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EFFECTS OF COLOURS AND FORMS OF TREES ON VISUAL PERCEPTIONS

HALDUN MUDERRİSOGLU[1], SUKRAN AYDIN[*], OZGUR YERLI[*] AND ELIF KUTAY[*]

Department of Landscape Architecture,
Faculty of Forestry [*]Düzce University, Duzce, Turkey
[1]E-mail: haldunm@duzce.edu.tr

Abstract

The objective of this study was to determine the effect of colour on the perception of tree forms and the effects of personal characteristics of the participants on their preferences. The students of science studies, medical science and social science of Duzce University, Turkey, participated in the study (n=159). The participants were asked to evaluate 5 different tree forms which were drawn by hand and coloured with 8 different colours by semantic differential method. According to the results obtained, pyramid-formed trees were preferred most and colour had a strong effect on the preferences of tree forms. Bright green trees were found to have the highest visual quality while blue-coloured trees the highest strength. Again, the results obtained in this study indicate that personal characteristics are effective on preferences of tree forms and colours.

Introduction

Unplanned and dense construction is one of the biggest problems which affects the quality of life of today's cities. Sheets & Manzer (1991) stated that one of the things that increase the quality of life in cities are the plants in the area. The effect of plants on the quality of life of the city dwellers can be seen in different ways. Plants increase the quality of air and water of cities, regulate temperature and provide habitat for the animals living in the city (Michelfelder, 2003). The prices of houses having plants nearby are higher than those without trees nearby (Henry, 1994). If there are plants near the workers in a workplace, their productivity increases (Lohr *et al*., 1996). Kuo *et al*., (1998), in their study, stated that there was a relationship between the amount of green areas in the city and the security of people. Kuo & Sullivan (2001), based on police reports, claim that vegetative cover decreases inclination to vandalism and crimes in society. Also, green areas around houses lead to strong neighbouring relations (Coley *et al*., 1997). There are many studies investigating the effects of plants on human health. Ulrich and Simons (1986) state that scenery with plants has the effect of regulating blood-pressure of people. Additionally, it was found that if there was vegetative cover in the angle of vision of patients, their admission duration in the hospital and pains decreased (Lohr & Pearson-Mims, 2000). The studies carried out indicated that those who were educated about or participated in studies on plants in their childhood developed more environmental attitudes than others when they were grown up (Waliczek & Zajicek, 1999).

Some researchers stated that plants, not only their directly used plants just for planting in the garden but also the plants within their angles of vision, were useful for them (Kaplan, 1992; Relf & Lohr, 2003). Therefore, line, form, colour and texture that will cause changes in the perception of people with their contributions to plant compositions are the basic criteria to be known very well (Fisher *et al*., 1984).

Colour is one of the basic topics of psychology. There are many studies about the effects of colour on people and how people's colour preferences change. Boyatzis and Varghese (1994) found out that bright colours such as pink, blue and red created positive emotion and darker colours such as brown, black and red created negative emotion. Hemphill (1996) found out that green, yellow and red evoke more positive responses than the other colours. Terwogt & Hoeksma (1995) state that age is a factor in colour preferences. They found that as people got older they preferred green more than yellow. Saito (1996) claims that the living place and culture of people are important in their colour preferences. Jacobsen (2002), in his study, indicated that the education of people as well as their culture was effective in their colour preferences. The effects of gender on colour preferences have been the most common subjects of the researchers. The studies carried out showed that blue is the favourite colour of both genders (Silver & Ferrante, 1995). Silver & Ferrante, in their study, found that women preferred black and pink more than men and men preferred red to pink. Hemphill (1996), who examined the effects of colours on people, stated that bright colours were perceived more positively by women than men and dark colours were perceived more negatively by women than men.

Although there are many studies about the effects of colour on human perception, there are a limited number of studies about the effects of plant colours on people. Behe *et al*., (1999) examined what effect colours of flowers had on choosing plants. According to this study, plants that had flowers in the colours of red and lavender were preferred more than those in pink and white. Those with blue flowers were the least preferred ones. Todorova *et al*., (2004) examined the colour preferences in street planting. They indicated that users preferred the flowers with bright colours. Kaufman & Lohr (1994) examined the effects of tree colours on preferences. According to their study, green and red trees were preferred more than purple and brown trees.

On the other hand, the studies examining the effects of the forms of plants on people are more than those on colour. Summit & Sommer (1999) indicated that trees having spreading and globular tree forms were preferred more than those having columnar and conical tree forms. Lohr & Pearson-Mims (2006), in their study, reached similar results. According to their study, trees having spreading forms gave positive emotion to people whereas trees having columnar and conical forms gave negative emotion. Orians (1998) stated that low bifurcation of trunk, spreading canopy, and compound-leaved trees were preferred. However, in some studies, findings differed on the tree forms which were preferred most. For instance, Williams (2002) showed that medium-sized and lobular or oval-formed trees were preferred. Muderrisoglu *et al*., (2006) found that pyramid formed trees had the highest visual quality and strength.

In the studies conducted so far, the effect of plant forms and colour on perception has not been examined. Therefore, the aims of this study were (1) to determine the effect of plant forms together with the colour on the preferences for trees and (2) to find out how demographic characteristics of people affect their colour and form preferences.

Materials and Methods

In the studies about plant use, several methods were used. The first of them are the studies carried out using real trees (Sommer *et al*., 1989). Another method is using photos of the trees that are determined (Williams, 2002). In some studies, photographs created by assembling, by means of several computer programs, were used (Todorova *et al*., 2006). A group of researchers carried out studies using sketches of plant forms (Summit

& Sommer, 1999; Muderrisoglu *et al*., 2006). In this study about the forms and colours of trees, the sketches drawn by hand were coloured on the computer. These sketches were evaluated by the respondents of the questionnaire. It was proven by many researchers that evaluations by showing photos achieved results fast and correctly (Hull & Stewart, 1992; Sommer *et al*., 1993).

Forms and colours: Five different forms of trees pyramidal, spreading, round, columnar and irregular are the five most preferred and common forms of trees in Turkey (Güncel *et al*., 2008, Muderrisoglu *et al*., 2006, Çelik *et al*., 2005). The forms of trees were drawn by hand and colours by Adobe Photoshop 7.0. The RGB (Red-Blue-Green) value of the selected colours are shown in Table 1.

The questionnaire was carried out among the students of Duzce University, Duzce, Turkey (N=159). Of the participants, 47% were male, 53% were female, 39% studied in science, 35% in medical sciences, and 26% in social sciences. Monthly incomes of the participants were quite low: 49% had a monthly income of 0-350 USD, 43% 351-1050 USD and 8% over 1050 USD. Of the students who participated in the study, 59% lived in cities, 28% in towns and 13% in villages. Of the participants, 49% evaluated the amount of green areas in their living places as medium, 26% a lot and 24% few.

The subjects for the study were divided into groups of 20 and asked to evaluate the photos reflected by a projector for 30 minutes. While evaluating, they were asked to use the given adjective pairs. In order to show the changes of the adjective pairs according to the tree forms, the data were analysed by using one-way ANOVA.

In order to determine the effect of the forms and colours of trees on visual perception, MANOVA test was used. The same test was used to indicate the change in the perception of forms and colours of trees with the characteristics of the participants. To determine the proportions of visual perception, the proportions of visual quality and strength were added and then arithmetical mean was found. Visual quality implicates the emotions at first sight, but visual strength is determined by the physical characteristics.

For analyses, SPSS 13.0 statistical packages were used.

Results

Perception of tree forms: In order to determine visual quality and strength, the given adjective pairs show changes according to the forms of the trees. This shows that the forms of trees selected for the study can clearly be separated from each other visually (Table 3). Pyramidal form has both the highest visual quality and strength and in visual quality it was followed by round, spreading, columnar and irregular forms and in visual strength it was followed by *round, columnar, spreading* and *irregular* according to their visual strengths (p= 0,001, Table 3).

Perception of tree colour: Colours of trees have different effects on the participants (Table 4). Bright green was evaluated as the highest visual quality (p=0,001). This colour was followed by blue yellow and brown. Respectively recognized with blue the highest visual strength (p=0,001, Table 4). This was respectively followed by yellow, bright blue and green.

Table 1. Effect of Colours trees on visual perceptions.

	Red	Green	Blue
Green	38	105	38
Bright green	142	198	63
Red	195	77	73
Pink	252	134	130
Blue	104	117	195
Bright blue	169	178	235
Brown	224	173	48
Yellow	251	250	64

Table 2. Evaluation of participants' characteristics.

		Evaluation Code		
		1	2	3
Participants' characteristics	Living area	Village	Town	City
	Income level (USD)	0-350	351-1050	>1050
	Gender	Male	Female	
	Green areas in living area	Low	Medium	High
	Education	Science	Medical	Social

The effects of tree colours and forms on visual perception: Visual quality of the tree forms show changes with the colour of the tree (p=0,05, Fig. 1). Round-formed trees with bright green colours had the highest visual quality, followed by blue and yellow, respectively (Fig. 1). The colour that causes visual quality decrease most is brown. Bright green, yellow and blue colours respectively improve the visual quality of columnar trees (Fig. 1). The colour that decreases the visual quality most for this tree form is red. Bright green, green, and blue are the colours that increase the visual quality of the pyramid-formed trees most while brown colour decreases it (Fig. 1). For irregular-formed trees, blue, yellow and bright green colours respectively increase the visual quality. While red colour decreases, yellow, bright green and bright blue colours increase the visual quality of spreading-formed trees, while brown colour decreases (Fig. 1).

Results of our analysis revealed that colour is effective on the visual strength of tree forms (p=0,01, Fig. 2). Blue coloured trees with round forms have the highest visual strength. These were followed by yellow, bright green, respectively. The colour that causes the visual strength of round-formed trees is green (Fig. 2). The visual strength of columnar-formed trees is highest in yellow, blue, bright blue and green colours respectively (Fig. 2). Green, yellow and blue colours increasethe visual strength of pyramidal-form trees, while brown decreases it (Fig. 2). For irregular trees, blue, yellow and bright green, respectively and decreased by green colour. While yellow, blue and bright blue colours enhance the visual strength of spreading trees and decreases it.

On perception of tree forms, income levels (p=0,05; R2=0,05), and the amount of green areas in living areas of the participants are effective (p=0,001; R2=0,05). On perception of colours of trees, living areas (p=0,05; R2=0,02), genders (p=0,05; R2=0,02) and education level (p=0,001; R2=0,03) of the participants are effective.

The participants with low income levels prefer round-formed trees, while those with higher income levels prefer pyramid-formed trees (Fig. 4). The participants who have low amounts of green areas in their living areas prefer pyramid-formed trees most and they prefer irregular-formed trees least (Fig. 4). Those living in green areas of average density prefer pyramidal most and spreading least. Those living in areas with more green areas prefer round most and irregular-formed trees least (Fig. 4).

Table 3. Descriptive adjectives for tree forms.

Forms		Adjective pairs										
		Boring interesting	**Disturbing comforting**	**Non-attractive attractive**	**Non-relaxing relaxing**	**Ugly beautiful**	**Stimulative tranquil**	**Stable moving**	**Plain ornamented**	**Untidy tidy**	**Total**	
		Quality adjectives					**Strength adjectives**				**Quality**	**Strength**
Round	M.[b]	3,2	3,1	3,3	3,0	3,2	2,6	2,9	3,0	3,8	3,18	3,12
Columnar	M.	2,9	2,7	2,9	2,6	2,8	2,4	2,9	3,0	3,3	2,82	2,95
Pyramidal	M.	3,3	3,0	3,3	2,9	3,3	2,4	3,2	3,2	3,7	**3,20**	**3,21**
Irregular	M.	3,4	2,3	3,3	2,1	2,7	1,7	4,0	3,6	1,7	2,80	2,80
Spreading	M.	2,8	2,8	2,8	2,8	2,8	2,8	2,8	2,9	3,0	2,84	2,92
Variance		**47 a**	**84 a**	**34 a**	**91 a**	**48 a**	**118 a**	**183 a**	**62 a**	**575 a**	**55 a**	**72 a**

a. $p<0,001$; b: Mean

Table 4. Descriptive adjectives for tree colours.

Colours		Adjective pairs									Total	
		Boring interesting	Disturbing comforting	Non-attractive attractive	Non-relaxing relaxing	Ugly beautiful	Stimulative tranquil	Stable moving	Plain ornamented	Untidy tidy		
		Quality adjectives					Strength adjectives				Quality	Strength
Green	M.[b]	3,2	2,8	3,0	2,7	3,0	2,6	3,0	2,8	2,9	2,95	2,90
Bright Green	M.	3,2	3,0	3,2	2,9	3,2	2,4	3,2	3,1	3,1	**3,15**	3,01
Red	M.	3,1	2,4	3,1	2,3	2,8	2,0	3,2	3,3	3,0	2,79	2,92
Pink	M.	2,9	2,9	2,9	2,7	2,9	2,7	2,9	3,0	3,1	2,90	2,97
Blue	M.	3,4	2,7	3,4	2,7	3,1	2,1	3,5	3,5	3,2	**3,10**	**3,11**
Bright blue	M.	2,9	3,0	3,0	2,8	3,0	2,7	3,0	3,1	3,2	2,98	3,03
Brown	M.	2,8	2,7	2,9	2,6	2,7	2,5	2,9	2,9	3,1	2,77	2,92
Yellow	M.	3,4	2,7	3,4	2,6	3,1	2,1	3,5	3,5	3,2	3,08	**3,10**
Variances		24 a	18 a	17 a	14 a	14 a	35 a	25 a	29 a	4 a	18 a	12 a

a. $p<0,001$; b: Mean

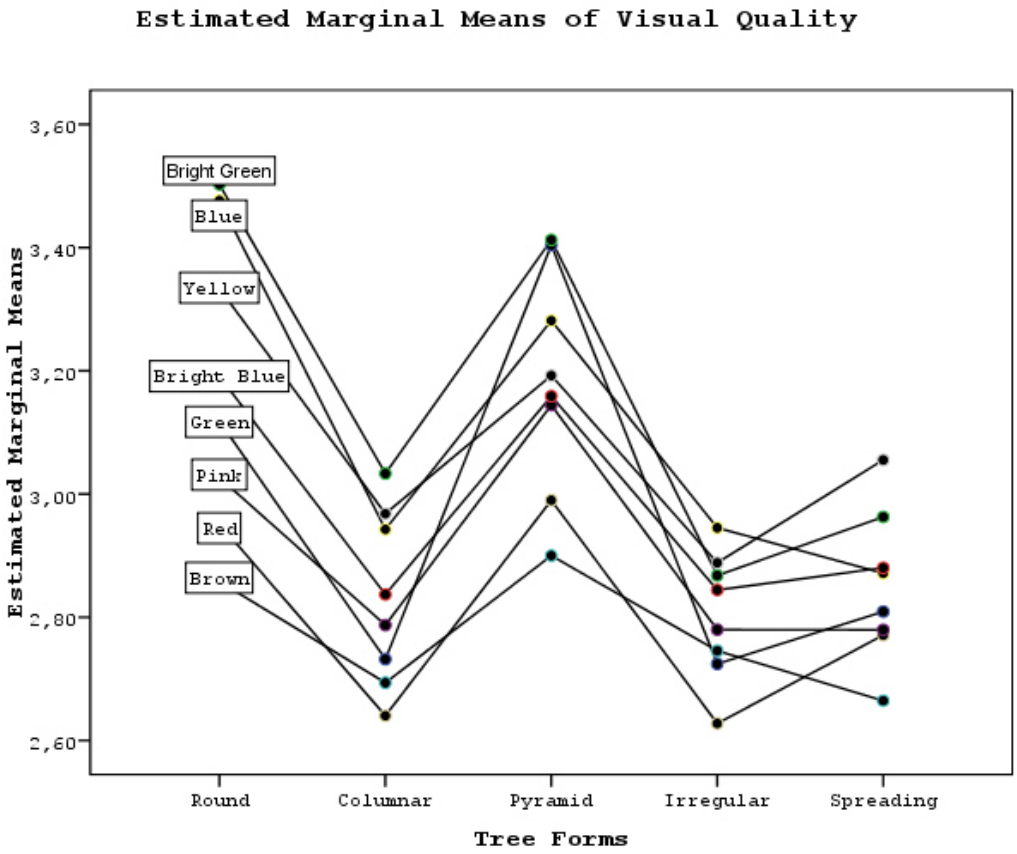

Fig. 1. The effects of tree colours along with forms on visual quality.

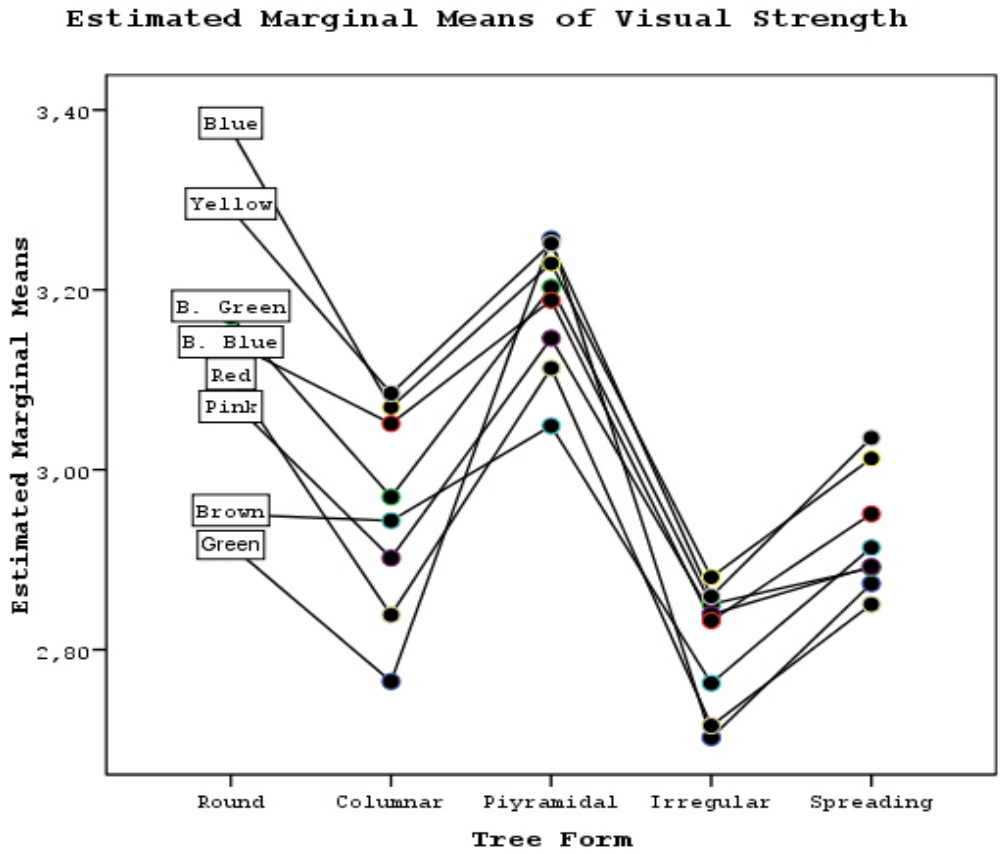

Fig. 2. The effects of tree colours along with forms on visual strength.

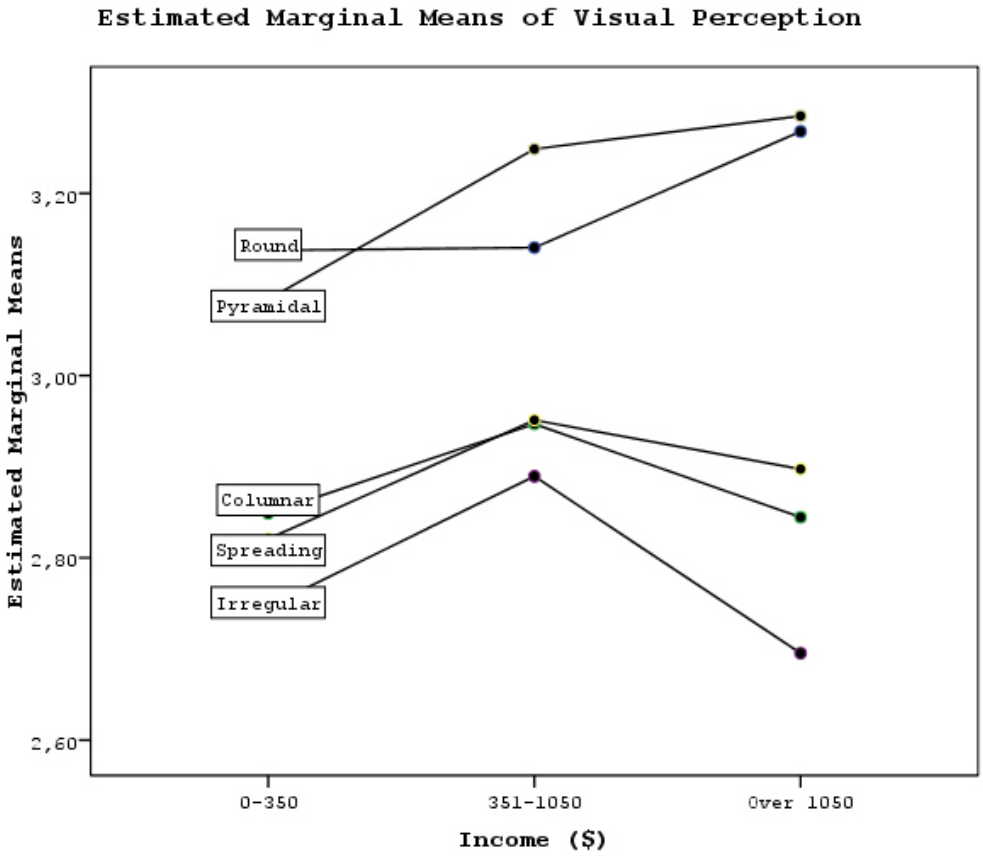

Fig. 3. The relationship between income and tree form preferences.

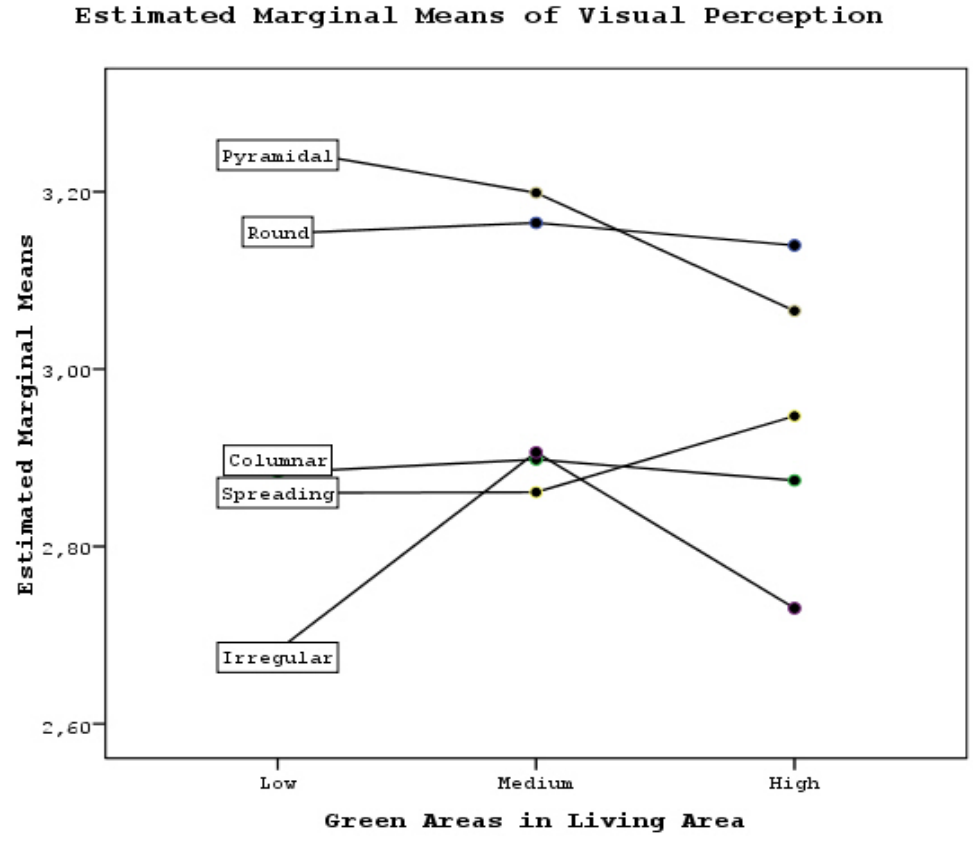

Fig. 4. The relationship between green areas in living area and tree form preferences.

The participants living in villages prefer blue, yellow and bright green trees the most, respectively, and red-coloured the least (Fig. 5). Those living in towns prefer yellow, blue and bright green trees most, respectively, and red-coloured trees the least (Fig. 5). Those living in cities prefer blue, yellow and bright blue trees most, respectively, and brown-coloured trees least (Fig. 5).

Male participants prefer yellow, blue, and bright green and red-coloured trees, respectively (Fig. 6). Female participants prefer bright green, blue and yellow and brown-coloured trees, respectively (Fig. 6). Female participants prefer bright colours more than male participants (F=28,18; p=0,001).

The participants with low amounts of green areas in their living areas prefer yellow, blue and bright blue-coloured trees, respectively (Fig. 7). The participants with average amounts of green areas in their living areas prefer bright green, blue and yellow-coloured trees, respectively, while they prefer brown-coloured trees least (Fig. 7). The participants with larger amounts of green areas in their living areas prefer yellow, blue and bright green-coloured trees, respectively, while they prefer red-coloured trees least (Fig. 7).

The participants studying science prefer respectively blue, yellow, bright green and brown -coloured trees (Fig. 8). The medical sciences student prefers bright green, yellow, blue, and brown-coloured trees, respectively. Student of social sciences preferred respectively yellow, bright green, blue and red coloured trees (Fig. 8).

Discussion

In this study, the findings observed in the previous studies about the perception of forms of plants could not be proven. Orians (1998), Summit & Sommer (1999) and Lohr & Pearson-Mims (2006) stated spreading as the most preferred tree form and columnar and conical as the least preferred tree form. However, the finding obtained in this study indicates *vice versa*. As in Muderrisoglu *et al*., (2006), pyramid-formed trees are the most preferred ones whereas spreading-formed trees are the least preferred ones. These different results show that studies about forms of plants should be repeated in different societies.

Several studies about colours indicated that the most preferred colour was blue (Silver & Ferrante, 1995). However, in the study carried out by Kaufman & Lohr (2004) about colours on trees, it was stated that green was the most preferred colour. The participants of this study indicated that bright green-coloured trees had the highest visual quality and blue-coloured trees had the highest strength. Similar results to the results obtained in the studies about the brightness of the colour can also be seen in this study (Boyatzis & Varghese, 1994; Todorova *et al*., 2004). It is seen that bright colours, such as bright green, bright blue, pink and yellow, are preferred more than darker brown, red and green.

How colours and tree forms together affect the perception have been neglected in the studies done so far. According to the data obtained in this study, the tree form for which colour differentiation is most effective is round. In the round-formed trees, the colour increasing visual quality most is bright green, the colour increasing the visual strength most is blue. In the round-formed trees, the highest preference is given to the colour blue. Columnar and spreading-formed trees are preferred more when they are in bright colours. For these forms, the colour increasing the preference most is yellow. Blue, in all tree forms, is the colour that increases both visual quality and visual strength. However, it has the biggest effect in spreading form. The tree form for which green colour is most preferred by all participants is pyramidal form. In all the other tree forms, green colour affects perception more negatively than the other colours. However, this is not the case

for bright green. Bright colours make the participants feel that trees are healthier, and on the other hand, reminds them of spring when all the plants awaken. This shows that in our tree colour preferences, the colours symbolising liveliness and health are effective. Jacobsen (2002) tried to match geometrical forms with colours. According to this study, triangle matches with red, circle matches with yellow. This matching can not be corrected for the plants having geometrical forms. This clearly shows that when colour comes together with an object, it causes differences in colour preferences of people although there are similarities in people's general liking of colours.

To indicate the relationships between the characteristics of the participants and tree form preferences has been a subject of several studies. They stated that culture (Fraser & Kenney 2000), their living areas (Muderrisoglu *et al*., 2006) and the type and level of their education were effective (Sommer *et al*., 1992; 1993). Fraser & Kenney (2000) stated that culture was more effective in our tree form preferences than gender and education. However, the findings supporting these results could not be reached in our study. In this study, it was observed that the amount of green areas in the living areas of the participants and their income were effective in plant form preferences. No difference was seen between the impact rates of these two participant characteristics on tree form preferences. The effect of education and gender on tree form preferences could not be proven. In many studies, examining the effect of gender on tree form preferences, it was stated that this effect was very weak or there was no effect at all (Williams, 2002).

In the present study, it was observed that the effect of characteristics of participants on the preference of tree colour was much higher than the preference of forms. As in the previous studies about colour, it was also observed in this study that living areas of participants (Saito, 1996), their genders (Silver & Ferrante, 1995) and the type of education they had (Jacobsen, 2002) were effective in their colour preferences. One of the contributions of this study to the literature is that it indicates the amount of green areas in the living areas of the participants is effective in their preferences of tree colours. The most effective characteristic of the participants for the preference of tree colour is education.

Conclusion

Three fundamental results are obtained in this study;

- Participants characteristics are effective on the preferences of the tree forms,
- Tree forms and colours together cause changes in preferences,
- Bright coloured trees are preferred the most.

It would be a great mistake to generalize the results of this study to all kinds of plant forms. The effects of the previous experiences of the participants related to the other plant forms on their preferences should not be discarded. This study should be repeated for all plant forms (ground cover and bushes).

Another result obtained in this study is that characteristics of the participants are more effective on tree colour preferences than on form preferences. This result supports the view that individuals for whom plant designs are made should be well known.

The observations in this study point to the importance of future studies to examine all the features such as foliage altogether, as well as form and colour.

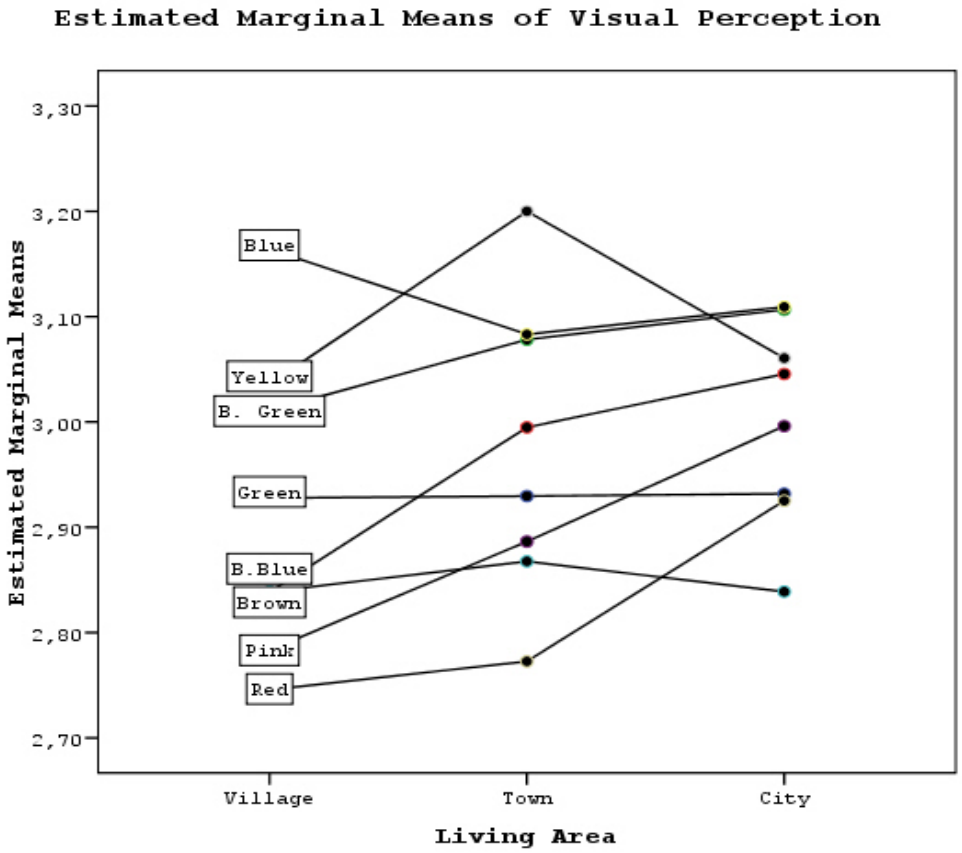

Fig. 5. The relationship between living area and tree colour preferences.

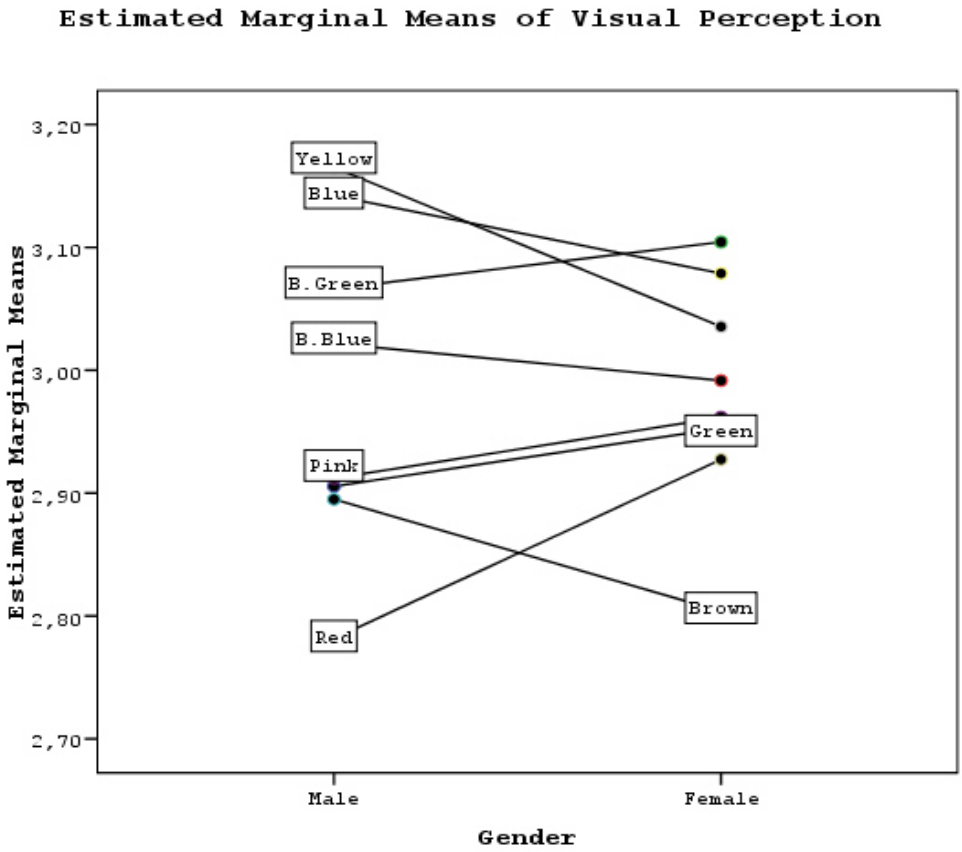

Fig. 6. The relationship between gender and tree color preferences.

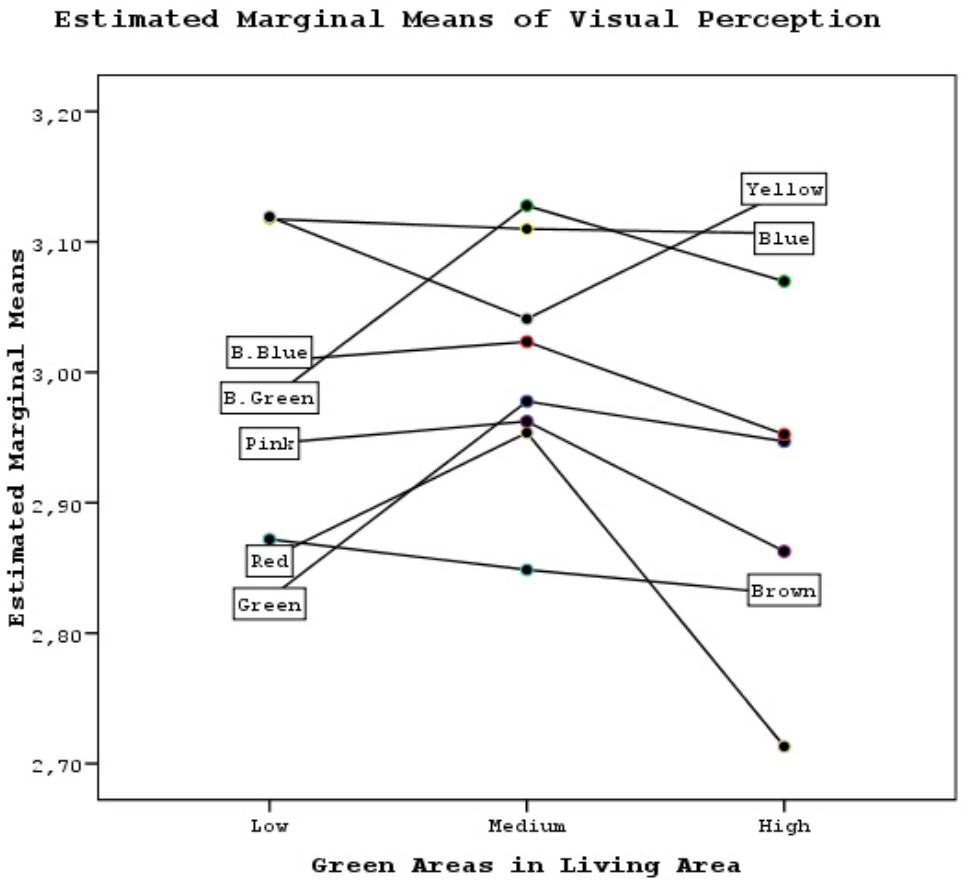

Fig. 7. The relationship between the amount of green areas and tree colour preferences.

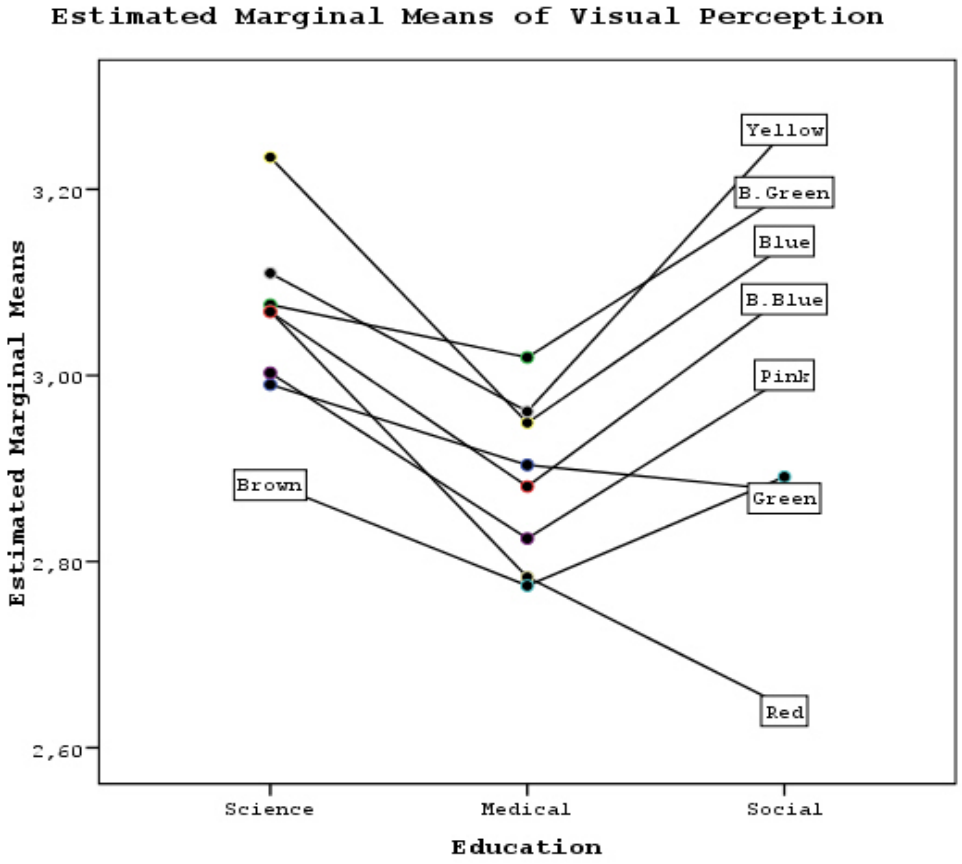

Fig. 8. The relationship between type of education and tree colour preferences.

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