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Article

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Abstract: Urban forest parks play a crucial role in contributing to the urban environment, residential well-being, and social welfare. Visitors’ perception of multi-sensory interactive experiences in urban forest parks is an important source of information for landscape planning. Whilst data elicited from visitors via questionnaires are temporally and spatially restricted, online media provide a public platform for the direct and comprehensive expression of park experiences beyond such restrictions. To look into visitors’ multi-sensory interactive experiences in an urban forest park in China, a total of 7447 reviews of such were collected from four authoritative online platforms using Python, and the ROSTCM tool was used to generate semantic and social networks out of the data set. The results showed that urban forest park visitors’ sensory experiences are dominated by visual and olfactory perceptions, followed by audio-visual and visual-tactile interactions. Among them, visual perception displays the highest degree of specificity and diversity, while tactile and gustatory perceptions are relatively infrequent and singular. The landscapes that affect visitors’ perceptual preferences mainly include floriculture, green vegetation, soundscapes, and sanitation utilities. Moreover, both the fresh air and the agreeable environment have a significant positive impact on visitors’ perceptions. The above findings not only have practical implications for the landscape planning and design of urban forest parks, but also provide theoretical insights into the evaluation of natural landscapes in urban forest parks from the perspective of tourists’ multi-sensory experiences.

Keywords: network text analysis; multi-sensory interaction; perception; urban forest parks; China

1. Introduction

Urban forest parks, as important ecological service systems in residential areas, are often called the “Heart of the City” due to their essential role in maintaining the overall ecological balance [1,2]. A good urban forest park can purify urban air, improve health and well-being, provide space for exercising, recreation, entertainment, and ecotourism [3], and help prevent obesity, increase immunity, and reduce the incidence of chronic diseases [4]. In addition, studies have demonstrated that the therapeutic landscape design and implementation in accordance with multi-sensory theory in urban forest parks play an active role in providing mental relaxation [5,6]. Multi-sensory interaction means engagement with the environment through all sensory organs, including the eyes, ears, nose, tongue, and skin [5]. Accordingly, identifying the specific elements that are characteristically appealing to forest park visitors can not only help optimize the visitors’ interaction with the park but also improve the experiential benefits of the park [7]. With the aging of the population and the expansion of sub-health problems, the relationship between urban forest parks and human health has received increasing attention [8,9]. Currently, the global public health crisis (COVID-19) has engendered an increasing awareness of the health-promoting and recreational functions of urban forest parks [10,11]. International treaties and guidelines
such as the European Landscape Convention (ELC) also point out the importance of public participation in landscape assessment [12]. Government agencies and research designers have long relied on traditional techniques of data collection, such as subjective evaluation methods and questionnaires, to study tourists’ perceptual preferences [13].

However, traditional data collection techniques are time-consuming and painstaking, and can only reach a limited number of respondents. Moreover, they may suffer from social desirability bias, and questionnaires often under-represent respondents’ views due to the restriction of predetermined items [14]. As a consequence, policymakers and research designers are unable to obtain a wide range of public insights. With technological developments, live presentation simulation methods [15] and assistive technologies, such as eye-tracking technology and GIS, are widely used to examine visitors’ evaluation of landscapes [16,17]. Nevertheless, these emergent methods are often constrained by various research conditions, including environment, funding, and sample size, and hence the conclusions may not be generalizable to wider contexts.

The emergence of interactive computer-mediated technology has facilitated the collection of research data, and reviews posted on social media platforms have started to be used as an alternative source of research data in recent studies [18]. Currently, there is a growing trend in China to share daily experiences and personal feelings on media platforms such as MicroBlog and Meituan [19]. Review data on social media platforms, also known as crowd-sourced data, refer to user-generated content shared on social networking platforms [20]. This type of data is provided by non-professional organizations and citizens, rather than professional experts and scientists. crowd-sourced data are available in a variety of formats, including textual materials, images, and videos [21], and are highly participatory, spontaneous, extensive, and representative [22]. Compared with other data collection methods, crowd-sourcing is less time-consuming, less costly, and less restricted by space [23]. Numerous studies have revealed that crowd-sourced data play a more important role in advancing landscape perception and preference research [24]. To date, the method has been widely used by academic workers as well as commercial practitioners to investigate tourists’ perceived tourism experiences, architectural landscape design, social public marketing, etc. [25].

In addition, crowd-sourced data can be applied for network text analysis which has a number of advantages over traditional data analytic methods. Firstly, network text analysis can deal with a massive amount of data with high processing efficiency [26]. Secondly, it can reveal the key concerns and sentiments manifested by different user groups [27]. Thirdly, network text analysis can integrate crowd-sourced data from multiple sources to improve the accuracy of results [28]. Therefore, this paper aims to examine the multi-sensory interactive perceptions of urban forest park visitors through network text analysis.

The significance and originality of this study can be highlighted as follows:

1. It is hoped that this study will contribute to the construction of a theoretical system of urban forest natural landscape evaluation from the perspective of visitors’ sensory experiences, and offer practical implications for landscape planning and design of urban forest parks.
2. As multi-sensory interactive experience is a relatively important area of ecotourism research, the result of this study can help enrich the knowledge domains and the theoretical development of accessibility in recreation and tourism, sensory experience [24].
3. This study makes an important contribution to extending the application scope of online text analysis methods from the field of consumer behavior to the field of multi-sensory interaction.

2. Literature Review

2.1. Network Text Analysis

Network text analysis is a method of analyzing text data collected from the Internet with the help of the ROSTCM semantic network and social network generating tool [24].
Text mining is a relatively new research field, and the main method is to collect a large amount of text data from the Internet (social media, newspapers, blogs, websites, forums, etc.) by computers, and after a series of pre-processing, a comprehensive analysis of the valid texts is performed by means of management information system and other technologies to find new knowledge connections and construct new models (Figure 1) [22]. ROSTCM is a data analysis application developed by Professor Shen Yang of Wuhan University with such functions as word segmentation, word frequency statistics, and NetDraw (Visual analysis) [24]. Feature words relating to the research topic are extracted from the text data for quantitative analysis and association mining, which can generate new knowledge domains through the reorganization of useful information [24].

Figure 1. Text mining process.

Text mining is mainly comprised of node analysis and cluster analysis. Specifically, the network text consists of connected nodes, where points represent specific words and feature values, and edges represent the degree of connectivity between individual words or feature values [22]. The number of edges owned by a node is the degree of connectivity between points, and the higher the degree of centrality of a node, the greater the influence it plays on the whole network [23]. Cluster analysis is the process of grouping objects into different clusters by their intrinsic associations [24]. Zhu J explored the emotional changes of urban forest park visitors during the outbreak of COVID-19 by mining and analyzing Microblog users’ review data [19]; Wan C investigated visitors’ preferences and values inspired by urban parks based on social media data in HK [20]. This technique has been widely used to explore users’ emotional responses and affective preferences. But there are few studies using the method to examine visitors’ multi-sensory interaction experience reviews.

2.2. Multi-Sensory Interaction

Multi-sensory interaction refers to one’s integrated engagement with the environment through all sensory organs, including the eyes, ears, nose, tongue, and skin [5]. Currently, the theory of multi-sensory interactive experience has attracted increasing attention from landscape designers and scholars with an interest in designing healing landscapes and promoting human multi-sensory interactive experience [29]. Mei H conducted a case study of Stanley Park in Canada to analyze the therapeutic functions of multi-sensory-based plant landscapes [5]. With the normalization of epidemic prevention and control, medical research on COVID-19 is constantly updated, and recent studies have shown that the senses of COVID-19 patients are severely affected, with 5.3% inflicted with taste disorders and 59.69% with smell disorders [10]. The high contagiousness of COVID-19 has led the public to pay more attention to health exercises and rehabilitation training [10,11]. This trend foreshadows another new construction goal for urban forest parks and underscores the design and improvement of landscapes with multi-sensory interactive experiences.

However, previous studies on multi-sensory interaction are mostly conducted through traditional methods, such as on-site questionnaires and the odor walking method [25,30]. Some scholars devised on-site questionnaires to access individuals’ soundscape preferences and color perception in urban recreational forest parks [30,31]. Other scholars used odor walking and semantic difference methods to induce a subjective evaluation of aroma perception and explored the relationship between the scent landscape and olfactory perception of phyto-communities in parks [30]. Such studies, however, due to inherent methodological limitations, only dealt with single sensory dimensions, such as visual, auditory, olfactory, and so on [31,32], and thus had little to offer concerning the overall landscape perception of urban forest parks.
2.3. Visitor Preferences for Urban Forests

A plethora of research has been conducted concerning people’s preferences for green spaces. It has been revealed that visitor preferences can be detected by visitors’ destination preferences and their attention to certain park facilities [29], and correlation analysis and text selection are the common methods used to measure such preferences [33]. Despite the bulk of relevant research, most studies are focused on people’s preferences for specific amenities or recreational facilities, such as trails in US urban and suburban forest parks [13], or different ways of green space maintenance, such as the sustainable management of green spaces of an urban forest park in the capital of Austria [34], rather than visitors’ overall preferences for the parks as a whole.

Tourists’ preferences for urban forests are found to be closely related to such properties of forests that can help relieve physical and mental stress and bring a sense of security [13,34]. The stronger the visitors’ preference is for a particular attraction, the richer their perception of its features will be [35]. In other words, visitors’ preferences for and their perceptions of forest park features are intertwined. While previous studies have identified characteristics of visitors’ preferences for green spaces [36], few studies have used web-based text analysis to explore visitors’ perceptions of urban forest parks.

In summary, the evaluation of multi-sensory interaction is an important part of urban green space planning and design, and the use of crowd-sourced data can provide a faster and more comprehensive understanding of visitors’ preferences and values in urban forest parks, thus promoting urban forest park landscape planning [37]. In this spirit, this paper intends to conduct a case study of the Baiyun Mountain Urban Forest Park, Guangzhou, China, by visualizing the keywords in visitors’ network reviews through the NetDraw tool and then exploring visitors’ perception of multi-sensory interactive experience through connectivity factor analysis of interconnected nodes between different keywords within the matrix and systematic clustering methods [24]. This is an endeavor that aims to reveal the types of park landscapes favored by most visitors by answering the following questions:

1. What preferences are characteristic of visitors’ multi-sensory interaction with urban forest parks?
2. What are the landscapes that influence visitors’ perceptual preferences?
3. What aspects are most noteworthy in the landscape planning and design of urban forest parks in China according to tourists’ sensory preferences?

3. Methods

3.1. Research Scope

Baiyun Mountain Urban Forest Park in Guangzhou City, Guangdong Province, China, is located in the southern subtropical monsoonal maritime climate zone. Its geographical scope is sketched in Figure 2. Thanks to its unique climatic conditions and abundant natural resources, seven sightseeing areas have been developed for public access, including the Mingchun Valley and the Yuntai Garden, namely the largest natural-style birdcage and the largest garden-style garden in China. The Park boasts 876 species of precious plants, and the air is filled with birdsong and floral scent in all seasons [38]. Delicious snacks of Cantonese style served in the Park are even more memorable for visitors. The special scenic resources and comprehensive dining and touring infrastructure bring visitors a uniquely fulfilling multi-sensory interactive experience [39]. In addition, located in the center of Guangzhou City, the Park is easily accessible and is the most frequently visited urban forest park in the city. The park covers an area of 28 square kilometers and comprises more than 30 linked hilly peaks. There are four entrances to the park, each of which is close to a traffic lane and can be easily accessed by visitors. The park provides undifferentiated access to all visitors, either local or non-local, from home or abroad. The entrance fee to the park is RMB 5 (CHI 0.7) per visit and some of the internal attractions are available for a separate fee, but none of the tickets cost more than RMB 20 (CHI 2.8). Most areas of the park are free for visitors. Therefore, it can be utilized as a typical case to shed light on the landscape planning and design of urban forest parks.
3.2. Research Framework

The network texts extracted in this study are narrations and reviews of visitors’ multisensory perceptions of the Park. To guarantee the representativeness of the sample, we collected visitors’ reviews posted online throughout an entire year spanning from January 2017 to January 2022. We used Python to retrieve and process our initial set of candidate texts from four social networking platforms, namely Mafengwo, Ctrip, Meituan, and MicroBlog. The GET request was used to procure review data from the servers of the four aforementioned platforms, and the POST request was to send the returned data to the servers for parsing. Considering the usage rate of each website, the proportion of positive reviews, and the comprehensiveness of sampling, we finally gathered a total of 10,593 reviews, the composition of which is shown in Figure 3.
The usefulness of the data crowd-sourced from the four platforms has been testified by other studies. Mafengwo is a popular travel site in China with over 100 million registered users and information covering more than 60,000 destinations worldwide [40]. Ctrip is a leading travel agency in China that provides a one-stop service for travelers from hotel reservations to attraction tickets and has the largest market share of approximately 60%. Nowadays, Ctrip has become a data source widely used in studies on the tourism industry [41]. Meituan is the biggest on-demand services platform in China and its users can share reviews on it regarding all aspects of life [42]. Sharing daily emotions and states on social media has become part of everyday life for MicroBlog users. As one of the most representative online social media in China, the Sina MicroBlog had 523 million active users in 2020 [43]. We chose these four platforms because large and reputable platforms have mature business models and ample clients who could offer opinions with adequate variance [44]. The four platforms are all free for registration and can be logged into with no age requirements. Similar studies that have used data from these platforms are showcased in Table 1.

Table 1. The application of the four platforms in related research.

<table>
<thead>
<tr>
<th>Platform</th>
<th>Study Area</th>
<th>Data Type</th>
<th>Key Findings</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meituan</td>
<td>Accommodation Sharing, Tourist attraction</td>
<td>User comments</td>
<td>A 15.4% increase in an attraction’s online popularity after the entry of accommodation sharing.</td>
<td>[45]</td>
</tr>
<tr>
<td></td>
<td>Text segmentation, Keyword extraction</td>
<td>User comments</td>
<td>Platforms offering fast, low-cost services can increase user satisfaction and dependability.</td>
<td>[46]</td>
</tr>
<tr>
<td></td>
<td>Text mining, Tourist Attractions</td>
<td>User comments</td>
<td>The results demonstrate that the characteristics of scenic spots, service attitude, and tourist facilities are the focuses of tourist evaluation.</td>
<td>[47]</td>
</tr>
</tbody>
</table>
Table 1. Cont.

<table>
<thead>
<tr>
<th>Platform</th>
<th>Study Area</th>
<th>Data Type</th>
<th>Key Findings</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ctrip</td>
<td>Content analysis, Tourist Preferences</td>
<td>Travel notes</td>
<td>It turned out that most Chinese honeymoon tourists prefer Asian and European countries, especially island countries for honeymoon tourism</td>
<td>[48]</td>
</tr>
<tr>
<td></td>
<td>Emotional Analysis</td>
<td>Tourist reviews</td>
<td>The findings determined the words that most closely represent the demands and emotions of this customer base</td>
<td>[49]</td>
</tr>
<tr>
<td></td>
<td>Tourism Destination Image</td>
<td>Tourist reviews</td>
<td>The tourist image of Guangzhou is mainly composed of cognitive, emotional, and conative image</td>
<td>[50]</td>
</tr>
<tr>
<td>MicroBlog</td>
<td>Geospatial Semantics Analysis</td>
<td>Short Texts</td>
<td>The cities can be classified into three groups according to their geospatial semantic components, i.e., tourism-focused, life-focused, and religion-focused cities.</td>
<td>[51]</td>
</tr>
<tr>
<td></td>
<td>Temporal and spatial analysis</td>
<td>Microblog text</td>
<td>Changes in visitor sentiment are influenced by the epidemic, the level of the economy, and geographical location.</td>
<td>[52]</td>
</tr>
<tr>
<td>Mafengwo</td>
<td>Destination Image, Emotion Analysis</td>
<td>Travel notes</td>
<td>The tourists’ perception of the destination image, cognitive theme, and emotional experience has different effects on the tourist experience.</td>
<td>[53]</td>
</tr>
<tr>
<td></td>
<td>Tourism Experience</td>
<td>User comments</td>
<td>The changes and analysis characteristics of the tourism experience index under the three-time dimensions.</td>
<td>[54]</td>
</tr>
</tbody>
</table>

As mentioned earlier, visitors to the park are of various geographical locations, including local residents, and tourists from home and abroad. As the study aims to analyze visitors’ sensory interaction with the park, there is no need to draw a distinction between local and non-local tourists; nor is there any need to distinguish between frequent and infrequent visitors. Anyone who visited the park and left their comments on any of the four platforms was included in the sample. The majority of comments in our dataset were given by young and middle-aged users, probably because children and older people use the online social platform less, which virtually constitutes an unavoidable defect for all research using web-based data. Nonetheless, we did remove duplicate texts and comments made by the same account to ensure that no bias would be germinated by identical data. We didn’t collect any other demographic information about the respondents and we kept them anonymous throughout the study.

Despite the bulky size of the data, some of the texts were duplicates, some deviated from the topic, and some described other sensory experiences unrelated to the park. Therefore, prior to the network text analysis, initial filtering was carried out. When the scraping of textual content from URLs was all set up, 7447 valid data were retained for further analysis.

Subsequently, the NetDraw function in the ROSTCM tool was used for content analysis. The top 50 high-frequency feature words related to multi-sensory interaction were extracted by the pre-processing steps: merging and replacing synonyms. Next, CONCOR analysis was conducted to construct nodal blocks to identify the relationship between blocks with the help of the Pearson correlation of co-occurrence matrix between keywords, so as to analyze the multi-sensory interactive experience characteristic of visitors to the park and to provide implications for future multi-sensory landscape planning and construction of urban forest in China (Figure 4).
4. Results

4.1. Content Analysis of High-Frequency Words

Table 2 shows the top 50 high-frequency words in the reviews of Baiyun Mountain Urban Forest Park. Previous studies have demonstrated that the frequency of words can be an important proxy for preference rating and can reveal the degree of importance of features and values [23]. The higher the frequency, the more important the characteristics and values are. The lexical analysis of keywords shows that the visitors predominantly use objective nouns to describe their cognitive experience of multi-sensory interaction.

Table 2. High-frequency characteristic word list.

<table>
<thead>
<tr>
<th>High-Frequency Words (Frequency)</th>
<th>High-Frequency Words (Frequency)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landscape (3297)</td>
<td>Panorama (63)</td>
</tr>
<tr>
<td>Environment (1532)</td>
<td>Creek (62)</td>
</tr>
<tr>
<td>Air (1319)</td>
<td>Sunrise (61)</td>
</tr>
<tr>
<td>Air refreshing (1013)</td>
<td>Birds’ twitter and fragrance of flowers (58)</td>
</tr>
<tr>
<td>Aesthetics (876)</td>
<td>Broad (57)</td>
</tr>
<tr>
<td>Facilities (490)</td>
<td>Mountains and waters (55)</td>
</tr>
<tr>
<td>Beautiful (424)</td>
<td>Taste (54)</td>
</tr>
<tr>
<td>Sightseeing (274)</td>
<td>Vegetation (54)</td>
</tr>
<tr>
<td>Respiration (237)</td>
<td>Sunset (53)</td>
</tr>
<tr>
<td>Peach blossom (195)</td>
<td>Plants (53)</td>
</tr>
<tr>
<td>Forest (161)</td>
<td>Delicacies (51)</td>
</tr>
<tr>
<td>Nightscape (140)</td>
<td>Restaurants (49)</td>
</tr>
<tr>
<td>Overlook (139)</td>
<td>Plank road (46)</td>
</tr>
<tr>
<td>Sanitary (123)</td>
<td>Tea-drinking (45)</td>
</tr>
<tr>
<td>Greening (122)</td>
<td>Dine (43)</td>
</tr>
<tr>
<td>Fresh (116)</td>
<td>Plum blossom (43)</td>
</tr>
<tr>
<td>Bean curd jelly (113)</td>
<td>Neatness (42)</td>
</tr>
<tr>
<td>Quietness (110)</td>
<td>Sunshine (40)</td>
</tr>
<tr>
<td>Luxuriance (79)</td>
<td>Visual field (40)</td>
</tr>
<tr>
<td>Green mountains and waters (78)</td>
<td>Flesh flowers (39)</td>
</tr>
<tr>
<td>Umbrage (72)</td>
<td>Soughing of the wind in the pines (37)</td>
</tr>
<tr>
<td>Catering (70)</td>
<td>Cool (36)</td>
</tr>
<tr>
<td>Delicious (69)</td>
<td>Lawn (36)</td>
</tr>
<tr>
<td>Green (67)</td>
<td>Gardens (34)</td>
</tr>
<tr>
<td>Mountain road (65)</td>
<td>Crowded conditions (33)</td>
</tr>
</tbody>
</table>
The high frequency of ‘air’ and ‘fresh’ is consistent with the results of Wang’s research which states that good air quality is what people like most about urban forest parks, and that access to fresh air is a driving force for park visits [55]. The number of reviews containing ‘(fresh) air’ totaled 2332, accounting for about 31% of the whole dataset. The results indicate that the olfactory interactive experience is of significant prominence to visitors in the park. Next to the number of positive affective expressions in response to the natural environment is that of the aesthetic expressions in response to the landscape environment [56]. The frequent use of such terms as ‘Beautiful’ confirms that visually driven aesthetic perception receives significant attention in landscape evaluation [56], thus reaffirming visitors’ clear preference for natural elements in urban forest parks [8].

Flowers, wildlife, and water sound, are the natural landscape elements most favored by visitors. In respect of visitors’ preferred non-natural landscape features, infrastructure environments, such as sanitation (123) and facilities (490), are more popular than lawns (36) and gardens (34). This may be closely related to the behaviors of the park visitors, such as picnicking and exercising in the park.

Word cloud image, an information text visualization technique that visually reflects the differences in word group importance by using a layout algorithm to represent word frequency in terms of text size, supplemented by a variety of color displays, shows that visual dimensions such as scenery, facilities, environment, and aesthetics are richly perceived, and olfactory dimensions such as air and breathing are saliently perceived (Figure 5).

4.2. CONCOR Analysis of Keywords

To further explore the association between keywords and multi-sensory interactive experiences, CONCOR analysis was performed to visually derive the connectivity patterns within the network and to cluster keywords with similarities [24]. As shown in Figure 6, the filtered high-frequency words cluster into seven groups in order of feature vector scores.
The high-frequency words subsumed in each cluster are listed as follows.

1-1. Natural landscape based on visual and olfactory interactive perception: Environment, Air refreshing, Aesthetics, Sightseeing Green mountains and waters Umbrage, Nightscape, Visual field, Panorama, Sunrise, Extensive, Mountains and waters, Broad, Sunset, The setting sun, Aero view

1-2. Humanistic landscape based on visual and olfactory interactive perception: Facilities, Beautiful, Respiration, Greening, Plants, Temple, Plank road, Gardens, Historic monuments, Flowers, Clear, Sculpture, Road markings, Crowded conditions

1-3. Visual and olfactory interactive experience during outdoor activities: Air, Fresh, Sanitary, Neatness, Picnic, Lawn, Flower scent, Oxygen, Greenspace

2-1. Urban forest park elements based on audio-visual interactive perception: Landscape, Forest, Creek, Quietness, Birdsong, and fragrance of flowers, Luxuriance, Soughing of the wind in the pines, Vegetation, Springwater, Current water, Parrots, Trails, Mountain springs, Music, Birdsong, Birds, Falls

3-1. Natural scenery based on visual and tactile interactive perception: Overlook, Cool, Mountain breeze, Breath, Warmth, The clear and crisp days of autumn, Temperature, Breeze, Wind, Shade

4-1. Natural landscapes based on the visual interactive perception: Peach blossom, Cherry blossom, Flesh flowers, Bamboo forests, Plum blossom, Metasequoia, Colors, Sunshine, Peafowl, Butterfly, Ridges and peaks, Blue sky and white clouds, Red flowers, Green, Leaf, Flowers and plants, Fog, Green hills

5-1. Gustatory perception and experience activities: Bean curd jelly, Delicacies, Dine, Mountain road, Restaurants, Diet, Taste, Tea-drinking, Delicious, Snacks, Honey, Ice cream, Romantic, Catering

What the CONCOR analysis revealed, as shown in Figures 7–13, is the significant association between urban forest park visitors’ experience and multi-sensory interaction preference theory [57].
Figure 7. 1-1. Natural landscape based on visual and olfactory interactive perception.

Figure 8. 1-2. Humanistic landscape based on visual and olfactory interactive perception.

Figure 9. 1-3. Visual and olfactory interactive experience during outdoor activities.

Figure 10. 2-1. Urban forest park elements based on audio-visual interactive perception.
Figure 11. 3-1. Natural scenery based on visual and tactile interactive perception.

Figure 12. 4-1. Natural landscapes based on the visual interactive perception.

Figure 13. 5-1. Gustatory perception and experience activities.

Vision, the major means of awareness and cognition, is a subjective image of an object produced by stimulating the visual organs [58], and olfactory sensation is the main way of fresh air perception [32]. Clusters 1-1, 1-2, and 1-3 mainly present the clusters of tourists’ perceptions based on visual-olfactory interaction. Cluster 1-1 represents the objectivity of tourists’ descriptions of the natural environment. The cluster image shows that tourists not only have a higher perception of ‘Environment’, ‘Nightscape’, and ‘Panorama’ but can also give aesthetics evaluation to the Urban Forest Park. The high centrality of ‘Air refreshing’ indicates that tourists’ perception of air is significant in their sightseeing behaviors. Cluster 1-2 describes the human landscape of the park. The close connection between facilities and breathing indicates that tourists pay high attention to the cleanliness of the environment and the freshness of the air when they enter into the humanistic landscape tour area [59].

The tourists’ focus on the integration of natural experience and humanistic landscape confirms the feasibility of the principle that urban forest park planning should take humanistic connotations into account [60].
Cluster 1-3 is a collection of outdoor activities carried out by tourists in Baiyun Mountain Urban Forest Park. The clustering image shows that ‘Picnic’ is closely connected with green space, lawn, and air, which indicates that tourists pay more attention to the service level of infrastructure of the park when they have picnics. The frequent occurrence of ‘Flower fragrance’, ‘Oxygen’, and ‘Fresh’ bears out that visitors’ olfactory interactive perception activities are significant and specific. Clusters 1-1, 1-2 and 1-3 show that tourists pay critical attention to air perception when using the park.

In terms of multi-sensory interactive experience, although the visual experience dominates, the sense of hearing is necessary for people to obtain information and fully perceive their surroundings [14–16]. A bulk of academic research has been conducted from the perspective of audio-visual interaction [57]. Cluster 2-1 is a group of words relating to the soundscape, such as ‘Soughing of the wind in the pines’, ‘Birdsong’, ‘Music’, and other soundscape sources such as ‘Stream’, ‘Current water’, ‘Mountain spring’ and ‘Parrot’. It shows that visitors be as a significant preference for natural and humanistic soundscapes, a moderate preference for the natural soundscape, including the sound of water, pines, birdsong, and so on, and a lower preference for humanistic soundscapes [58]. This can be attributed to the fact that the regional planning of Baiyun Mountain Urban Forest Park is mainly oriented toward ecological conservation [38].

People are constantly in direct contact with the external environment and thus resonate with the natural environment. ‘Temperature’, ‘Cool’, and ‘Autumn’ in Cluster 3-1 are evidence of visitors’ tactile perception of the outside world. The cluster being centered around the verb ‘Overlooking’ indicates that the tactile perceptual interaction is more pronounced when they are viewing from high places.

Cluster 4-1 displays visually dominant sensory elements, including floral categories such as ‘Cherry blossom’ and ‘Red flowers’; forest landscapes such as ‘Green mountains’ and ‘Bamboo forests’; ‘Butterfly’, animals such as ‘Peafowl’ and ‘Butterfly’; high-level landscapes such as ‘Blue sky and white clouds’, ‘Fog’, and ‘Sunshine’. The convergence of many types of visual landscapes illustrates that human visual perception is characteristic of motion and variation. Moreover, the cluster being centered around flowers and sunlight suggests that tourists have higher perceptual preferences for flower landscapes and sunlight, followed by animals. The preference for flowers can be accounted for by the location of the park as the city of Guangzhou is known as a city of flowers in China, and the preference for sunshine can be ascribed to the hot and humid weather. Cluster 5-1 involves the catering services in the park, with ‘Bean curd jelly’, ‘Tea-drinking’, ‘Snacks’ and ‘Restaurant’ pointing to the products or services therein and ‘Delicious’ and ‘Romantic’ relating to tourists’ sensory experience of the cuisine and the atmosphere. These two clusters being obviously apart indicates that visitors involved in different types of activities have different multi-sensory interaction preferences for the landscapes in the urban forest park. While sightseers have a stronger perceptual preference for visual and natural landscapes, picnickers give more weight to the perceptual experience of food and sanitation.

As shown in Figure 14, the overall share of clusters is presented in a tree diagram.

The cluster analysis identified the following characteristics of tourist’s multi-sensory interactive perception preferences in urban forest parks:

Visual perception dominates the preferences for multi-sensory interactive experiences, which is consistent with the result of relevant medical studies showing that people rely on their eyes for 87% of the information coming from the outside world and that 75%-90% of human activities are caused by vision [59]. As shown by the six cluster images related to the visual experience, tourists have the strongest preference for flowers, followed by green areas, and lastly, the infrastructure.

Air freshness is the hotspot of olfactory perception interaction. The three cluster images of visual and olfactory interactions show that tourists’ sensory experience of urban forest park landscapes is mostly focused on visual and olfactory perceptions. The factors that attract visitors with different travel purposes include the fresh air, the green plants, and the diverse floral fragrances, among which the fresh air is the most significant.
Figure 14. Tree diagram of the share of each cluster.

A natural soundscape is preferred over a humanistic soundscape. Visitors’ salient perception of natural soundscapes in the park stems from the park’s long history of soundscape relics development. The combination of motion and stillness is characteristic of urban forest park landscapes as visitors rely more on auditory-visual senses to gain interactive perception. The study reveals that tourists have a stronger preference for perceptual preferences for water sounds and animal sounds.

The tactile experience is focused on the interaction with the natural landscape. Tactile interactions with the natural vegetation landscape are least reported in the reviews, and the few contents being reviewed point to the weather in the upland areas of the park after climbing activities.

The gustatory experience is closely related to humanistic activities. People’s gustatory experience in the park takes place mainly during picnics and tea-drinking activities. The results suggest that tourists tend to have a singular taste in the natural landscape in the park.

5. Discussion

By summarizing the major findings of the current study and drawing on relevant views of other scholars, this section further explores the perceptual characteristics of visitors’ multi-sensory interactive experience in urban forest parks and offers some significant implications for the landscape design of urban forest parks.

5.1. Perceptual Characteristics of Visitors’ Multi-Sensory Interactive Experience in Urban Forest Parks

This study found that there was obvious multi-sensory interaction in visitors’ perceived experience in urban forest parks, which is consistent with the findings of most studies with a focus on single-dimensional sensory interactions [31,32]. Among the five dimensions of sensory interaction, the most prominent were the visual and olfactory perceptions in this study, which corroborates the influence of natural and human soundscapes on visitors’ audio-visual interactions as demonstrated by visitors’ comments, and fills the gap in existing studies [57]. Consistent with other studies on visitors’ multi-sensory perception of urban forest park, this study also clarifies the dominance of visual perception in multi-
sensory interaction [60]. What is noteworthy is that this study found that when visitors are exercising, picnicking, sightseeing or doing other activities in urban forest parks, their perceptual interaction with the environment is predominantly visual and olfactory, as they are easily attracted to specific flowers such as peach blossom and cherry blossoms, which is a new finding in multi-sensory interactive experience research.

5.2. Effect of Multi-Sensory Interactive Experience on Visitors’ Perception of Activities

This study found that the neatness of the natural landscape and environment can affect visitors’ ability to perceive ongoing activities, which is consistent with the findings of Song X and Xiao J [31,32]. Visitors are keenly concerned about the neatness of public infrastructures, such as trails and restrooms, and during their visits to urban forest parks whether the environment is neat or not is easily noticeable to them. This study also found that visitors’ gustatory perception of the park under study is closely related to the restaurant in the park and the culture of Cantonese cuisine. The gustatory perception is mainly manifested in the evaluation of dining tastes and the atmosphere of the restaurant, which indicates that the gustatory perception should be further explored in future research on visitors’ interactive experience in urban forest parks [61]. Another new finding worthy of mentioning is that visitors’ tactile experience was mainly focused on indirect contact with the natural landscape, especially their exposure to the wind in the forests and the weather conditions after climbing up to high grounds [5]. The shortage of review texts concerning direct tactile perception in this study reveals the absence of tactile sensory interaction facilities for visitors in urban forest parks and the necessity to provide design recommendations in subsequent research.

5.3. Implications of Multi-Sensory Interactive Experience for Landscape Planning

This study can also offer practical implications for the future landscape design of urban forest parks from the perspective of multi-sensory interactive experience.

(1) Improving the neatness and richness of the visual landscape of urban forest parks:

As discussed earlier, the neatness and richness of the landscape are important factors affecting visitors’ audiovisual interaction. Therefore, on one hand, the parks should improve the neatness of overall infrastructure and the park environment through regular maintenance, such as cleaning the trails, restrooms, and the restaurants. On the other hand, based on visitors’ high perception of floral landscape, urban forest park managers can take advantage of the climate features and regularly hold flower-themed exhibitions to enrich visitors’ visual experience.

(2) Constructing tour areas where the olfactory landscape can be visualized:

A new finding of this study is visitors’ rich use of visual-olfactory perception of urban forest parks. However, up to date, there are relatively few studies on the construction of olfactory sensory landscapes in China’s urban forest parks. It is thus suggested that Chinese urban forest park researchers and designers refer to the principle applied in the building of an olfactory sensory garden in Sheffield, UK. Brightly colored flowers can be planted on either side of the entrance to the garden to provide visual guidance, trees and shrubs should be planted around the exhibition area to facilitate fragrance concentration, and exhibition junctions should be designed to face the prevailing wind so that the wind can partially pass through the garden, carrying the fragrance to every corner of the exhibition area [62]. The core of the olfactory landscape lies in the visitors’ subjective awareness, behavior, and perceptual range, and subjective factors are more difficult to control in the design [63]. Therefore, we can refer to Belgian olfactory artist Peter de Cupere’s “Scent Scenario” installation, which uses “fog” to attract visitors to stop and feel [64].

(3) Strengthening the protection of human soundscape relics while developing natural soundscape resources in a scientific and diversified manner:
This study found that the human and natural soundscapes were significantly perceived by visitors to the urban forest park [65]. Unfortunately, it has been shown in earlier research that the soundscape remains of Baiyun Mountain urban forest park are at the risk of disappearing [38]. It has been revealed that bird twitting accompanied by insect chirping and water flowing or light music accompanied by temple bells could enhance participants’ sense of involvement and significantly reduces stress [66]. Therefore, in respect of humanistic soundscape conservation, park managers can conserve valuable sound as a resource by preserving historical tapes. On top of that, park managers can develop natural sound landscape resources in many ways, for example, by creating sound sequences by using the sound of water falling on different building materials or the sound of wind blowing through different buildings, to encourage visitors to identify the soundscape of different materials and buildings to enhance their interactive experience.

(4) Enriching tactile perception through directly accessible infrastructure:

The study found that visitors to urban forest parks have a weaker tactile perception of water bodies, plants, and park landscape facilities, except for the wind. Therefore, various forms of water landscape, such as over-water wooden boardwalks and pools, can be built in the future to provide people with a hydrophilic tactile experience. More than that, paths can be paved with cobblestones, bark, and wood chips, and signposts can be made with carved designs to extend visitors’ visual and olfactory interactive experience with their hands and feet as they are the most directly sensitive organs for tactile perception [5]. In addition, to ensure that visitors can fully enjoy the beauty and novelty of the park design, the plants and flowers on both sides of the road in the urban forest park should be regularly pruned and maintained; toxic, thorny, hard, and untouchable plants should be avoided.

(5) Enriching gustatory perception by providing various culinary services:

The study found that the gustatory experience of visitors to urban forest parks is relatively homogeneous. To enrich people’s gustatory perception and to spread local culinary culture, managers can improve catering services in the park by setting up more restaurants of different styles or enriching the variety of food and beverage served. Managers can also integrate into the food services “natural oxygen bars”, “flower foods” and other theme-based restaurants to create a brand that is unique to the urban forest park.

6. Conclusions and Further Work

This study reflects the perceptions of different stakeholders about their urban forest park experiences. A distinct advantage of this study is that it reveals the multi-sensory interactive experience of visitors to an urban forest park. The data collected are highly authentic and representative as they are tourists’ self-reports of direct experiences. In regard to visitors’ overall multi-sensory preferences, it is found that the perception of visual and olfactory landscapes was the most prominent, followed by the audio-visual perception of natural and humanistic soundscapes, while the tactile and gustatory perceptions were the least reported. These findings demonstrate that visitors’ evaluative texts should be taken into account in landscape design.

The innovative use of crowd-sourced data ensures that visitors to the urban forest park are maximally represented, though some groups, such as those who do not like to share their experiences on social networking platforms, may have been under-represented. Besides, our dataset could lend itself to a wider range of qualitative and quantitative analyses, including sentiment analysis with a view to identifying visitors’ positive and negative emotions towards urban forest parks.

However, the generalizability of this study is also limited by the use of web-based data. First, the demographic information of may be ambiguous as users may have concealed their age, gender, place of residence, etc. In addition, sentiment analysis is one of the important elements of network text analysis [19], but this study only focuses on the multi-sensory interactive experience without further exploring emotional or attitudinal issues, such as the sentiment polarity of the visitors’ review texts, which could help urban forest park designers.
make finer-grained decisions. Therefore, in-depth interviews and fieldwork combined with qualitative and quantitative analysis can be conducted to detect the emotional attitudes behind visitors’ sensory experiences.

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**Data Availability Statement:** Data are available upon the enclosure in the ZIP folder.

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