Does Plant Color Affect Emotional and Physiological Responses to Landscapes?

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Abstract

Research has shown that people have distinct preferences for and positive emotional responses to trees with a wide canopy. This is the same shape that trees have in regions of Africa's savannas with appropriate water for human habitation. Tree color is another important cue to habitats that are appropriate for human habitation. For example, nutrient deficient trees would appear yellowish. This paper covers the results of the first phase of a research study designed to test whether people have distinct preferences for and positive emotional and physiological responses to tree canopies of different colors. Results from the first phase showed that people prefer green and red trees to purple and orangish-brown trees. This is consistent with the hypothesis that people respond to specific tree colors because they may be cues to the survival characteristics of a habitat.

INTRODUCTION

Plants perform many positive functions within the urban environment, such as controlling erosion, enhancing water infiltration into soils, and cooling our cities. Furthermore, research has shown that plants play an essential role in improving air quality (Wolverton et al., 1989). In addition to the physical benefits that plants provide within the built landscape, plants promote positive physiological, psychological, and economical responses in people. Viewing nature is associated with reductions in stress, improvements in mental alertness, greater productivity, and, in areas of commerce, increased spending (Ulrich, 1986; Relf, 1991; Lohr et al., 1996). Additional improved health effects include shorter hospital stays, reduced pain, and fewer headaches (Ulrich, 1984; Lohr and Pearson-Mims, 2000; Tove, 2000;). If we can better understand people's preferences and responses to individual elements of nature such as tree form or color, then plant producers, landscape designers, and public and private land managers could have a powerful set of tools to utilize when outlining specifications for our environments, both built and natural.

Surprisingly, few studies have specifically examined the influence of plant color on people's emotional and physiological behavior. Sommer and Summit (1995) commented that, in the investigation of generic plant attributes such as tree size and shape, color has been neglected. In fact, early studies on plant preferences intentionally avoided colors other than green to remove distractions (Kaplan and Kaplan, 1989). Some researchers have examined flowering plant color preferences. In their study of preference for geraniums, Behe and others (1999) found that flower color took precedence over leaf color and price. Red and lavender flowers were preferred over white and pink ones. A simulated blue flower color was the least preferred of all. Most customers preferred plant leaves with plain or zonal patterns to ones with white margins.

While plant color has been largely unexamined, color has been studied since ancient times in many cultures. Color research has typically involved looking at colored chips or sitting in different colored rooms. These methods showed that blue was preferred to red and that yellow was least preferred (Hemphill, 1996). Hue (the color we see, such

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as red) was once thought to be the driving force in color preference. Preference is now known to be more linked to saturation (how strong a color is) than to hue (Jacobs and Hustmyer, 1974). Studying color and emotion, Hemphill (1996) found that green, yellow, and red colored cards evoked more positive responses than other colors. Using change in skin resistance, Jacobs and Hustmyer (1974) found greater arousal for red, followed by green, then yellow. Heart rate and respiration did not change. Terwogt and Hoeksma (1995) noted that colors and emotions differed between age groups. The preference for yellow decreased with age and the preference for green increased with age.

Researchers have specifically examined tree form and its influence on people. In a study on preferred tree form, Sommer and Summit (1995) studied tree canopy, trunk size, and shape. In this study, respondents viewed slides of tree icons and rated variations in the tree attributes. People expressed preferences for wider canopies and shorter trunks for street trees. Additionally, Lohr and Pearson-Mims (1996) examined people's responses to different tree forms and urban elements. Data suggested that more positive emotions were associated with tree forms than with the forms of inanimate objects. Furthermore, a spreading tree form elicited more positive and fewer negative emotions than a conical, globose, or columnar tree or an inanimate object. This reaction has been linked to survival cues in relation to the landscape (Orians and Heerwagen, 1992; Kellert and Wilson, 1993). Trees with this preferred shape are associated with habitats that are good for human survival. As suggested in Kellart and Wilson (1993), there is an emotional connection between human beings and other living organisms; one that involves complex learning rules passed down through generations.

Intuitively, it seems that responding to changing seasons would be important for survival. Plant colors could be a cue to these changes. For example, intense fall leaf colors would indicate a time to prepare for winter. Spring flowers would signal winter's end. Thus it would be reasonable to assume that some responses to plant color may be pre-programmed as responses to tree form appear to be, because they both provide useful survival information. This could help explain why certain plant colors would evoke different responses. Vibrant green might indicate a healthy, nutrient-rich plant with high sugar and carbohydrate content, whereas yellow foliage might indicate an unhealthy nutrient deficient plant. In fact, this has been documented in other primates. Lucas and others (1998) reported that macaques monkeys relate leaf color to nutritious foods by selecting leaves with a particular hue of yellow-green and red that correspond with high nutrients levels. This is significant because macaque color vision is identical to that of humans, which may indicate that humans could have the same color cues for selecting plants that would sustain them.

This research project examined responses to tree color. The results will not only contribute to the growing body of knowledge on utilizing plants to benefit people, but will be used to generate practical applications for incorporating plants of particular color into built and natural environments. If this study shows that people respond differently to plants with different colors, then this will have implications for plants that are recommended for specific situations, such as parks, schools, hospitals, business districts and highway vegetation plantings, as well as local, state and federal lands. The results could also impact management strategies: if green is shown to have greater calming effects than yellow, that can help justify spending money on design and management practices that provide for selection and maintenance of plant health, thereby promoting their natural, lush green color. Calming plant colors could then be incorporated into parks or hospitals in order to provide relaxing and restorative surroundings. Conversely, arousing landscape plantings could be implemented along highways to reduce driver fatigue.

This paper discusses Phase 1 of a two-phase research study addressing what effect plant color has on people's emotional and physiological states. Phase 1 focuses on general plant color preference ratings. Phase 2 will monitor emotional and physiological responses to selected tree colors. The objective of Phase 1 was to determine the range of tree colors that evoke human responses.

MATERIALS AND METHODS

Preference ratings were used to quickly screen responses to a wide range of hues and intensities. Researchers looking at people's preferences for landscapes have established this method as valid for exploring plant-people relationships (Daniel and Boster, 1976; Balling and Falk, 1982; Ulrich, 1986; Sommer and Summit, 1995;). Rating pictures is an effective and easy way to study people's vegetation preferences (Shafer and Richards, 1974; Daniel and Boster, 1976; Ulrich, 1981). Studies have shown that examining people's responses to viewing pictures of plants is a reliable representation of people's responses in the presence of live plants (Shafer and Richards, 1974; Coeterier, 1983; Hull and Stewart, 1992).

The image of a generic mature tree with a spreading canopy and dark trunk was computer-generated. The image was designed to be easy to recognize as representing a tree and to be visually interesting and pleasing. The image was not meant to represent any specific species of tree, thus distracting participants from associating a particular color with a particular plant species. Preliminary testing showed that the image met these criteria. Photographic computer software was used to vary the canopy color. Images in 52 different colors, varying in hue and intensity, were printed at 9 cm by 6 cm.

In further preliminary tests, nine respondents (ages: 27-77) were shown the 52 printed images. They were asked to look at all of the tree colors and then asked to indicate which trees they liked and disliked. They were told nothing about what the colors represented. Demographics were collected. Respondents were then asked for comments they wished to make about specific trees. Comments revealed that some people thought that some canopy colors looked like trees in leaf, while other colors seemed to represent trees in flower, fall color, or dead. This further indicated that the generic image was successful in representing trees in general.

Based on the responses from these nine respondents, a subset of images of the tree in 11 colors was selected. It included colors that evoked very positive or very negative ratings. Trees that evoked variable responses (positive for some people and negative for others) were not selected. The subset retained some variation in hue and intensity. Green, red, purple, and brown were represented in the subset. Different intensities of red and green were also represented. Yellow hues were not included in the subset, because they tended to receive neutral ratings. The subset of colors was then shown to 24 respondents (ages: 20-61) who were asked to rate each tree color by saying if they liked it, disliked it, or felt neutral about it. Results from these 24 respondents are discussed below. Data were analyzed using a Duncan's mean separation test in the General Linear Model procedure in SAS (SAS Institute Inc., 1999).

RESULTS AND DISCUSSION

As expected, people expressed a range of preferences among the presented tree colors (Table 1). All green and red trees, regardless of hue and intensity, evoked positive responses. These results indicated that people do have preferences for different colors. Those who chose these tree color preferences may be expressing survival cues with respect to the landscape (Orians and Heerwagen, 1992; Kellert and Wilson, 1993). The green colors could represent a healthy tree, one with good nutritional qualities, which would symbolize a sustainable landscape. Likewise, the reds could represent, for example, a tree full of ripened fruit.

Purple trees (P1A and P2, Table 1) received both neutral and negative ratings. Respondents commented that the purple color did not look real for a tree or that it may be in flower. Flowers could be an indication of spring flowers, signaling winter's end. Conversely, orange-brown colored trees were rated negatively, which could indicate a nutrient deficiency tree or one that is in decline or dead. Furthermore, the orange-brown tree colors could be a response to the changing of fall into winter. The fruitfulness of summer food supplies is now replaced with the scarcity that the winter landscape brings and the need for greater survival techniques.

Interesting, GRN1A was rated differently from GRN4A indicating that people can respond differently to trees within the same color hue (Table 1). These responses to different hues appear to again be related to the evolutionary survival theory (Orians and Heerwagen, 1992; Kellert and Wilson, 1993). The deeper green tree, GRN1A, would have a higher sugar and carbohydrate content than the lighter GRN4A tree color and allow for greater survival opportunities for humans. These results seem to concur with Lucas and others' (1998) findings that macaques chose leaves with particular yellow-green and red levels that were high in nutrients. This suggests that humans have similar color cues for selecting plants. It also suggests that our color preferences are based on survivability.

To understand these phenomena, Phase 2 will examine whether these preferences are associated with physiological responses as well. Emotional and physiological responses, such as heart rate, electro-dermal activity, and muscle activity during smiling and frowning, will be recorded while respondents view slides of trees of different foliage colors.

CONCLUSIONS

This research showed that people exhibit strong responses to a range of tree colors, varying in hue and intensity. Generally, greens and reds were preferred to purples, oranges, and browns. These responses were generally consistent with predictions based on potential survival information.

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Tables

Table 1. Red, green, and blue color gamut level of and preference for selected tree canopy colors, with code names and hue.

Code	Hue	Red (Gamut)	Green (Gamut)	Blue (Gamut)	Preference[z]	
GRN1A	Dark green	0	128	0	0.71	a
GRN2B	Medium green	80	128	80	0.58	ab
RD1A	Bright red	201	74	74	0.37	abc
GRN4	Light green	141	198	63	0.29	abc
GRN3A	Green	103	165	103	0.25	abc
RD1B	Red	184	84	84	0.25	abc
GRN4A	Bright green	0	255	0	0.12	bcd
P1A	Purple	177	148	189	0.0	cde
P2	Bluish purple	150	153	197	-0.25	def
OR3A	Brown	202	150	86	-0.42	ef
OR4A	Orange-brown	255	173	48	-0.50	f

[z] Based on a scale from 1 (like) to -1 (dislike). Means followed by different letters are significantly different at the 5% level, based on Duncan's mean separation.