

# Research on Spontaneous Play and Environmental Characteristics Related to Children's Interaction With Plants in Community Parks of Tianjin

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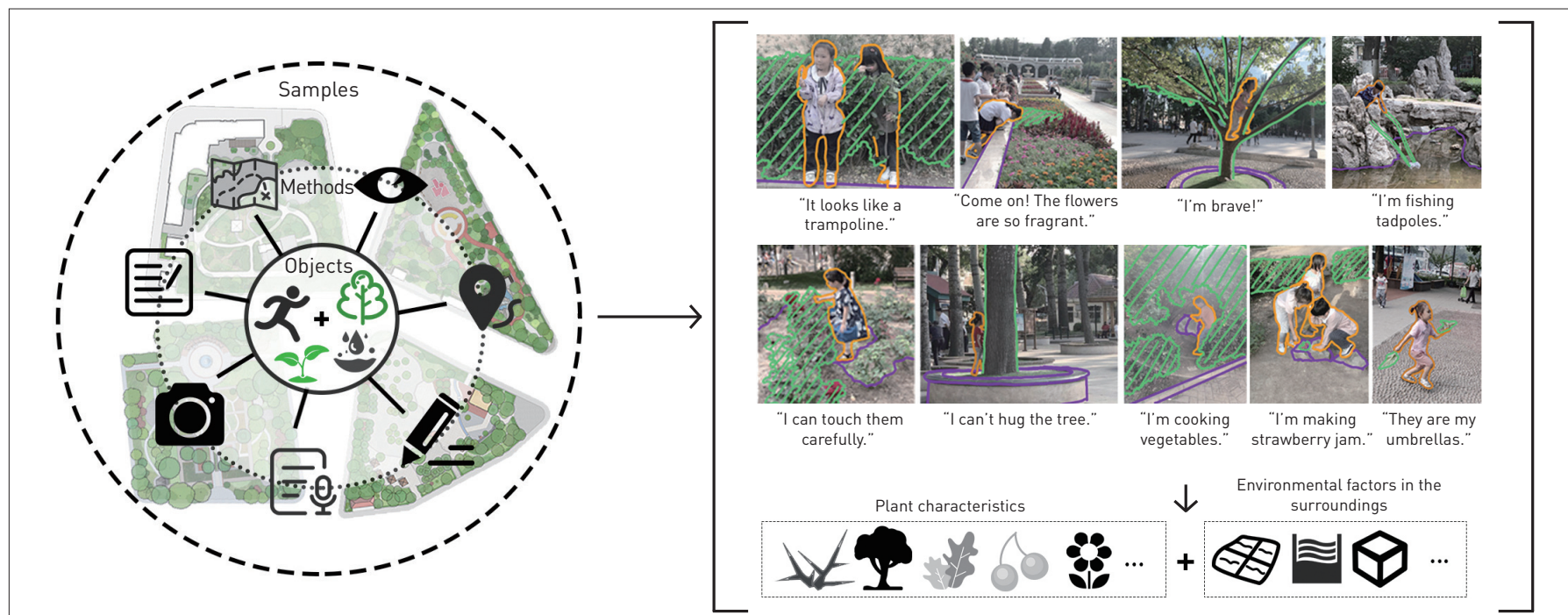
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## GRAPHICAL ABSTRACT



## HIGHLIGHTS

- Children's play preferences vary in different spatial and plant design settings
- Children prefer plants with distinctive leaves, flowers, fruits, and thick branches
- Environmental factors like soil and planting containers stimulate children's interaction with plants to varying degrees
- Children can make use of plant and site characteristics for challenging and adventurous play
- Design should create environments that can stimulate children's spontaneous play and expand affordances of plants

## KEYWORDS

Children;  
Community Park;  
Plant Landscape;  
Environmental Characteristics;  
Spontaneous Play

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With the advance of inclusive city and child-friendly city construction, children's opportunities to access nature have gained increasing concern. This study explored the play preference of children aged between 3 and 12 years old when they interact with plants, as well as the corresponding environmental characteristics, with four community parks in Tianjin as examples. It collected data on behaviors, plants, and environmental factors in the surroundings concerning children's play with plants via multiple methods including behavioral observation, behavioral mapping, questionnaire, and semi-structured interview, which were examined under theories related to cognitive development, children's play, and affordance. Employing methods such as quantitative analysis and cross tabulation analysis, the study further obtained the frequency of children's various types of play and the affordance provided by different plants in varied environments, as well as the specific play behaviors in these environments. The findings show that due to the biophilic nature, children are able to actively make use of

existing green spaces and utilize the perceived affordance, used affordance, and shaped affordance of plants to play various types of games in high-density urban environment. Children's interaction/play with plants increases their direct connection with nature and can basically meet their daily needs for natural experience; green spaces where there are plants with diverse species and characteristics and varied environmental factors in the surroundings can stimulate more plant affordances. Future landscape design should pay more attention to how to facilitate children's natural and spontaneous play by creating diverse places for different play needs, introducing rich and distinctive plants, developing supporting functions of other environmental elements, encouraging challenging and adventurous play, and strengthening safety and environmental education.

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## 1 Introduction

### 1.1 Community Parks as Important Environments for Children to Access Nature

The *New Urban Agenda* proposed by the United Nations suggests that future urbanization should focus on dimensions of inclusiveness, equity, and sustainability<sup>[1]</sup>. To build an inclusive city, it is critical to seek common development for multiple interest groups of different cultural backgrounds, ages or geographical origins<sup>[2][3]</sup>. Of these groups, children, as vulnerable ones, need places that can support their physical and mental development in urban environments.

Early childhood and adolescence are important stages of individuals' growth, and alienation from nature will not only make people be less aware of life, but also impact their physical and mental health<sup>[4]</sup>. Related social experiments and studies have shown that being close to nature can positively affect children's sensory development<sup>[5]</sup>, attention and cognitive development<sup>[6]</sup>, as well as psychological restoration, physical activity and social cohesion<sup>[7]</sup>, which can enhance children's experience of nature and life and

effectively alleviate the nature-deficit disorder<sup>[5]</sup>, autism spectrum disorder<sup>[8]</sup>, etc.

Although children's direct contact with nature plays an irreplaceable role in their growth<sup>[9]</sup>, accelerating urbanization has encroached a lot of natural playgrounds for children<sup>[10]</sup>, resulting in children's less access to nature than their elder generations<sup>[11]</sup> and that their natural games or nature-based outdoor activities noticeably decreased<sup>[12][13]</sup>. In response, more and more playground design projects in urban environments begin to seek for a closer integration with nature<sup>[14][15]</sup>. Given the time constraints, distance, and mode of children's mobility, community parks provide important places for children's daily recreational activities<sup>[16]</sup> and connection with nature<sup>[17]</sup>. Compared with comprehensive parks, community parks are more accessible and can intensify children's direct experience of nature<sup>[18]</sup>.

### 1.2 Game and Environmental Preferences Encouraging Children's Connection With Nature

"Biophilic" means that humans have natural and inherent emotional connection with other creatures<sup>[19]</sup>. Due to their special

**Table 1: Summary of different types of play**

Type	Goal/intent	Characteristics
<b>Exploration</b>	To obtain visual or auditory information from an object	Explore the object's specific physical properties
<b>Functional play</b>	To experience sensory stimulation through simple, repetitive muscular movements	Simply for the enjoyment of the physical sensation the play creates
<b>Games-with-rules</b>	To engage in a competitive game-type activity following pre-established rules and limits	Child accepts prearranged rules, adjusts to them and controls his/her actions and reactions within the given limits
<b>Constructive play</b>	To create or construct something	Have obvious purpose, such as building or creating, and reading is included; its main difference with functional play lies in the goal of play
<b>Dramatic play</b>	To dramatize life situations or bring life to an inanimate object	Child in a dramatic role or engage in some types of pretense play

**NOTE**

The types, goal/intent, and characteristics of play are mainly sourced from Ref. [28].

affection for and tendency to play with plants, children are willing to relax and play in places rich of plants<sup>[20]</sup>. American scholar Robin C. Moore classified plants in children's play places by their functions<sup>[21]</sup>, providing a preliminary reference for the planting design of outdoor spaces for children. Research also found that tree roots and trunks in outdoor spaces can provide special sensory stimulation for children<sup>[9][22]</sup>; more trees and plants with rich forms and colors can greatly enhance children's interest in outdoor play<sup>[23]</sup>. Moreover, spatial location of plants and barriers in the space may influence children's preferences when playing with plants<sup>[9]</sup>; the disparity of environmental settings around plants will also stimulate varied playing paths of children<sup>[24]</sup>. One study further proves that children's play takes place more often in some "in-between spaces," rather than formally-designed playgrounds<sup>[25]</sup>. These findings corroborate that plants play an important role in children's interaction with nature and provide an important reference for further exploration of the relationship between vegetated spaces and children's play. However, public spaces in current high-density urban areas are increasingly losing their natural qualities, and the integration of plants and children's play spaces in urban parks is also insufficient<sup>[10]</sup>. What is worse, planners and designers' lack of understanding of children's interaction with plants in urban environments limits the functions that plants can

play in children's connection with nature.

According to some studies, spontaneous play is the game that is chosen, directed, and communicated by children themselves depending on their own interests and needs<sup>[26]</sup>. Adopting this concept, this study defines spontaneous play as the free, non-facility play created and developed by children by utilizing existing environmental elements of the site. Children's spontaneous play in traditional parks is a biophilic activity upon their natural preference and needs, providing significant evidence for the design of children's play spaces. The relationship between children's spontaneous play and the environment setting can be examined under theories related to cognitive development, children's play, and affordance.

Some researchers classified play as exploration, functional play, game-with-rules, constructive play, and dramatic play by the extent of perception and thinking, basing on the cognitive-developmental theory<sup>[27]</sup> and the Play Observation Scale<sup>[28]</sup> proposed by Kenneth H. Rubin. Specific descriptions of these categories are shown in Table 1. This research employed this classification to record children's play behaviors and probe into the relations with natural environment.

The theory of affordance, emphasizing the objective information in the environment, suggests that any possibility

of interaction between the body and the environment will generate “behavior”<sup>[29][30]</sup>. Marketta Kyttä and William Gaver classified the actualized affordance into perceived affordance, used affordance, and shaped affordance<sup>[31]~[33]</sup> to describe the characteristics and extent of children’s interactions with the environment<sup>[20]</sup>. This theory expands the research perspective of children’s environmental perception and clearly presents the functions of environmental elements in children’s play, providing opportunities to fill in the gap in cognizing types of children’s interactions with plants in Chinese cities and the corresponding environmental characteristics, and to enrich the application of affordance in studying children’s connection with nature.

Based on the above theories and from the perspective of children’s environmental perception, this study takes community parks in Tianjin, China as examples to identify children’s preferences of play types with plants and the corresponding environmental characteristics, hoping to provide guidance for the inclusive design of green spaces at community level and creating better physical spaces for children to access nature.

## 2 Study Area and Sample Selection

Tianjin is an important industrial and trading city. It has recently started a series of urban construction projects including renewal of old residential communities and child-friendly city construction. Choosing community parks from the central districts with a higher density would be more representative to probe into green spaces for children’s daily life in urban areas.

According to the Standard for Classification of Urban Green Space (CJJ/T85-2017)<sup>[34]</sup>, a community park is the green space to serve residents living within a certain range for daily recreational activities, with an area no smaller than 1 hm<sup>2</sup>. Considering that green spaces in high-density urban areas are limited, this study chose community parks covering an area of about 1 hm<sup>2</sup> and free to the public. Research has proved that children are more likely to use parks in the distance of less than 500 m<sup>[35]</sup>, thus community parks within the 500-meter walking distance from homes or schools were selected. Then a pre-research was conducted in community parks of the central Nankai District, Heping District, and Hexi District to learn the differences in landscape elements and vegetation settings, so as to ensure that the selected sample sites cover most of the common plant species and planting types in the city. Thus, four representative community parks were selected as sample sites for the study, including Fenghu Park in Nankai District, Tonglou Park in Hexi District, and Tushan Park and Munn



Fenghu Park



Munan Park



Tushan Park



Tonglou Park

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1. Sample sites

Park in Heping District (Fig. 1). The vegetation in these four sample parks keeps well-maintained condition; Fenghu Park and Tushan Park saw a higher level of vegetation density and intimate spaces enclosed by plants, while Tonglou Park and Munan Park had more tree planters and shrubs, with more open spaces.

During the pre-research, it was observed that children who interact/play with plants in community parks were mostly under the age of 12. The preliminary interviews also showed that children aged 3 years old and above had better language and expression ability, higher cognitive and physical activity level, and were more likely to express their ideas clearly and interact/play with plants spontaneously. Thus, children aged between 3 and 12 years old were selected as the research objects.

## 3 Research Methods and Data Collection

### 3.1 Research Contents and Methods

The research process mainly included three parts.

1) Collected basic information of plants in the community parks: field measurements, site surveys, and plant inventories (species, location, size, form, etc.), which can be used for children’s behavioral mapping and analysis.

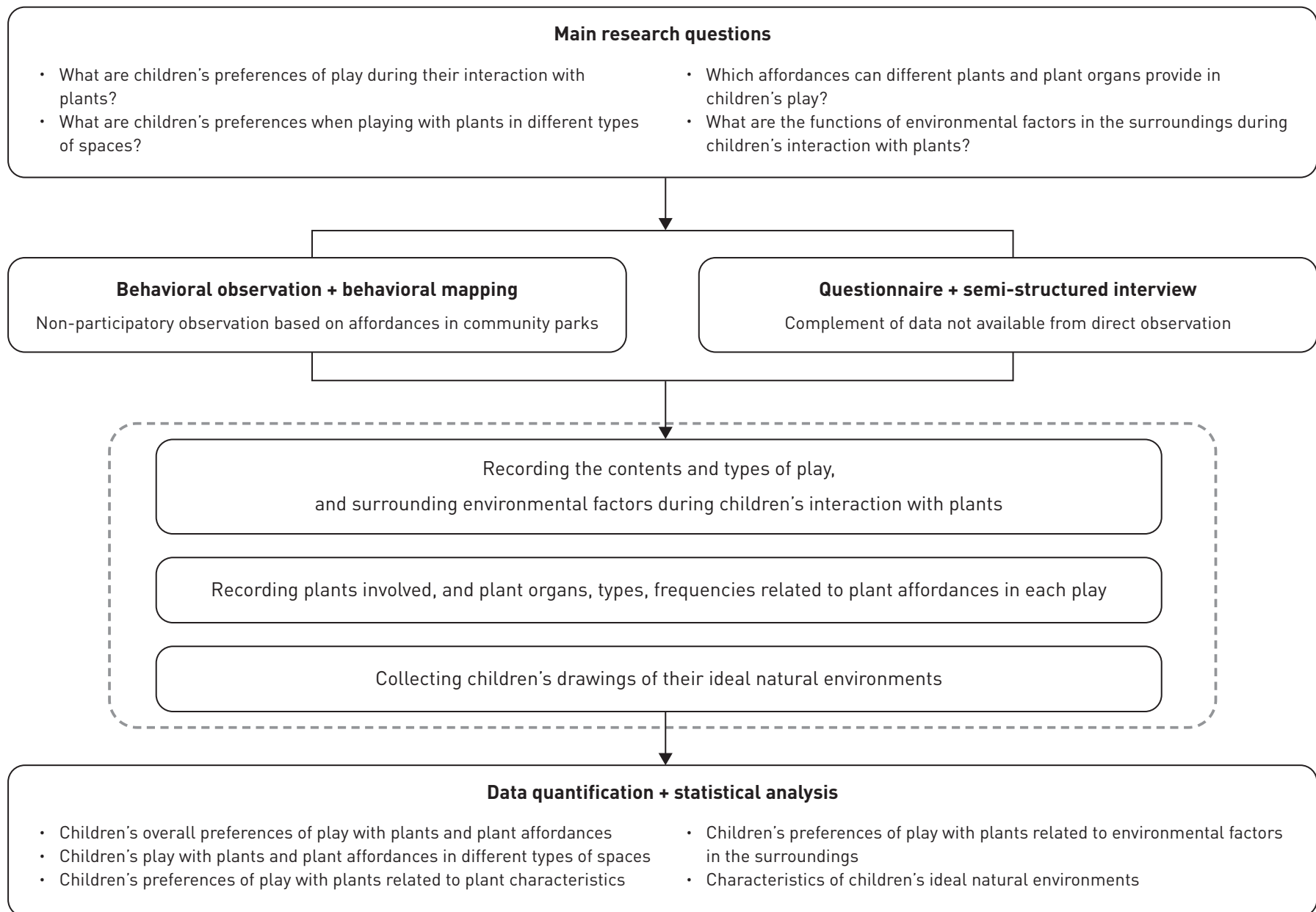
2) Observed and mapped children's behaviors: investigated children's play behaviors by methods of questionnaire<sup>[36][37]</sup>, semi-structured interview<sup>[20]</sup>, behavioral observation<sup>[9][25]</sup>, and behavioral mapping<sup>[9][38][39]</sup>. Behavioral observation made the researchers be aware of the content of children's play. Information about plants and the surrounding environment during children's play can also be recorded basing on Kyttä's theory of affordances. Behavioral mapping can explore the spatial patterns of children's play.

And 3) collected further information from questionnaires and

interviews: questionnaire survey combined with interviews can obtain information about the research objects, frequency and types of their activities, their preferences and ideal environment for play. This step was to investigate the extent of children's interaction with plants and to supplement the findings of observation and mapping.

The triangulation method can effectively avoid the limitations of a single research method and ensure the validity and reliability of qualitative research<sup>[40][41]</sup>. As can be seen from the framework of the study (Fig. 2), after collecting data by a combination of methods including behavioral observation, behavioral mapping,

## 2. Research framework



questionnaire, and interview in the field research, this study quantified the data and used statistical methods such as quantitative analysis and cross tabulation analysis. The research analyzed the frequency of children's various types of play and the affordance provided by different plants in varied environments, as well as the specific play behaviors in these environments. All these can help conclude children's environmental preferences during their spontaneous play with plants.

### 3.2 Data Collection

The pre-research results showed that children aged 3 to 12 years old usually play outdoors after school for a short time, so the field research was carried out between 16:00 and 18:00 on weekdays from late May to late June, 2021. To avoid the interference of cloudy and rainy weather on children's outdoor play, field surveys were all took place in sunny days with stable temperature.

During behavioral observation, one or two researchers observed each child's interaction/play with plants in the community park, keeping a distance of 1 to 3 m away, while recording basic information about the child (gender, age, etc.), the type of play, the plants they interacted/played with, and the affordance the plants provided. The behavioral mapping can reflect the behaviors and the movements of children's interaction with plants and the length of time they spent. To avoid insufficient or repetitive observations of children's play<sup>[38]</sup>, each observation for each child was controlled around 5 ~ 10 minutes per day.

## 4 Results and Analysis

### 4.1 Preliminary Results

The field survey collected data of the play behaviors of 132 children altogether<sup>①</sup>. Combined with semi-structured interviews with children<sup>②</sup>, a total of 125 questionnaires were

① Of the 132 children, 26 were observed in Fenghu Park, 35 in Tonglou Park, 33 in Tushan Park, and 38 in Munan Park.

② Questionnaires and interviews were used to learn children's self-reported experience, which did not conducted on the same day with the behavioral observation and mapping. This means that only some of the subjects attended both of the two types of investigation. The study obtained the ethics approvals by the Ethics Committee of Tianjin University.

returned (130 questionnaires distributed in the four community parks), and 121 of them were valid.

Examples of children's interaction/play with plants in community parks and the observation results of their behaviors are shown in Table 2, and the movement patterns of all children in each park are shown in Figure 3.

### 4.2 Spontaneous Play Characteristics of Children's Interaction With Plants

As can be seen from the survey results shown in Figures 4 and 5, when children played with plants, they most preferred the used affordance, followed by perceived affordance, and then shaped affordance. In terms of types of play, functional play was the most commonly observed, followed by exploration, constructive play, dramatic play, and games-with-rules. The spontaneous play by the type of plant affordance is shown in Table 3.

The frequency of used affordance was the highest. Children took plants as tools (to complete the play) or as toys (plants as the main part of the play for children to collect, place, climb, hug, or hold). Used affordance was mainly found in the games-with-rules and functional play (Table 3).

The perceived affordance of plants was mainly revealed from children's senses of sight, smell, and touch, including activities of smelling the fragrance of *Rosa chinensis* and touching the exocarp hairs of *Prunus armeniaca*. Other senses, such as taste, were less invoked by children during their play. The plays based on perceived affordance were mostly seen in the play of exploration (Table 3).

The least frequent shaped affordance was observed mainly in the dramatic play and constructive play. During their play, children used plants as materials in different scenes, such as "swords" for "battles," "ingredients" for "cooking," and "fishing rods" and "bait" for "fishing." The shaped affordance often occurred along with the used affordance—in the shaped affordance, plants were imagined (re-created) as other objects, and in the used affordance plants merely being used as tools or toys (Table 3).

### 4.3 Preference of Children's Play in Different Spatial and Planting Settings

Although varied in landscape patterns, overall the studied four parks cover three types of spaces, i.e., open, semi-open, and enclosed. This research analyzed the occurrence of affordance in different spatial and planting settings. The cross tabulation results show that the occurrence of affordance in each type of spaces was always used affordance, perceived affordance, and shaped

**Table 2: Observation results of children’s play with plants (excerpted)**

No.	Gender	Age	Description of play	Type of play	Plant involved	Plant organ providing affordance	Environmental element	Type of space	Type of plant design	Affordance of plant		
										Perceived affordance	Used affordance	Shaped affordance
1	Girl	5	Compete in counting “eyes” on the trunk	Games-with-rules	<i>Populus tomentosa</i>	Trunk	Planting container	Semi-open	Sparse forest	Observe	As toys	
2	Girl	4	Push the tree	Functional play	<i>Fraxinus chinensis</i>	Trunk	Pavement	Semi-open	Tree array		As toys	
3	Girl	6	Pick leaves and fruits of <i>Rosa xanthina</i>	Functional play	<i>Rosa xanthina</i>	Leaf and fruit	Terrain	Enclosed	Dense forest		As toys	
4	Boy	8	Observe fruits of <i>Rosa chinensis</i>	Exploration	<i>Rosa chinensis</i>	Fruit	Terrain	Open	Group planting	Observe		
			Pick up fruits of <i>Melia azedarach</i> and observe the inside	Exploration	<i>Melia azedarach</i>	Fruit	Pavement	Open	Mass planting	Observe		
				Functional play	<i>Melia azedarach</i>	Fruit	Pavement	Open	Group planting		As toys	
5	Girl	7	Pull leaves of <i>Rosa multiflora</i> ; compete in a high jump to pick leaves of <i>Styphnolobium japonicum</i> ‘Pendula’; and display leaves by size on the ground	Games-with-rules	<i>Rosa multiflora</i>	Leaf	Stone	Semi-open	Sparse forest		As toys	
				Games-with-rules	<i>Styphnolobium japonicum</i> ‘Pendula’	Leaf	Terrain	Open	Sparse forest		As toys	
6	Girl	5	Make “strawberry jam”	Dramatic Play	<i>Rosa chinensis</i>	Flower	Path	Semi-open	Flower hedge	Observe and appreciate	As “food materials”	Make “strawberry jam”

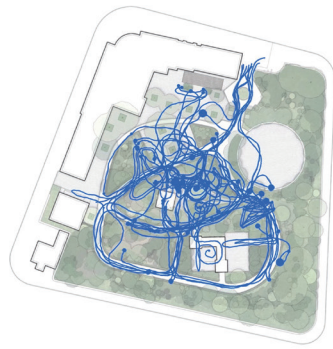
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**Table 2: Observation results of children's play with plants (excerpted)**

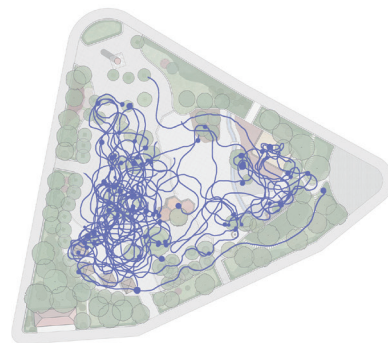
No.	Gender	Age	Description of play	Type of play	Plant involved	Plant organ providing affordance	Environmental element	Type of space	Type of plant design	Affordance of plant			
										Perceived affordance	Used affordance	Shaped affordance	
7	Girl	7	Dig a hole with branches of <i>Styphnolobium japonicum</i>	Functional Play	<i>Styphnolobium japonicum</i>	Branch	Soil	Semi-open	Sparse forest		As tools		
				Taste and smell leaves of <i>Buxus megistophylla</i>	Exploration	<i>Buxus megistophylla</i>	Leaf	Path	Semi-open	Hedge	Taste		
					Exploration	<i>Buxus megistophylla</i>	Leaf	Soil	Semi-open	Hedge	Smell		
8	Boy	6	Collect different "food materials" and other "goods" and who has the most wins the game	Games-with-rules	<i>Cercis chinensis</i>	Fruit	Soil	Enclosed	Sparse forest	Observe and appreciate	As "food materials"		
				Games-with-rules	<i>Duchesnea indica</i>	Leaf	Soil	Semi-open	Sparse forest	Observe and appreciate	As "food materials"		
				Games-with-rules	<i>Euonymus alatus</i>	Leaf	Path	Semi-open	Hedge	Observe and appreciate	As "food materials"		
				Games-with-rules	<i>Rosa xanthina</i>	Flower	Path	Open	Dense forest		As "food materials"		
9	Boy	6	Role play to cook "cilantro" and "beans"	Dramatic play	<i>Cercis chinensis</i>	Fruit	Soil	Enclosed	Sparse forest	Observe and appreciate	As "food materials"	Create "new dishes"	
				Dramatic play	<i>Duchesnea indica</i>	Leaf	Soil	Semi-open	Sparse forest	Observe and appreciate	As "food materials"	Create "new dishes"	
				Dramatic play	<i>Rosa multiflora</i>	Whole shape	Stone	Enclosed	Sparse forest	Enjoy the intimate feel			

**NOTE**

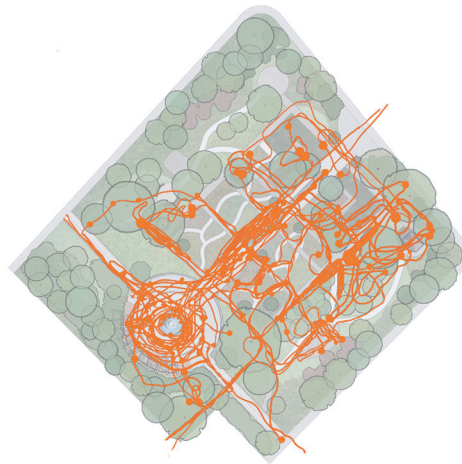
Basing on Yoshinobu Ashihara's *Exterior Design in Architecture*, this study categorized spaces into open spaces, semi-open spaces, and enclosed spaces according to the child's sight within a 1.5 m radius and in a cone-shaped range (approximately 60° in top angle) from the child's eyes (Source: Ref. [42]).



Fenghu Park



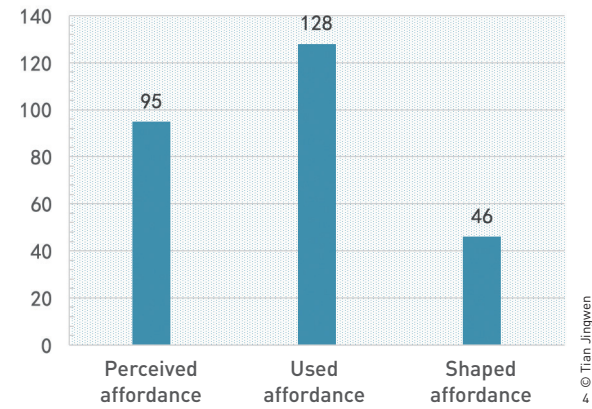
Tonglou Park



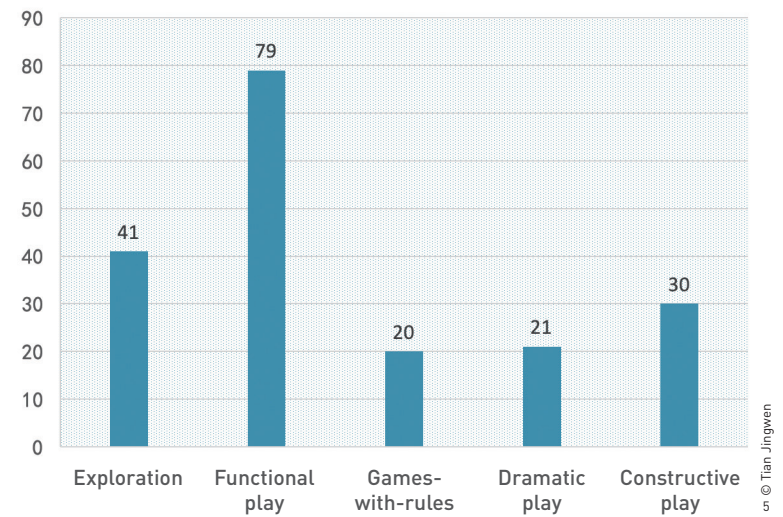
Munan Park



Tushan Park



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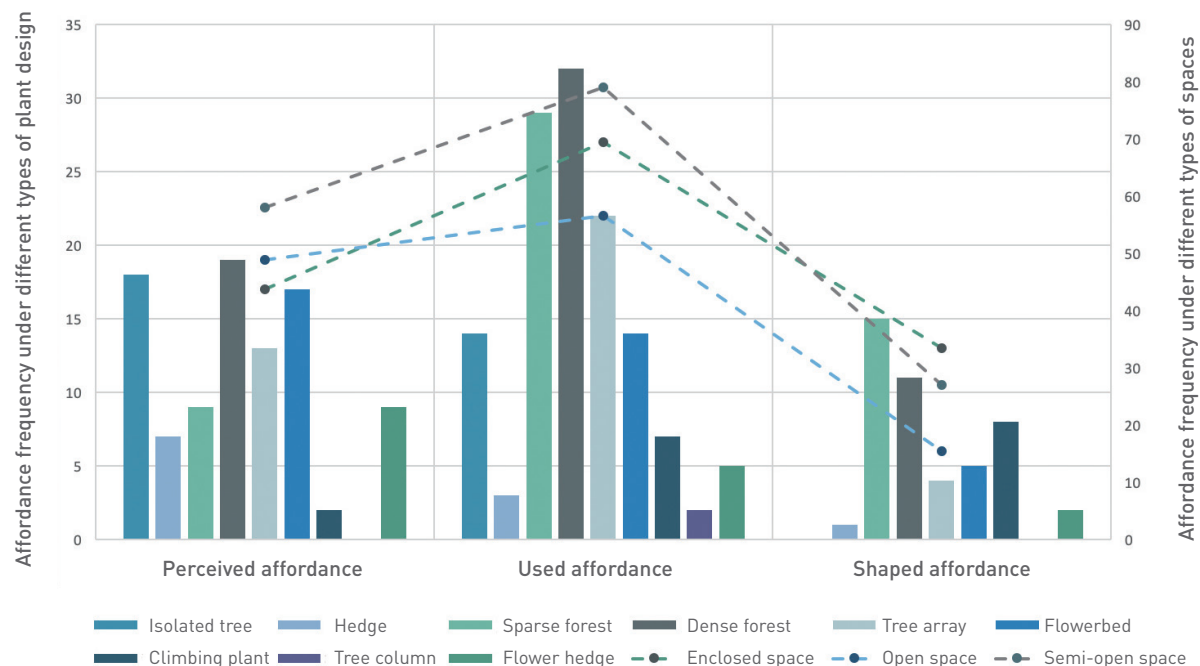


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**Table 3: Spontaneous play corresponding to different types of affordances**

Affordance of plant	Type of play	Description of play	Relations
<b>Perceived affordance</b>	Exploration	Play through senses with various plant organs	Smell flowers, leaves, and fruits; taste fruits and leaves; enjoy the sound of stepping on leaves; observe fruits, branch thorns, leaves, and trunk textures; touch petals, exocarp hair of fruits, trunk, and leaves to perceive the overall shade of plant; etc.
<b>Used affordance</b>	Games-with-rules; functional play	Play with rules; play through physical activities, using plants as tools or toys	Compete in collecting fruits and flowers and counting trunk lenticels; jump high to touch leaves; dig holes with branches; hang arms over plant branches; climb trees; lean on hedges; encircle the tree trunks; etc.
<b>Shaped affordance</b>	Dramatic play; constructive play	Role play with imagination; Creative work	Build “secret bases,” role play; “fishing” with branches and use leaves as “bait”; Weave garlands and knots using grass; make collage with leaves and flowers, draw by tracing shadows on the ground; collect leaves and flowers to make plant specimens; etc.

3. Behavioral mappings of children’s play in the four community parks, which were generated by combining all children’s movement patterns (shown in lines) and the length of time they spent playing with plants (shown in circles, sourced from Ref. [39]). Considering that ages of children, types of spaces, and other environmental factors of the parks may influence children’s play with plants, this study chose different numbers of children to make the mappings in different parks. The larger the number of children were recorded, the denser the lines of movement will be; the more time children spent in one place, the larger the circles will be—indicating that such environments are more popular with children.
4. Frequency of plants’ affordances
5. Frequency of different types of play
6. Frequency of affordances under different types of spaces and plant design



**Table 4: Proportion of each plant organ that provides affordances in different spatial types**

Type of space	Flower	Leaf	Fruit	Branch	Trunk	Whole shape
Open	23.08%	20.51%	7.69%	10.26%	7.69%	30.77%
Semi-open	9.35%	32.71%	11.21%	15.89%	7.48%	23.36%
Enclosed	4.76%	26.19%	9.53%	19.05%	7.14%	33.33%

affordance, from the highest to the lowest (Fig. 6). Moreover, the shaped affordance occurred the most in enclosed spaces, while the used affordance and perceived affordance occurred more in semi-open spaces. In terms of the planting types, the perceived affordance occurred the most in “dense forest,” around “isolated tree” and “flowerbed,” while the used affordance and shaped affordance were seen mostly in the “dense forest” and “sparse forest.”

Further analysis was conducted on children’s interaction/play with plants in different types of spaces to obtain the proportion of

the affordance provided by each plant organ part (Table 4). Results show that the affordance provided by “flower” and “whole shape” occurred the most in open spaces; children preferred interacting/playing with “leaf” in semi-open spaces; and spaces created utilizing the “whole shape” of plants were preferred by children in enclosed spaces.

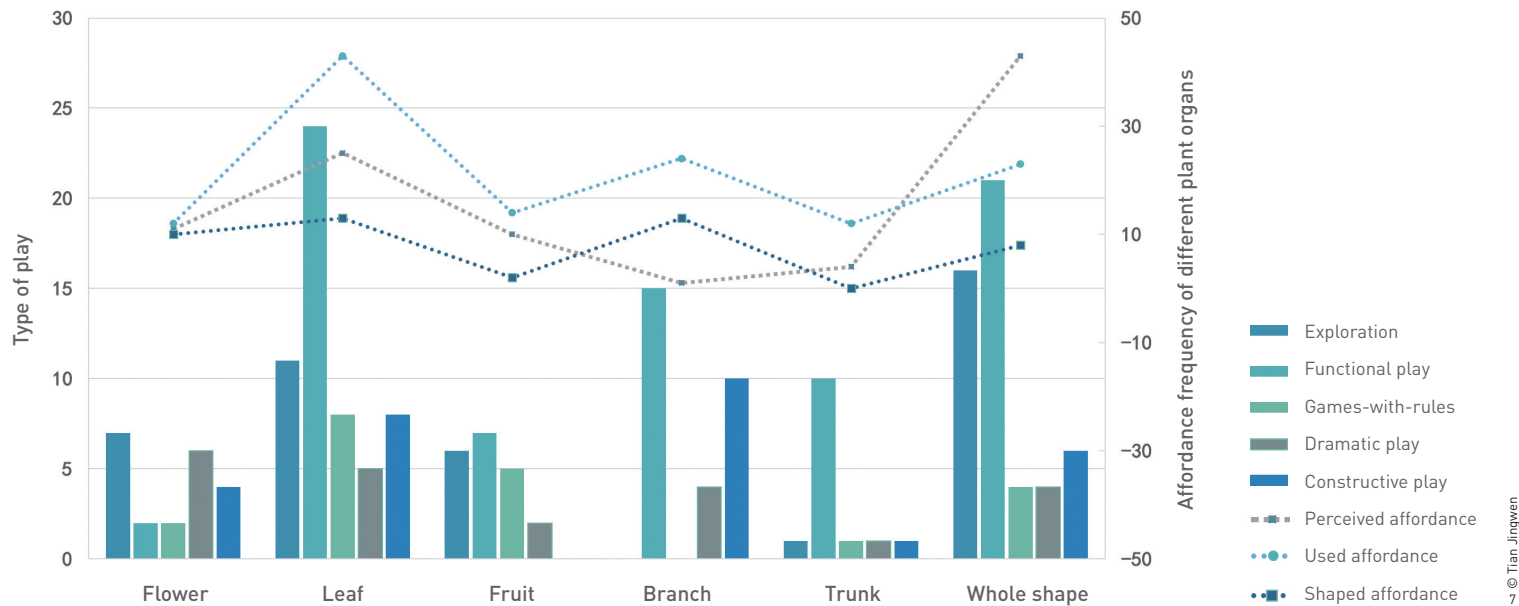
#### 4.4 Plant Characteristics and Other Environmental Factors Influencing Children’s Play

In combination of behavior observation and mapping results, the comparative analysis on children’s play with the same plant species in different places suggests that plant characteristics and the environmental factors in the surroundings had a more significant effect on children’s play.

##### 4.4.1 Plant Characteristics

A cross tabulation analysis was carried out on plant affordance and children’s play (Fig. 7). A chi-square test (Table 5) with SPSS software reveals the significant difference ( $p < 0.001$ ) between the occurrence of different plant organ’s affordance and children’s play.

Supported by the analysis on the spatial settings through behavior observation, the characteristics of plants preferred by children during their interaction/play with plants can be summed up as follows.



7. Frequency of different plant organs' affordances and different types of play

**Table 5: Results of the chi-square test between different types of play and affordances provided by plant organs**

		Frequency of affordances
<b>Different types of play</b>	Chi-square value	48.355
	Degree of freedom	20
	Asymptotic significance (2-sided)	.000***

**NOTE**

\*\*\* means  $p < 0.001$ .

(1) Reachable plants with special tactility

Children preferred plants that are reachable and touchable directly or by other tools. For example, some children leaned on the *Buxus megistophylla* hedge and bounced from it, taking “as a trampoline”; some others walked and touched the top leaves of the hedge, enjoying the “tough and flat” feel. Another example was the lateral branch of a *Platycladus orientalis*, which is about 1.6 m high and grows horizontally—many children played with this smooth branch to hang arms or jump (Fig. 8-1).

(2) Fragrant plants

Aromatic plants were favored by children—they are always

curious about the smells of different plants or the source where the smell came from (Fig. 8-2). In this process, children will be stimulated to connect with nature and excited about unexpected surprises: they discovered insects such as *Aspongopus chinensis* and earthworms (*Pheretima* spp.) in the flowerbeds as they bent over to observe the flowers.

(3) Plants with thorns or acicular leaves

Most of planning design standards for children’s playgrounds exclude plants with shoot thorns. The study found that although some children feared to be pricked by plants, there were still around 60% of children preferred such plants, including *Rosa multiflora*, *R. chinensis*, and *R. xanthina*, as well as coniferous trees like *Cedrus deodara* and *Juniperus chinensis* (Fig. 8-3). When asked if they were afraid to touch these plants, children often replied that they could “touch them carefully,” “slowly,” or “it is very challenging.”

(4) Trees with thick trunks

Trees with thick trunks were preferred by younger children. For example, there were often three to five children circling around the trunk of a *Platanus acerifolia* hand in hand or carefully examining the texture of the trunk. Children also frequently gathered around other thick trees like *Juglans regia*, *Populus tomentosa*, and *Styphnolobium japonicum* to touch, lean on, or observe the trunks (Fig. 8-4).

(5) Trees with low branching points and moderate branching angles

Children aged between 3 and 12 years old are usually under 1.6 m



8. Examples of children's interaction/play with plants related to plant characteristics in community parks

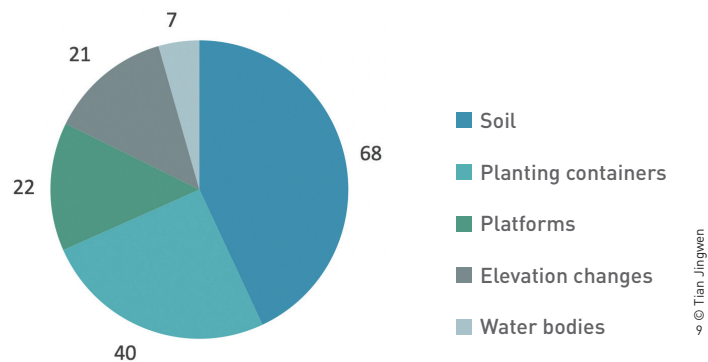
in height. In the sample parks, they were often observed climbing trees with low branching points or moderately angled branches, such as *Prunus salicina*, *Malus 'Radiant'*, and *Malus × micromalus* (Fig. 8-5).

#### (6) Fallen branches

Fallen branches were also favored tools in children's spontaneous play. For example, the long and straight branches of *Salix babylonica* and *Lonicera japonica* were used as "fishing poles" and "kite lines" (Fig. 8-6).

#### (7) Low weeping shrubs

Weeping shrubs can naturally form intimate enclosed spaces which can only be accessed by children. In this study, such plants were preferred by children about the same age to play various games. For example, natural arched spaces created by plants such as *Lycium chinense*, *Rosa multiflora*, *R. xanthina*, and *Lonicera japonica* attracted children to enter and play games such as "cooking," "building castles," and "passing through tunnels" (Fig. 8-7).



9. Frequency of environmental factors in the surroundings in children's interaction/play with plants

#### (8) Blossoming plants with distinctive-shape or bright-color flowers

Abundantly blossoming plants such as *Rosa xanthina*, *R. multiflora*, *R. chinensis*, *Syringa oblata*, and *Prunus davidiana* were preferred in children's play. Funnel-shaped, spiciferous, and trumpet-shaped flowers, including *Portulaca grandiflora* and *Celosia cristata*, were also favored by children (Fig. 8-8).

#### (9) Plants with distinctive leaf shapes and textures

It was also found that pinnate, lanceolate, palmate, subcordate, and serrate leaves were more likely to attract children. For example, *Duchesnea indica* with serrate leaves (obtuse apex) were mistaken for *Coriandrum sativum* as the children picked them and shouted that "I found coriander." For plants with palmate leaves such as

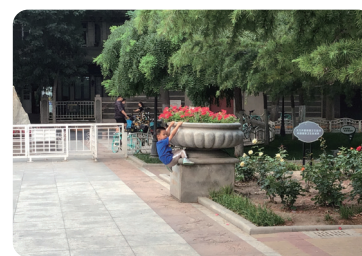
*Parthenocissus tricuspidata*, children observed the veins and carried out "biological experiments" on them. The larger leaves of *Hosta plantaginea* were played as "umbrellas." Children also cut the fleshy leaves of *Portulaca oleracea* off for the sap. Some children took curly and paper-like fallen leaves of *Platanus acerifolia* home for a special collection. Older children used the leaves of *Liriope spicata* to weave balls (Fig. 8-9).

#### (10) Plants with fruits

Children observed and collected fruits of *Melia azedarach* and *Cercis chinensis* that look like edible fruits for games like role play. Smaller, firmer, round, and smooth fruits or seeds of plants such as *Rosa xanthina* were often taken as "bullets" or "materials" in their play. Plants with bright-color fruits, such as *Lycium chinense* and *Malus 'Radiant'*, attracted children to engage in physical activities (climbing trees, picking) and other creative activities. In interviews about fruits, most children urgently explained that "these seem edible but actually not," and they hope to "plant some apple trees or pear trees" in the parks (Fig. 8-10).

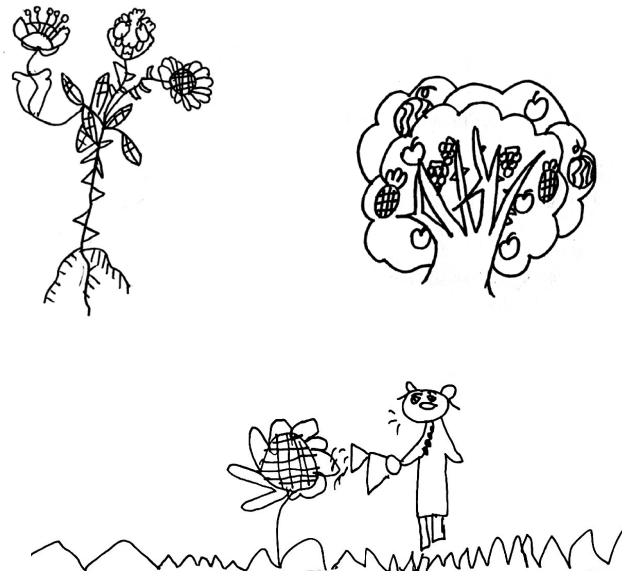
#### 4.4.2 Other Environmental Factors

In addition to the characteristics of plants, environmental features of the surroundings also influenced what and how children's play with plants. Observation results of children's play with plants in Table 2 have shown that when interacting with plants, children's preferred environmental factors varied. The most frequently (from high to low) observed environmental elements in children's play were soil, planting containers, platforms, elevation changes, and water bodies (Fig. 9).



10. Examples of children's interaction/play with plants related to environmental factors in the surroundings in community parks

11. Examples of children's drawings of their ideal natural environments



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#### (1) Soil

Bare soil can stimulate children's imagination and creativity in functional, constructive, and dramatic play. For instance, they can "dig the soil to make a flower castle" or "make pots for cooking" or "make tunnels to transport branches" (Fig. 10-1). In addition, children preferred hardened soil in these plays.

#### (2) Planting containers

Planting containers include flowerbeds, tree beds, and flowerpots. Younger children often crouched or stood on planting containers to touch plants and pick leaves. Older children almost lay on the containers to observe or smell plants, or sit on the containers to enjoy the cool with friends. Others climbed onto the flowerpots with decorated surfaces to observe the plants (Fig. 10-2).

#### (3) Platforms

Environmental elements with flat surfaces such as stones, bricks, paths, tables, and chairs are often used by children as "shelves," "worktables," or "stoves." They placed the "materials" collected from the environment on the platforms to count, display, or play creative games (Fig. 10-3).

#### (4) Elevation changes

Terrains with natural undulation, rockeries, terraces, and steps all form elevation changes in space. To children, exploring plants growing high above the ground was a "very exciting" game or "an adventure" (Fig. 10-4).

#### (5) Water bodies

Apart from Fenghu Park, there are fountains, small channels, and pools with rockery (0.45 ~ 1.6 m in depth) in the other three parks.

Children were observed looking for plants in the water bodies or using branches to paddle the water. For example, two nine-year-old boys "fishing for tadpoles" with branches said that "it's a pity that there is no lotus flowers in the pool." In their opinion, lotus flowers can not only beautify the environment but also provide food for tadpoles (Fig. 10-5).

### 4.5 Children's Understanding of the Environment With Plants

Through questionnaire survey and the open-ended question—"What other plants would you like to see here, and why?"—the study explored children's expectations of an ideal environment with plants, either by verbal description or by drawings. The Word Cloud result of the collected statements, combined with children's drawings (Fig. 11), reveals that children were most interested in "tall trees," "grass," "sunflowers," "apple trees," and "pretty" "flowering" plants. In general, children paid more attention to plants' shape, flowers, and fruits.

A small number of children expressed satisfaction with the current community parks, while the majority provided further expectations on specific needs, preferences, and perceptions of plants summarized as follows.

1) Children's requirements for planting design: children preferred plants that are bright in color, edible, and with special functions. For example, they stated that "I want more yellow sunflowers, they are so bright"; "I want to plant apple trees so I can harvest apples"; and "I want to plant more flycatchers that can eat bugs." Children also hoped to add more design elements into

vegetated spaces like “designers can set swings besides plants,” “I hope to have a slide and a sandpit with more plants near them,” and “I would like to plant grass on the trunk so that the tree would look more interesting and lush.” School-age children wanted to have access to plants mentioned in textbooks or on television, who stated that “I hope to see jasmine and silk trees, which I have learned from my textbook” and “I wish I could see those plants in the park!” This reflects that children are eager to learn knowledge more about plants, which should be responded by future design of community green spaces that extends the functions of plants.

2) Children’s awareness of environmental protection: some children thought about the relationship between plants and environmental protection when interacting with plants. For example, they said “the more trees the better, to protect the earth”; “we can plant more flowers to absorb carbon dioxide and protect the environment”; “I want to plant lots of trees for birds to build their home”; “I want to plant the northeast China ash, which is a national second-class protected plant I’ve learned from the television.”

And 3) plants are the bridge to connect children with the outside world: several children mentioned their family members in interviews when explaining their favorite plants. For example, some said “there are apple trees in my grandma’s yard” and “my mum loves roses best.” This suggests that plants are important elements to facilitate parent-child relationships, where in-depth research is needed by further efforts.

## 5 Conclusions

Taking four community parks in Tianjin as examples, this study explores the play preference of children aged between 3 and 12 years old when they interact with plants, as well as the corresponding environmental characteristics. The findings show that children are able to actively use the perceived affordance, used affordance, and shaped affordance of plants to play various types of games in high-density urban environment. Children’s interaction/ play with plants increases their direct connection with nature and can basically meet their daily needs for natural experience. The play preferences of children explored in this study can provide new ideas for design from children’s perspectives and real needs, so as to create environments that can stimulate children’s spontaneous play, expand the potential affordances of plants, and enrich children’s play types. To demonstrate the concern for children in an inclusive city, design should pay more attention to how to facilitate children’s natural and spontaneous play while respecting their instinctive

play needs with plants. Adjustment can be made in each stage from planting design to maintenance and management to promote the equitable, inclusive, and sustainable development of cities. Thus, this study proposes the following five design suggestions.

### 1) Creating diverse places for different play needs

The degree of spatial openness, frequency of plants’ affordances, and children’s play needs all varied in different types of spaces. In enclosed spaces, children preferred dramatic play with their peers. Thus, design can utilize low shrubs with no thick stem to create a naturally intimate space, with platforms that can further facilitate the shaped affordance of plants. Semi-open spaces saw relatively high frequency of used affordance and perceived affordance of plants, for which plants with distinctive leaves can be selected to encourage children’s physical activities. In open spaces, flowering plants can be introduced to encourage children to perceive plants and to simulate more explorative activities.

### 2) Introducing diverse and distinctive plants

This study found that children preferred plants with distinctive leaves, flowers, fruits, and thick branches, which is consistent with previous research<sup>[9][23]</sup>. In addition, children’s preference for “plants with thorns or acicular leaves” contradicts the principle that “plants with thorny branches and sword-shaped or thorny leaves should not be used within the normal range of visitors’ activities” according to the Code for Design of the Public Park (GB51192-2016). However, relevant research has shown that with proper access to such plants, “adventurous” play can improve children’s ability to respond to various risks and increase their awareness of self-protection<sup>[43]</sup>. Thus, while introducing diverse and distinctive plants, it might be better to combine with more precise safety education design (e.g. displaying information on plant characteristics on the site), rather than simply excluding the use of plants with thorns or acicular leaves.

### 3) Developing supporting functions of other environmental elements

The assistance of other environmental elements such as soil, planting containers, and platforms is also important in children’s spontaneous play with plants. In common green spaces, children can actively use existing environmental elements for creative play. In comparison to other elements, soil, substrate of the natural environment, was more attractive to children according to results of this study. It can encourage children’s constructive play and functional play. In view of this, design can provide soils of different textures, or create special spaces to guide children to interact with plants and soils if possible; for spaces with limitations in providing soils, planting activities can be introduced to promote children’s

direct connect with plants and soil.

In addition, this study found that insects in community parks also attracted children. Related research has shown that natural environments with more diverse animals<sup>[22]</sup> can intrigue children's play. Future research can explore how and whether insects and birds, as important media in nature, can bring about more affordances in children's interaction/play with plants.

#### 4) Introducing challenging and adventurous play

Results showed that children favored easy challenging games related to plants. Therefore, plants with appropriate height can be utilized to provide the perceived affordance and encourage children's more diverse interaction/play with plants. In addition, children usually use words such as "be brave and go on the adventure" for self-motivation when doing various physical activities, as well as support and encourage each other and share their "adventure experiences" in such plays—This also proves the importance of adventurous play for children's growth<sup>[44]</sup>, where plants are significant environmental elements and favored by children. Climbable trees, plants on high rockeries, and dense arbor forests can be introduced into sites under careful management, rather than being completely prohibited on the grounds of security risks.

#### 5) Strengthening safety and environmental education

It is undeniable that safety should be given top priority in both creating green spaces and children's play. We need more precise design to meet children's demands of connection with nature, especially under the promotion of child-friendly cities and inclusive cities. Inevitably, children's spontaneous play with plants will break or damage plants more or less. Design strategies can integrate challenging play with safety and environmental education to enhance children's understanding of life, encouraging them to respect life safety and protect the environment.

There are also limitations in this study. For instance, the study spanned less than one year and the children were not subdivided into smaller groups. Future research could be carried out all-year-round or even over several years to compare children's play with plants from a more comprehensive perspective. The children could also be subdivided into pre-school and school-age groups for more precise results. And further investigation can be conducted on the influence of the characteristics in for example spatial structure of plant communities and vegetation diversity on children's play with plants.

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# 天津市社区公园儿童与植物交互的自发游戏及环境特征研究

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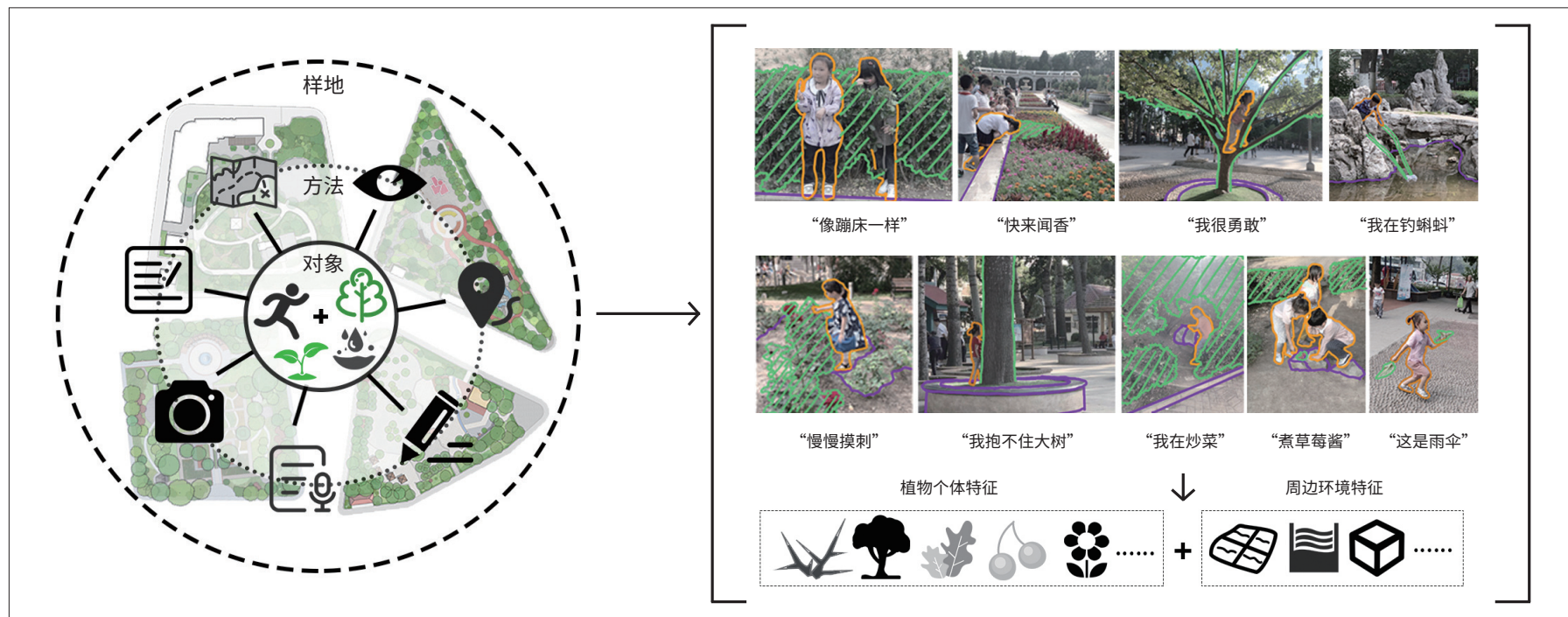
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## 图文摘要



## 文章亮点

- 不同的空间类型及植物配置下儿童的游戏偏好不同
- 儿童偏好叶片独特、能开花和结果、枝干粗壮的植物
- 土壤、种植容器等环境要素的辅助在不同程度上促进了儿童与植物的交互游戏
- 儿童善于利用植物及场地特点开展挑战与冒险游戏
- 设计应创造能激发儿童自发开展亲自然游戏的环境、扩展植物潜在的可供性

## 关键词

儿童;  
社区公园;  
植物景观;  
环境特征;  
自发游戏

## 摘要

随着包容性城市、儿童友好城市建设的兴起,城市儿童的亲自然权利受到广泛关注。本研究以天津市中心城区的4个社区公园为例,依据认知发展理论、儿童游戏相关理论、可供性理论等,通过行为观察、行为笔记、问卷调查、半结构式访谈等方法收集儿童的游戏行为、记录游戏发生时的植物信息及周边环境信息,以探

究3~12岁儿童与植物互动时的游戏类型偏好及对应的植物环境特征。研究采用统计学中的计量分析、交叉表卡方检验等,分析儿童开展各类游戏的频数及不同植物个体、不同环境要素下植物各类可供性的发生情况,以及样本人群在不同环境下开展游戏的具体情况。结果显示,在高密度城市环境中,儿童能够发挥亲自然天性,利用现有绿地特征,积极运用植物的感知可供性、使用可供性和塑造可供性开展各类游戏。儿童与植物的交互游戏增加了其与自然的直接接触,可初步满足城市儿童日常生活中的自然体验需求。植物种类丰富、特色鲜明及周边环境特征多样的绿地空间,能够激发更多的植物可供性。设计应关注儿童天然、自发开展的游戏内涵,针对特定空间类型满足游戏需求、引入种类丰富且各具特色的植物、开发其他环境要素的辅助功能、引入挑战与冒险游戏及增强安全与环境教育,促进城市的公平性、包容性及可持续性发展。

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## 1 引言

### 1.1 社区公园为儿童提供重要的亲自然环境

联合国《新城市议程》提出未来城市化发展应关注包容性、公正与可持续性等层面<sup>[1]</sup>。包容性城市(inclusive city)建设的关键在于为不同文化背景、不同年龄或来自不同地域的多元利益群体谋求共同发展<sup>[2][3]</sup>。儿童作为城市中的弱势群体,城市环境建设应保证其身心健康发展。

幼儿和青少年时期是人类成长的重要阶段,疏离自然不仅会让人失去对生命的体察,更会影响身心健康<sup>[4]</sup>。相关社会实验和研究表明,亲近自然对儿童的感官发育<sup>[5]</sup>、注意力及认知发展<sup>[6]</sup>,以及心理恢复能力、身体活动和社会凝聚力<sup>[7]</sup>等多项身心发育因子有积极影响,能够加强儿童的自然体验与生命体验,并可有效缓解自然缺失症<sup>[5]</sup>,同时对于孤独症等疾病具有显著的改善效果<sup>[8]</sup>。

尽管儿童与自然的直接接触在其成长中发挥着不可替代的作用<sup>[9]</sup>,但随着城市化进程的加速,天然的游戏场地正在逐渐减少<sup>[10]</sup>,儿童与自然的直接联系逐渐减少<sup>[11]</sup>,儿童参与自然游戏或自然式户外活动的程度也明显降低<sup>[12][13]</sup>。在此背景下,越来越多的游戏空间设计提出应与自然紧密结合<sup>[14][15]</sup>。鉴于出行时间、距离、方式的限制,社区公园成为儿童日常休闲活动的主要场地<sup>[16]</sup>和亲自然活动的重要场所<sup>[17]</sup>。相较于综合性公园,社区公园的可达性较强,且能在儿童直接的自然体验上发挥更显著作用<sup>[18]</sup>。

### 1.2 儿童亲自然游戏与环境偏好

“亲自然性”(Biophilic)是人类与生俱来的、与其他生物之间的天然情感联系<sup>[19]</sup>。儿童对植物有特殊的情感认同与游戏倾向,他们希望

能在植物丰富的环境中放松玩耍<sup>[20]</sup>。美国学者罗宾·C·摩尔根据植物在儿童游戏场地中的应用价值对其进行分类<sup>[21]</sup>,为儿童户外活动场地中的植物选择提供了初步参考。户外活动空间中的树根、树干能为儿童提供独特的感官刺激<sup>[9][22]</sup>;更多的树木及形态色彩丰富的植物可以极大地提升儿童户外游戏的兴趣<sup>[23]</sup>。植物种植的位置、空间中的障碍物会影响儿童游戏时对植物的偏好<sup>[9]</sup>;植物周边环境不同,则儿童的游戏路径不一<sup>[24]</sup>。更多时候,儿童游戏会发生在一些“中介空间”(in-between space)内,而非正式设计的游戏空间中<sup>[25]</sup>。上述结论表明,植物在儿童亲自然体验中承担了重要的角色,为进一步探索植被空间与儿童游戏之间的关系提供了重要依据。然而,当前高密度城市区域中的公共环境大多缺少自然特征,城市公园儿童游戏空间中植物与场地结合不足<sup>[10]</sup>,加之规划设计师对城市环境中儿童与植物交互情况了解不足,使植物在儿童亲自然活动中可发挥的功能受到了限制。

有研究将儿童根据自身兴趣和需要,自由选择、自主展开、自发交流的游戏定义为“自发游戏”(spontaneous play)<sup>[26]</sup>。本研究将这一概念拓展到儿童亲自然游戏中,指儿童利用场地环境条件,自主开发创造的非设施类游戏。自发游戏是儿童在传统公园中的亲自然探索,可以展现儿童的自然偏好和需求,为儿童游戏空间设计提供重要依据。对于儿童自发游戏与环境之间的联系,可结合认知发展理论、儿童游戏相关理论、可供性理论等学科知识进行分析。

既有研究基于认知发展理论<sup>[27]</sup>并综合美国学者肯尼斯·H·鲁宾提出的游戏观察量表<sup>[28]</sup>,按照感知、思维的程度将游戏分为探索性、功能性、规则性、建构性与戏剧性游戏,其具体内涵如表1所示。以此为依据,可记录儿童的游戏行为,明确儿童游戏行为与自然环境物理特征之间的联系。

表 1: 游戏行为总结表

行为类型	目标或意图	特征
探索性游戏	从物体中获取视觉或听觉信息	探究物体的物理属性
功能性游戏	通过简单、重复的肌肉运动来刺激感官	只为享受身体愉悦的活动，无其他目的
规则性游戏	提前建立游戏的规则，并参与这个充满竞争性的游戏	需要有竞争、有规则，然后在这个范围内行动
建构性游戏	创造或建造某物	活动有明显目的，比如建造或创造，阅读包含在其中，与功能性游戏的主要区别在于儿童玩耍过程中的目标
戏剧性游戏	把生活情景戏剧化或给无生命的物体生命化	带有假装、扮演性质的活动

**注**

游戏行为类型、目标或意图及特征主要参考自文献 [28]。

可供性理论强调环境中的客观信息，提出身体与环境之间交互的可能即“行为”<sup>[29][30]</sup>。马尔凯塔·屈泰和威廉·盖弗将已实现的可供性分为感知可供性（perceived affordance）、使用可供性（used affordance）和塑造可供性（shaped affordance）三类<sup>[31]-[33]</sup>，用以描述儿童与环境相互作用的特征和程度<sup>[20]</sup>。可供性理论拓展了儿童环境感知研究的视角，科学呈现了环境要素在儿童游戏中发挥的功能，可填补国内对儿童与植物互动类型及环境特征认知的不足，充实可供性理论在儿童亲自然领域中的研究。

基于上述理论，本研究以天津市社区公园为例，从儿童环境感知视角出发，以期明确儿童与植物互动时的游戏类型偏好及对应的植物环境特征，以为包容性社区绿地设计提供指导，丰富儿童亲自然生活的物质空间内容。

## 2 研究区域与样本选择

天津市是中国重要的工商业城市，近年来逐步启动老旧小区改造及儿童友好型城市建设的相关工作。由于中心城区建筑密度相对较高，以此为对象来探究高密度城区儿童日常生活环境的绿地空间将更具代表性。

根据《城市绿地分类标准》（CJJ/T85—2017）<sup>[34]</sup>，社区公园是指一定社区范围内居民就近开展日常休闲活动服务的绿地，规模宜大于1hm<sup>2</sup>。但考虑到高密度城区内的绿地面积有限，本研究首先将社区公园

的样地要求限定为面积1hm<sup>2</sup>左右且免费向公众开放。已有研究表明，儿童使用500m以内步行可达公园的可能性更高<sup>[35]</sup>，因此继续筛选出儿童从住宅或学校出发、步行500m能够到达的社区公园。之后对从南开区、和平区和河西区三个中心城区筛选出的多个社区公园进行实地预调研，观察公园内部景观要素与空间类型差异，以确保最终选取的样地能够较为全面地涵盖城市中常见的植物环境类型。研究最终选定4个代表性社区公园作为调查样地——南开区风湖公园、河西区佟楼公园、和平区土山公园和睦南公园（图1）。这4个样本公园内植被状况良好，风湖公园和土山公园的植被密度较大，植物围合的私密空间较多；佟楼公园和睦南公园则更多应用乔木树池、灌木种植，营造的开敞空间较多。

预调研过程中观察到社区公园内与植物交互游戏的主体人群年龄多在12岁以下，且研究人员在初步访谈过程中发现3岁以上的儿童语言能力更强，认知水平、身体活动水平更高，更易自主地表达想法、自发地与植物展开交互游戏，因此选定3~12岁的儿童作为研究对象。

## 3 研究方法 with 数据获取

### 3.1 研究内容及方法

研究过程分为三部分。

1) 明确社区公园内植物的基本信息：通过实地测量，绘制公园地图、记录植物详情（物种、位置、大小、形态等），用于儿童行为笔记

与特征分析。

2) 儿童行为实地观察与记录: 运用4种常用的方法对儿童游戏行为进行调查, 包括问卷调查<sup>[36][37]</sup>、半结构式访谈<sup>[20]</sup>、行为观察<sup>[9][25]</sup>和行为注记<sup>[9][38][39]</sup>。通过行为观察可明确儿童游戏的内容, 基于屈泰的可供性分类, 记录游戏发生时的植物及周边环境信息。行为注记则能从平面空间上探究儿童游戏的规律。

3) 其他问卷及访谈信息收集: 通过问卷调查结合访谈的形式, 获取目标人群的基础信息、活动频率、活动内容、活动偏好及理想环境等信息, 探究儿童与植物游戏交互的程度, 补充实地观察结果。

三角互证 (triangulation) 方法可有效避免单一研究方法的局限性, 保证定性研究的效度和信度<sup>[40][41]</sup>。研究首先采用行为观察、行为注记及问卷调查与访谈等方法进行调研, 再对实地调研获取的数据进行量化处理, 采用统计学中的计量分析、交叉表卡方检验等, 以探究儿童开展各类游戏的频数及不同植物个体、不同环境要素下植物各类可供性的发生情况, 以及样本人群在不同环境下开展游戏的具体情况, 由此得出儿童在与植物的自发游戏中偏好的环境特征。具体研究框架如图2所示。

### 3.2 调研数据获取

预调研发现, 3~12岁儿童日常在户外游戏的时间大多为放学后, 且时长有限, 因而现场调研于2021年5月下旬至6月下旬工作日的16:00至18:00点开展。为排除阴雨天对儿童户外游戏的影响, 调研选择在天气较晴朗且温度较为稳定的条件下进行。

行为观察即1~2名调研人员以旁观者身份观察社区公园内每名儿童与植物交互游戏的情况, 观察时与儿童保持1~3m的距离, 同时记录儿童基础信息 (性别、年龄等)、发生游戏类别、交互植物及植物可供性情况等观察信息。行为注记记录儿童与植物交互的行为及行动轨迹、与植物游戏停留时长。为避免对儿童游戏观察的片面性和重复性<sup>[38]</sup>, 对每个儿童每天的观察控制在5~10分钟。

## 4 结果与分析

### 4.1 初步调研结果

本次调研最终共收集到受观察的132名儿童的游戏行为数据<sup>①</sup>。调研人员采取问卷发放结合半结构式访谈的方法对儿童进行提问<sup>②</sup>, 4个社

① 132名儿童分别包括风湖公园内26名、佟楼公园内35名、土山公园内33名及睦南公园内38名。

② 问卷和访谈是为获取儿童的主观表达结果, 其与研究者的行为观察和行为注记并非一天发生, 而是分多次进行, 因此两类被试并非一一对应, 但有部分重合。本研究通过了天津大学伦理委员会的伦理审查。

区公园内总共发放问卷130份, 最终回收问卷125份, 有效问卷信息为121份。

社区公园内儿童与植物交互游戏的情况及其行为观察记录内容示例如表2所示, 各个公园内所有儿童的行为轨迹如图3所示。

### 4.2 儿童与植物交互的自发游戏特征

由图4和图5所示统计结果可知, 儿童与植物交互游戏时, 最偏好植物的使用可供性, 其次是感知可供性, 最后是塑造可供性; 就游戏类型而言, 最常开展的是功能性游戏, 而后依次为探索性游戏、建构性游戏、戏剧性游戏和规则性游戏。三种植物可供性所对应的儿童与植物互动产生的自发游戏如表3所示。

植物的使用可供性频数最高, 主要体现在两个方面: 一是儿童将植物作为游戏中的工具, 帮助其完成游戏步骤等; 二是儿童将植物作为游戏中的玩具, 对其实施收集、摆放、攀爬、环抱、手持等一系列动作, 此时的植物是游戏中的主体部分。与使用可供性相关的主要为“规则性游戏”和“功能性游戏” (表3)。

植物的感知可供性主要体现在视觉、嗅觉和触觉层面, 如闻月季花香、摸杏 (*Prunus armeniaca*) 的茸毛等; 其他诸如味觉等方面则较少被儿童关注。由感知可供性展开的游戏与“探索性游戏”的内涵相吻合 (表3)。

频数最低的是塑造可供性, 主要体现在“戏剧性游戏”和“建构性游戏”中。在游戏过程中, 儿童会将植物用作不同情境下的物件, 如“战场”上的“刀”“剑”、“厨房”中的“食材”、钓鱼时的“鱼竿”“诱饵”等。塑造可供性往往与使用可供性同时出现, 区别在于前者表明在游戏中植物会被“再创造”, 后者则体现为植物在游戏中只是单纯地被使用 (表3)。

### 4.3 不同空间类型及不同植物配置手法下的儿童游戏偏好

调研的4个公园虽景观格局不一, 但整体上涵盖了开敞空间、半开敞空间和私密空间三类活动空间。本研究分析了不同空间类型及不同植物配置手法下的可供性发生情况, 交叉表频数分析结果如图6所示。可以看出, 三类空间下可供性的频数由高到低均为使用可供性、感知可供性和塑造可供性。塑造可供性在私密空间下发生的频数最高, 半开敞空间下使用与感知可供性的频数都处于较高水平。感知可供性最多发生在“密林”“孤植树”和“花坛”形式下, 而使用可供性和塑造可供性均最多发生在“密林”和“疏林”中。

同时进一步统计分析三类空间下儿童与植物交互游戏的情况, 分别计算三类空间中植物各器官可供性的占比 (表4)。分析可得, 开敞空间下“花”和“整体形态”的可供性频数最高, 半开敞空间下儿童偏好与“叶”展开交互, 私密空间下植物整体形态营造出的环境更受儿童喜爱。

表 2: 儿童与植物交互游戏的行为观察统计表 (部分)

编号	性别	年龄 (岁)	游戏行为 描述	游戏 类别	涉及 植物	提供可供性 的元素	周边 环境要素	空间 类型	植物 配置手法	植物要素可供性表现		
										感知 可供性	使用 可供性	塑造 可供性
1	女	5	比赛数树干上的“眼睛”	规则性	毛白杨 ( <i>Populus tomentosa</i> )	干	种植容器	半开敞型	疏林	观察	当成玩具	
2	女	4	推大树	功能性	白蜡树 ( <i>Fraxinus chinensis</i> )	干	铺装	半开敞型	树阵		当成玩具	
3	女	6	摘黄刺玫的叶、果	功能性	黄刺玫 ( <i>Rosa xanthina</i> )	叶、果	地形	私密型	密林		当成玩具	
4	男	8	观察月季花的果实	探索性	月季花 ( <i>Rosa chinensis</i> )	果	地形	开敞型	丛植	观察		
			捡起楝树掉在地上的果实并观察果实内部	探索性	楝 ( <i>Melia azedarach</i> )	果	铺装	开敞型	群植	观察		
				功能性	楝 ( <i>Melia azedarach</i> )	果	铺装	开敞型	群植		当成玩具	
5	女	7	扯蔷薇叶片、比赛跳高扯龙爪槐叶子, 并在地面上按大小排列叶片	规则性	野蔷薇 ( <i>Rosa multiflora</i> )	叶	置石	半开敞型	疏林		当成玩具	
				规则性	龙爪槐 ( <i>Styphnolobium japonicum</i> ‘Pendula’)	叶	地形	半开敞型	疏林		当成玩具	
6	女	5	做“草莓酱”	戏剧性	月季花 ( <i>Rosa chinensis</i> )	花	道路	半开敞型	花篱	观赏	当作“食材”	创造“草莓酱”

续表见下页

表 2: 儿童与植物交互游戏的行为观察统计表 (部分)

编号	性别	年龄 (岁)	游戏行为 描述	游戏 类别	涉及 植物	提供可供性 的元素	周边 环境要素	空间 类型	植物 配置手法	植物要素可供性表现		
										感知 可供性	使用 可供性	塑造 可供性
7	女	7	用槐树枝挖坑  尝大叶黄杨叶片的味道、闻香味	功能性	槐 ( <i>Styphnolobium japonicum</i> )	枝	土壤	半开敞型	疏林		当成工具	
				探索性	大叶黄杨 ( <i>Buxus megistophylla</i> )	叶	道路	半开敞型	绿篱	尝味道		
				探索性	大叶黄杨 ( <i>Buxus megistophylla</i> )	叶	土壤	半开敞型	绿篱	闻香味		
8	男	6	边走边收集各类“食材”和物品, 比谁收的多	规则性	紫荆 ( <i>Cercis chinensis</i> )	果	土壤	私密型	疏林	观赏	当作“食材”	
				规则性	蛇莓 ( <i>Duchesnea indica</i> )	叶	土壤	半开敞型	疏林	观赏	当作“食材”	
				规则性	卫矛 ( <i>Euonymus alatus</i> )	叶	道路	半开敞型	绿篱	观赏	当作“食材”	
				规则性	黄刺玫 ( <i>Rosa xanthina</i> )	花	道路	开敞型	密林		当作“食材”	
9	男	6	炒菜, “香菜”炒“豆角”	戏剧性	紫荆 ( <i>Cercis chinensis</i> )	果	土壤	私密型	疏林	观赏	当作“食材”	创造“菜肴”
				戏剧性	蛇莓 ( <i>Duchesnea indica</i> )	叶	土壤	半开敞型	疏林	观赏	当作“食材”	创造“菜肴”
				戏剧性	野蔷薇 ( <i>Rosa multiflora</i> )	整体形态	置石	私密型	疏林	感受 私密空间		

注

参考芦原义信的《外部空间的设计》, 按照以儿童为圆心的 1.5m 范围内, 以及以人眼为中心约 60° 顶角圆锥范围内的视线遮挡情况, 将儿童户外活动空间类型分为开敞空间、半开敞空间和私密空间 (来源: 参考文献 [42])。

表 3: 不同类型可供性对应的自发游戏

植物可供性	游戏类别	对应的游戏行为		联系
感知可供性	探索性游戏	通过感官与植物各器官之间展开的游戏	闻花、叶、果香味; 尝果实、叶片; 听踩叶子的声音; 观察果实、枝刺、叶片、树干纹理; 抚摸花瓣、果皮茸毛、树干、叶片等, 感知植物整体环境……	植物特征多样, 发生的可供性较丰富; 三类可供性之间往往相互融合, 伴随发生
使用可供性	规则性、功能性游戏	涉及游戏规则, 或儿童通过身体活动, 将植物作为工具或玩具直接展开的游戏	比赛收集果实、花朵、数树干皮孔; 跳高摸树叶; 用树枝挖坑; 在植物枝干上吊臂; 爬树; 靠在绿篱上; 环抱树干……	
塑造可供性	戏剧性、建构性游戏	发挥想象力进行角色扮演; 发挥创造力创作作品	搭建“秘密基地”、过家家; 用树枝“钓鱼”、叶片作“诱饵”; 编花环、编草结; 用树叶、花朵拼画, 描地上的树影作画; 收集叶片、花朵做标本……	

表 4: 不同空间类型下植物提供可供性的各器官占比

空间类型	花	叶	果	枝(茎)	干	整体形态
开敞空间	23.08%	20.51%	7.69%	10.26%	7.69%	30.77%
半开敞空间	9.35%	32.71%	11.21%	15.89%	7.48%	23.36%
私密空间	4.76%	26.19%	9.53%	19.05%	7.14%	33.33%

表 5: 游戏与植物各器官可供性间卡方检验结果

游戏类型	各器官可供性发生频数	
	卡方	自由度
	48.355	20
	渐进显著性(双侧)	
	.000***	

注

\*\*\* 表示  $p < 0.001$ 。

#### 4.4 影响儿童游戏的植物个体特征及其他环境特征

结合行为观察与行为注记结果, 对比不同位置下儿童与相同植物的互动游戏情况发现, 相较而言, 植物个体本身的特征、周边其他环境特征对儿童展开游戏的影响更为显著。

##### 4.4.1 植物个体特征

针对实地调研过程中植物的可供性表现及儿童游戏情况进行交叉表统计分析(图7), 同时将数据导入SPSS软件进行交叉表卡方检验(表5), 结果显示不同的植物器官可供性发生情况与儿童游戏之间存在极显著差异( $p < 0.001$ )。

结合行为观察中的空间特征, 分析得出儿童与植物互动游戏时偏好的植物个体特征如下。

##### (1) 可触及的范围内有特殊触感

儿童偏好可视范围内可以触及或借助外力可触的植物。例如, 有的儿童会靠在大叶黄杨上再弹起, 认为绿篱“像蹦床一样”; 还会边走边抚摸大叶黄杨的顶层叶片, 认为“硬硬的, 还很平”。又如, 一棵侧柏(*Platycladus orientalis*)的侧枝距地约1.6m, 与其枝干呈90°横向生长, 许多儿童利用这根光滑的侧枝进行吊手、蹦跳的游戏(图8-1)。

##### (2) 芳香植物

有香味的植物往往受到儿童的青睐, 他们会探究不同植物的气味、寻找气味的来源(图8-2)。这可以激发儿童对自然的好奇心, 在俯身观察的过程中还会发现花坛里的九香虫(*Aspongopus chinensis*)、

蚯蚓 (*Pheretima* spp.) 等昆虫, 收获意料之外的乐趣。

### (3) 有枝刺或针叶状植物

儿童游乐区植物选择相关规范大多要求避免使用带刺植物。在调研过程中也确有部分儿童表示害怕被刺扎伤, 但仍有约六成的儿童表示喜爱带刺植物。有皮刺的野蔷薇、月季花、黄刺玫, 以及针叶状的雪松 (*Cedrus deodara*)、圆柏 (*Juniperus chinensis*) 都是儿童较为偏好的植物 (图8-3)。当被问及是否害怕与带刺植物接触时, 儿童往往表示“可以小心地去摸”“速度很慢的”“很有挑战性”。

### (4) 主干粗壮的大乔木

胸径较粗的大乔木更受年龄稍小的儿童喜爱。例如, 常常能观察到3~5个儿童牵手在二球悬铃木 (*Platanus acerifolia*) 树坛上转圈或仔细打量树干纹理。此外, 粗壮的胡桃 (*Juglans regia*)、毛白杨、槐周围也经常可以观察到有儿童抚摸、倚靠、观察 (图8-4)。

### (5) 分枝点低矮、枝干分杈角度适中的小乔木

3~12岁儿童身高通常不足1.6m, 因此常观察到他们在分枝点较低、枝干分杈角度适中的小乔木上进行爬树等活动。此类小乔木包括李 (*Prunus salicina*)、绚丽海棠 (*Malus* ‘Radiant’)、西府海棠 (*Malus × micromalus*) 等 (图8-5)。

### (6) 掉落的零散枝条

公园中掉落的零散枝条也是儿童在自发游戏中较为青睐的工具。例如, 垂柳 (*Salix babylonica*)、忍冬 (*Lonicera japonica*) 枝条比较长且直, 可用作“钓鱼竿”“风筝线”等 (图8-6)。

### (7) 低矮的垂枝型灌木

垂枝型灌木易于围合成天然的、成人较难进入的私密环境, 适于同龄儿童之间开展各类游戏, 因而深受欢迎。例如, 枸杞 (*Lycium chinense*)、野蔷薇、黄刺玫、忍冬等植物形成的天然拱形空间会吸引儿童进入, 开展“做饭”“建城堡”“钻地道”等游戏 (图8-7)。

### (8) 花型独特、颜色鲜艳的开花植物

社区公园内的开花植物较多, 黄刺玫、野蔷薇、月季花、紫丁香 (*Syringa oblata*)、山桃 (*Prunus davidiana*) 等都是儿童在交互游戏中偏好的植物。漏斗状、穗状、喇叭状的花也较受儿童喜爱, 包括大花马齿苋 (*Portulaca grandiflora*)、鸡冠花 (*Celosia cristata*) 等 (图8-8)。

### (9) 叶片形状、质感特殊的植物

呈羽状复叶、披针形、掌状分裂、近心形、有锯齿等特征的叶片较容易引起儿童的关注。例如, 蛇莓的叶片先端圆钝有锯齿, 形似茺荑, 儿童会边采边喊“我这有香菜”。对于地锦 (*Parthenocissus tricuspidata*) 等掌状分裂叶片, 儿童会观察其脉络, 之后对其开展“生物实验”。玉簪 (*Hosta plantaginea*) 的叶片大, 儿童会将其当作“雨伞”。马齿苋 (*Portulaca oleracea*) 叶片呈肉质, 儿童会探寻叶片中是否

存有汁液。二球悬铃木落叶干枯后会自然卷曲、质感似纸张, 儿童会带回家收藏。年龄稍大的儿童, 会利用山麦冬 (*Liriope spicata*) 的叶片编织草球, 创造属于自己的“艺术品” (图8-9)。

### (10) 果实特殊的植物

楝、紫荆的果实形似食用果实, 儿童会观察、收集此类果实, 并进一步开展过家家等游戏。黄刺玫等植物果实较小、较硬且圆润, 可用作“子弹”或“物资”; 枸杞、海棠等植物果实颜色鲜艳, 可吸引儿童进行爬树、采摘等身体活动和其他创作活动。在有关果实的访谈中, 大多数儿童会迫切地解释“这些都是不能吃的”, 及表达“种点苹果树、梨树”的愿望 (图8-10)。

## 4.4.2 其他环境特征

除植物本身的特性外, 周边环境特征也会影响儿童与植物交互游戏的内容与方式。分析表2数据可知, 在游戏时, 儿童对周边环境特征的偏好程度不一。本研究中记录的环境要素依据在游戏时的频次高低排序分别为: 土壤、种植容器、置物面、竖向变化和水 (图9)。

### (1) 土壤

裸露的土地可激发儿童的想象力和创造力, 有利于开展功能性、建构性和戏剧性游戏。例如, 孩子们可以“刨土做花城堡”“挖土锅做饭”“挖地道运树枝”等 (图10-1)。此外, 在挖掘类游戏中, 儿童更偏好板结的土壤。

### (2) 种植容器

种植容器包括花坛、孤植树坛、花钵等。年龄稍小的儿童常常蹲或站在种植池上抚摸植物、揪叶片; 年龄稍大的儿童会半趴在植坛上观察植物形态、闻植物气味, 或与同伴一起坐在植坛上乘凉。另有儿童爬上外表形态起伏变化的花钵观察其中的植物 (图10-2)。

### (3) 置物面

拥有较平表面的置石、砖、道路和桌椅等物体常被儿童用作“置物架”“操作台”或“炒菜的灶台”。他们会将采摘来的“物料”放在置物面上清点或进行创作, 或当作“炒菜的灶台” (图10-3)。

### (4) 竖向变化

自然起伏的地形、堆叠的假山高台、顺应高差建设的台阶等均营造了空间上的竖向变化。探索高处的植物在儿童们看来是“很刺激”的游戏, “是一个冒险的旅程” (图10-4)。

### (5) 水

除风湖公园外, 其他三个公园分别设有喷泉水池、小水渠、叠石水池。实地调研发现, 池深范围为0.45~1.6m。儿童会主动寻找水体中是否存在植物, 或用植物枝条撩拨水面。例如, 有两个用树枝“钓蝌蚪”的9岁男生表示“水池里没有荷花很可惜”, 他们认为水池里种上荷花不仅能美化环境, 还能让蝌蚪有食可吃 (图10-5)。

## 4.5 儿童内心理解的植物环境

通过问卷及开放性问题“你希望这里多增加一些什么植物？为什么？”（儿童可以通过语句来描述，也可以把想象的样子画出来），研究探索了城市儿童对理想植物环境的期望。研究将收集到的语句内容进行词云分析，同时结合儿童的图画表达（图11）发现，儿童最期待的是“大树”“小草”“向日葵”“苹果树”，以及“好看”“开花”的植物等。总体而言，儿童对植物的整体形态及花、果器官较为关注。

少数儿童对社区公园现状表示满意，大多数儿童提出了见解和期待，其对植物的具体需求、态度和感知可总结为以下三点。

1) 儿童对植物设计的需求：儿童对植物的认知有独特的视角，偏好色彩鲜艳、可食用及有特殊功效的植物。例如，“希望多种些黄色的太阳花，颜色很鲜艳”“想种苹果树，可以吃苹果”“希望多种一些捕蝇草，吃掉虫子”等。儿童也关注植物空间的趣味性，希望能结合其他设计要素。例如，“可以把植物和秋千种在一起”“希望有滑梯和沙坑，旁边多种植物”“在树干上种草，这样树会显得更有意思、更丰富”。学龄儿童希望实地接触到书本、电视上提到的植物，“希望能种紫茉莉、合欢，语文课本里讲过这些植物”“真希望能真的见到那些植物！”这反映了儿童对植物学习的渴求，也为更好地发挥社区绿地的功能提供了拓展方向。

2) 透过与植物的交互，反映出儿童的环境保护意识：部分儿童在与植物交互游戏时会思考植物与环境保护间的关系，例如，“树越多越好，这样可以保护地球”“多种些花，吸收空气里的二氧化碳，保护环境”“希望种很多小鸟可以安家的树”“想种水曲柳，电视上看到是（国家）野生二级保护植物”。

3) 植物是儿童与外界情感联结的载体：多位受访儿童在解释最喜欢的植物时均提及了家人，例如，“我姥姥家门前院子里就有苹果树”“我妈妈最喜欢玫瑰花”等。表明植物在亲子情感中发挥了纽带作用，之后可进一步扩展相关研究。

## 5 结论

本文以天津市4个社区公园为例，探究了3~12岁儿童与植物互动时偏好的游戏类型及对应的周围环境特征。研究表明，在高密度城市环境中，儿童能够积极运用植物的感知可供性、使用可供性和塑造可供性开展各类游戏。儿童与植物的交互游戏增加了其与自然的直接接触，可初步满足城市儿童日常生活中的自然体验需求。本研究探索的儿童游戏偏好可为设计提供新的思路，指导设计从儿童视角和需求出发，创造能激发儿童自发开展亲自然游戏的环境，扩展植物更多潜在的可供性，丰富儿童游戏类型。为切实体现包容性城市对儿童群体的关注和关爱，设计更应关注儿童天然、自发开展的游戏内涵，尊重儿童对绿地植物的本

能游戏需求，相应调整从植物景观设计到养护管理的各个环节，促进城市的公平性、包容性及可持续性发展。本研究提出以下五点设计建议。

### 1) 针对特定空间类型满足游戏需求

不同类型的空间开敞度不同，植物的各类可供性频数不一，儿童在特定空间中的游戏需求也不同。私密空间下，由于视线遮挡且活动空间较为封闭，儿童倾向于在此与同伴进行戏剧性游戏，因此可利用低矮、无明显主干的灌木形成天然私密空间，同时搭配置物面等进一步促进塑造可供性的发生。半开敞空间中植物的使用可供性与感知可供性通常频数较高，因此可选取叶片富有特点的植物来鼓励儿童开展体力活动。开敞空间中可种植更多的开花植物，激发儿童探索欲望，引导儿童感知植物，展开探索性游戏。

### 2) 引入种类丰富且各具特色的植物

本研究发现，儿童偏好叶片独特、能开花和结果、枝干粗壮的植物，这与既往研究结果一致<sup>[9][23]</sup>。此外，儿童偏好“有枝刺或针叶状植物”，这与《公园设计规范》（GB51192-2016）中要求的对于“游人正常活动范围内不应选用枝叶有硬刺和枝叶形状呈尖硬剑状或刺状的植物”这一原则相悖。但已有研究表明，在正确接触这类植物的前提下，具有“冒险”意味的游戏能锻炼儿童更好地面对风险，提升自我保护意识及适应各种情况的能力<sup>[43]</sup>。因此建议在提供丰富且具有特色的植物时，辅以更加精准的安全教育设计（如在场地中展示植物特征信息），而非完全去除此类植物产生的可供性。

### 3) 开发其他环境要素的辅助功能

在儿童与植物的自发游戏中，土壤、种植容器、置物面等环境要素的辅助也必不可少。在常见的绿地内，儿童可以自发地利用现有环境要素，创造性地组合并开展游戏。其中土壤作为自然环境的基底，可促使儿童进行更多的建构性和功能性游戏。相比其他环境要素，儿童在亲自然游戏中对土壤更为喜爱。鉴于此，场地设计时可尽量提供不同质地的土壤，在有条件的情况下可开辟专门的空间引导儿童与植物和土壤互动；若无法实现，也开展种植体验活动，促进儿童与植物和土壤的直接接触。

此外，本研究发现，社区公园中出现的昆虫也会吸引儿童的关注。相关研究表明，动物多样性较高的植被环境<sup>[22]</sup>会极大激发儿童游戏兴趣。各类昆虫、鸟类作为自然界中的重要媒介，对儿童与植物交互游戏的作用如何及能否激发更多可供性，可在未来展开进一步研究。

### 4) 引入挑战与冒险游戏

由研究结果可知，儿童更多关注与植物相关的、难度相对较低的挑战。因此，可根据儿童的身高条件，设计高度适宜的植物，积极调动儿童的好奇心，将植物更多的潜在可供性首先转化为感知可供性，从而进一步促使儿童与植物发生更多样的交互游戏。此外，儿童还习惯用“勇敢去冒险”等词句来激发各类身体活动，同时也会相互扶持和鼓励，分

享“冒险”的心得经验。这进一步印证了冒险游戏对儿童成长的重要性<sup>[44]</sup>。可攀爬的树、种植于假山高处的植物、种植密度高的乔木林均是儿童偏好的环境，这些挑战可以在有效管理的前提下开展，而非以安全隐患为由，完全禁止。

### 5) 安全与环境教育

不可否认，在绿地环境营造与儿童游戏过程中，安全性应当放在首位。但在推进儿童友好城市及包容性城市建设的背景下，则需要通过更加精准的设计来满足儿童的亲自然游戏需求。与此同时，儿童与植物交互产生的自发游戏或多或少会导致对植物的伤害或破坏。因此，将具有挑战性的游戏与安全教育及环境教育相结合，可加深儿童对生命的认知，促使儿童尊重生命安全并关注自我与环境的关系。

本研究也存在一定的局限性，如调研时间跨度不足一年、未细分儿童群体等。未来研究可开展全年甚至多年的观察与分析，更全面地比较儿童与植物游戏的各类情况；还可将3~12岁儿童群体细分为学前组与学龄组，使研究成果更具针对性；以及进一步探究植物群落空间结构、植被多样性等生境特征对儿童与植物游戏的影响。

- 图 1. 调研样地概况
- 图 2. 研究框架
- 图 3. 四个社区公园中儿童游戏行为注记图。调研人员根据每个儿童的活动内容与轨迹逐一进行记录，最后叠加所有儿童的活动轨迹及时长生成行为注记图。其中线条表示行动轨迹、圆点表示与植物游戏停留时长（参考自文献 [39]）。公园内儿童的整体年龄情况、公园环境等因素可能影响儿童与植物游戏的情况，因此各公园记录的行为注记人数不一。所记录的儿童人数越多，则活动路线叠加密度越高；圆点越大，则停留时间越长——说明此类环境更受儿童欢迎。
- 图 4. 植物可供性发生频数统计
- 图 5. 各类游戏发生频数统计
- 图 6. 不同空间类型及不同植物配置手法下的可供性发生概况
- 图 7. 各植物器官可供性及不同类型游戏的发生情况
- 图 8. 社区公园中有关植物个体特征的儿童与植物交互游戏的典型表现
- 图 9. 儿童与植物交互游戏中周边环境特征统计结果
- 图 10. 社区公园中有关周边环境特征的儿童与植物交互游戏的典型表现
- 图 11. 儿童对理想绿地环境的绘画描述示例