color white, and may tend to prefer the color they are accustomed to. At a conscious level, when people are asked about their color preferences by means of a questionnaire that make an appeal to cognitive capacities, the responses may be influenced by conditions they are accustomed to or by learnt color associations.

Practical implications

The frequently marked preference for white and the second ranked "no preference" does not mean that color is not relevant. Color has a profound impact on the atmosphere of a space. However, the huge diversity in preferred colors and the many influencing factors on preferred colors for each type of space such as personal characteristics, type of person, habit, learned associations, culture and context, makes it rather difficult to develop guidelines for color applications in the built environment to fit with individual preferences. Besides, a preference for a particular color does not mean that the whole space should be painted in that particular color. In private spaces people can make their own choices. In semi-private places such as work environments but also in leisure facilities, health care facilities of educational facilities, spaces are shared by many different people. Probably white and other light colors are most safe to apply, in combination with additional colors that do not dominate too much. Maybe we should try to learn more from nature. Every day nature shows sparkling and sensational but harmonious color combinations. It is widely acknowledged that nature positively influences human health (Van den Berg, 2007; Ulrich and Zimring, 2004). Finding inspiration in nature as a well-balanced tutor might be helpful to create more pleasant and harmonious colorful environments.

References

Acking, B. C., Küller, H. (1972). The perception of an interior as a function of its colour. *Ergonomics,* 15 (6), 645-654.

Adams, F.M., Osgood, C.E. (1973). A cross-cultural study of the affective meaning of color. *Journal of Cross-Cultural Research* 4(2): 135–156.

Bakker, I.C., van der Voordt , D.J.M., Vink, P. de Boon, J.(2013a). The use of questionnaires in colour research in real-life settings: in search of validity and methodological pitfalls. *Theoretical Issues in Ergonomics Science*, (ahead-of-print), 1-15. DOI: 10.1080/1463922X.2013.815287.

Bakker, I.C., van der Voordt , D.J.M., de Boon, J., Vink, P. (2013b). Red or blue meeting rooms: does it matter? The impact of colour on perceived productivity, social cohesion and wellbeing. *Facilities*, 31(1/2), 68-83.

Bakker, I., Voordt, T., Vink, P., Boon, J., Bazley, C. (2013c), Color preferences for different topics in connection to personal characteristics. *Color Research & Application*. Vol. 40 No. 1, 62-71.

Bakker, I.C., (2014). Uncovering the secrets of a productive work environment, A journey through the impact of plants and colour. PhD Thesis, Delft University of Technology.

Baniani, M., Yamamoto, S. (2014). A comparative study on correlation between personal background and interior color preference. *Color Research & Application,* DOI: 10.1002/col.21906.

Bellizzi, J. A., Crowley, A. E., Hasty, R. W. (1983). The effects of color in store design. *Journal of retailing.* Vol 59(1), 21-45.

Van der Voordt, T., Bakker, I., and De Boon, J. (2017) Colour preferences for four different types of spaces. *Facilities* 35(3/4), pp. 155-169. DOI: http://dx.doi.org/10.1108/F-06-2015-0043

Bellizzi, J. A., Hite, R. E. (1992). Environmental color, consumer feelings, and purchase likelihood*. Psychology & marketing,* 9(5), 347-363.

Birren, F. (1955). *New Horizons in Color*. New York: Reinhold.

Brill, M., Margulis, S.T., and Konar, E. (1985). BOSTI: *Using Office Design to Increase Productivity*. Vol. 2, Buffalo, New York.

Camgöz, N., Yener, C., & Güvenç, D. (2002). Effects of hue, saturation, and brightness on preference. *Color Research & Application*, 27(3), 199-207.

Choungourian, A. (1968). Color preferences and cultural variation. *Perceptual and Motor Skills*, 26(3c), 1203-1206.

Countryman, C. C., Jang, S. (2006). The effects of atmospheric elements on customer impression: the case of hotel lobbies. *International Journal of Contemporary Hospitality Management*, 18(7), 534-545.

Crowley, A. E. (1993). The two-dimensional impact of color on shopping. *Marketing letters*, 4(1), 59-69.

Crozier, W. R. (1996). The psychology of colour preferences. *Review of Progress in Coloration and Related Topics,* 26(1), 63-72

Davidoff, J. (1991). *Cognition through Color*, MIT Press, Cambridge.

de Destefani, L. R. G., Whitfield, T. W. (2008). Esthetic decision-making: How do people select colours for real settings? *Color Research & Application*,33(1), 55-60.

Dijksterhuis, A. (2007). *Het slimme onderbewuste, denken met gevoel*. Amsterdam: Uitgeverij Bert Bakker, 33, 53, 74–79, 95, 102.

Dul, J., Ceylan, C., Hendriks, H. (2007). A practical instrument to measure the creativity potential of the work environment; *Proceedings of the 10th European conference on Creativity and Innovation*, Copenhagen, Denmark.

Fridel Anter, K. (2000). *What colour is the red house? Perceived colour of painted facades.* KTH, Superseded Departments, School of Architecture, Uppsala University.

Funk, D., Ndubisi, N. O. (2006). Colour and product choice: a study of gender roles. *Management research news*, 29(1/2), 41-52.

Gage, J. (1995), *Colour and Culture* in Lamb T., Colour: Art and Science, Cambridge University Press 188-189.

Goldstein, H., Goldstein, V.(1940). *Art in Everyday Life.* Third edition. New York: Macmillan Company.

Götz, K. O., Götz, K. (1975). Colour preferences, extraversion, and neuroticism of art students. *Perceptual and Motor Skills*, 1975, *41*, 919–930.

Guilford, J.P.(1934). The affective value of color as a function of hue, tint, and chroma. *Journal of Experimental Psychology* 17(3):342–370.

Hanss, D., Böhm, G., Pfister, H. R. (2012). Active red sports car and relaxed purple–blue van: affective qualities predict color appropriateness for car types. *Journal of Consumer Behaviour,* 11(5), 368-380.

Hårleman, M. (2012). Study of colour shifts in various daylights: Dominantly reddish and greenish rooms illuminated by sunlight and skylight. *JAIC-Journal of the International Colour Association*, 1.

Hellman, G.T. (1952). Profiles - An Emolument for Heliotrope. *The New Yorker*, 39-50.

Hofstätter, P.R, Lübbert, H. (1958). Eindrucksqualitäten von Farben. *Zeitschrift für Diagnostische Psychologie und Persönlichkeitsforschung* 6: 211–227.

Holmes, C.B., Buchanan, J.A. (1984). Color preference as a function of the object described. *Bulletin of the Psychonomic Society* 22(5): 423–425.

Van der Voordt, T., Bakker, I., and De Boon, J. (2017) Colour preferences for four different types of spaces. *Facilities* 35(3/4), pp. 155-169. DOI: http://dx.doi.org/10.1108/F-06-2015-0043

Huang, W., Xu, W. (2009). Interior Color Preference Investigation Using Interactive Genetic Algorithm. *Journal of Asian Architecture and Building Engineering*, 8(2), 439-445.

Humphrey, N.K. (1976) in Colour in Architectitrc. Eds Porter, T. and Mikellides, B. (London: StudioVista, 1976) in Crozier, W. R. (1996). The psychology of colour preferences. *Review of Progress in Coloration and Related Topics,* 26(1), 63-72.

Hurlbert, A. C., Ling, Y. (2007). Biological components of sex differences in color preference. *Current Biology*, 17, R623–R625.

Inui, M. (1966). *Practical analysis of interior color environment.* Tokyo: Building Research Institute.

Inui, M. (1969). Colour in the interior environment. *Lighting research and technology*, 1(2), 86-94.

Jadva, V., Hines, M., Golombok, S. (2010). Infants' preferences for toys, colors, and shapes: Sex differences and similarities. *Archives of sexual behavior,* 39(6), 1261-1273.

Janssens, J. (2001). Facade Coulours not just a Matter of Personal Taste, a psychological account of preferences for exterior building colours, *Nordisk Arkitekturforskning, Nordic Journal of Architectural Research*, 2001:2.

Kaplan, S. (1995). The restorative benefits of nature: Toward an integrative framework. *Journal of environmental psychology,* 15(3), 169-182.

Kaplan, R., Kaplan, S. (1989). *The experience of nature: A psychological perspective*. CUP Archive.

Fjeld, T. (2000). The effect of interior planting on health and discomfort among workers and school children. *HortTechnology*, 10(1), 46-52.

Kaya, N., Crosby, M. (2006). Color associations with different building types: An experimental study on American college students. *Color Research & Application,* 31(1), 67-71.

Kaya, N., Epps, H.H. (2004). Relationship between colour and emotion, a study of college students, *College Student Journal,* Vol 38(3),396-405.

Kundel, C. (1976). Clothing Practices and Preferences of Blue-Collar Workers and Their milies1. *Home Economics Research Journal,* 4(4), 225-234.

Kwallek, N., Lewis, C.M. (1990). Effects of environmental colour on males and females: A red or white or green office, *Applied Ergonomics*, 21.4, 275- 278.

Lind, C. (1993). Psychology of Color: Similarities Between Abstract and Clothing Color Preferences. *Clothing and Textiles Research Journal* , Vol. 12 no. 1 57-65.

Madden, T. J., Hewett, K., Roth, M. S. (2000). Managing images in different cultures: A cross-national study of color meanings and preferences. *Journal of international marketing,* 8(4), 90-107.

Mahnke, F.H. (1996). *Color, Environment, and Human Response*. Van Nostrand Reinhold, New York. 65, 151.

Manav, B. (2007). Color-emotion associations and color preferences: A case study for residences. *Color Res Appl* 32: 144–150.

McManus I.N., Jones, A. L., Cottrell, J. (1981). The aesthetics of colour. *Perception*, 10(6), 651-666.

Mehta, R., Zhu, R. J. (2009). Blue or red? Exploring the effect of color on cognitive task performances. *Science,* 323(5918), 1226-1229.

Miller, S. ,Schlitt, J.K. (1985). *Interior Space: Design concepts for personal needs,* New York, Preager.

Minato, S. (1977). Color in industrial design, in F. W. Billmeyer and G. Wyszecki. Eds. ,AIC Color '77. *Proceedings of the Third Congress of the International Colour Association*, Adam Hilger Ltd., Bristol.

Norman, R. D., Scott, W. A. (1952). Color and affect: A review and semantic evaluation. *J. Gen. Psychol*. 46, 185–223.

Van der Voordt, T., Bakker, I., and De Boon, J. (2017) Colour preferences for four different types of spaces. *Facilities* 35(3/4), pp. 155-169. DOI: http://dx.doi.org/10.1108/F-06-2015-0043

Oberman, L.M., Pineda, J.A., Ramachandran, V.S. (2007). The human mirror neuron system: A link between action observation and social skills, *Soc Cogn Affect Neurosci,* 2(1): 62-66.

Palmer, S. E., Schloss, K. B. (2010). An ecological valence theory of human color preference. *Proceedings of the National Academy of Sciences*, 107(19), 8877-8882.

Park, Y., Guerin, D.A. (2002). Meaning and Preference of Interior Color Palettes Among Four Cultures.*Journal of Interior Design,* Vol 28 (1), 27–39.

Radeloff, D.J. (1991). Psychological Types, Color Attributes, and Color Preferences of Clothing, Textiles, and Design Students. *Clothing and Textiles Research Journal*, Vol. 9 no. 3 59-67.

Rice, A. H. (1953). Color: What Research Knows About the Classroom. *Nation's Schools*, Vol. 52, 1953,1-8; 64.

Rosenbloom, T. (2006). Color Preferences of High and Low Sensation Seekers, *Creativity Research Journal,* 18:2, 229-235.

Saito, M. (1996). Comparative studies on color preference in Japan and other Asian regions, with special emphasis on the preference for white. *Color Research & Application,* 21(1), 35-49.

Schloss, K. B., Strauss, E. D., & Palmer, S. E. (2012). Object color preferences. *Color Research and Application. doi*, 10, 1002.

Schneider, W. (1987). *Sinn und Un-Sinn, Umwel sinnlich erlebbar gestalten in Architektur und Design*, Bauverlag, GWBH, Wiesbaden und Berlin.

Scott, S. C. (1993). Visual attributes related to preference in interior environments. *Journal of Interior Design,* 18(1-2), 7-16.

Sivik, L., (1970). Om färgers betydelse (with English summary: Colour connotations and perceptive variables). Swedish Colour Center, Stockholm.

Sivik, L. (1974). Colour meaning and perceptual colour dimensions: A study of exterior colours. Göteborg. *Psychol Rep* 4:1–24.

Slatter, P. E., Whitfield, T. W. (1977). Room function and appropriateness judgments of color. *Perceptual and Motor Skills,* 45(3f), 1068-1070.

Smets, G. (1982). A tool for measuring relative effects of hue, brightness and saturation on color pleasantness. *Perceptual and Motor Skills,* 55(3f), 1159-1164.

Stalker, D.(1956). *Color Preferences and their use in selected residences in Manhattan, Kansas,* Thesis, Kansas State University.

Taft, C. (1997). Color meaning and context: comparisons of semantic ratings of colors on samples and objects. *Color Research & Application,* 22(1), 40-50.

Taylor, C., Clifford, A., Franklin, A. (2013). Color preferences are not universal. *Journal of Experimental Psychology*: General, 142(4), 1015.

Turley, L. W., Milliman, R. E. (2000). Atmospheric effects on shopping behavior: a review of the experimental evidence*. Journal of Business Research*, 49(2), 193-211.

Ulrich, R. & Zimring, C. (2004). *The Role of the Physical Environment in the Hospital of the 21st Century: A Once-in-a-Lifetime Opportunity.* Center for Health Systems and Design, Texas A&M University.

Van den Berg, A. E., Hartig, T., Staats, H. (2007). Preference for nature in urbanized societies: stress, restoration, and the pursuit of sustainability. *Journal of social issues*, 63(1), 79-96.

Weinberg, L. (1922). *Color in Every Day Life,* New York: Moffat, Yard & Co. 12.