

Article

Subjective Preference and Visual Attention to the Attributes of Ornamental Plants in Urban Green Space: An Eye-Tracking Study

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Abstract: Visual attributes of greenery strongly affect the attention and preferences of people. We invited 90 volunteers to participate in a study on the subjective rating and eye tracking on the landscape attributes of greenery to determine the relationship between subjective preference and visual attention to the visual attributes of greenery. The results showed that the subjective ratings of Tree + shrub + grass (IV-A), blue flower (II-A), red flower (II-B), pink flower (II-C), broad-leaved tree (I-C), and bamboo (I-E) were relatively high, belonging to the high rating group. The random forest model showed that the fixation count could indicate a subjective preference. People generate visual attention by fixating on attractive visual attributes with high subjective ratings.

Keywords: visual perception; visual attributes; landscape design; eye-tracking; subjective rating



Citation: Zheng, J.; Huang, Y.; Chen, Y.; Guan, L.; Liu, Q. Subjective Preference and Visual Attention to the Attributes of Ornamental Plants in Urban Green Space: An Eye-Tracking Study. *Forests* **2022**, *13*, 1871. <https://doi.org/10.3390/f13111871>

Academic Editors: Anna Maria Palsdottir, Patrik Grahn and Jonathan Stoltz

Received: 21 October 2022

Accepted: 7 November 2022

Published: 9 November 2022

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1. Introduction

All organisms exhibit environmental preferences, which might change as a result of evolution [1]. Preference for perceived beauty among humans depends on the perception of the natural environment and visual attention [2]. Subjective preference is closely related to the aesthetic value of the environment and modified by individual bias, which originates from the visual attention generated by visually attractive stimuli in the environment [3–6]. There is a strong linear correlation between the subjective preference and visual attention in humans, and this correlation might originate from the generation of memory [7]. People are generally more interested and visually attracted when they gaze at positive visual stimuli [4]. The stimuli with high visual attractiveness might draw visual attention and increase people's preference for such stimuli [8]. There is a nonlinear dose response to the subjective preferences of people for environmental features [9]. Environmental changes can drive the subjective preferences of people for specific landscape attributes. The differences in color and size are especially noticed using the saliency method [10]. The gaze sequences in which people view a displayed product with different marketing elements accurately predict product choice [11,12]. People have distinct visual interests and subjective preferences for specific features of ornamental bamboo [13].

Eye tracking can be used as an adjunct to self-reporting or subjective evaluation [14]. Eye-tracking measures can explain visual attention and eye movement patterns [15]. Non-participatory surveys should be conducted to reduce the bias that occurs during self-reporting or subjective ratings [16]. Some studies combined subjective ratings with eye-tracking to determine visual attention and subjective preferences of people. For example, eye-tracking techniques were used to explain subjective preferences for plant features [13]. Another study was conducted to explain the effects of seasonal changes in vegetation on human physiology and psychology [17]. The results of an eye-tracking study showed that

artificial elements affect the visual perception of mountain landscapes [18]. The measure of eye movement had a significantly positive relationship with landscape design intensity, which might be correlated with preferences and restorative perceptions [19]. The use of eye-tracking technology provides new insights into ornamental plant selection for urban green spaces [20]. The eye-tracking measures (e.g., fixation count, percentage of dwell time, fixation duration) can be used to interpret the human response to landscape elements, and it can also be used to assess natural aesthetic values [2].

Eye-tracking measures can be used to determine visual attention or preference of people for environmental features. The high attractiveness of environmental elements can draw visual attention and increase the number of gazes [21]. The fixation count and the percentage of dwell time were found to be significantly positively correlated with preference under different landscape design intensities [19]. The subsequence of a gaze can be used to judge the visual attractiveness of products when choosing them [11]. Landscapes with a high ornamental value are associated with an increase in pupil size, fixation duration, and fixation count to the area of interest, and a decrease in saccade amplitude [22]. More fixations were found in less restorative environments, which might be related to the lower cognitive effort required by humans to process natural environments [23]. However, other studies showed that there is no correlation between the number of fixations and restoration [24]. Exposure to restorative environments would help people recover from a stressful experience [25]. Visual-spatial frequency and power spectra would influence preference, cognitive load, and eye movements [26]. It was shown that places for forest recreation space that were associated with a greater frequency of eye movements had relatively lower subjective ratings [27]. The diameter of the pupil can reflect color preference and visual comfort [28]. Additionally, pupil diameter can reflect visual interest [29]. People pay visual attention (i.e., fixation count) to the features of bamboo with high subjective ratings [13]. Bamboo is a common type of greenery in urban landscapes. Different types of plant arrangements occur in urban green spaces, with a wide variety of plant communities and colorful flowers. Many studies have investigated the subjective preference for ornamental features such as flower color [30]. The method combining subjective preference surveys with eye-tracking technology has been used extensively to determine the preference for specific features or select species in urban green spaces [13,20]. Many studies have investigated the subjective preferences of people for plant attributes, but non-participatory surveys need to be conducted as additional evidence to confirm the authenticity of subjective preference. The purpose of this study attempts to explore the relationship between subjective preference and visual attention to the visual attributes of greenery. In this study, we addressed the following questions: (1) Which visual attributes of ornamental plants would attract people's attention the most? (2) How did the response of the eyes of the participants change when viewing the different attributes of ornamental plants, as determined by eye-tracking? (3) Which measures of eye tracking were highly correlated with subjective preference? To address these questions, we designed questionnaires and eye-tracking experiments and evaluated the subjective preference and visual attention to attributes of ornamental plants.

2. Method

2.1. Participants

In total, 90 volunteers (31 males and 59 females) participated in the eye-tracking technology and subjective preference survey from August through September of 2021. The average age of the volunteers was 23.13 years (from 20 to 35 years old). The participants were recruited randomly, with 10% and 90% comprising temperate zone regions and tropical or subtropical regions. Those people with natural color vision, a certain aesthetic foundation, and a wide range of aesthetic perspectives were selected as participants.

2.2. Stimuli

Typical attributes of ornamental plants in urban green spaces were selected as stimuli. The attributes of ornamental plants were subdivided into four categories based on vegeta-

tion type, flower color, leaf color, and layer (Supplementary Figure S1). The subdivisions based on their attributes were as follows.

- (1) Vegetation type: grassland (I-A), shrub (I-B), broad-leaf tree (I-C), coniferous tree (I-D), bamboo (I-E), and palm (I-F)
- (2) Flower color: blue flower (II-A), red flower (II-B), pink flower (II-C), purple flower (II-D), white flower (II-E), and yellow flower (II-F)
- (3) Leaf color: green leaf (III-A), yellow leaf (III-B), and red leaf (III-C)
- (4) Layer: tree + shrub + grass (IV-A), shrub + grass (IV-B), shrub (IV-C), and grass (IV-D)

2.3. Procedure

The participants were invited to a quiet laboratory alone. They were asked to sit comfortably on a chair approximately 55 cm from the computer screen where the pictures were displayed. Each experimental stimulus was displayed for 15 s, with a five-second interval between pictures. When the participants were ready, they were informed of the intent, requirements, and procedure of the experiment. Before starting the eye-tracking experiment, the aim and purpose of this experiment were clarified, and the eye-tracking device and procedure were acknowledged [31]. Calibration and validation procedures of the eye tracker were conducted at the beginning of the experiment. After the experiment, the participants were invited to fill in the questionnaire regarding their preference for stimulus.

2.4. Measure

2.4.1. Subjective Ratings

A five-point Likert scale method was used to rate the degree of subjective preference for vegetation type, flower color, leaf color, and layer. The scale ranged from 1 to 5 representing strongly dislike, dislike, average, like, and strongly like, respectively.

The reliability and validity tests reflected the accuracy of the questionnaire and the consistency and stability of the results. The value of Cronbach's α was used to determine the degree of reliability. When the value of Cronbach's α was greater than 0.6, the data met the requirements of the reliability test [32]. The validity test mainly refers to the validity of the questionnaire, and the KMO (Kaiser–Meyer–Olkin) value was measured to determine the requirement of validity.

2.4.2. Eye-Tracking Measures

The eye-tracking experiment was conducted using a desktop EyeLink 1000 Plus, which recorded the eye movement data of the participants while they were viewing the stimuli (1024 × 768 pixels) for 15 s each. The sampling frequency was 1000 Hz/2000 Hz. The eye-tracking measures, pupil size (mm), first fixation duration, dwell time percentage (%), fixation count, saccade amplitude (degree), saccade velocity (degree/second), and saccade count were determined. The eye-tracking heatmap was generated by Data viewer (SR Research Ltd., Ottawa, ON, Canada).

2.5. Data Analysis

The program of experiments was performed using the SR Research Experiment Builder (SR Research Ltd., Ottawa, ON, Canada). The visual analysis was conducted in the Data viewer. One-way ANOVA and Tukey's HSD post hoc tests were performed to determine subjective preferences and eye-tracking measures related to the attributes of ornamental plants. A Chi-squared test was performed for the eye-tracking measures and subjective ratings. The mean decrease accuracy was measured using the Random Forest algorithm. All statistical analyses were performed in R 3.6.3 and SPSS 19.0.

3. Results

3.1. Eye-Tracking Heatmap

The heatmap of the different attributes of ornamental plants was different (Figure 1). The heatmap was generated based on the fixation area and fixation duration. The hotspots were concentrated in one or multiple areas in the heatmap of most stimuli.

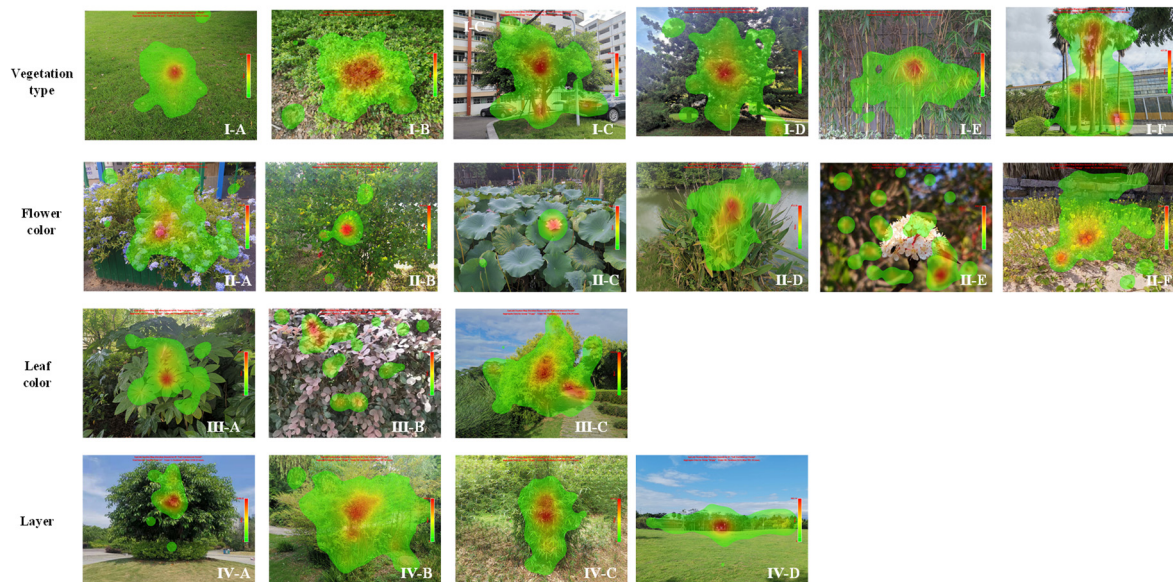


Figure 1. A heatmap of four categories associated with different visual attributes showing the position and duration of fixation. The red areas had the longest fixation time and were visually more attractive, while the green areas had the shortest fixation time and were visually less attractive.

3.2. Subjective Ratings

The results of the reliability test (Cronbach's $\alpha = 0.687$), validity test (KMO = 0.576), and Bartlett's test of sphericity ($p = 0.000$) indicated that the questionnaire data were suitable. Among the different types of vegetation types, bamboo plants (I-E) and broad-leaved trees (I-C) had relatively high scores (Figure 2). Shrubs (I-B) and coniferous trees (I-D) had the lowest scores of 3.39 and 3.32, respectively. Concerning flower color, white flowers (II-E) had a relatively low score of 3.14. Concerning leaf color, the green leaf (III-A) had the lowest score of 3.32, which was significantly lower than the score of the yellow leaf (III-B) and the red leaf (III-C) ($p < 0.05$). Among the layers, tree + shrub + grass (IV-A) had a relatively high score of 4.00. The score of grassland (IV-D) was 3.44, which was the lowest. The differences in the subjective ratings among the different categories were not significant ($p > 0.05$).

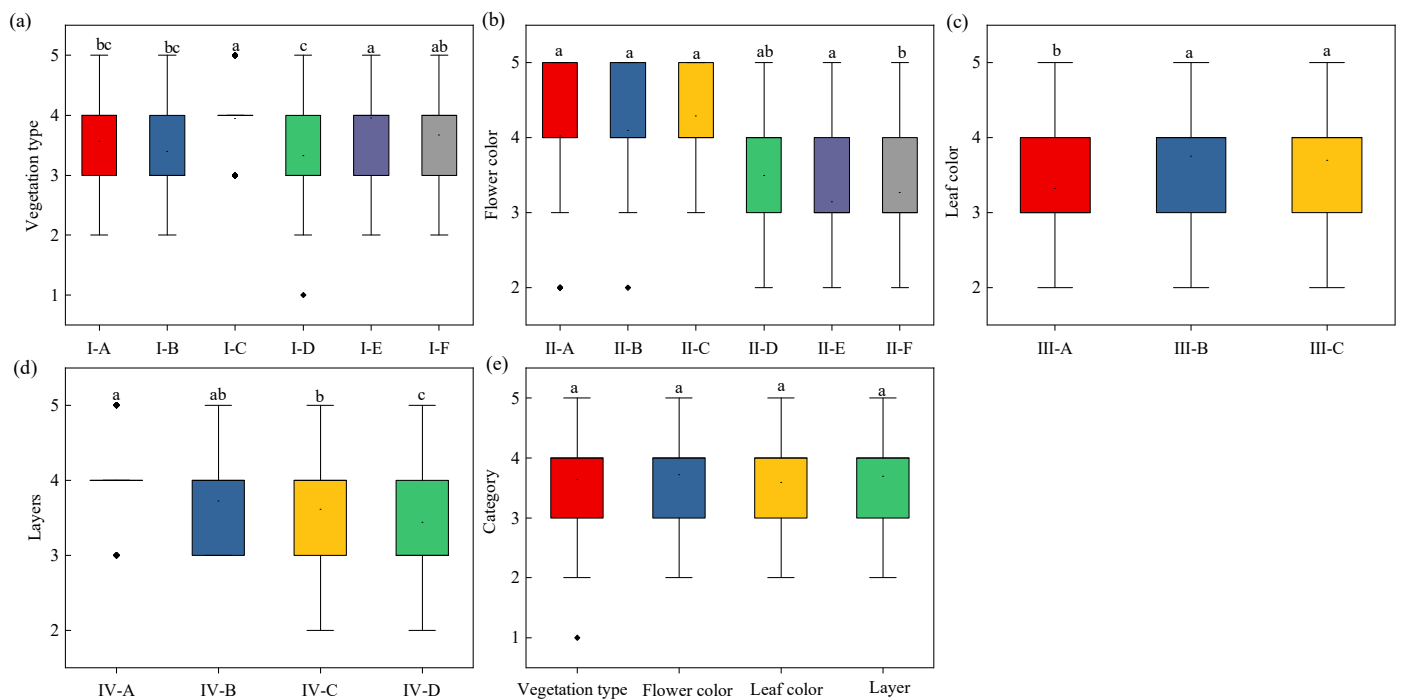


Figure 2. The subjective ratings of four categories in urban ornamental plants are shown; (a–e) represent vegetation type, flower color, leaf color, layers, and categories, respectively; I-A–I-F represent grassland, shrub, broad-leaf tree, coniferous tree, bamboo, and palm, respectively; II-A–II-F represent blue, red, pink, purple, white, and yellow flowers, respectively; III-A–III-C represent green, yellow, and red leaves, respectively; IV-A–IV-D represent tree + shrub + grass, shrub + grass, shrub, and grass, respectively. Different lowercase letters indicate significant differences among different attributes with the same category ($p < 0.05$). Little square represents the mean and rhombus filled with black represents outliers.

3.3. Eye-Tracking Measures

3.3.1. Vegetation Type

The first fixation duration and saccade velocity did not differ significantly among the different vegetation types ($p > 0.05$, Figure 3). Grassland (I-A) had the lowest fixation count of 19. Shrubs (I-B) and broad-leaved trees (I-C) had the highest percentage of dwell time, with 93.97% and 97.44%, respectively; the dwell time did not differ significantly between I-B and I-C ($p > 0.05$).

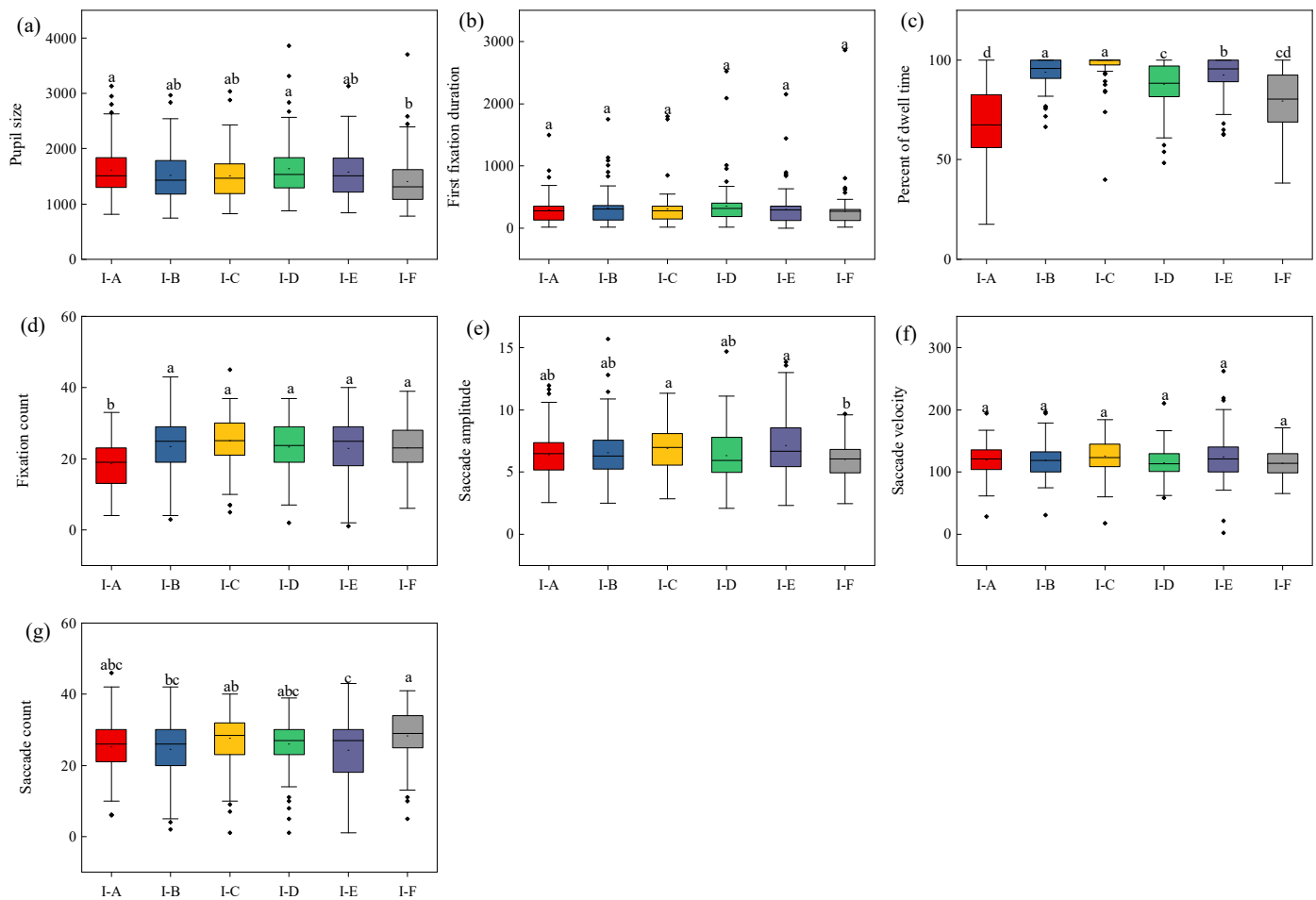


Figure 3. The eye-tracking measures of vegetation type are shown; (a–g) represent pupil size, first fixation duration, the percentage of dwell time, fixation count, saccade amplitude, saccade velocity, and saccade count, respectively; I-A–I-F represent grassland, shrub, broad-leaf tree, coniferous tree, bamboo, and palm, respectively. Different lowercase letters indicate significant differences among different attributes with the same category ($p < 0.05$). Little square represents the mean and rhombus filled with black represents outliers.

3.3.2. Flower Color

The pupil size and first fixation duration did not differ significantly among the different flower colors ($p > 0.05$, Figure 4). Blue flowers (II-A) had the highest percentage of dwell time and fixation count, while white flowers (II-E) had the lowest percentage of dwell time and fixation count. Red flowers (II-B) had relatively low saccade amplitude and saccade velocity, with only 4.18° and 95.51 , respectively.

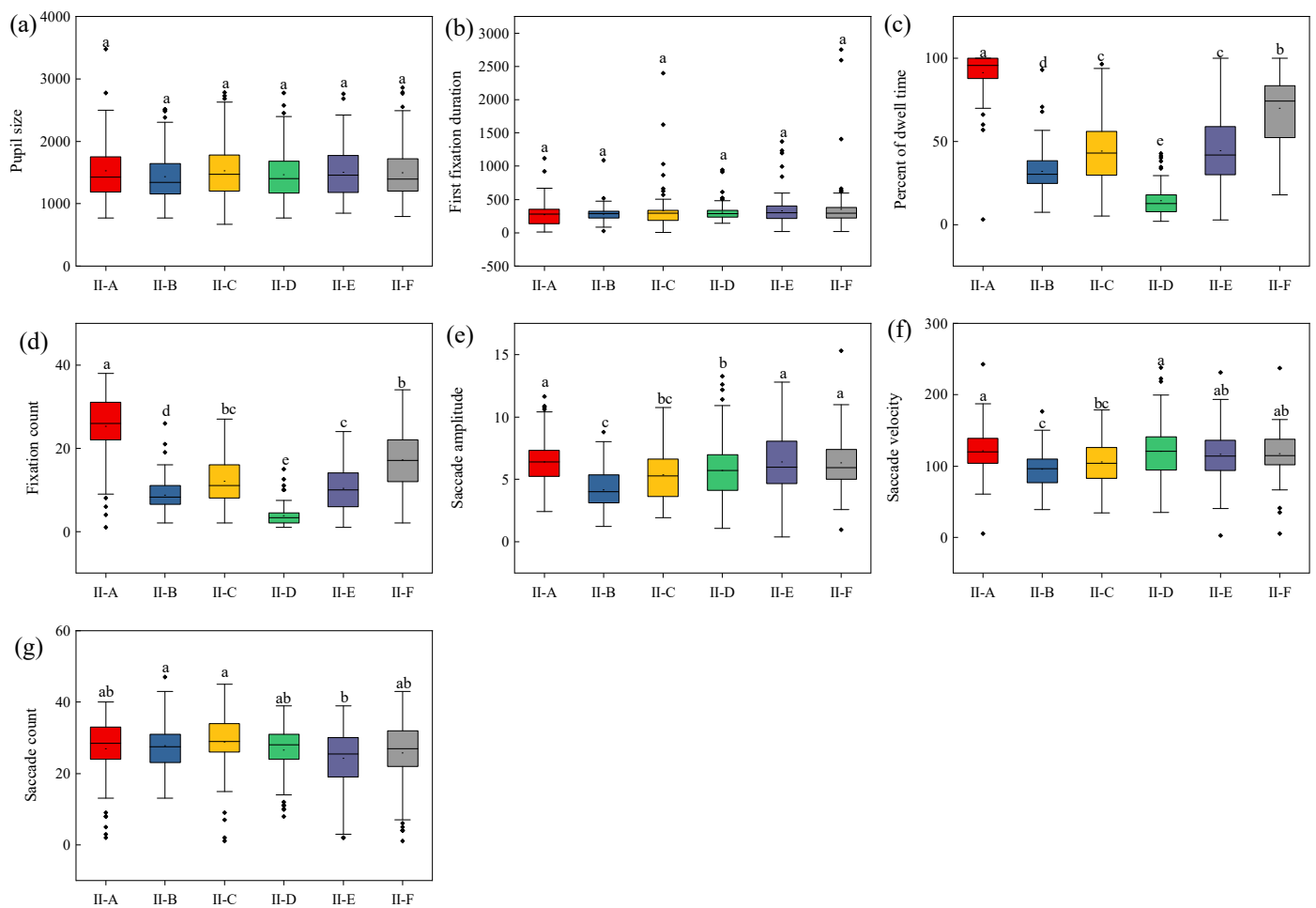


Figure 4. The eye-tracking measures of flower color are shown; (a–g) represent pupil size, first fixation duration, the percentage of dwell time, fixation count, saccade amplitude, saccade velocity, and saccade count, respectively; II-A–II-F represent blue, red, pink, purple, white, and yellow flowers, respectively. Different lowercase letters indicate significant differences among different attributes with the same category ($p < 0.05$). Little square represents the mean and rhombus filled with black represents outliers.

3.3.3. Leaf Color

The first fixation duration, saccade velocity, and saccade count did not differ significantly among leaf colors ($p > 0.05$, Figure 5). The pupil size for green and yellow leaves was significantly larger than that for red leaves ($p < 0.05$). The percentage of dwell time and fixation count for green leaves were the lowest at 65.86% and 16.24, respectively.

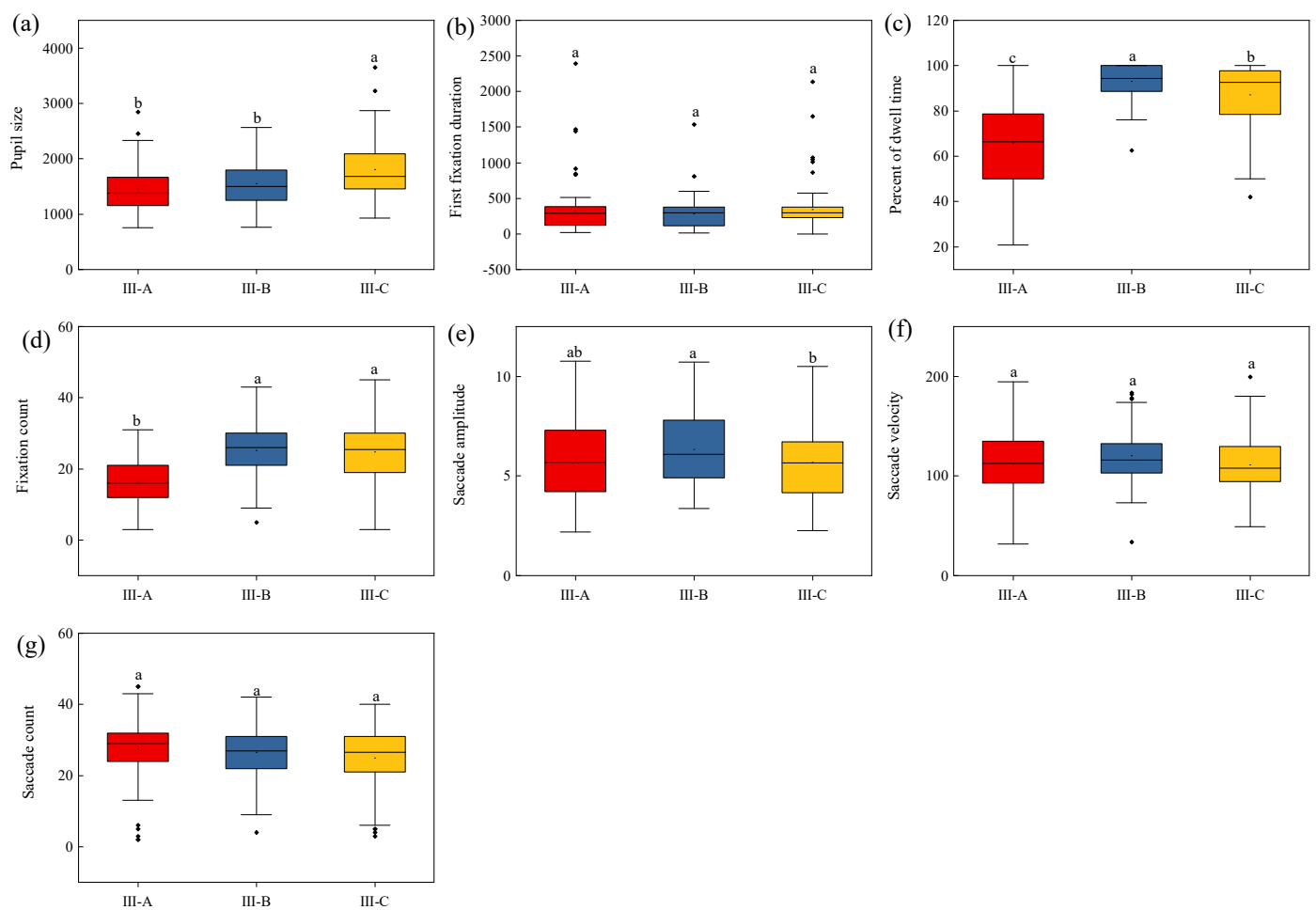


Figure 5. Eye-tracking measures of leaf color are shown, (a–g) represent pupil size, first fixation duration, the percentage of dwell time, fixation count, saccade amplitude, saccade velocity, and saccade count, respectively; III-A–III-C represent green, yellow, and red leaves, respectively. Different lowercase letters indicate significant differences among different attributes with the same category ($p < 0.05$). Little square represents the mean and rhombus filled with black represents outliers.

3.3.4. Layer

The pupil size did not differ significantly among the different layers ($p > 0.05$, Figure 6). Trees + shrub + grass (IV-A) had the highest percentage of dwell time and fixation count at 96.20% and 25.43, respectively. The categories IV-A and shrubs (IV-C) had the lowest saccade amplitude and saccade velocity.

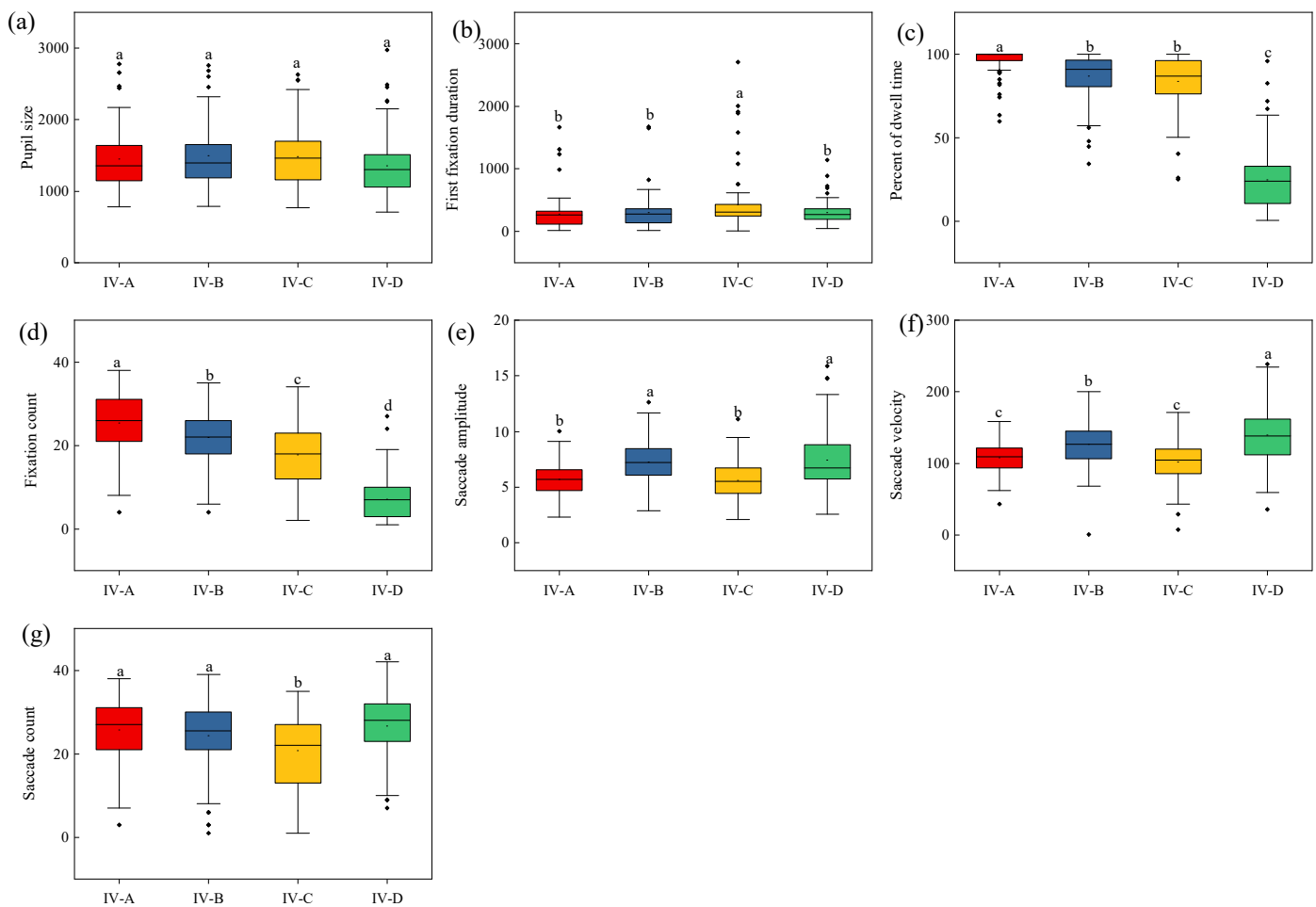


Figure 6. Eye-tracking measures for different layers are shown, (a–g) represent pupil size, first fixation duration, the percentage of dwell time, fixation count, saccade amplitude, saccade velocity, and saccade count, respectively; IV-A–IV-D represent tree + shrub + grass, shrub + grass, shrub, and grass, respectively. Different lowercase letters indicate significant differences among different attributes with the same category ($p < 0.05$). Little square represents the mean and rhombus filled with black represents outliers.

3.4. Hierarchical Clustering Analysis

Ornamental features were classified into three groups by hierarchical clustering analysis; clusters A, B, and C indicated high, medium, and low rating groups, respectively (Figure 7). The SSII, LSI, LSII, SSIII, SVTI, SCIII, and tree belonged to cluster A, as they were given higher subjective ratings by the participants.

The subjective scores of the different types of greeneries were classified into three categories based on cluster analysis and included high ratings (Cluster A), medium ratings (Cluster B), and low ratings (Cluster C) (Figure 7). Among them, the subjective ratings of IV-A, II-A, II-B, II-C, I-C, I-D, and I-E were relatively high.

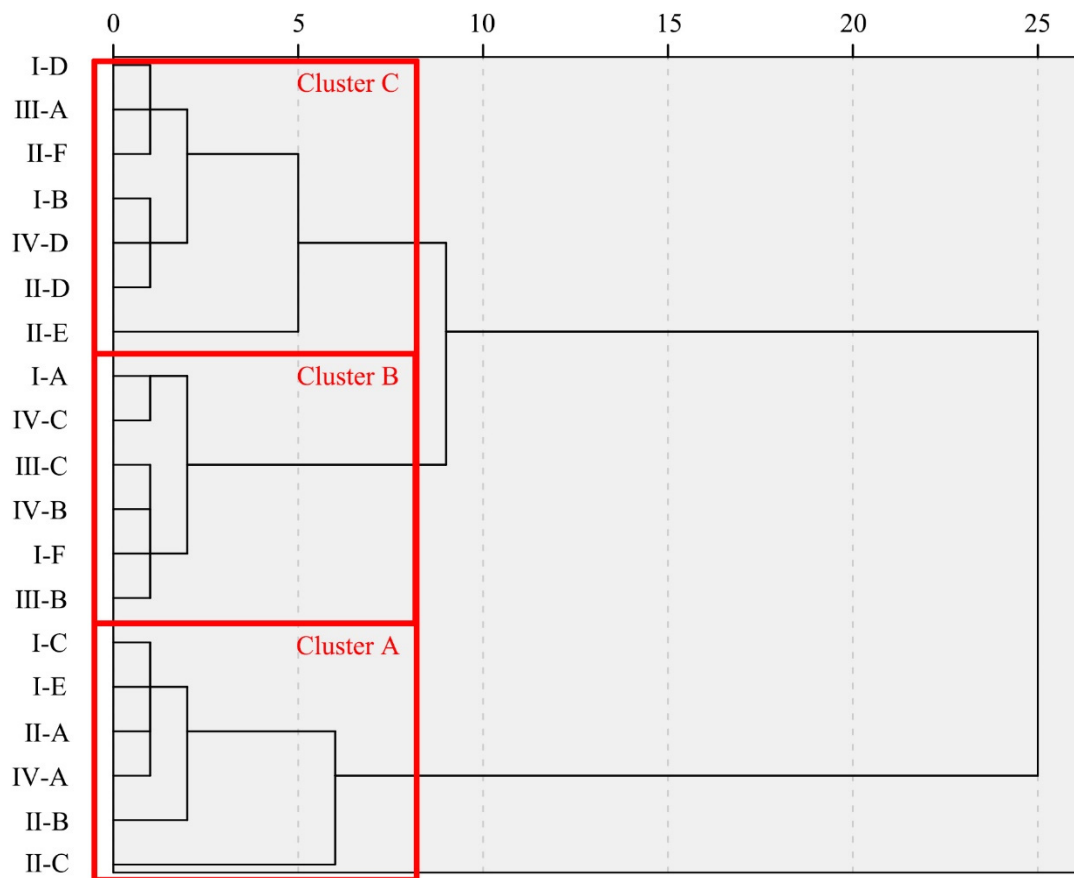


Figure 7. Hierarchical clustering analysis of the ratings of the ornamental features. Based on the Euclidean distance, these features were classified into three groups, Cluster A (high ratings), Cluster B (medium ratings), and Cluster C (low ratings). I-A–I-F represent grassland, shrub, broad-leaf tree, coniferous tree, bamboo, and palm, respectively; II-A–II-F represent blue, red, pink, purple, white, and yellow flowers, respectively; III-A–III-C represent green, yellow, and red leaves, respectively; IV-A–IV-D represent tree + shrub + grass, shrub + grass, shrub, and grass, respectively.

3.5. Chi-Squared Test

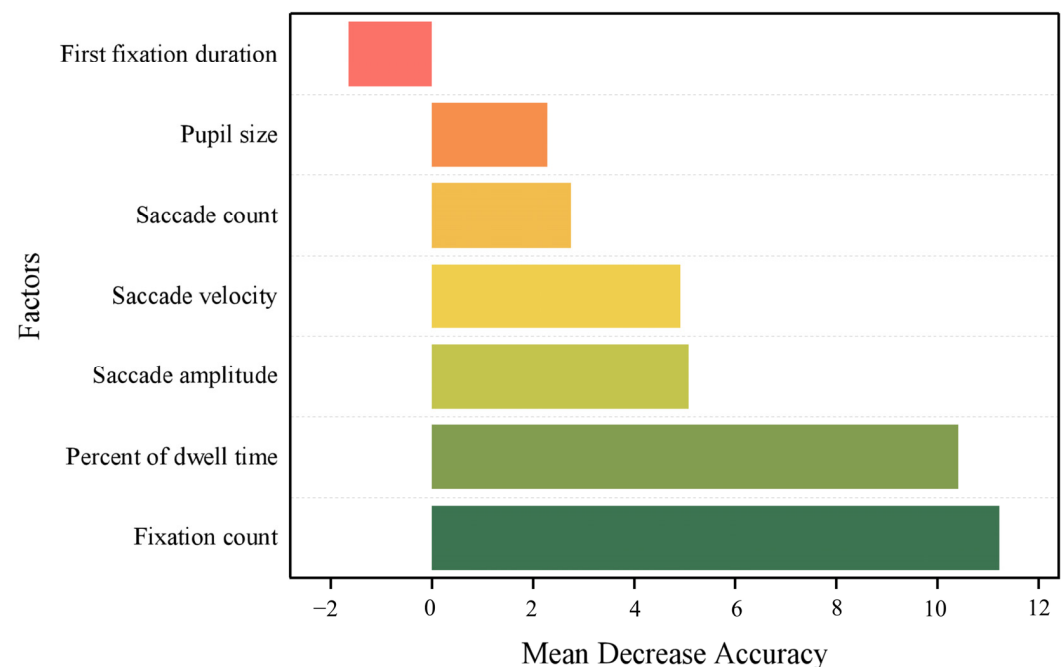
The saccade count and subjective ratings for the vegetation type were significantly correlated ($r = 0.09$, $p < 0.05$, Table 1). For flower color, a highly significant correlation was found between fixation count, saccade amplitude, saccade counts, and subjective ratings ($r = 0.111$, -0.171 , -0.148 , $p < 0.01$, Table 1). Leaf color, pupil size, the percentage of dwell time, and fixation count were highly significantly correlated with subjective ratings ($p < 0.01$). For layer, there was a highly significant correlation of the subjective ratings with the percentage of dwell time, fixation count, and saccade count ($p < 0.01$).

The best combination of trees in the random forest classification model (500) was determined for the highest accuracy of the random forest model. The OOB (out of the bag) error estimate of the error rate of the random forest was 53.72%, which indicated that the variable explained 46.28% of subjective ratings. The order of mean decrease accuracy of eye-tracking measures concerning subjective ratings was fixation count > the percentage of dwell time > saccade amplitude > saccade velocity > saccade count > pupil size > first fixation duration (Figure 8).

Table 1. Chi-square test of eye-tracking measures and subjective ratings of visual attributes.

Eye-Tracking Measures	Vegetation Type		Flower Color		Leaf Color		Layer	
	<i>r</i>	χ^2	<i>r</i>	χ^2	<i>r</i>	χ^2	<i>r</i>	χ^2
Pupil size	−0.020	2131.860	0.026	1567.094	0.162 **	804.330	0.070	1065.167
First fixation duration	−0.050	1222.827	−0.072	1060.040	−0.001	623.700	−0.064	785.029
Percent of dwell time	0.067	1747.592	0.072	1424.126	0.248 **	635.790	0.215 **	885.330 *
Fixation count	0.056	179.028	0.111 **	163.850	0.202 **	116.790	0.32 **	145.626
Saccade amplitude	0.013	2155.151	−0.171 **	1580.703	0.028	804.270	−0.092	1074.119
Saccade velocity	0.019	2157.575	−0.083	1596.287	−0.020	810.000	−0.089	1074.119
Saccade count	0.090 *	152.627	0.148 **	148.810	−0.069	124.160	0.141 **	130.343

r: Spearman coefficient, *: $p < 0.05$, **: $p < 0.01$ (two-tailed).

**Figure 8.** The order of mean decrease accuracy of eye-tracking measures concerning subjective ratings.

4. Discussion

Understanding the preferences, emotions, and perceptions of ornamental plants in urban green spaces can help in selecting species and arranging plants [33]. The heatmap showed eye movements associated with the stimuli [13]. Due to the central effect, most hotspots were concentrated in the center of the picture [34]. However, in this study, we interpreted the visual physiological responses and subjective ratings associated with different stimuli. The results of our study were less affected by the central effect. A greater visual appeal occurs when people encounter features that draw visual attention [4]. In this study, when certain features were focused on by the participants as they performed a visual search, visual attractiveness was generated, and thus, the hotspots differentiated to form multiple areas (Figure 1 I-C, I-F, II-F, and III-C), which also weakened the influence of the center effect on the results of this study. The homogeneity of landscape features or the high visual attractiveness of some landscape attributes might cause visual attention to be concentrated in one spot, as shown in Figure 1 I-A and II-C. The heatmap partly showed the distribution of highly visually attractive features. This information helps to understand the key attractive features of the environment and provides more ideas for landscape planning and design.

Comparing similar attributes of ornamental plants using a saliency-based method can reveal the landscape preferences and physiological responses for specific features [13]. The morphological characteristics of trees can predict the subjective ratings of people [5]. The preference is related to bottom-up processing of the visual features of the natural scene [35]. The low-level visual features (i.e., color spatial, shape) of naturalness are important to esthetic preference [35,36]. In this study, subjective preferences did not differ significantly among different landscape categories (Figure 2e), indicating that flower color, leaf color, vegetation type, and layer resulted in similar overall subjective preferences. However, in another study, flower color was the primary factor that affected the product choices of customers, followed by foliage color and price [37]. Additionally, flowering plants were found to be more popular than foliage plants [33]. We found no significant differences in the subjective ratings of foliage and leaf color overall ($p > 0.05$), but the participants had clear preferences for specific plant attributes. The results of the cluster analysis showed that people preferred blue flowers (II-A), red flowers (II-B), and pink flowers (II-C) in the high rating group (Figure 7, Cluster A), while the subjective ratings of leaf color were all in the medium and low rating groups (Figure 7, Clusters B and C). These results suggested that the subjective preference for visual attributes depended on the visual appeal generated by that feature rather than on organ attributes.

Trees + shrub + grass (multi-layers, IV-A), broad-leaf (I-C), and bamboo (I-E) had relatively high subjective ratings. A multi-layered community structure is positively associated with ecological benefits and has advantages in microclimate regulation [38]. A diverse community of colorful ornamental plants on the streets produces a greater sense of well-being for urban residents [39]. In China, “learning from nature” is advocated to build multi-level plant communities for developing natural forests. Therefore, people have preferred multi-layer communities from the earliest times to the present day, which can increase the exposure of people to green space, promote the well-being of urban residents, generate ecological benefits, and provide visual ornamental value. Among different vegetation types, arboreal bamboo plants have a higher subjective preference [13]. The preference for an arboreal canopy in the modern period might be an instinct formed as a result of evolutionary adaptations, as a canopy cover probably increased the survival of ancient humans [40]. Tree height and the crown-height ratio are important features for predicting subjective preferences [5]. Therefore, the subjective ratings of broad-leaved trees were higher than that of deciduous trees, as they had a dense crown and were greener. The differences in the climate in which the participants are located can influence their attitudes toward plant attributes [33,41]. Most participants were from the tropical and subtropical regions, where broad-leaved species are more widely used in urban green spaces. Coniferous trees are not favored by many, as they are widely used in cemeteries and are associated with negative feelings. Thus, coniferous trees are used less and have relatively low subjective ratings.

Color strongly influences humans, and it is a key parameter for regulating, guiding, and inducing specific psychological states in individuals [42]. Color establishes an emotional connection with humans from different religions and cultures [33]. In this study, people preferred red, blue, and pink flowers, which was similar to the results of other studies. People liked red flowers the most, followed by blue, green, and yellow flowers [43]. People prefer to buy red flowers because they convey positive emotions, while blue, green, purple, white, and dark colors induce calming thoughts [30]. Red flowers are the most popular as they convey high energy, followed by purple, orange, and mixed-colored flowers [33]. Colors give rise to aesthetic subjective preferences and emotional perception [44]. Colorful plants in urban green spaces can promote the well-being of urban residents [39]. Additionally, leaves with color stripes also showed a high subjective rating [13]. People have subjective preferences for specific colors of leavers or flowers because the visual stimulations of colors affect their emotions (positive, calming, comforting, etc.). The color preference bias is related to the evolution of human perception of color and the visual habits formed by different environmental contexts (i.e., climate or cultural context) [33,41]. In this

study, the emotional perception and color bias might change with climate and greenery planting practices; this still needs more evidence.

Eye-tracking measures reflect the psychological contribution of landscape design intensity to the subjective preferences and restorative perceptions of people [19]. They indicate the subjective preferences of people for landscape features [13]. A higher mean decrease accuracy (%IncMSE) in the random forest model indicates the higher relative importance of the variables [45]. In this study, the results of the random forest model indicated that the relative importance of fixation count on subjective ratings was high. This result was consistent with those of other studies [13,22,46]. Visual attractiveness was determined based on the fixation count and fixation duration [11]. Visual attributes with low subjective preferences might be related to visual avoidance or low visual interest and low visual search and eye movements for stimuli. This can lead to a decrease in the fixation count. A decrease in eye movement is related to lower cognitive effort when people observe natural scenes [23]. Beautiful pictures are more visually appealing than ugly ones [2]. The visual value of stimuli can lead to a longer duration of fixation [47]. When the participants viewed the landscape attributes that had a high ornamental value, the fixation duration and fixation count increased, and the saccade amplitude decreased [22]. Conversely, in a study, robot faces with positive emotions induced lesser fixation and fixation duration than those with negative or neutral emotions [48]. The results of our study supported those of previous studies, which suggested a higher subjective preference for pictures with a significant visual appeal. Pictures that have a significant visual appeal elicit sufficiently high fixation to induce an increase in fixation count [11,13]. When people see pictures, processing occurs in five stages; the first three stages are mainly related to the quick processing of the contents of the picture, the bottom-up process that helps to perceive and analyze the picture; the last two stages are related to understanding and thinking about the contents of the picture, such as the top-down process [49]. Thus, the aesthetic value of the picture determines the fixation duration of the picture [49]. When people study features, they are reluctant to spend time observing and fixating on features with low visual attractiveness and low preference, suggesting a lower fixation count.

Pupil size does not indicate visual attention or preference for stimuli. Pupil diameter indicates how interested a person is in a stimulus [29]. A higher aesthetic stimulus increases pupil size [22]. However, a study showed that pupil size increased during emotional arousal and autonomic activation, regardless of whether people were shown a pleasant or an unpleasant image [50]. The results of this study were similar to those of the latter study, i.e., pupil size did not respond significantly to subjective preferences. Another study showed that pupil size was not strongly correlated with the subjective preference for ornamental bamboo features [13]. Perhaps all stimuli in this study increased pupil size, but there was no significant difference in pupil diameter between categories. We assumed that the pupil size would quickly respond to stimuli when viewing pictures with different degrees of attractiveness. The pupil size stabilizes when people think deeply about the contents of the stimulus in the last two stages of the five-stage image processing model. However, these findings need to be confirmed in future studies.

5. Conclusions

The combination of eye-tracking technology and subjective preference can accurately explain subjective preference and visual attention to landscape attributes of greenery. The participants preferred tree + shrub + grass (IV-A), blue flower (II-A), red flower (II-B), pink flower (II-C), broad-leaved tree (I-C), and bamboo (I-E). The random forest model showed that fixation count and the percentage of dwell time can indicate subjective preference. People generate visual attention by fixating on attractive visual attributes with high subjective ratings. The limitation of this research is that we have no specific experimental design to explain the effect of cultural context or region of participants on the color bias. In addition, some visual attributes (for example, fruit color/type) or a combination of attributes were not involved in this study. Future studies should consider

methods, such as a combination of EEG and eye-tracking techniques, for determining the underlying physiological mechanisms of subjective preference generation. We would also invite participants from different climate areas or cultural contexts to reveal the mechanism of color preference bias. In the current study, we performed the machine learning algorithm (Random Forest algorithm) to explore the relationship between eye-tracking measures and subjective ratings. This study supplied an adjunct to explore the correlation between eye movements with mental health or fatigue, and the restorative effect of using eye-tracking technology. It also provided new insights into the mechanisms of subjective preference for the attributes of ornamental plants by performing eye tracking.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/f13111871/s1>.

Author Contributions: Data curation, Y.H., Y.C. and L.G.; Funding acquisition, Y.C., L.G. and Q.L.; Investigation, Y.H. and Y.C.; Software, J.Z.; Visualization, Q.L.; Writing—original draft, J.Z.; Writing—review & editing, J.Z. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by [Introduction of Talents Project of Putian University of Science and Technology] grant number [2021074], [Fujian Province educational research project of young and middle-aged teachers] grant number [JAT210386], [Special project of scientific research and innovation of Putian University] grant number [2021ZP02, 2021ZP03], [Fujian Social Science Foundation Project] grant number [FJ2022C072], [The Second Batch of 2021 MOE of PRC Industry-University Collaborative Education Program, Kingfar-CES “Human Factors and Ergonomics”] grant number [202102055016].

Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

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