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Evaluating color combinations using abstract graphics versus pictures of simulated urban settings

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Abstract

Preference for 'color combinations' have received remarkably little empirical attention and no study compared people's responses to 'abstract color combinations' and 'color combinations in urban settings'. This study aims to fill this gap and focuses on color combinations rather than isolated colors. 22 color compositions (11 abstract graphics + 11 simulated urban settings) were created. Color compositions included analogous and complementary hues, warm and cool hues, low (5 hues) and high (10 or 11 hues) diversity color compositions. 104 participant evaluated color compositions for (1) arousal, (2) naturalness, (3) relaxation and preference for various objects and settings including (4) clothing, (5) bathroom walls, (6) mall indoors, (7) restaurant indoors, (8) house indoors, (9) building exteriors and (10) any type of object, using a 7-point bipolar scale. The results showed that; (1) color compositions of abstract graphics and pictures of simulated urban settings were rated similarly for ratings of naturalness and preference for any type of object and setting, (2) low and high diversity color compositions were rated similarly for all scales except preference for house indoors, (3) analogous and complementary color compositions were rated similarly for all scales except preference for clothing, (4) warm and cool color compositions were rated similarly for all scales except preference for bathroom walls. The applied value of these results and areas for future research are discussed.

Keywords
Color combination preference, Computer simulations, Environmental aesthetics, Environmental perception, Environmental psychology.

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1. Introduction

Several studies investigated the most liked colors for various objects. However, only a limited number of them focused on urban environments. There are three reasons to study color preference in urban settings. First, scientific knowledge (and also common knowledge) suggest that the most and the least liked colors for one object may not be similar to that of another. Put it differently, the most liked color for a car or a sofa would be different than that for a building façade. Second, urban environments offer a variety of colors. Yet, most research focused on people's emotions for 'isolated' colors. This lack of interest on color combinations highlights the necessity to understand people emotions to color combinations (rather than isolated colors) in urban settings. Third, color preference studies tend to use color samples rather than contextual colors. Studies comparing people's responses to abstract colors (e.g. color samples) and contextual colors (e.g. pictures of objects and settings) produced inconsistent results on whether abstract colors are good representatives of contextual colors. Such inconsistencies call for more research on the use of abstract and contextual colors in understanding people's preference for color combinations in urban settings.

In brief, colors in urban environments influence people's judgments of environmental quality. Yet, little is known about how people evaluate color combinations in urban settings. Put it differently, color combinations have received remarkably little empirical attention and no study compared people's responses to 'abstract color combinations' and 'color combinations in urban settings'. This study aims to fill this gap by (1) investigating people's preference for various color combinations; including analogous and complementary hues, warm and cool hues, few and more hues, and (2) comparing people's evaluations of "abstract color compositions" and "contextualized color compositions - pictures of simulated urban settings".

In terms of environmental aesthetics building exterior color is an important attribute that influence environmental experience and aesthetic evaluations (Nasar, 1988). Although color is an integral part of design process, environmental coloration is usually practiced in an ad-hoc manner without scientific approach (Smith, 2003). Designers tend to rely on natural talent or practical knowledge that comes from 'learning by doing' or 'trial and error' (Janssens, 1996). Given that, one could not deny: scientific knowledge may prevent unpredicted, unintentional and costly mistakes.

Separate from environmental aesthetics literature, a voluminous number of color research have investigated whether people tend to like some colors over others (Kreitler & Kreitler, 1972; Whitfield & Wiltshire, 1990). Studies revealed certain amount of agreement for the most and the least liked colors. People tend to like blue (Whitfield & Wiltshire, 1990; Camgoz et. al., 2002; Crozier, 1999; Eysenck, 1941; Granger, 1955; Guilford & Smith, 1959; Helson & Lansford, 1970; Hogg et. al., 1979; Saito, 1994; Valdez & Mehrabian, 1994) and dislike yellow (Eysenck, 1941; Guilford & Smith, 1959; Helson & Lansford, 1970; Saito, 1994; Valdez & Mehrabian, 1994). However, such empirical work have extensively used colored chips (samples) and ignored the importance of context (Chin, 2012). There have been only few color evaluation studies on building interiors (Acking & Kuller, 1972; Hogg et. al., 1979; Kuller & Mikellides, 1993; Kwallek, 1996; Kwallek et. al., 1996; Kwallek et. al., 2007; Slatter & Whitfield, 1977; Stahre et. al., 2004; Stansfield & Whitfield, 2005; Stone & English, 1998) and even less on building exteriors (Janssens, 1996; Cubukcu & Kahraman, 2008; Janssens, 2001; O'Connor, 2006; O'Connor, 2011; Kuller, 1996; Sivik, 1974). Put it differently, little is known about how people evaluate urban settings.

Common knowledge suggests that the most and the least liked colors in general (or for specific objects) may not apply to color preference in urban settings. A number of studies have been devoted to compare evaluations of abstract colors and contextual colors. For example the most popular colors for women's fashion were compared to that of residential interior (Stansfield &

Whitfield, 2005). Similarly, color preferences for color chips (or samples) were compared to pictures of automobile colors (Saito, 1983), colored objects (Taft, 1997) (eg. furniture, bicycle, and computer), building interiors (Hogg et. al., 1979; Ural & Yilmazer, 2010), and exteriors (Sivik, 1974). Some of these studies revealed consistencies, while the others revealed contradictions between evaluations of abstract and contextual colors. Such inconsistencies between findings of various studies may stem from methodological differences. Yet, these contradictory findings call for more research on comparisons of abstract and contextual color evaluations, especially in the context of urban environment.

Moreover, colors always exist with other colors. Yet, most studies on color emotions have focused on evaluation of a 'single (isolated) color'. Similarly, research on building exterior colors tended to investigate single color applications on a single building (O'Connor, 2011). In such studies building exterior color was manipulated via a digital imaging software, to control hue, saturation, and brightness of that façade (Cubukcu & Kahraman, 2008) and to control color harmony with its surrounding (O'Connor, 2006). Only a limited number of studies investigated color emotions for 'color pairs' (Ou et. al., 2004) and a few were focused on color combinations (Ural & Yilmazer, 2010). For 'color pairs', investigators argued that some emotions (e.g. warm versus cool, hard versus soft) for a color pair could be predicted by averaging individual color scores. However, empirical evidence also suggested that such predictions are not applicable to evaluative scales such as preference (like versus dislike). People's attitude towards 'color combinations' are more complex. In general, people tend to prefer harmonious colors. However, the explanations for harmonious colors are confusing. According to some theorists similar hues (analogous hues) would produce harmonious colors, while for others contrasting colors could also produce color harmony as long as they complement each other (O'Connor, 2011). In brief, color emotions for 'color combinations in urban context' have received remarkably little empirical evidence. This article hopes to pave the way for such research.

Recently, Ural and Yilmazer (2010) investigated whether people's perception for color combinations for indoor settings vary when color combinations are presented via different visualization techniques. The visualization techniques included color chips, abstract compositions, perspective drawings, and three dimensional (3D) models. The results showed poor associations between the semantic ratings of 'color chips' and other media and significant associations between 'abstract compositions', 'perspective drawings' and '3D models'. Thus, the authors argued that abstract compositions are good representatives of architectural coloring. Inspired from that study, the present study aims to focus on color combinations in urban settings and investigate whether people's emotional response to color combinations differ when color combinations are presented on abstract graphics and pictures of simulated urban settings. Empirical research showed that responses to color photographs accurately reflect on site responses (Cubukcu, 2003; Stamps, 1990). In parallel, colored pictures have been extensively used as representatives of real objects (Saito, 1983; Taft, 1997) and settings (Janssens, 1996; Cubukcu & Kahraman, 2008; Kuller, 1996; Sivik, 1974; Saito, 1983; Taft, 1997) in studies of color emotions.

2. Method

2.1. Color compositions

The design of color compositions of abstract graphics and simulated urban settings required a sequential process.

First, 22 hues with 15^0 hue intervals ($360 / 15 = 24$ hue 90^0 and hue 270^0 were excluded from the sample) were selected from a HSB model color space. In HSB model, any color is represented by a set of three numbers representing hue, saturation, and brightness. Hue values vary from 0^0 to 360^0, each representing a distinct color. Saturation is measured as a percentage from 0% (white) to 100% (fully saturated color). Brightness is measured as percentage from 0% (black) to 100% (fully bright color). For this study various saturation and brightness levels were tested for each hue then it is seen that half saturated and fully bright hues produced perceptible hue differentiation and proper building exterior colors. Thus half saturated (50% saturation) and fully bright (100 % brightness) hues were selected.

Second, three types of 'color combinations' were determined based on hue similarity and the diversity (number) of hues. For the first type, six color combinations were created each of which included five similar (or analogous) hues (either warm or cool hues). For the second type, three color combinations were created each of which included 10 dissimilar (or complementary) hues (both warm and cool hues). For the third type, two color combinations were created each of which included 11 similar hues (either warm or cool hues). This way about half of the compositions included low diversity (5 hues) and the other half included high diversity (10 or eleven hues). Similarly, about one third of the compositions included warm colors, one third of them included cool colors and the rest included both warm and cool colors. Table 1 shows the hues that were used in each color combination.

For the color compositions of abstract graphics, eleven compositions were generated as a 8 by 5 checkerboard pattern (2 cm X 2 cm squares). For each color type a random number was assigned to each pixel. For 'Type 1', the numbers ranged from 1 to 5 (Table 2) for 5 hues. For 'Type 2', the numbers ranged from 1 to 10 (Table 3) for 10 hues. For 'Type 3', the numbers ranged from 1 to 11 (Table 4) for 11 hues. The hues in each color combination were associated with these random numbers to apply colors to checkerboard patterns (Tables 2 to 4). For each color combination, these 8 by 5 checkerboard patterns were repeated three times (mirrored and 1800 rotated forms were used in repeats) to achieve a wider differentiation between short and long sides of a rectangle (Differentiation between short and long sides was necessary to simulate a series of building facades in an urban setting). This way, the checker board included 40 (8 X 3) cells on the long side and 5

Table 1. *Three types of 'color combinations' (including 11 separate combination) were specified based on hue similarity and the number of hues in the combination.*

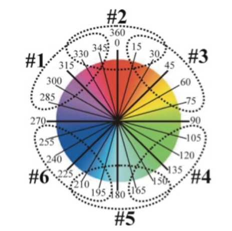
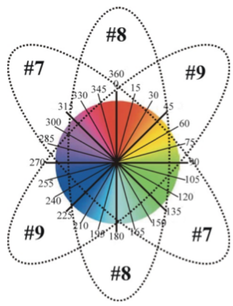
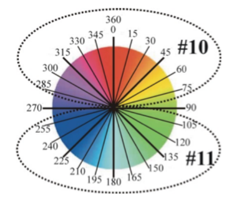
TYPE 1 (5 analogous hues)			
#1	Warm Colors 1	285^0, 300^0, 315^0, 330^0,345^0	
#2	Warm Colors 2	330^0,345^0,0^0,15^0,30^0	
#3	Warm Colors 3	15^0,30^0,45^0,60^0,75^0	
#4	Cool Colors 1	105^0,120^0,135^0,150^0,165^0	
#5	Cool Colors 2	150^0,165^0,180^0,195^0,210^0	
#6	Cool Colors 3	195^0,210^0,225^0,240^0,255^0	
TYPE 2 (10 complementary hues)			
#7	Warm and Cool Colors 1	285^0, 300^0, 315^0, 330^0,345^0, 105^0,120^0,135^0,150^0,165^0	
#8	Warm and Cool Colors 2	330^0,345^0,0^0,15^0,30^0, 150^0,165^0,180^0,195^0,210^0	
#9	Warm and Cool Colors 3	15^0,30^0,45^0,60^0,75^0, 195^0,210^0,225^0,240^0,255^0	
TYPE 3 (11 analogous hues)			
#10	Warm Colors	285^0, 300^0, 315^0, 330^0,345^0, 0^0,15^0,30^0,45^0,60^0,75^0	
#11	Cool Colors	105^0,120^0,135^0,150^0,165^0, 180^0,195^0,210^0, 225^0,240^0,255^0	

Table 2. *The right side shows the random numbers (from 1 to 5) assigned to each cell on the 8X5 checkboard pattern. The left side shows the hues assigned to each cell for color combination #1 as an example. For the remaining TYPE 1 color combinations similar procedure was followed.*

For "Type 1 color combinations", random numbers (ranging from 1 to 5) were assigned to each cell								Hues assigned to each cell for "color combination # 1" is shown as an example for other combinations							
3	5	5	4	3	5	4	1	315	345	345	330	315	345	330	285
4	2	1	2	1	5	1	3	330	300	285	300	285	345	285	315
5	5	1	5	3	2	2	3	345	345	285	345	315	300	300	315
3	1	1	5	3	4	5	3	315	285	285	345	315	330	345	315
1	3	2	2	2	4	2	4	285	315	300	300	300	330	300	330

Table 3. *The right side shows the random numbers (from 1 to 10) assigned to each cell on the 8X5 checkboard pattern. The left side shows the hues for color combination #7 as an example. For the remaining TYPE 2 color combinations similar procedure was followed.*

For "Type 2 color combinations", random numbers (ranging from 1 to 10) were assigned to each cell								Hues assigned to each cell for "color combination # 7" is shown as an example for other combinations							
2	7	8	5	6	5	2	6	345	165	180	30	150	30	345	150
8	3	4	4	6	8	6	9	180	0	15	15	150	180	150	195
8	7	3	9	3	7	2	7	180	165	0	195	0	165	345	165
5	10	1	4	10	9	8	2	30	210	330	15	210	195	180	345
6	8	1	2	2	2	8	2	150	180	330	345	345	345	180	345

Table 4. *The right side shows the random numbers (from 1 to 11) assigned to each cell on the 5X8 checkboard pattern. The left side shows the hues for color combination #10 as an example. For the remaining TYPE 3 color combinations similar procedure was followed.*

For "Type 3 color combinations", random numbers (ranging from 1 to 11) were assigned to each cell								Hues assigned to each cell for "color combination # 10" is shown as an example for other combinations							
10	7	8	1	8	4	2	4	240	195	210	105	210	150	120	150
1	10	5	5	4	2	10	9	105	240	165	165	150	120	240	225
8	4	7	10	9	10	1	7	210	150	195	240	225	240	105	195
9	4	11	10	2	8	2	4	225	150	255	240	120	210	120	150
3	5	1	3	2	1	6	3	135	165	105	135	120	105	180	135

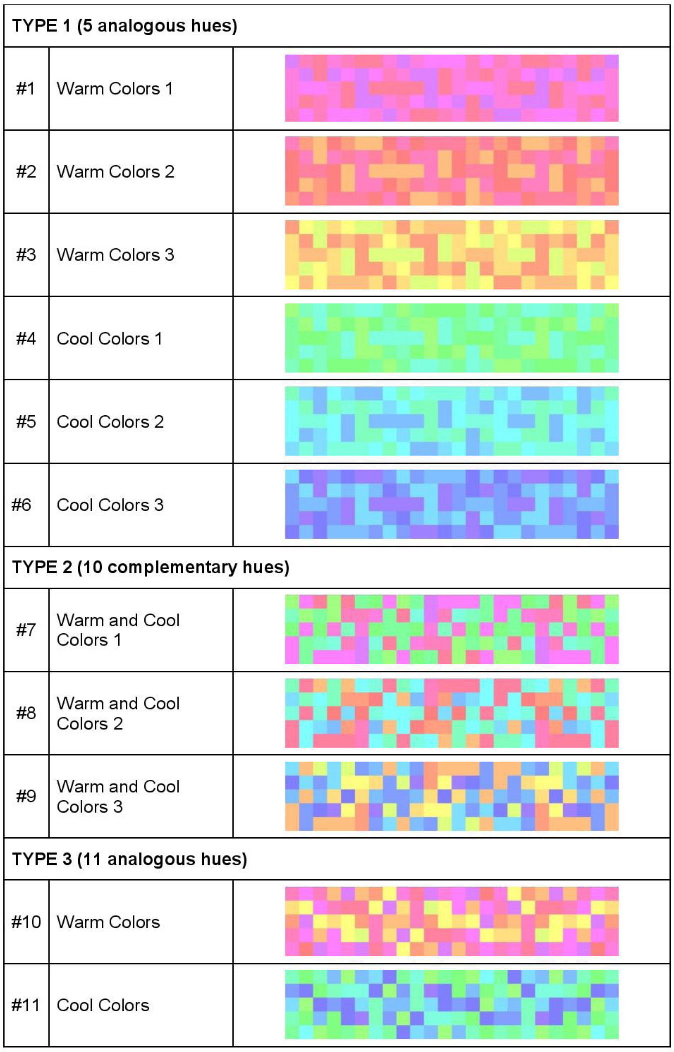


Figure 1. *Abstract color compositions.*

cells on the short side. Figure 1 shows the eleven 'abstract color compositions'.

For the color compositions of simulated urban settings, three types of building silhouettes were designed considering the proportional relations between hues in each type of abstract graphic color combination. Same proportional relations in simulated urban setting color compositions were achieved by controlling the total area of building façades. To that end, the height and the width of each building façade was manipulated. For 5 analogous hues (see 'type 1' in table 1), each hue was presented on two building facades. Thus the composition involved 10 buildings (Figure 2). For 10 complementary hues (see 'type 2' in table 1), each hue was presented on one building façade. Thus the composition involved 10 buildings (Figure 2). For 11 analogous hues (see 'type 3' in table 1), each hue was presented on one building. Thus, the composition involved 11 buildings (Figure 2). The location of each building in the composition was specified randomly. Figure 3 shows the eleven 'simulated urban setting color compositions'.

Note, the number of hues and the proportion of each color on each of the eleven color combinations were the same in 'abstract color compositions' and 'simulated urban setting color compositions'. However, the adjacency of each color to each other was not controlled between 'abstract color compositions' and 'simulated urban setting color compositions'. This methodological limitation should be accounted in further studies.

In brief, there were 22 color compositions (11 abstract graphics + 11 simulated urban settings) and each participant was asked to rate 8 of them. In order to keep participants interest, participants were not asked to rate all color compositions. The compositions that will be evaluated by each participant was selected by stratified random sample. Six sub-groups were determined, each of which involved 8 color compositions. In each group, four were '5 analogous' hues, two were '10 complementary' hues and two were '11 analogous' hues. Also in each group, half of the color combinations were 'abstract color compositions' and the other half were 'simulated urban setting color compositions'. Finally, cool and warm color combinations were equally balanced in each group.

2.2. Survey

Studies showed arousal, naturalness, and relaxation are particularly important when studying color preference (Cubukcu & Kahraman, 2008) in physical environments, because studies on environmental aesthetics showed that environmental preference is affected by such emotions (Nasar, 1988). People prefer environments with moderate levels of arousal, high levels of naturalness, and relaxation (see literature review in Cubukcu and Kahraman, 2008). Thus, this study examined people's emotions of arousal, naturalness, and relaxation in addition to preference. 7-point bipolar semantic differential scales were used to measure arousal (1 = sleepy, 7 = arousing), naturalness (1 = artificial, 7 = natural), and relaxation (1 = distressing, 7 = relaxing). Preference was evaluated in 7 ways using a 7-point bipolar scale (eg. 1 = dislike, 7 = like). Participants were asked to rate their preference on each color combinations for objects [including (1) clothing, (2) any type of object] and for settings [including (3) bathroom walls, (4) mall, (5) restaurant and (6) house indoors and (7) building exteriors].

The survey included questions about participants' demographic characteristics (age, gender, color deficiency, and the city they grow-up) and their familiarity with colors via three questions. The first question asked whether they are involved (or not involved) in activities related to color such as painting. The second one asked how they evaluate the diversity of color in their environment (simple / diverse / do not know). The third one asked whether they are conservative or flexible in color preference for various objects. For this last question participants were asked to pick one comment among four; (1) I am conservative, I have favorite colors which I tend to use on various objects; (2) I am a little flexible. Put it differently, although my color preference depends on the object, I have favorite colors which I tend to use more often; (3) I am flexible, my color preference depends on the object, and (4) I do not care about colors.

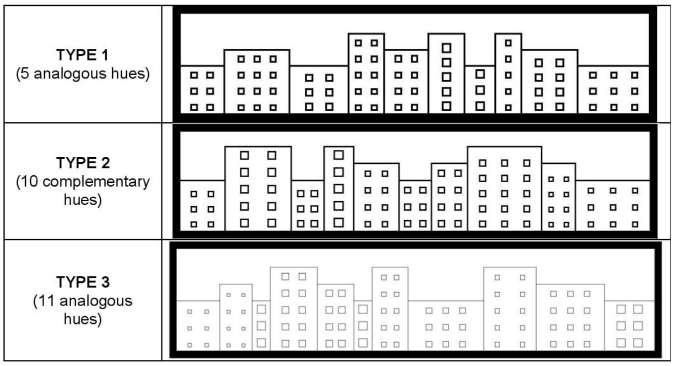


Figure 2. The building areas in simulated urban settings were controlled to achieve the same proportion of each color in each type of abstract color compositions.

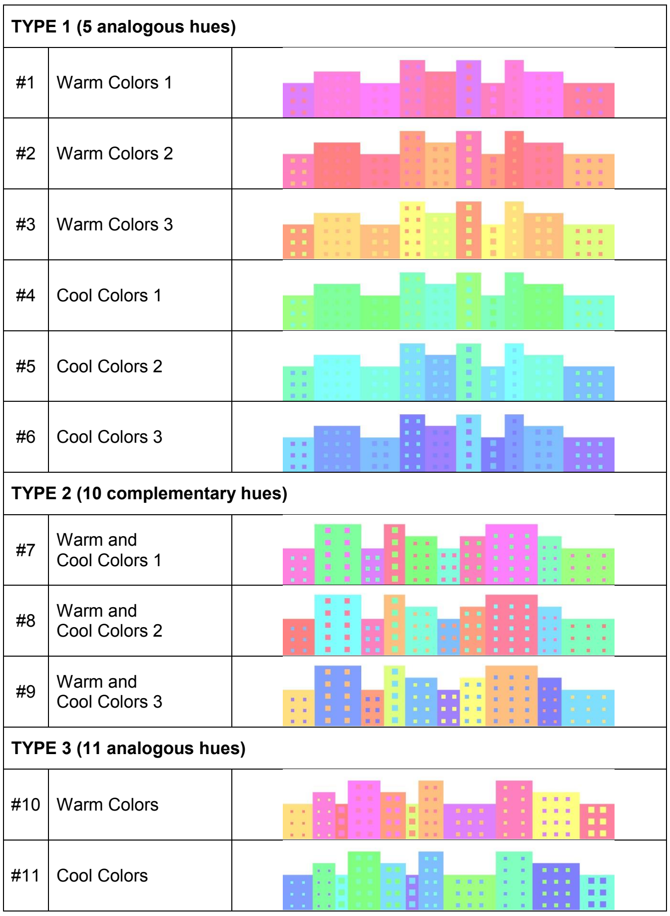


Figure 3. Simulated urban setting color compositions.

2.3. Participants

104 students studying in Ege University, Geography Department agreed to participate in the study. However, 14 participants were excluded from the sample, 13 for not using corrective equipment (contact lenses or eyeglasses) for their vision deficiencies and 1 for being colorblind. Thus, the results were analyzed for 90 participants between the ages of 17 and 30 (MEAN: 22.58; SD = 2.30). The study group was about balanced as to gender (41% female, 59% male). All participants were university students, and no participant reported having a diverse cultural background; majority (about 30%) spent

Table 5. Participants' evaluations (mean scores for various scales) for abstract graphics and pictures of simulated urban settings.

	Statistical Difference	Abstract Graphic Mean (n = 360)	Simulated Urban Settings Mean (n = 360)
Sleepy (1) X Arousing (7)	t = 1.78, df = 718, p = 0.08	3.29 (SD = 1.79)	3.05 (SD = 1.81)
Artificial (1) X Natural (7)	t = 1.00, df = 718, p = 0.32	2.88 (SD = 1.65)	2.75 (SD = 1.72)
Distressing (1) X Relaxing(7)	t = 2.02, df = 718, p = 0.04	3.19 (SD = 1.77)	2.93 (SD = 1.77)
Preference (1 = dislike,7 = like)			
Clothing	t = 0.00, df = 718, p = 1.00	3.13 (SD = 1.86)	3.13 (SD = 2.03)
Bathroom walls	t = -0.06, df = 718, p = 0.96	3.33 (SD = 1.99)	3.34 (SD = 2.09)
Mall indoors	t = 0.74, df = 718, p = 0.46	3.10 (SD = 1.85)	2.99 (SD = 1.86)
Restaurant indoors	t = 0.20, df = 718, p = 0.23	2.99 (SD = 1.79)	2.83 (SD = 1.83)
House indoors'	t = 0.98, df = 718, p = 0.33	2.82 (SD = 1.76)	2.69 (SD = 1.82)
Building exteriors'	t = 0.93, df = 718, p = 0.35	3.01 (SD = 1.82)	2.88 (SD = 1.92)
Any type of object	t = 1.40, df = 718, p = 0.16	3.49 (SD = 1.89)	3.28 (SD = 1.99)

Table 6. Participants' evaluations (mean scores for various scales) for color compositions with few (5 hues) and more (10 or eleven hues) hues.

	Statistical Difference	Few Hues Mean (5 hues) (n = 360)	More Hues Mean (10 – 11 hues) (n = 180)
Sleepy (1) X Arousing (7)	t = -1.57, df = 718, p = 0.12	3.07 (SD = 1.80)	3.28 (SD = 1.80)
Artificial (1) X Natural (7)	t = 0.55, df = 718, p = 0.58	2.85 (SD = 1.73)	2.78 (SD = 1.64)
Distressing (1) X Relaxing(7)	t = 0.21, df = 718, p = 0.83	3.07 (SD = 1.90)	3.04 (SD = 1.64)
Preference (1 = dislike,7 = like)			
Clothing	t = 1.57, df = 718, p = 0.12	3.24 (SD = 2.00)	3.01 (SD = 1.89)
Bathroom walls	t = 0.86, df = 718, p = 0.39	3.40 (SD = 2.12)	3.27 (SD = 1.95)
Mall indoors	t = -0.10, df = 718, p = 0.92	3.04 (SD = 1.88)	3.05 (SD = 1.83)
Restaurant indoors	t = 0.29, df = 718, p = 0.77	2.93 (SD = 1.89)	2.89 (SD = 1.73)
House indoors	t = 1.73, df = 718, p = 0.08	2.87 (SD = 1.86)	2.64 (SD = 1.71)
Building exteriors	t = 0.62, df = 718, p = 0.54	2.99 (SD = 1.93)	2.90 (SD = 1.82)
Any type of object	t = 0.86, df = 718, p = 0.39	3.45 (SD = 2.03)	3.32 (SD = 1.85)

most of their life in the third largest city of Turkey, Izmir. Most participants (about 90%) revealed that they are not involved in activities related to color (such as painting). About half of the participants (48%) rated the diversity of color in their living environments as high. For general color preference, results showed that about 18 % were conservative, about 32% were a little flexible, about 31% were flexible, and about 19% revealed that they do not care about colors.

2.4. Procedure

Six groups of people (18, 17, 18, 13, 17, and 21) were seated in a classroom and received a brief written and verbal instruction about the task. First they viewed a Mondrian Painting projected onto a screen (which was about 122 cm × 152 cm) and filled the survey. They rated a painting first, rather than the color compositions, to get familiar with the evaluative questions. Then one randomly selected color composition was displayed and participants were asked to fill the evaluative questions (arousal, naturalness, relaxation and preference for various objects and settings) on the form. The color composition was replaced randomly by another until 8 compositions were assessed for all scales. The survey took about 20 – 25 minutes for each group. The participants were not allowed to ask questions to the investigator or to each other during the evaluation of 8 images.

3. Results

Participants' evaluations were compared between different type of color compositions; abstract graphics versus pictures of simulated urban settings, low versus high diversity (number) of hues, analogous versus complementary hues, warm versus cool hues.

Color compositions of abstract graphics and pictures of simulated urban settings were rated similarly for ratings of naturalness and preference for any type of object and setting. Both types of color compositions were rated as below average for all scales (means ranged from 2.69 to 3.49). However, the difference between color compositions of abstract graphics and pictures of simulated urban settings achieved a statistical significance for arousal and relaxation scores. Abstract graphics were found to be more arousing and more relaxing compared to pictures of simulated urban settings (Table 5).

Color compositions with few (5 hues) and more (10 or 11 hues) hues were rated similarly for ratings of arousal, naturalness, relaxation, and preference for any type of object and setting except house indoors. Both types of color compositions were rated as below average for all scales (means ranged from 2.64 to 3.45). For house indoors, color compositions with few hues were found to be more preferable than color compositions with more hues and this difference achieved marginal significance (Table 6).

Color compositions with analogous and complementary hues were rated similarly for ratings of arousal, naturalness and relaxation and preference for any type of setting and object except clothing. Both types of color compositions were rated as below average for all scales (means ranged from 2.67 to 3.41). For clothing, color compositions with analogous hues were found to be more preferable than complementary hues, and this difference achieved marginal significance (Table 7).

Color compositions with warm and cool hues were rated similarly for ratings of arousal, naturalness, relaxation and preference for any type of object and setting except bathroom walls. Both types of color compositions were rated as below average for all scales (means ranged from 2.75 to 3.54). For bathroom walls, color compositions with cool hues were found to be more preferable than that with warm hues, and this difference achieved statistical significance (Table 8).

Table 7. *Participants' evaluations (mean scores for various scales) for color compositions with analogous and complementary hues.*

	Statistical Difference	Analogous Colors Mean (n = 540)	Complementary Colors Mean (n = 180)
Sleepy (1) X Arousing (7)	t = 1.24, df = 718, p = 0.21	3.12 (SD = 1.79)	3.32 (SD = 1.84)
Artificial (1) X Natural (7)	t = 0.63, df = 718, p = 0.53	2.84 (SD = 1.69)	2.74 (SD = 1.67)
Distressing (1) X Relaxing(7)	t = -0.70, df = 718, p = 0.48	3.03 (SD = 1.81)	3.14 (SD = 1.64)
Preference (1 = dislike,7 = like)			
Clothing	t = 1.93, df = 718, p = 0.06	3.21 (SD = 1.97)	2.88 (SD = 1.87)
Bathroom walls	t = 0.24, df = 718, p = 0.81	3.34 (SD = 2.07)	3.30 (SD = 1.95)
Mall indoors	t = -1.15, df = 718, p = 0.25	3.00 (SD = 1.88)	3.18 (SD = 1.77)
Restaurant indoors	t = -0.28, df = 718, p = 0.78	2.89 (SD = 1.84)	2.94 (SD = 1.71)
House indoors'	t = 0.76, df = 718, p = 0.45	2.78 (SD = 1.82)	2.67 (SD = 1.70)
Building exteriors'	t = -0.10, df = 718, p = 0.92	2.94 (SD = 1.89)	2.96 (SD = 1.82)
Any type of object	t = 0.67, df = 718, p = 0.50	3.41 (SD = 1.99)	3.30 (SD = 1.78)

Table 8. *Participants' evaluations (mean scores for various scales) for color compositions with warm and cool hues.*

	Statistical Difference	Warm Colors Mean (n = 272)	Cool Colors Mean (n = 268)
Sleepy (1) X Arousing (7)	t = 0.45, df = 538, p = 0.66	3.16 (SD = 1.79)	3.09 (SD = 1.79)
Artificial (1) X Natural (7)	t = 0.55, df = 538, p = 0.58	2.88 (SD = 1.70)	2.79 (SD = 1.66)
Distressing (1) X Relaxing(7)	t = 0.36, df = 538, p = 0.72	3.00 (SD = 1.82)	3.06 (SD = 1.81)
Preference (1 = dislike,7 = like)			
Clothing	t = -1.53, df = 538, p = 0.13	3.08 (SD = 1.99)	3.34 (SD = 1.94)
Bathroom walls	t = -2.22, df = 538, p = 0.03	3.15 (SD = 2.02)	3.54 (SD = 2.11)
Mall indoors	t = -0.14, df = 538, p = 0.89	2.99 (SD = 1.78)	3.01 (SD = 1.98)
Restaurant indoors	t = 0.17, df = 538, p = 0.86	2.91 (SD = 1.78)	2.88 (SD = 1.91)
House indoors	t = -0.38, df = 538, p = 0.70	2.75 (SD = 1.81)	2.81 (SD = 1.83)
Building exteriors	t = -1.34, df = 538, p = 0.18	2.83 (SD = 1.84)	3.05 (SD = 1.94)
Any type of object	t = -0.92, df = 538, p = 0.36	3.33 (SD = 1.95)	3.49 (SD = 2.04)

4. Discussion

Voluminous number of studies have focused on color preference. Although color preference could be product specific, colors in urban settings received remarkably little empirical evidence. One reason for this lack of interest could be related to the methodological limitations to represent and control the variety of colors in urban settings. This study investigated people's evaluation of color combinations which are presented in two different forms; (1) pictures of simulated urban settings, (2) abstract graphics. A previous study on architectural indoors (Ural & Yilmazer, 2010) found that abstract compositions are good representatives of architectural coloring. In another study (Guerin et. al., 1994) six abstract color palettes were developed to represent six pictures of interior environments. Based on the results, authors argued that abstract color palettes are valid testing instruments to study meaning of color in interior environments. The present study supported those findings. People evaluated pictures of simulated urban settings and abstract graphics similarly for scales of arousal, naturalness, relaxation, and preference. Recall, questions on preference were specified for different objects (eg. clothing) and settings (eg. mall or house indoors). Results indicate that, people are able to predict the application of color combinations on various objects and settings no matter how the color combinations are presented; either by abstract graphics or pictures of simulated urban settings. Put it differently, when people are asked to imagine color combinations on various objects they are not influenced by presentation technique. In brief this study provide empirical evidence that, abstract compositions are good representatives of simulated urban settings and could be used to understand people's preference for combinations of colors in outdoor settings. This finding is particularly important for urban designers and environmental psychologist who need to understand people's response to various color combinations in urban settings. They could save time when they use abstract graphics rather than computer models of real world settings. Note however, this study compared only two conditions; abstract graphics and two dimensional simulated urban settings. Future studies should compare abstract graphics with three dimensional real and virtual environments.

This study also investigated the influence of diversity of colors on preference. In this study, color combinations included 5, 10 and 11 hues to represent low and high diversity of colors. Results showed that both were rated similarly (below average) for ratings of arousal, naturalness, relaxation, and preference for any type of objects and settings except house indoors. Only for house indoors people tend to prefer less hue diversity. Note, in this study diversity was achieved by hue differentiation in a color combination. Future studies may use saturation and brightness differentiation to test influence of color diversity on preference. Also, in this study color combinations had 5 to 11 hues. Greater differentiation in color compositions (eg. using 3 to 100 hues) may yield different findings. In brief, whether diversity contributes to, or detracts from, environmental visual quality calls for more research.

It is widely believed that, in urban environments buildings have to be in harmony with each other (Ünver & Dokuzer, 2002) Color theorists and practioners showed great interest in laws of color harmony (Sivik & Hard, 1994; O'Connor, 2010). Theory and research showed that analogous and complementary colors could produce color harmony. Although this study did not intend to provide empirical support to laws of color harmony (whether analogous or complementary colors produced harmony), it showed that both analogous and complementary colors were rated similarly for ratings of arousal, naturalness and relaxation and preference for any type of object except clothing. Only for clothing, analogous color compositions were found to be more preferable than complementary ones. However note, this study did not measure color harmony. Thus, future studies should test how people rate analogous and complementary colors in terms of color harmony and how color harmony influences people's color preference in urban settings remains to be seen. Moreover, in this study analogous and complementary hues were selected from HSB (hue, saturation, brightness) model color space with 150 hue intervals. There are web based tools (such as the color wheel expert, color wheel pro, color wizard see Chin (2012) for a review) to select matching colors. Similarly, Chin (2012) introduced a color selection system with which one can select proper color for building exteriors using a 3D coloring simulation tool for city scenes. Future studies may consider using such tools to design various color combinations that could be considered to be harmonious and inharmonious.

Previous studies on color emotions usually grouped colors as warm and cool colors. Studies showed that although color preference varies in time, people tend to prefer warm colors for residential interiors (Stansfield & Whitfield, 2005). Also warm colors are found to be more arousing and less relaxing than cool colors (Yildirim et. al., 2011). Considering the environmental aesthetic literature which argues that people tend to visit moderately arousing and highly relaxing environments and avoid highly arousing and distressing environments, one expects both warm and cool colors to be preferable in urban settings. The findings of the present study showed that warm and cool color compositions were rated similarly for ratings of arousal, naturalness, relaxation and preference for any type of object and setting except bathroom walls. Only for bathroom walls, cool hues were found to be more preferable. Note, this study focused on cool and warm colors to study color combinations in urban settings. However, existing urban settings involve achromatic colors (eg. white) or more variety which cannot be grouped as warm and cool. A useful extension of this study may focus on color combinations in existing urban environments rather than cool and warm colors. It is necessary to highlight the fact that, this paper makes no claim to provide concrete evidence relating to the most preferred hues (warm or cool) in urban settings, as urban environments provide a variety of colors. It intends to generate further discussion and research on preference of color combinations in urban settings. In other words, the research is not definitive or conclusive. It aims to pave the way to study color combinations rather than isolated colors.

Hard and Sivik (2001) highlight the fact that "the number of colors is very large and the number of possible colour combinations is almost infinite" (p 4). Studying color combinations required a systematic way of selecting color combinations. In this study, the selection was based on hue differentiation. The combinations vary according to which they involve (1) warm, cool or both type of colors, (2) analogous or complementary colors, and (3) diversity of colors (5, 10 and 11 hues). In selecting color combinations future studies may consider using Shigenobu Kobayashi's (Kobayashi, 1981; Kobayashi, 1987) seminal publications on "color image scale". With more than hundred basic colors he created more than thousand color combinations. The color combinations were then matched with about two hundred semantic concepts like urbane, traditional, modern, and comfortable. Future studies which would test people's emotional response to Shigenobu Kobayashi's color combinations in real and simulated urban settings are on call.

Finally the methodological limitations related to the experimental set up and the characteristics of the subject group should be addressed. There are three limitations. First, colors' proportional relations in abstract graphics and pictures of simulated urban settings were controlled but adjacency of colors in two types of presentation techniques were not controlled. Subsequent studies should control adjacency of colors in abstract graphics and contextual presentations. Second, pictures of simulated environments were used to represent an urban setting. Future studies should examine to what extent the evaluation of colors on pictures on a computer screen is relevant for judgments of real urban settings. Third, the target population of this study was young students in Western Turkey. Whether the results of the present study will apply to different cultures remains to be seen. More work needs to be done to test the generalization of the results to various demographic groups (children, elderly) as well.

5. Conclusion

Voluminous number of studies have focused on color preference in general. Although color preference could be product specific, colors in urban settings received remarkably little empirical evidence. One reason for this lack of interest could be related to the methodological limitations to represent and control the variety of colors in urban settings. This study investigated people's evaluation of color combinations which are presented in two different forms; (1) pictures of simulated urban settings, (2) abstract graphics. Results showed that, abstract compositions are good representatives of simulated urban settings and could be used to understand people's preference for combinations of colors in outdoor settings. This finding is particularly important for urban designers and environmental psychologist who need to understand people's response to various color combinations in urban settings. This study is important as it integrates two literatures, environmental psychology and color research in general, and environmental aesthetics and color preference in particular. The methodology derived from color research literature could inspire new research in environmental aesthetics. More research needs to be done to understand the relation between color and environmental aesthetic evaluations.

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