

Research on Perception-Based Urban Park Plant Landscape Design

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Received: 16 May 2023; Accepted: 25 May 2023; Published: 5 July 2023

Abstract:

The rapid development of China's socio-economic conditions and the continuous improvement of people's living standards have led to increasing demands for the surrounding landscape environment. People have shifted their focus from a singular emphasis on aesthetics and functionality to a higher quality of landscaping, gradually integrating "perception" and "experience." This article, based on a review of previous literature, introduces the concepts of perception, experience, and the creation of plant landscapes. It provides an overview of the current research methods and status of domestic and international studies on the perception and experience of plant landscapes, and offers predictions for future research and development in this field. The aim is to provide a reference for incorporating better perceptual and experiential features into urban park plant landscape design in the future.

Keywords:

Perceptual Experience, City Park, Botanical Landscape

1. Research Background

1.1. Perceptual experience is lacking in city park landscapes.

With the rapid development of modern society, people face increasing pressure in their daily lives and work. Landscape designs that are solely based on visual aesthetics are no longer able to meet people's needs for a comfortable and relaxing living environment. People urgently need a comfortable and relaxed living environment. Landscape design has evolved from being purely decorative to reflecting the way people live in the natural environment. During the process of visiting park landscapes, people instinctively use all five senses to perceive the surrounding environment. Through various stimuli provided by the landscape, they can have a comprehensive experience of the park landscape. However, in current city park landscape design, there is still a focus on pursuing visual effects while ignoring people's overall sensory experience. Only focusing on the visual aspect of the landscape neglects other senses, which in turn affects the quality of landscape design. [1]

1.2. The importance of comprehensive planning in city park landscapes.

Landscape architecture is an important part of people's lives and a significant place for leisure and entertainment. A beautiful environment can bring positive stimulation to people's senses and allow them to engage in interactive experiences with the landscape, thereby relieving stress and nurturing emotions. City parks, due to their open and diverse spatial requirements, should exhibit characteristics of humanization and diversification in their design. [2]

Landscape architecture is created by humans and serves humans, but different people have different requirements for landscape architecture.

In the design of park landscapes, attention should not be neglected for vulnerable groups such as the elderly, children, and the disabled. Designers have the responsibility to create a landscape that allows them to experience the spatial environment through their own perceptual methods. This allows them to feel the beauty of nature and meet their physiological and psychological needs through a comprehensive landscape experience, truly achieving equality for all in the face of landscape.

2. Related concepts

2.1. Landscape perception theory

The theory of landscape perception is an independent theory developed from environmental psychology. It originated in the 1950s and refers to the sensory and cognitive experience of individuals as the perceiving subject towards the external environment object. This involves the use of sensory organs such as vision, hearing, smell, and touch to obtain information about the landscape elements of the external environment. It can be understood as the relationship between individuals and the external landscape environment. [3] As John Simonds said, "People are not planning for places, spaces, or forms, but for an experience". [4]

The American scholar Kaplan also proposed a landscape perception model that integrates humans, landscape, and their interactions into a closed loop, and believes that landscape perception is a continuous process. Landscape perception can be simply understood as the interaction between humans, landscape, and the results of their interaction.

2.2. City Park

City parks are the main places for human social life, and their green spaces are excellent places for interaction between humans and nature. Plants are the main landscape element that occupies most of the space in city parks. Through changes in form, texture, color, and the release of odors, plants have an impact on people's sensory experiences, including vision, hearing, taste, touch, and smell. Through high-quality plant landscape perception design in city parks, the interaction between humans and nature can be enhanced, and people's sense of identity with nature can be strengthened.

2.3. Botanical landscape

Designing plant landscapes with perception in mind can fulfill people's multisensory experience needs and create a comprehensive and three-dimensional experiential environment. Recognizing the important role of plants as the main landscape element in parks, understanding the research methods, theoretical practices,

and the role of perception in plant landscapes is of great significance for updating city park landscape design. Currently, there are rich research achievements on plant landscapes and perceptual experience both domestically and internationally, mainly focused on research methodology exploration, theoretical improvement, and practical applications.

3. Methods for the Study of Plant Landscape Perception Experience

Currently, domestic and foreign research on the cognitive experience of plant landscapes mainly focuses on two levels: human physiology and psychology, attempting to interpret the role of plant landscapes from a quantitative perspective and improve their scientific and operational evaluation. In terms of measuring physiological indicators, instruments are mainly used to measure changes in various physiological indicators of subjects before and after exposure to plant landscapes, such as blood pressure, pulse, heart rate, EEG, and eye movement trajectories, in order to obtain data on the impact of plant landscapes on human physiological health. Evaluation of psychological indicators mainly relies on perception scales and questionnaires, which allow participants to express their subjective feelings using rating scales, semantic differentials, pictures, and other methods. However, due to individual differences, psychological indicators have some subjectivity and limitations. [5]

(1) Literature analysis method

By searching academic papers, reading various relevant books at home and abroad, and reviewing relevant materials, this method involves selecting and comparing to summarize the advantages and disadvantages to apply to the subsequent design. Analyzing and reviewing various types of literature can not only understand the development trend and existing research results but also observe practical cases that have been built at home and abroad, analyze them, and provide design ideas.

(2) Theory combined with practice

In the landscape design of perception experience, it involves the integration and application of various disciplines, such as the theory of sensory experience and environmental psychology. This article briefly explains these theories and guides the practice by combining them with practical cases in the research.

4. Research Status of the Perception Experience of Garden Plants on Garden Landscape

Currently, the theoretical research on multi-sensory experience in China is still in its early stages, and the application of multi-sensory experience in park landscape design is not yet widely seen, with a focus mainly on visual and auditory aspects. There is relatively little research on other sensory experiences. Meanwhile, research on individual sensory organs is slowly developing.

From a practical perspective, research on multi-sensory experiential design started by targeting specific groups of people. However, since the 1980s, there have been many explorations and applications in China, leading to the establishment of a number of parks for the blind. In recent years, parks focusing on “sensory experience” have gradually emerged, such as the “Blind Plant Garden” in Suzhou, the “Sensory Park” in Changsha, and the “Yanzhong Green Space” in Shanghai.

There are 276 relevant literature on multisensory experience in China, and the research trend is on the rise, with 40 of them combining with landscape design. Among them, Wang Maolin and Qin Liping explored the concept of five-sense design in landscape from different sensory elements and proposed that the combination of the five senses is the foundation of landscape design. Yi Maole's "The Application of Five Senses in Landscape Design" analyzes the use of the five senses in design; Yuan Ye's "Research on the Application of Five Senses Design in Landscape Design" summarizes the application methods of five senses design in landscape design and the concept of creating a five-sense environment. [6] Xu Lu and Qiu Er's "Analysis and Trend of Research on Five-sense Landscape Design at Home and Abroad" analyzed and summarized the research status of five-sense landscape design in China and abroad, and discussed the future development direction. Huang Muxuan analyzed and researched the sensory experience landscape design of city parks in "Research on Sensory Experience-based Landscape Design of City Parks". [7]

5. The Impact of Perceptual Experience of Plant Landscapes in City Parks

5.1. Theory and Practice of Plant Landscape Perceptual Experience

Based on this foundation, a large amount of research has been conducted on the cognitive experience of park plants, and a relatively complete theoretical system has been established. "Stress reduction theory" and "attention restoration theory" were proposed by foreign scholars, suggesting that being in nature and observing plant landscapes can promote people's physical and mental health, while "therapeutic landscapes" and "horticultural therapy" use "plant landscapes" as intermediaries to directly and indirectly benefit people's bodies and minds through stimulation of the five senses. Against this background, the concept of "landscape ecology" has been proposed, advocating for the integration of human sensory and psychological factors into the construction of city ecological environments.

Under the support of a relatively complete theoretical system, the practice of plant perception experience in botanical gardens has gradually developed. For example, the Bishan-Ang Mo Kio Park in Singapore and the Elizabeth and Nona Evans Restorative Garden have designed planting experience areas in community gardens between high-density cities, allowing people to gain tactile and gustatory sensory experiences through planting and harvesting crops. However, the current design practices of plant landscape perception experience in both domestic and international contexts mainly focus on hospitals and sanatoriums, and have not yet been widely applied in city public spaces. [8]

5.2. Perceptual experience and health of botanical gardens

Plant landscapes not only bring a good ecological environment to the city, but also allow people to stimulate their five senses, including sight, hearing, smell, taste, and touch, by admiring the color and form of plants, listening to the sound of the wind blowing through the plants, touching the various textures of the plants, and tasting the fruits of the plants. This can directly or indirectly stimulate the perception of the five senses and improve the physical and mental health of the human body. Landscape plants have high restoration potential. For example, large-scale green landscapes can effectively alleviate visual fatigue and improve mood. The volatile substances released by plants and the negative ions in the air can have physiological effects such

as regulating blood pressure, suppressing pain, and enhancing anti-pain ability, thereby regulating people's emotions and mental states. This is exemplified by “forest therapy” and “healthcare landscapes”. Plant landscapes can also have the effect of alleviating and isolating noise, creating a peaceful resting space. Listening to the natural sounds emitted by the forest can be invigorating for people. [9]

5.3. *Perceptual experience and traditional culture of botanical gardens*

In order to create city landscapes that are more suitable for China's development needs, domestic scholars have explored new perspectives from the perspective of traditional cultural concepts based on existing research on plant landscapes. Zhang Jinli, using Taoist moral and health concepts as a guide, discusses the design principles, spatial creation, and plant landscape planning of healing landscapes under this philosophy. Yang Huan and others analyzed the relationship between the Five Elements theory of traditional Chinese medicine and the surrounding environment, and applied it to the design practice of rehabilitation flowers. Wang Xuan believes that the design of plant landscapes should pay attention to the application of plant feng shui, integrating plant qi field, plant essence, and the attributes of the plant's yin and yang Five Elements, in order to achieve a balance between people and plants. Research on the perceptual experience of plant landscapes and traditional culture in China has presented a diverse development trend. [11]

5.4. *The role of perceptual experience in botanical gardens in different groups*

Individuals of different ages and physiological conditions have different perceptions of the external environment. Children have a strong sensory perception, young adults are influenced by aesthetic tendencies, the elderly have weaker sensory perception, and sick individuals have poorer sensory perception. In order to create green spaces suitable for different groups' needs, scholars at home and abroad have analyzed the differences in perception and sensation of plants from different groups' perspectives. Based on the characteristics of children's sensitivity to the five senses, it is proposed to combine and match different senses to create plant landscape spaces with multiple modes in city parks, so as to enhance children's cognitive abilities. By observing the evaluation feedback of college students on plant landscapes of different colors, it was found that professional and cultural background factors can affect the visual perception preferences of young people. [12] It is known that older people may experience physiological degradation, and therefore, color arrangements of plants with seasonal variations can enhance their sensory capabilities. Additionally, the fragrance and health benefits of plants can also meet the needs of older people for health and wellness. [13]

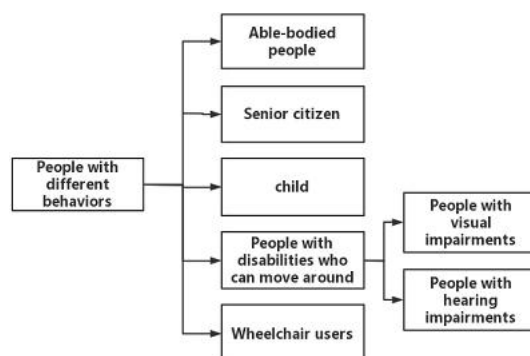


Figure 1. *Different behavioral groups.*

6. Strategies and Methods of City Park Plant Landscape Design Based on Perceptual Experience

6.1. Create a visual experience environment

6.1.1. Use light and shadow to build visual perception

(1) Using natural light: By utilizing natural light such as sunlight, cloud shadows, and tree shadows, a rich and diverse light and shadow effect can be created in the park to enhance people's visual perception experience. Seating, bridges, and paths can be placed in the woods, where light and shadow intertwine to form beautiful natural scenery.

(2) Utilizing artificial lighting: At night, artificial lighting can be used to enhance the visual experience of the park. By placing light poles and ground lights under trees, a warm and cozy nighttime environment can be created. Different colors and brightness of lighting can be used to create different light and shadow effects in the plant landscape.

(3) Using water reflection: The reflection on the water surface can create a unique light and shadow effect. Setting up ponds, fountains, and other water features in the park, and using water surface reflection to create dynamic light and shadow effects. At night, using water surface reflection of lights can make the park's light and shadow effects more diverse and colorful.

(4) Utilizing architectural structures: In the design of city park plant landscapes, the facades of buildings can also be a good means of creating light and shadow effects. By utilizing the materials and forms of the building facades, various light and shadow effects can be created. By adjusting the shape and layout of the buildings, the light and shadow effects can be even more impressive.

(5) Utilizing landscape installations: Setting up landscape installations such as sculptures, artistic installations, etc. in the park can create unique light and shadow effects through clever design and layout. By placing lighting fixtures around the landscape installations, the light and shadow effects can be made more prominent.

6.1.2. Use color to render visual perception

(1) Using color contrast: Color contrast can help enhance the visual effect of the landscape. By using color wheel theory, colors can be combined into contrasting pairs, such as cool tones with warm tones, bright colors with dark colors, to create a strong visual contrast effect. Using color contrast to create a sharp contrast between plants and their surrounding environment, making the plants more prominent.

(2) Using color saturation: Color saturation can affect the emotional experience of viewers. High saturation colors can make people feel excited and vivid, while low saturation colors can make people feel calm and relaxed. According to the emotional theme of the landscape, different saturation colors can be selected to create corresponding emotional experiences.

(3) Utilizing color brightness: Color brightness can affect the spatial and depth perception of a landscape. Colors with high brightness can make people feel closer, while colors with low brightness can make people feel farther away. Based on the spatial needs of the landscape, different colors with varying brightness can be chosen to create different spatial and depth perceptions.

(4) Utilizing Color Themes: Choose colors according to different themes. For example, warm colors can create a cozy atmosphere and are suitable for places with intimate relationships, while cool colors can create a refreshing atmosphere and are suitable for places promoting health and cleanliness. Choose appropriate colors according to the theme and atmosphere of the park.

(5) Utilizing color combinations: By using different combinations of analogous colors and complementary colors, different visual effects can be created. However, it is important to avoid overly complex color combinations, as they may detract from the viewer's visual experience.

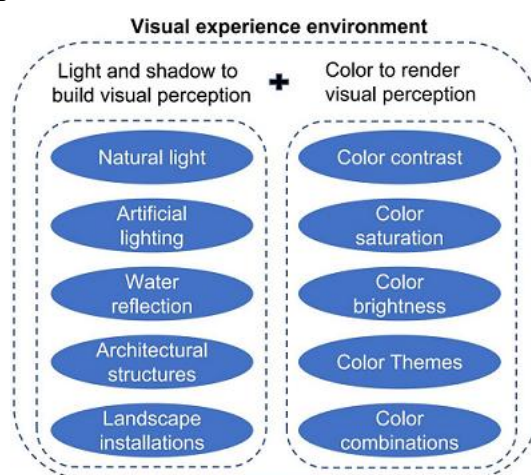


Figure 2. Elements of creating a visual experience environment.

6.2. Create an olfactory experience

6.2.1. Olfactory experience of microclimate

(1) Choose suitable plants: Different plants have different aromatic scents. Choose plants that are suitable for planting based on the park's climate conditions and environmental characteristics. For example, flowers such as jasmine and roses can create a strong floral fragrance, while trees such as fragrant Chinese toon and osmanthus can create a fresh scent. [14]

(2) Creating an aromatic path: Setting up an aromatic path in the park allows visitors to experience the fragrant smells as they walk. The aromatic path can be made up of different plants, and visitors can enjoy different scents along the way. [15]

(3) Creating a humid environment: A humid environment can increase the moisture content in the air and make the fragrance more intense. Creating a humid environment can be achieved by adding water sources and setting up fountains.

(4) Setting up fragrance misters: Installing fragrance misters in the park that periodically spray the scents of plants can allow visitors to experience the aroma throughout the park. The misters can be placed in corners or areas with lower foot traffic to avoid disturbing visitors.

(5) Use multi-level design: Multi-level design can enhance the olfactory experience of visitors. For example, setting plants of different heights in the park can allow visitors to experience fragrant scents at different heights.

6.3. Create an environment for the auditory experience

6.3.1. Experience time and space in the auditory world by creating natural sounds

(1) Plant selection: Choosing the right plants can help create a natural sound atmosphere in city park landscapes. For example, plants such as bamboo and weeping willows can sway in the wind, creating gentle natural sounds.

(2) Setting up water features: In the plant landscapes of city parks, the sound of water is a common natural sound. Setting up water features such as fountains and streams in the park can create the sound of flowing water.

(3) Creating a natural audio tour guide: Creating a natural audio tour guide in the park can allow visitors to hear natural sounds while walking. For example, visitors can hear sounds such as bird songs, insect sounds, and cicada songs, which can increase visitor interaction and engagement.

(4) Nighttime lighting: Installing appropriate lighting fixtures in the park can create a nighttime sound atmosphere. For example, setting soft lighting around water features allows visitors to hear natural sounds such as the sound of flowing water and frog calls at night.

(5) Sound design: In the plant landscapes of city parks, different auditory effects can be created through sound design. For example, setting up echo walls or speakers in the woods can create music, natural sounds, and other auditory effects.

6.3.2. Choose the artistic conception of artificial sound to bring auditory perception

(1) Musical elements: Setting up appropriate music equipment in the park can create a specific atmosphere. For example, lively music can make visitors feel joyful, while melodious music can create a pleasant atmosphere.

(2) Animal sounds: Playing animal sounds in the park can make visitors feel immersed in the environment. For example, playing bird songs, insect sounds, and cicada songs can allow visitors to experience the beauty of nature.

(3) Natural sounds: Playing natural sounds in the park, such as wind, flowing water, and rain, can allow visitors to experience the beauty of nature. These sounds can be played through equipment such as speakers and loudspeakers.

(4) Artificially created sounds: Setting up some sounds with special significance in the park, such as the sound of bells, whistles, and percussion, can create a rustic atmosphere and allow visitors to experience the charm of history.

(5) Audio guide: Setting up an audio guide in the park can allow visitors to hear about the park's history, culture, and other information while listening to sounds, increasing visitor interaction and engagement.

6.4. Create a tactile experience

6.4.1. Use the touch of the “hand” to build the skin sensory environment

(1) Texture and tactile sensation of plants: Planting different types of plants in the park, each with its own unique texture and tactile sensation, can increase visitor engagement and experience. For example, soft grass, rough tree bark, and smooth leaves. These plants can be touched by visitors, allowing them to feel the tactile sensation of the plants and enhance their experience.

(2) Tactile sensation of ground materials: The ground materials in the park can also

be used to create a tactile environment. For example, different types of pebbles, wooden planks, tiles, etc., each with a different texture, shape, and size, can be touched by visitors to experience different tactile sensations.

(3) Interactive Art Installations: Setting up interactive art installations in the park, such as sculptures, arch bridges, and swings, allows visitors to experience different tactile sensations. For example, swings can provide visitors with a sense of changes in gravity and wind, enhancing their interaction and experiential sense.

(4) Water features: Adding water features such as fountains, streams, and small ponds can provide opportunities for visitors to touch and feel the flow and texture of water, enhancing their sensory experience and engagement in the park.

6.4.2. Use the tactile sensation of “feet” to build the skin sensory environment

(1) Tactile experience from ground materials: The ground materials in a park can be used not only to create a tactile environment but also to create a tactile experience for the feet. For example, different types of tiles, wooden planks, and stones can be used in the park, with each type of ground material having different shapes, sizes, and textures. This allows visitors to feel different textures underfoot and experience various tactile sensations.

(2) Tactile sensations from terrain changes: Setting up terrain changes such as small hills and grassy slopes in the park can allow visitors to experience different sensations through their feet, enhancing their interaction and experience in the park.

(3) Interactive art installations: Setting up interactive art installations such as trampolines and rock climbing walls in the park can allow visitors to experience different sensations through their feet, enhancing their interaction and overall experience.

(4) Water features: Setting up water features in the park, such as small streams and ponds, can allow visitors to walk barefoot in the water and feel its temperature and flow, enhancing their sense of participation and experience.

6.4.3. Use the touch of the “torso” to build the skin sensory environment

(1) Texture of plant landscape: In city parks, different types of plants have different textures, such as rough, smooth, soft, etc. Visitors can touch the plants with their hands to feel their textures, increasing their sense of participation and experience.

(2) Texture of stone, wood and other installations: In city park plant landscapes, some installations such as stones and woods can be placed. Visitors can touch and feel the texture of these installations by hand, enhancing their sense of participation and experience.

(3) Interactive art installations: Setting up interactive art installations such as wooden bridges, suspension bridges, etc. in the park can allow visitors to experience different textures through physical contact, enhancing their interactive and experiential feelings.

(4) Spatial design: In city park landscaping, special spaces can be designed such as mazes, grass huts, etc., allowing visitors to experience different tactile sensations through physical contact, increasing their interaction and sense of experience.

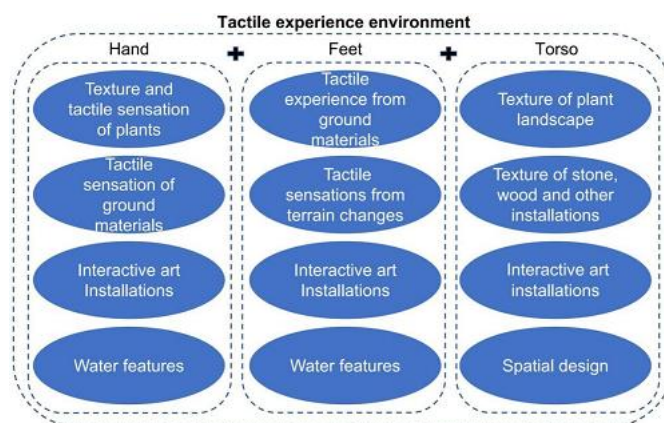


Figure 3. Environmental elements for creating tactile experience.

6.5. Create a multi-sensory experience

6.5.1. The combination of single factor and multi-factor

(1) Integrating color, light and sound: By coordinating the colors, lighting, and sounds in a specific area, a particular atmosphere and environment can be created. For example, using soft colors, gentle lighting, and soothing music to create a relaxed and comfortable atmosphere.

(2) Using the scent and texture of plants: Using the scent and texture of plants to create a natural environment that allows visitors to feel the natural breath and texture.

(3) Using multimedia technology: By using projection, sound, lighting, and other multimedia technologies, different sensory experiences can be merged together to create a multisensory atmosphere.

6.5.2. The coexistence of “primary” and “secondary” senses

(1) Highlight the main sensory experience: Choose a main sensory experience, such as visual, olfactory, or auditory, in the design and highlight it to create the best effect. For example, if visual is the main sensory experience, visual focal points such as flower beds and colored lights can be set up in the park.

(2) Enhancing the experience with other sensory experiences: While emphasizing the main sensory experience, other sensory experiences can be used to enhance the richness of the overall experience. For example, in a scene where visual experience is the main focus, soft music and floral scents can be used to enhance the overall sensory experience.

(3) Creating multiple sensory experiences: In design, multiple sensory experiences can be integrated to create a richer overall experience. For example, in a park, a pond can be created to offer a unique experience through multiple sensory experiences, such as the tactile sensation of the water, the reflection on the water surface, and the sound of birds.

6.5.3. “Virtual” and “Real” in a Multisensory Environment

(1) Use projection technology: Set up projection equipment in the park and stimulate the audience's visual experience through projected images and light and shadow, creating a more vivid landscape experience. For example, project different light and shadow effects on the flowers and leaves of plants to allow viewers to more

intuitively feel the vitality and beauty of the plants.

(2) Utilizing Sound Effects: Setting up audio equipment in the park and playing sound effects to stimulate the audience's auditory senses, creating a more immersive auditory environment. For example, setting up fountains around the park's water pool and playing natural sounds such as flowing water and bird chirping, allowing visitors to feel the flow of water and the vitality of life.

(3) Using aroma technology: Setting up aroma devices in the park to stimulate the audience's sense of smell with the released fragrances and create a fresher atmosphere. For example, setting up fragrant flower beds in the park and releasing different floral fragrances to create a refreshing and pleasant atmosphere, allowing the audience to relax and enjoy the beauty of nature.

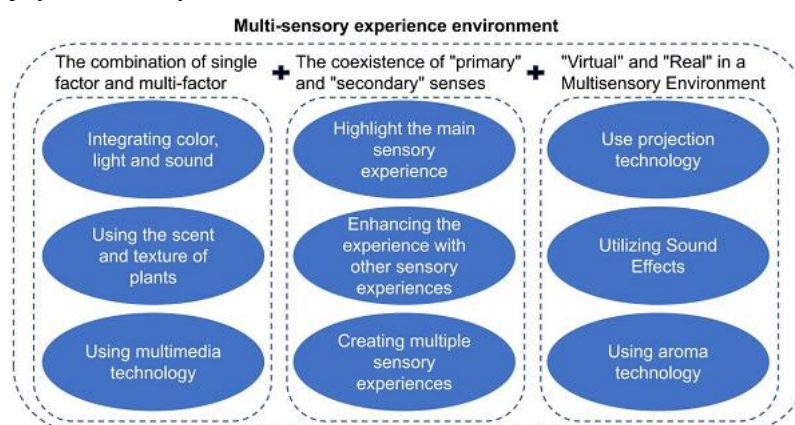


Figure 4. Elements of creating a multi-sensory experience environment

7. Conclusions

The research on the design of plant landscapes in city parks based on perceptual experience shows that people's perception of park plant landscapes is multidimensional and involves multiple senses. Therefore, in the design of plant landscapes in city parks, it is necessary to fully consider the multi-sensory experience and create a more diverse and rich sensory environment, providing people with a more comfortable and enjoyable spatial experience.

Indeed, designing a multi-sensory environment in city park plant landscapes requires using different design techniques for different senses. For example, incorporating elements of color, light and shadow, scent, sound, and texture to create a multi-sensory environment. In addition, it is necessary to consider the combination of multiple sensory elements and the creative use of virtual and real elements to ensure that the application of multi-sensory elements is more coordinated and natural.

In the future, as urbanization accelerates and people's requirements for city park plant landscapes continue to increase, the design of city park plant landscapes based on sensory experiences will receive more and more attention. It is necessary to further investigate the mechanisms and rules of multi-sensory experience and explore more innovative and personalized design techniques to provide better solutions for the creation and improvement of city park plant landscapes. At the same time, the public's perception and experience of city park plant landscapes also need to be continuously investigated and studied to better meet people's needs for natural environments and improve the quality of urban ecological environments.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

Funding

This work was supported by the Guangdong Education Science Project (Higher Education Special Project) (2021GXJK200), and the Guangzhou Philosophy and Social Science 14th Five-Year Plan Project (2021GZGJ274).

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