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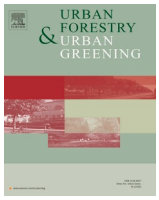

Original article

Needs and expectations of German and Chinese children for livable urban green spaces revealed by the method of empathy-based stories

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ABSTRACT

One of the important features of cities is to provide high-quality outdoor environments for various groups of citizens. Although children are frequent users of green spaces, the knowledge and perspectives applied in planning and design of urban green spaces are mostly defined by adults. This results in spaces and practices that may limit the daily lives and creativity of urban children. Promoting child-friendly cities benefits from knowledge produced by children themselves, regarding their perceptions and experiences, as well as ideas and suggestions. This study provides empirical results concerning children's needs and mental images for urban green spaces in two urban areas in two countries (Chengdu, China, and Ruhr Region, Germany). 765 children, ages 8–10 were surveyed through the method of empathy-based stories (MEBS). Participants were asked to use their imagination to write stories according to given scenarios. Our study shows that MEBS can be used to gather meaningful data with children, and that children are an important stakeholder group in urban planning, landscape design and management with an ability to express their diverse needs and preferences towards green spaces. Both designed green spaces (e.g. gardens, parks) and wild nature (e.g. forests, meadows) can offer a range of activities and experiences for children in their everyday lives: opportunities for play, socializing, contact with nature, aesthetic and restorative experiences, learning and exploration. Our findings include indications of children's awareness of the diverse ecosystem services that green spaces provide, as well as of urban sustainability and livability. While we found German and Chinese children to have corresponding needs and expectations regarding urban green spaces and nature, we also found some variation. We suggest that the use of, and experiences in green spaces are linked not only to the landscape but also to conceptual-cultural contexts.

1. Introduction

Urbanization creates a range of environmental, social, and economic challenges for societies (UNCHS, 1996; UNDESA, 2014). On average, one-third of the human population in developed nations are children, and in developing nations, this proportion can be as high as 60 % (UNICEF, 2003). Yet, it is mostly adult knowledge and perspectives that are harnessed in urban planning and policymaking. This results in landscapes and practices that may limit the daily lives of urban children and negatively impact their development, health, and well-being (Malone, 2010). The United Nations Children's Fund's (UNICEF) Child-Friendly Cities Initiative highlights the importance of children's participation in the planning of cities (UNICEF, 2017). Including children's voices in urban planning can benefit the children themselves and help create cities that meet the needs of everyone (Gill, 2014). Additionally, children can also play an important role as transformers in urban planning, which could promote sustainable development (Nordström and Wales, 2019).

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Although children are among the most frequent users of public open spaces, urbanization restricts their opportunities to go outside to play and socialize (Kyttä, 1997; Marzi and Reimers, 2018). Having the opportunity to go out every day, with access to green spaces, also allows children to gain benefits from being in contact with nature (Chawla, 2015; Roberts et al., 2019). Firstly, children's physical and mental health can be promoted (Wells and Evans, 2003; Kelz et al., 2015; Vanaken and Danckaerts, 2018). Outdoor activities can shift sedentary lifestyles towards more active ones (Hills et al., 2007) and children are more physically active and play for longer when they are outdoors, particularly without adult accompaniment (Mackett et al., 2007). At the same time, natural environments may provide positive physiological effects such as increased diversity of beneficial skin bacteria and lower blood pressure (Kelz et al., 2015), less allergic sensitization (Ruokolainen et al., 2015), better abilities in balance and coordination (Fjørtoft, 2004) and protection against respiratory diseases (Hartley et al., 2020). Besides, stress levels and Attention Deficit Hyperactivity Disorder (ADHD) symptoms may be mitigated by contact with nature (Wells and Evans, 2003; Di Carmine and Berto, 2020; Barger et al., 2021). Secondly, children's prosocial behavior, as well as intellectual, social-emotional and cognitive capacities can be developed when interacting with plants and animals (Putra et al., 2020). Lastly, regular contact with nature during childhood encourages environmentally responsible behavior and can lead to positive environmental attitudes and values during adulthood (Kaiser et al., 1999; Wells and Lekies, 2006; Damerell et al., 2013; Gill, 2014).

The quality of urban green spaces has implications for children's willingness to play in and interact with nature (Jansson et al., 2016; Wales et al., 2020). This calls for in-depth information on the preferred elements and experiential potential of green outdoor environments for children (Feng and Astell-Burt, 2017). Instead of constructing "spaces for children", which are perceived and controlled by adults, children's expectations should be considered in urban green space planning to create "children's places" - places they have a personal connection with (Rasmussen, 2004; Derr et al., 2018). According to Rasmussen (2004), only children are able to communicate the qualities of children's places. Therefore, designing child-friendly urban green spaces benefits from knowledge produced by children themselves, concerning their perceptions and experiences, as well as ideas and suggestions.

In order to adopt such a user-centered approach, a variety of research methods is necessary to capture children's experiences, perspectives and ideas. Our research provides insight into a storytelling method, the method of empathy-based stories (MEBS), and its ability to reveal children's preferences, expectations, values and mental images regarding urban green spaces. We hypothesized that this method allows children to produce rich and specific information on urban landscape features and reveals experiential qualities that they prefer and find meaningful. Our specific aims were to: 1) collect empirical information concerning children's needs and mental images regarding urban green spaces, 2) test the usefulness of MEBS as a method for collecting data on children's perspectives of urban green spaces, and 3) test whether the method works across different cultural-geographic contexts.

2. Material and methods

2.1. The method of empathy-based stories

MEBS is considered suitable for studies examining participants' perceptions, expectations, ideas and interactions regarding specific topics (Eskola, 1988; Wallin et al., 2018). The term 'empathy-based stories' is established in the scientific literature, and 'empathy' in this context is understood as an ability to place oneself into a specifically described situation (Juntunen and Saarti, 2000; Wallin et al., 2018; Särkelä and Suoranta, 2020). Participants are asked to empathize to a specific situation given in a script (a frame story provided by the researcher) and continue the story based on their own imagination (Eskola, 1988; Wallin et al., 2018). The scripts place the participants into situations that the researchers are interested in (see Table 1). Typically, several scripts are developed with two or three different versions of each script. The variety of scripts and their versions offer variation in key elements of interest, ensuring comprehensive data not biased by a too narrow set of scripts. The versions also allow studying how the answers (here children's stories) change depending on key elements of the scripts (Mesimäki et al., 2017). In our study, each participant received one of our 17 script versions and was asked to continue the story by writing and/or drawing (Mesimäki et al., 2017; Wallin et al., 2018).

We developed the scripts based on three interlinked concepts related to important principles in contemporary design and planning of urban (green) spaces, namely sustainable development, livability and ecosystem services. We conceived 8 scripts containing altogether 17 versions that reflect various aspects of these concepts. Understanding both user perceptions and their physical interactions with the environment may offer pathways to better conceptualize the livability of cities (Ruth and Franklin, 2014). Thus, the script versions were designed to facilitate children in providing information about their behavioral, sensuous, social, accessibility, psychological well-being, and spatial design needs (Matthews and Limb, 1999). The script versions provided realistic and fictive, and otherwise contrasting situations to help harvest comprehensive and rich data, and to foster creativity that is not constrained by the limits of reality (Mesimäki et al., 2017). We also included scripts without any nature-related content to see whether green space and nature would emerge even when not suggested by the script.

2.2. Data collection and the participants

We gathered data using MEBS with schoolchildren in Germany (from March to August 2016) and in China (from June to October 2019). In each country, we included urban areas with different population densities and landscape features (Appendix A). Data were collected from three cities in both Germany and China, involving six and three schools, respectively.

We used our networks to access a sufficient number of school classes and participants. Our predetermined criteria for selecting participants were an ability to understand abstract concepts and imagine situations described in the scripts to maximize validity and richness of the data, c.f. purposeful sampling (Eskola, 1988). Altogether 765 children took part in the study, 313 from Germany and 452 from China, with a good balance of females (54 %) and males (46 %). We collected the data from grades 3 and 4, except for one school in Germany with only grade 4. The children's ages varied from 8–10 years old. We used the informed consent procedure with all participants, including permission to take part in the study from the children's guardians and teachers. The children were instructed to complete the task individually to ensure independent answers. We collected at least 15 stories per script version per country, which is considered as a minimum to achieve 'data saturation' in MEBS.

2.3. Analysis

We excluded 174 stories with non-relevant or ambiguous information (Appendix A). This resulted in 591 stories (337/57 % from China, 254/43 % from Germany; for examples of the stories, see Appendix B).

We used both explorative and hypothetico-deductive analyses to reveal children's needs and expectations towards urban green spaces (Palinkas et al., 2015). The meaningful contents from the stories were analysed following two steps: 1) first-level coding that formed Dataset1, and 2) pattern coding that formed Dataset2 (Fig. 1). In Dataset1 the contents were coded and categorized as 'mentions' into presence-absence data (Feinerer et al., 2008; Silge and Robinson, 2018), while Dataset2 was formed of specific thematic categories (Maguire and Delahunt, 2017). A 'mention' refers to a child having mentioned the focal category topic at least once in her/his story. The two datasets were

Table 1
Script focus and versions, and the script text that was delivered to the participants.

Script focus	Script version (number of stories included in the analysis/total number of mentions produced by the script version/average number of mentions per story per script version)	Script text
1. Utopia (comfortable future)	1.1 sensory experiences (39/401/10.3)	Imagine you have a time machine and travel to the future. You arrive in a city green space* where you feel comfortable. What can you see, hear, smell and touch?
	1.2 social context (28/248/8.9)	Imagine you have a time machine and travel to the future. You arrive in a city green space* where you feel comfortable. Who is there and what are they doing?
	1.3 utopia vs. reality (28/265/9.5)	Imagine you have a time machine and travel to the future. You arrive in a city green space* where you feel comfortable. In what way is it different from the spaces you know today?
2. Accessibility, motivation	2.1 today (37/313/8.5)	Imagine you want to go outside today and spend your free time in a green space*. How do you get there? Why?
	2.2 future (34/326/9.6)	Imagine you are living in the future. You want to go outside and spend your free time in a green space*. How do you get there? Why?
3. An ideal place for social interaction	3.1 no additional restriction (32/262/8.2)	Imagine you and your friends are living in the future. You win a green space* that you want to share with your friends. You can use it whichever way you want. What is the space like? What are you doing there?
	3.2 forbidden to build houses (29/280/9.7)	Imagine you and your friends are living in the future. You win a green space* that you want to share with your friends. You can use it whichever way you want except to build houses. What is the space like? What are you doing there?
4. Emotional needs	4.1 sad situation (28/213/7.6)	Imagine a day you feel a little sad. Which place do you want to go to? With whom? Why? Describe this place.
	4.2 happy situation (32/259/8.1)	Imagine a day you feel very happy. Which place do you want to go to? With whom? Why? Describe this place.
5. Empowerment	5.1 no empowerment (25/252/10.1)	Imagine the greatest city of the world. How would this city be like?
	5.2 empowerment (29/179/6.2)	Imagine you are incredibly rich. You can change all bad things that bother you in your hometown into something wonderful. What do you want to change? Why?
6. Inclusion/exclusion of green space	6.1 urban full of green spaces (39/378/9.7)	Imagine a city with plenty of different green spaces. How would the city be like?
	6.2 urban without green spaces (46/448/9.7)	Imagine a city without green spaces. How would the city be like?
7. Restorative environments	7.1 hunger (44/407/9.3)	School is out. You had a very hard day. You are very hungry and incredibly tired. It is time to go home. On your long way back home, you are looking for a green space* where you can rest for a while. What is the space like? What is there to get new energy for the rest of your way back home?
	7.2 heat (45/455/10.1)	School is out. You had a very hard day. It is very hot outside and you are incredibly tired. It is time to go home. On your long way back home, you are looking for a green space* where you can rest for a while. What is the space like? What is there to get new energy for the rest of your way back home?
	7.3 noise (32/254/7.9)	School is out. You had a very hard day. It was a very loud day and you are incredibly tired. It is time to go home. On your long way back home, you are looking for a green space* where you can rest for a while. What is the space like? What is there to get new energy for the rest of your way back home?
8. Landscape elements	8.1 plants (44/267/6.1)	Today, you and your friends can travel with a space rocket to a city on planet Mars. Currently, no plants are growing there. How should the city on planet Mars look like for you? Which plants do you want to bring with you? How could the plants you bring on Mars survive?

* In 10 of the scripts, there was a short definition to describe the relatively abstract word green space "(e.g., park, forest, river, meadow)", denoted in the table with an asterisk.

qualitatively analysed, Dataset1 also quantitatively as explained below.

We examined Dataset1 as a whole to get an overall understanding of the contents in the main- and sub-categories via a treemap. To reveal patterns in the data and to test our hypothesis, we performed a non-metric multidimensional scaling (NMDS) with Raup-Crick index as the distance metric and a multi-response permutation procedure (MRPP). MRPP was used to test for separation between comparable scripts, where more negative T values suggest greater differences between groups (McCune et al., 2002). Both NMDS and MRPP were conducted using the vegan package in R (Oksanen et al., 2008). After this, we created word clouds to visualize differences between the script versions. To highlight

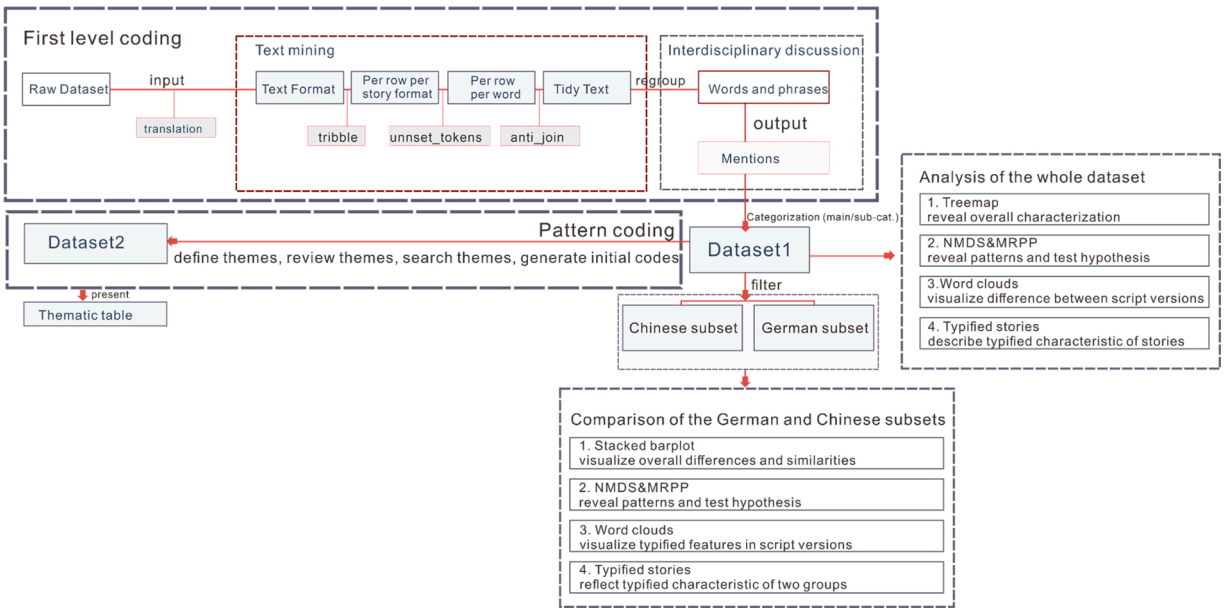

Fig. 1. Data processing and analysis flowchart. First-level coding to acquire Dataset1 was data-driven and involved text mining and interdisciplinary discussions to determine meaningful contents that were coded as 'mentions' and categorized into main- and sub-categories. For instance, "lily" and "rose" were included in the "flowers" sub-category, while "flowers" and "trees" were included in the "vegetation" main-category. Treemap, stacked barplot, word clouds and typified stories were utilized to visualize the results of Dataset1 as a whole, as well as the Chinese and German subsets. Pattern coding (Dataset2) aimed to reveal themes that had not been found in the first level coding (Dataset1).

characteristics of the stories in Dataset1, we chose scripts and versions with the richest contents from the word cloud results to present typified stories that are often used in MEBS (Wallin et al., 2018).

Next, Dataset1 was filtered into two subsets: a Chinese and a German one. For each subset, we separately calculated the number of mentions in a sub-category/number of participants and used these relative numbers to visualize differences and similarities between the two subsets as a stacked barplot. We also ran NMDS and MRPP to identify differences between Chinese and German data among the scripts and versions and created word clouds and typified stories for the Chinese and German subsets. Furthermore, we checked for differentiation among the schools with NMDS and MRPP but did not find any, thus the results

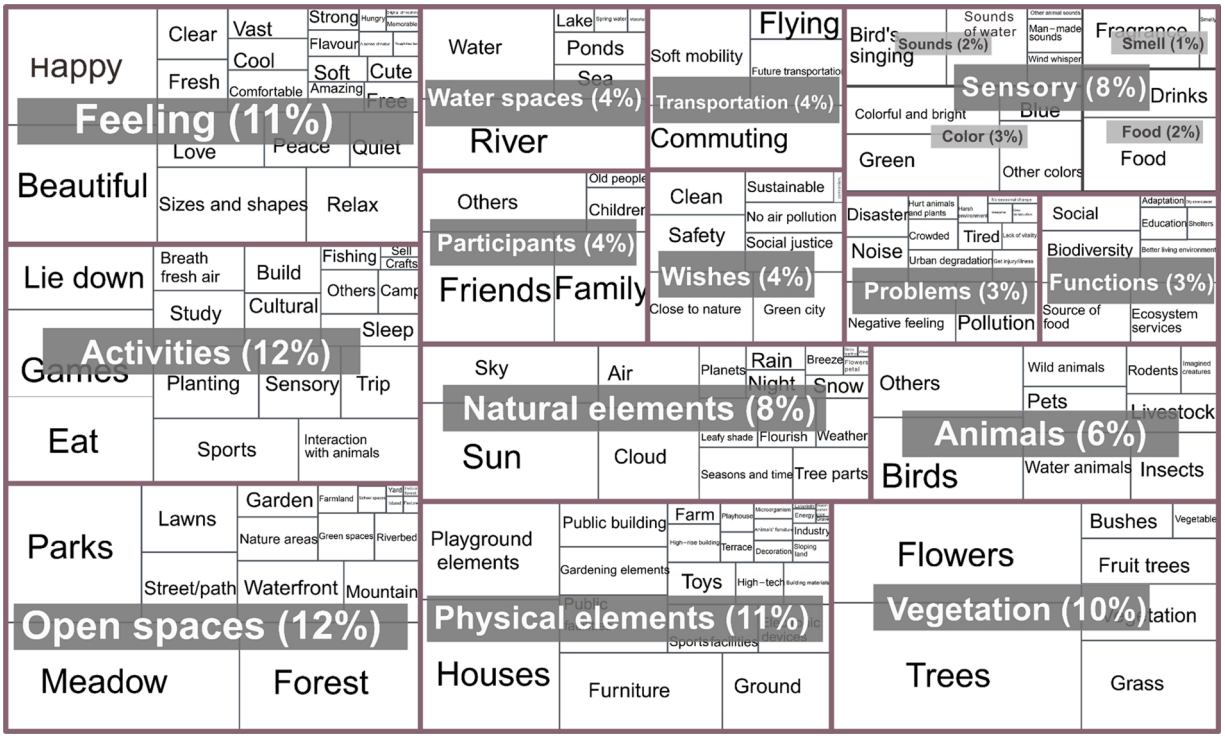

Fig. 2. Treemap presenting the categorization of mentions in Dataset1. The size of the boxes portrays the number of mentions (the larger the box, the higher the number of mentions). White text on grey bars inside the boxes with thick borders represents the main-categories, while the black text inside the white boxes with thin borders represents the sub-categories. The main-category "Open spaces" only includes terrestrial ones.

are not shown. All analyses were conducted in R version 3.6.2 (R Core Team, 2020). For details of the first-level coding process, see Appendix C.

3. Results

Our results show that children are able to produce rich data that can be interpreted meaningfully. The data gathered with MEBS offers information for the planning and design of child-friendly urban green spaces within the framework of sustainable development, ecosystem services and livability. More specifically, our results reveal specific natural elements, functions, uses, structures, and experiential qualities that children prefer and consider meaningful.

3.1. First-level coding results

3.1.1. Characterization of Dataset1

From the children's stories, we obtained a total of 5207 mentions that formed 14 main-categories and 176 sub-categories (Fig. 2). There were nine mentions per participant on average (min = 2, max = 31), and 2689 mentions (i.e. 52 %) in the Chinese and 2518 (48 %) in the German subset. Below, the title of each category is represented with a capital letter. Among the 14 main-categories, Open spaces and their Physical elements as well as Activities and Feelings composed the largest main-categories. Different types of green and blue spaces were described, ranging from wild natural (e.g. Rivers, Forests) to designed urban spaces (e.g. Parks, Lawns).

Activities and Physical elements in the data conveyed a rich set of uses and needs from very physically active to passive. The Feelings category displayed a variety of mental experiences like Happy and Beautiful. The main-categories related to nature portrayed a wide range of Natural elements (e.g. Sun, Rain) as well as diverse Vegetation (e.g. Trees, Flowers, Vegetables), and Animals (e.g. Birds, Water animals, Insects). For Sensory aspects, especially Sounds (e.g. Birds singing), Smell (e.g. Floral fragrances), Colors (e.g. Green, Blue) and Food (e.g. Specific food or Edible nature) were mentioned. Children also vividly described societal issues and showed environmental awareness, as displayed in the contents of Wishes, Problems, and Functions, e.g. mentions like "more biodiversity areas in the city", "urban degradation", "water/air pollution".

Among the 176 sub-categories, the 10 most common ones were Trees, Meadow, Flowers, Forest, Parks, Houses, Beautiful, Happy and Sun, mentioned 1147 times, accounting together 22.8 % of all mentions.

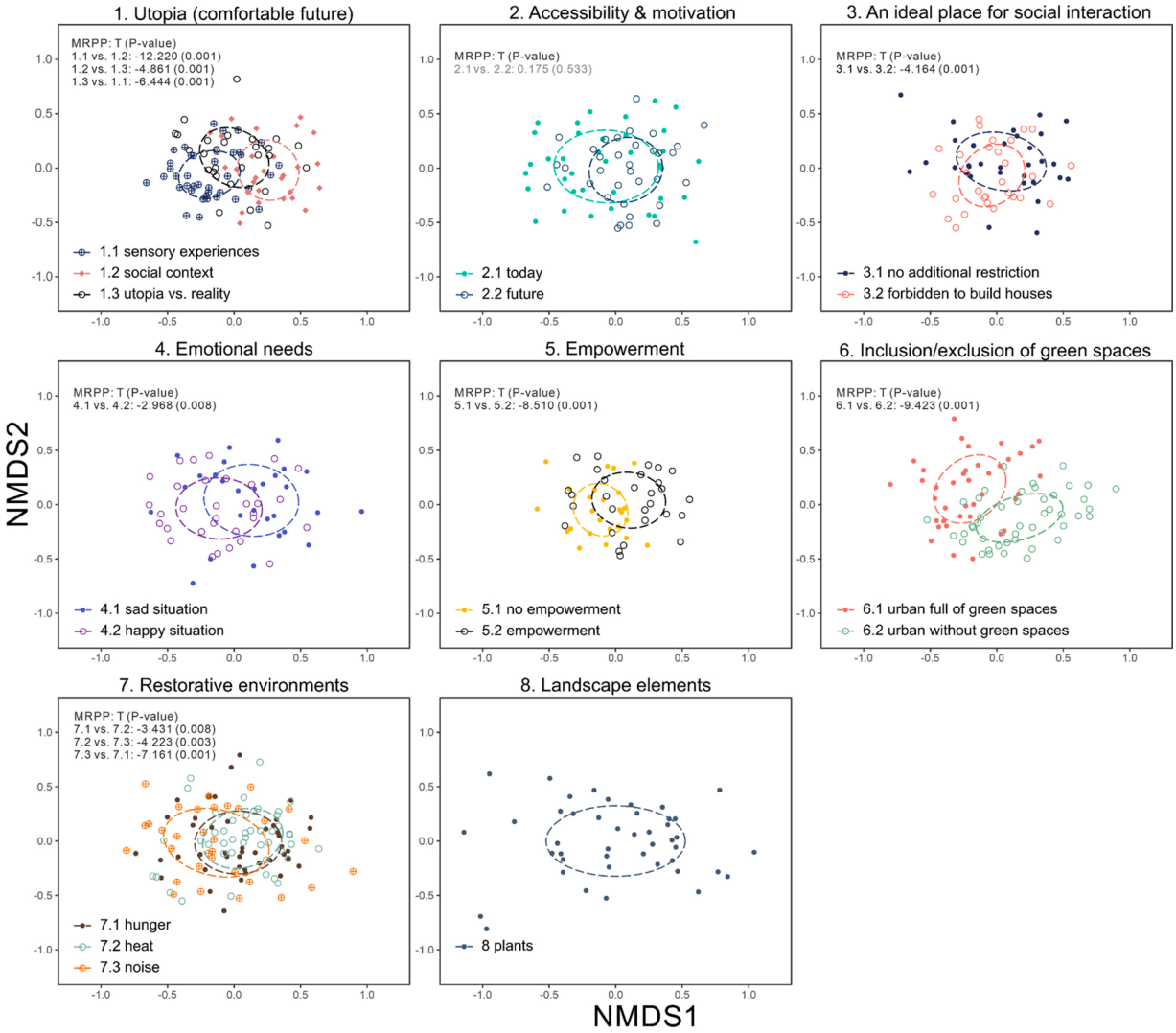

Fig. 3. NMDS and MRPP results. NMDS ordination plots based on Dataset1 highlight differences between script versions (presented in Table 1). The standard deviations of a particular version of each script are represented by ellipses. The top left corner in each panel shows the MRPP results of pairwise comparisons of script versions, with T (and p) values (in light grey when statistically insignificant). T describes the size of the difference between scripts. The more negative is T, the greater the difference.

3.1.2. Different script versions produced different contents

NMDS results for the 176 sub-categories (consisting of mentions from the children's stories) revealed statistically significant differences between the contents that the 17 versions of the scripts had inspired ($r^2 = 0.269$, $p = 0.001$; Fig. 3; for script versions, see Table 1). Specifically, pairwise within-script comparisons of the sub-categories by MRPP gave statistically significant differences between most script versions (Fig. 3), as well as across all scripts (Appendix D).

For each script version, the most numerous sub-categories, i.e. those that together make up 50 % of the mentions for that version, are shown in Appendix E. In Fig. 4, we give examples of typical features of children's needs and expectations towards green spaces through a selection of typified stories that highlight interesting contents and differences between scripts and versions.

A comparison across script versions showed that children were highly oriented by the script version to the given situation and provided relevant content. For example, "bird's singing" and "floral fragrances" were often mentioned in script 1.1 (sensory experiences in a comfortable future), "family members", and "friends" appeared in script 1.2 (social context), and "walk", "ride a bike", or "take a bus" were repeatedly found in script 2 (accessibility/motivation). The average number of mentions varied across script versions (Table 1). Script 1.1 (Utopia/Sensory experiences) produced the richest stories, while 8.1 (Landscape elements/Plants) generated the lowest number of mentions on average.

3.1.3. Comparing Chinese and German datasets

Data analyses generated relatively similar categorization of the contents of the Chinese and German stories, even though the data-driven first-level coding was carried out independently for each subset. Analysis of each subset produced the same main-categories while there were 126 sub-categories in the German subset, and 159 sub-categories in the Chinese one. One hundred and nine out of a total of 176 sub-categories were the same in both subsets.

In both the German and Chinese subset, the top 20 list of sub-categories (40 % of all mentions in each subset) included River and Water (in the Water spaces main-category); Commuting (in Transportation); Birds (in Animals); Trees and Flowers (in Vegetation); Friends (in Participants). Chinese children mentioned the following more frequently: Happy (in the Feeling main-category); Family (in Participants); Other animals (that included diverse infrequently mentioned species in Animals); Green city (in Wishes); Forests and Parks (in Open spaces); Biodiversity (in Function of green spaces); Grass (in Vegetation); Pollution (in Problems); Birds' singing, Fragrance and Green (in Sensory); Soft mobility (in Transportation). However, German children mentioned the following more frequently: Beautiful (in Feelings); Source of food (in Function); Colorful and bright, Food and Drinks (in Sensory); Others (In Participants); Houses and Playground elements (in Physical elements); Sun (in Natural elements); Negative feeling (in Problems); Meadows (in Open spaces); and Safe and Close to nature (in Wishes) (Fig. 5).

In the Chinese subset, there were at least 3 times more mentions in some sub-categories than in the German subset, e.g. Birds' singing, Sounds of water (in Sensory), Ecosystem services and Better living environment (in Functions), Planting (in Activities), Gardening elements (in Physical elements), Pollution (in Problems). In the German dataset, e.g., Playground elements, Furniture, Sports facilities (in Physical elements), Food and Drinks (in Sensory), Source of food (in Functions), Street/path (in Open spaces), Sun (in Natural elements), Disaster (in Problems) were mentioned 3 times more often than in the Chinese subset. Furthermore, Chinese children provided more contents in the main-categories of Wishes, Sensory, Feelings, Functions and Problems, while German children produced more mentions in the main-categories of Physical elements, Natural elements and Animals (Fig. 5).

There were sub-categories that did not occur in one subset while they were relatively frequent in the other, e.g. Grass, Convenient and Clean were frequent in the Chinese subset and Rodents, Bushes and Lakes in the German subset (Fig. 5, Appendix F). These illustrate differences in the conceptualizations of green spaces and their features and functions.

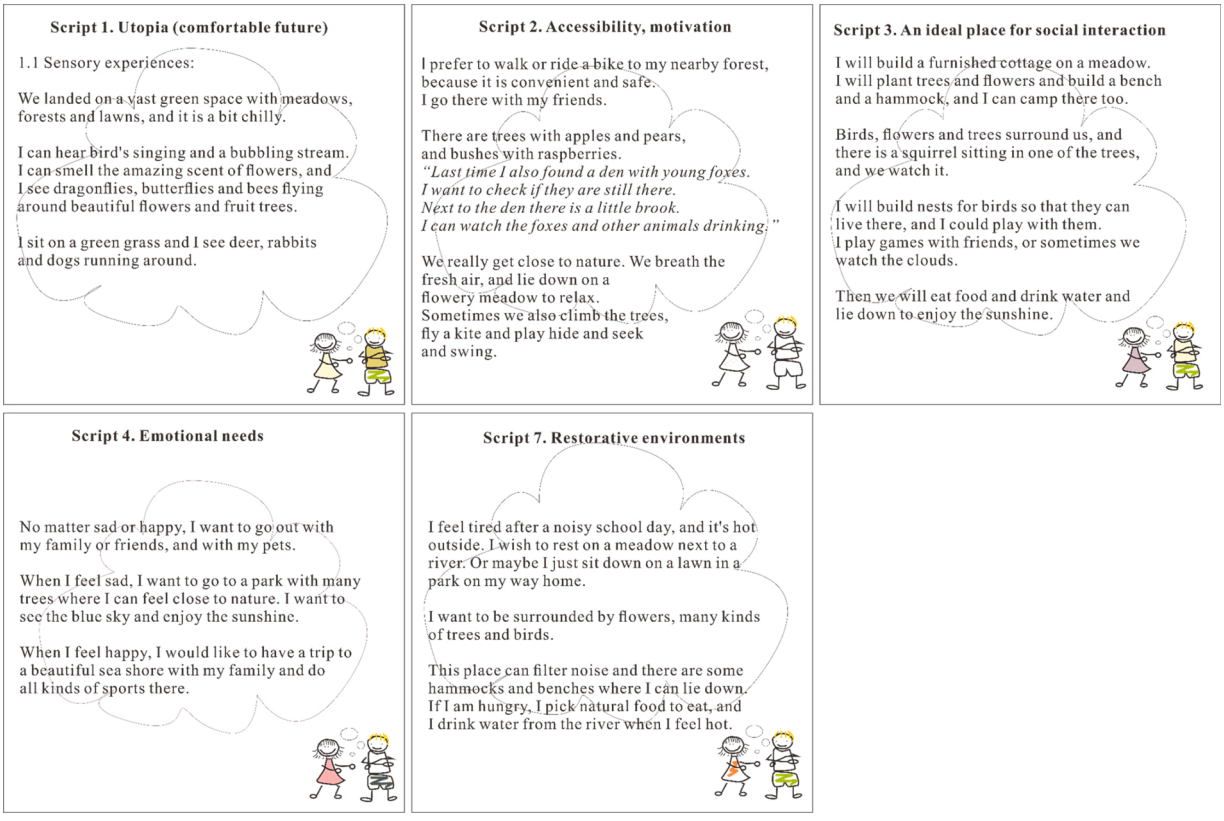

Fig. 4. Five typified stories exemplify contents that are typical for the script, based on Dataset1 (Table 1).

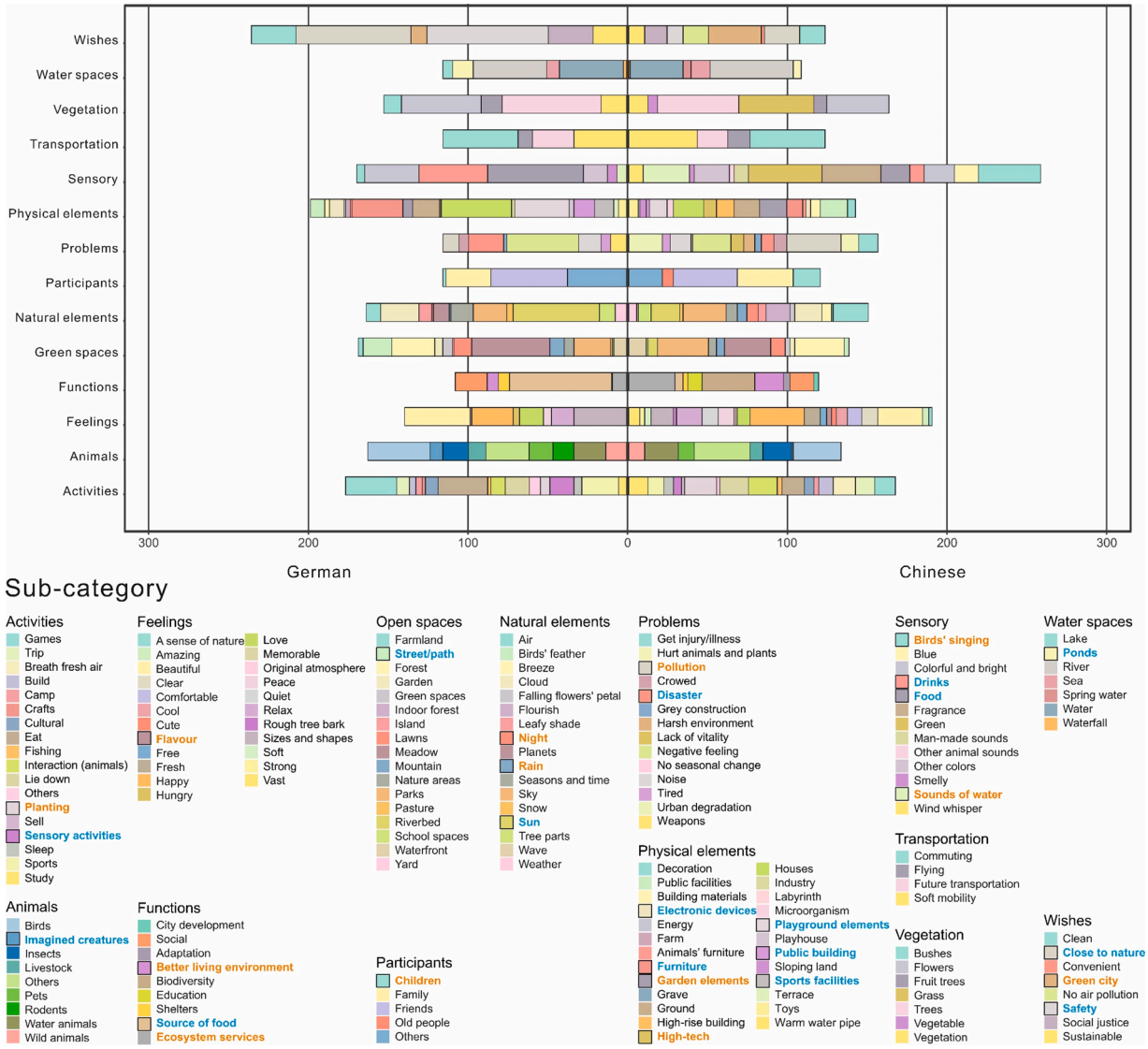

Fig. 5. Stacked barplot showing the relative number of mentions per hundred stories (x-axis) in the main-and sub-categories of the Chinese and German data subsets. Different colors represent different sub-categories, and the length of each rectangle represents the relative number of mentions in the sub-category. Blue words with bold font and a black border around the boxes in the legend highlight typical features in the German dataset, and orange words with bold font and a black border around the boxes highlight typical features in the Chinese dataset (i.e. one subset including at least three times more mentions in the sub-category compared with the other subset). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article).

For example, Chinese children explicitly mentioned different grass species, which resulted in a Grass sub-category in the Chinese subset. The German subset contained the sub-category Rodents, which included mostly squirrels and rabbits. Because rabbits in Chinese culture can refer to livestock, pets and wild animals, they were categorized into the relevant category based on the context given in the story. While the occurrence of Lakes in the German subset and lack of them in the Chinese subset likely represents a true difference in the landscapes, the occurrence of Bushes in the German and lack of them in the Chinese subset is presumably a reflection of linguistic issues, as the conceptualization of vegetation in Chinese differs from that in German. Here the Chinese word for bush represents a wider concept of lush vegetation, whereas the German word for bush explicitly refers to a specific growth form of woody species.

We also explored differences between the Chinese and German subsets statistically. This comparison revealed statistically significant differences (NMDS $r^2 = 0.124$, $p = 0.001$; Fig. 6), and MRPP showed statistically significant differences between the two subsets in all scripts and versions. The greatest differences were produced by scripts 6 and 7 (Appendix F). For example, in script 6.2 (exclusion of green spaces, Table 1) urban problems (e.g. Water pollution and Air Pollution, "*reduced dust in urban areas*") were found in the Chinese dataset, whereas the German data included contents like House and Playground elements. In script 7, Chinese children described how sensory experiences like Fragrance, Bird singing and Sounds of water could relax them, while German data included more concrete contents, such as mentions related to food, eating and drinking. Typified stories for the German and Chinese subsets are presented in Fig. 7.

3.2. Pattern coding

Based on Dataset2, 22 themes were created under two topics: children's basic needs towards green spaces, and design features to provide child-friendly environments and spaces (Table 2). Children's needs cover a wide range of issues from basic physical ones to self-fulfillment. Design features include multifunctional spaces with diverse natural and designed elements that could satisfy children's various experiential and functional needs, but also provide explorative opportunities e.g.,

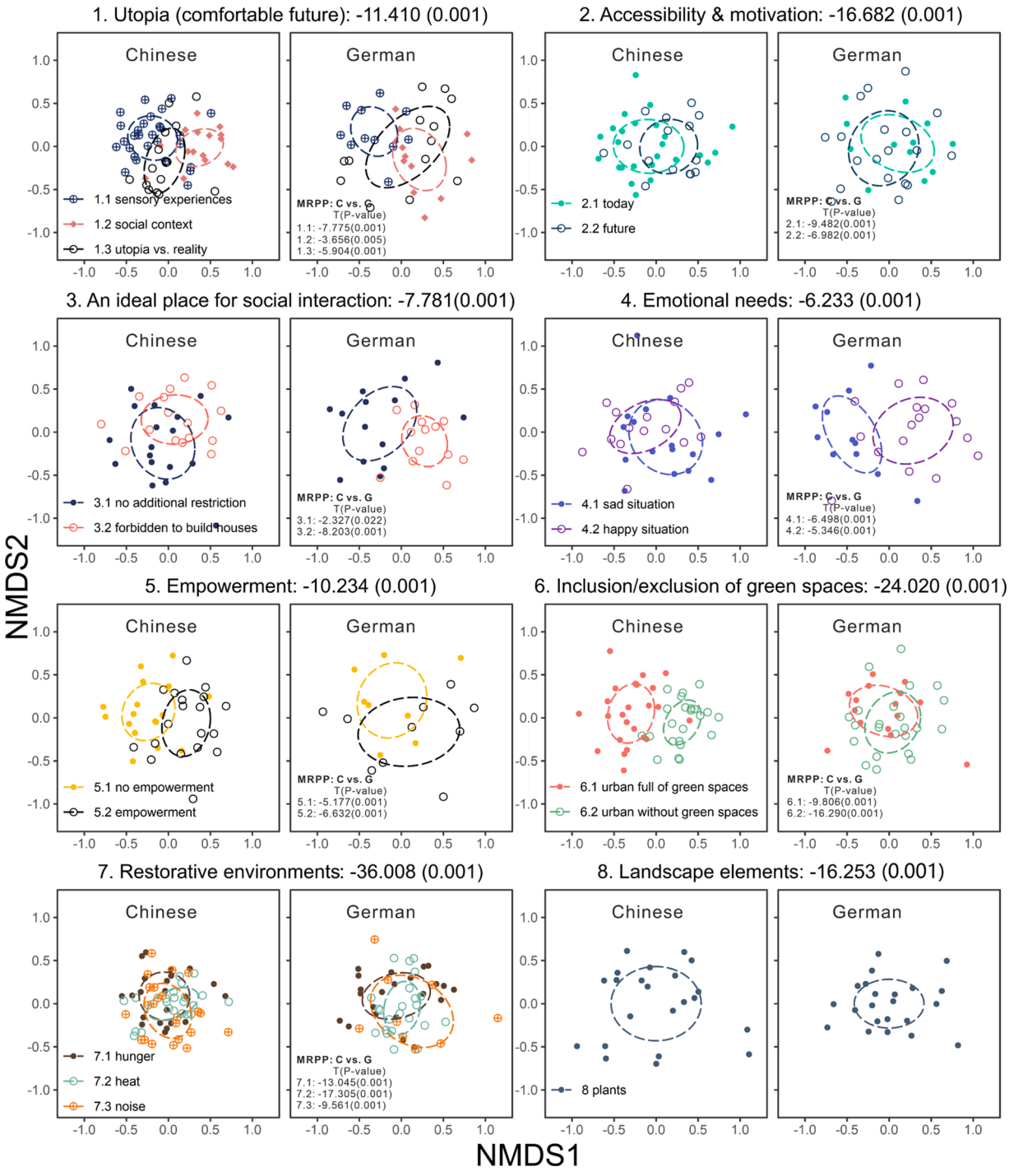

Fig. 6. Results of NMDS and MRPP analyses based on Dataset1 highlighting differences between the Chinese and German data. The standard deviations of a particular version of each script are represented by ellipses, for each subset. Results of the MRPP comparisons of script versions are shown in the lower section of each panel. T (with p-value) describes the size of the difference between script versions. The more negative is T, the greater the difference. For the scripts and versions, see Table 1.

acquiring knowledge when playing in green spaces.

4. Discussion

In this study, we explored children's needs and desires concerning green spaces, an important aspect when planning for child-friendly cities (Jansson et al., 2016). We show that a child-friendly storytelling technique, MEBS, allows children to vividly express their specific needs, expectations, and interactions with nature, which provides useful information for planning. Additionally, our study showed that meaningful information could be revealed about children's daily needs in relation to the concepts of sustainable development, ecosystem services, and livability.

While children in our data mostly conceptualized green spaces as the ones given to them as examples in the scripts, they were not restricted to these examples but envisioned a diverse array of settings. They imagined different types of green spaces that provide a variety of activities, experiences, contact with nature, and other benefits (Fjørtoft, 2004;

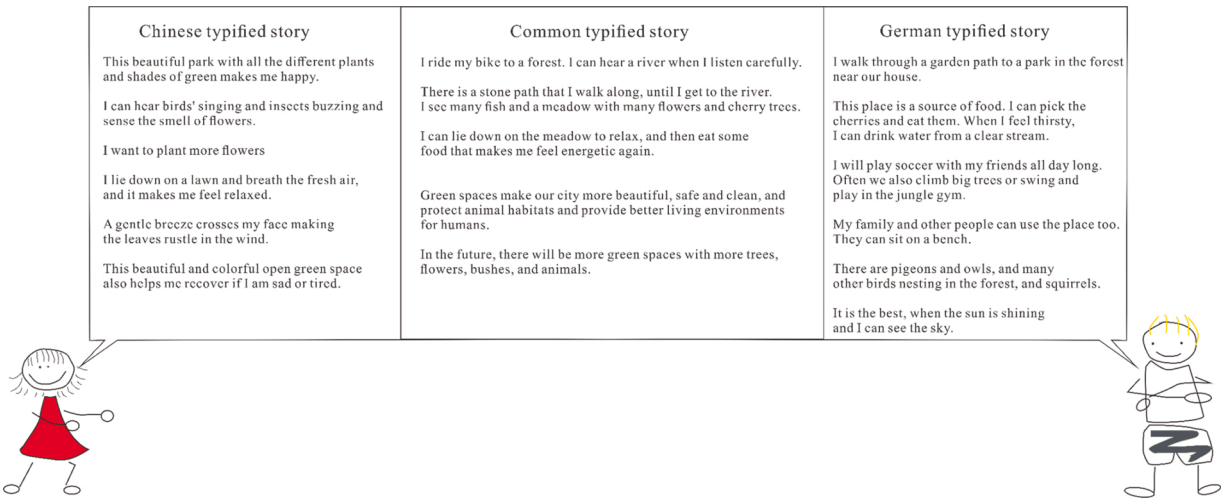

Fig. 7. Typified stories representing common and distinctive features of the Chinese and German subsets, based on Dataset1.

Ruokolainen et al., 2015). While our findings indicate that there are needs and aspirations that are similar across different cultures and locations, they also suggest variation related to the cultural-geographic context.

4.1. Children's needs in urban green spaces

4.1.1. Playable green spaces

Children in our research envisaged playing in different types of green spaces, where diverse playable contents supported versatile types of play. The playable green spaces from a child's perspective not only included designed green spaces like parks, playgrounds and gardens, but also forests, ponds, riverbeds, waterfronts, wetlands, farmland and boulevards. This is in line with research that highlights that creeks, woods, fields, vegetable gardens and maze-like alleys can function as playgrounds for children (Yu, 2020). Loosely planned or undefined areas allow room for exploration by children themselves (Kyttä, 1997; Kellert, 2002; Rasmussen, 2004; Jansson et al., 2016).

If we continue to restrict children to their homes, playgrounds, and schoolyards, they risk missing out on the benefits green spaces provide (Kyttä, 1997, 2004). Urban planners and designers should therefore pay careful attention to children's access to and perspectives of green spaces. In line with Woolley and Lowe (2013), our results suggest that, in order to transform general urban green spaces towards more playable ones, both man-made facilities and natural elements are needed.

In our study, children described diverse man-made facilities, especially playground elements, toys and sports equipment to facilitate various types of play, in agreement with findings by previous research (Hills et al., 2007; Kimberly and Keith, 2014; Cohen et al., 2020). Yet, a number of activities mentioned in our data were supported by natural elements such as growing plants, watering, sowing and picking flowers.

4.1.2. Contact with nature and sensory experiences

Children explore nature and learn about it using all their senses and their whole body (Mårtensson et al., 2014). This multisensory experience allows children to perceive nature as a "sense of wonder" and in a "deep and direct manner" (Tuan, 1977; Hyun, 2005). In agreement with the above studies, our study revealed a variety of visual, audible, olfactory and tactile experiences that children imagined to derive from nature.

In our data, experiences in nature were linked to both action and rest, where views, sounds, smells or touch led to action or relaxation, thus emphasizing the wide variety of stimuli and experiences that nature provides as described by Wells and Evans (2003) and Chawla (2015). For example, the acoustic and visual character of water features have been found to produce positive adjectives such as "fresh" and "cheerful" among children (Jeon et al., 2012). The tactile features of water (i.e. drinking river water, washing face and feet in a river) have also been found to attract children more than adults (Yamashita, 2002). Apart from water, plants also provided multisensory experiences in children's stories, especially edible and aromatic plants. Children imagined finding and eating fruits and berries in a green space, providing them visual, olfactory and tactile experiences.

4.1.3. Aesthetic experiences and restoration

Our research indicates that urban green spaces can offer children aesthetic experiences and opportunities for restoration. Independent of whether a child was sad or happy, green spaces were always important destinations, and beauty was mostly expressed in connection with green or blue spaces and living things like trees and flowers. This is in line with Finlay et al. (2015) and Kelz et al. (2015), who revealed that green and blue spaces provide therapeutic landscapes where visitors take pleasure from landscape elements and peaceful environments.

To improve pleasurable aesthetic experiences for children, our results suggest that urban planners and landscape designers need to increase the richness and aesthetic value of the landscape by using visual, audible, olfactory, and tactile planning and management approaches. In our data, the visual stimulation provided by plants (due to their forms, texture, size and colors) was often mentioned and described to provide pleasure and aesthetic value. In addition, Hansen and Alvarez (2010) showed that the physical characteristics of plants give landscapes unique characters. Thorpert and Nielsen (2014) explained how the perception of vegetation-borne colors is inherent to human landscape experiences and can influence moods and feelings. Furthermore, natural sounds and fragrances are perpetual and dynamic property of the landscape (Pijanowski et al., 2011; Jeon et al., 2012; Henshaw, 2013; Kubartz, 2014).

4.1.4. Learning

Our results suggest that children's creativity and learning (e.g. "I could recognize different plants through playing in parks") can be nurtured through contact with nature as also suggested by Dyment (2005). Plants and animals can serve as a transformative link between nature and children and help children to know the biological world from a cognitive scientific perspective, resulting in a caring relationship with nature (Inagaki and Hatano, 1996; Vining, 2003). While research suggests that the provision of educational trails and storytelling posts in, for instance outdoor kindergartens (Melhuus, 2012), school gardens (Blair, 2009) and community gardens (Ferris et al., 2001) could promote learning, children did not frequently mention such elements in our data.

Table 2
Pattern coding analysis results showing the 22 main themes and their contents in Dataset2, from the perspective of children's needs and design implications from their stories. The italicized text represents actual quotes.

Topic	Theme	Contents/example
Children's needs	Play	Play in a grassland, labyrinth, hide and seek, swim, run, ride a bike, dog walking, keep animals, football, basketball, on a trampoline, a slide, fly a kite; "*One can play with balls or climb, swing*."
	Learning	Do some investigation in a green space, record seasonal change, acquire knowledge from a forest, read books, write diary, homework, sing, watch films, listen to music;" *I like to go there [forest] because I can read my book quietly and relaxed*."
	Daily travel	School journey, school trip, to travel across/around cities, walk; "*I ride my bike into the forest to watch animals and plants*."; "*To get into the forest, I walk out of our front door.*"; "*I pass through green spaces on my way home.";* "*A street links my places with school.";* "*If I feel happy, I'd like to go hiking with my parents in an urban forest*."
	Feelings and sensual experiences	To see, hear, smell, touch; "*look up to the stars/sky*"; happy, love, memorable, peace, cool, fresh, amazing, beautiful, relax, quiet, love nature; "*I love the forest and the fungi and it feels like home*."
	Social interaction in green spaces	Gather together, country fair, chat or share with friends; "*play a game with family";* "*I want to go to the park because I can play there with my friends.*";" *I want to go there with my brother.*"; "*father brings me here*"; "*going to green spaces with my pets*"
	Eating	Edible nature, fruit, apple, pear, orange, strawberry, banana, blackberry, BBQ, cooking, picking, ice cream, candy, chocolate, drink water, tea, refreshment; "*My favorite place is a big meadow for a picnic.*"; "*Eat fish from the river with my mom*"; "*I came across a river I can drink from.*"
	Recreation	Put up a tent, enjoy landscape attractions, fishing, camping, "*I climb and jump and sing and dance* [in the forest]"; "*Find things in nature to do crafts*"; "*I go into the forest to meet my friends for a treasure hunt."*
	Relax and restoration	Sit on grass, sunbathe, lie down in a meadow, take a nap in a grassland, breathe fresh air; "*This is my beautiful meadow where I can rest and nobody can bother me.*"; "*I usually go to a park and sit on the bench to rest.*"; "*I hear the gurgling of the river and it relaxes me*."
	Contact with nature and exploration	"*Always want to go to parks*"; "*spend casual time in the wild environment*"; "*the building will be located on the side of the river.*"; pet animals, climb trees, swim in the river; "*I want to go to the meadow because one can hear nature.*"; "*I wash myself in the river.*"; "*With my grandpa, we plant flowers*"; "*There are many dung beetles and also roe deer and foxes.";* "*I go into the forest. I am all alone except for the wild animals in the forest.*"; "*I would try to play and be with the animals*."
Design features	Safety and convenience	Security, tools for safety, easy access; "*It's not safe enough to go outside alone.*"; "*I don't want to get injured from traffic accidents*"; "*not suitable to go outside alone*"; "*don't want to get ill in a poor environment*"; "*chemical products affect the environment*"; "*technology makes our life more convenient*"
	Aesthetics	"*Beautiful forests*"; "*colorful flowers bloom together, so amazing*"; "*I miss the park, the river, the meadow and the forest because [without such] it wouldn't be beautiful anymore.";* "*I go back and take a picture of the beautiful flowers*"; "*One can play in the meadow. I want to go there because it is beautiful.*"; "*The city is very beautiful now that it is like a forest*."
	Environmental health and better living environment	Purify water, promote activities, cleanliness; "*Improve living standards";* "*nice environment*"; "*provide good study environment*"; "*good for your physical and mental health";* "*I want to be in the forest because the air is good*"; "*There shouldn't be so many harmful emissions that harm the world and nature*";" *breathe fresh air*"; "*drink clean water*"; "*no rubbish*"; "*dispose of garbage*"; "*no air pollution*"; "*no exhaust fumes*"
	More open urban spaces could become "children's places"	More animals, nature and trees, less streets; water spaces (river, pond, spring, waterfall, lake, sea, riverside, island), natural landscape (grassland, forest, woody area), agricultural landscape (farm, farmland), green spaces (parks, theme parks, school spaces, yard, garden, lawns, pocket parks, waterfronts), designed landscape (school, amusement park, playground); "*There is a big meadow. I play there with my dog*"; "*We could play by the water and played fighting in the water.";* "*It is beautiful there with more forests to play in.*"; "*Everything would be nice and green and one could play in a lot more places.*"; "*I would extend the schoolyard and plant a meadow.*"
	Diverse playable contents	Nature elements, diverse vegetation (more trees, grass, flowers, bushes); "*there are more leaves to play with in the fall*"; animals (dogs, birds, etc.), water (rivers, fountain, lake, stream), rough tree bark, soft ground, jungle gym, climbing wall, slide, sandbox, swing, see-saw, toys; "*more suitable for children to play*"; "*picking a beautiful bird feather in green spaces.*"; "*There are more bushes to build huts and fallen trees to climb on.*"
	Design elements	Air, breeze, sunshine, tree shade, tree stump, roots, branches, leaves, falling flowers, petals, bird feathers; "*cherry petals falling on the ground*"; stone, wood etc.; "*There are beautiful, old rocks where one can rest*"; diverse materials and colors (shades of green, emerald, cyan-blue, blue, yellow, purple, red, orange, pink; mud, stone, pebble, salt stones, sand, forest ground, soft

(*continued on next page*)

Table 2 (*continued*)

Topic	Theme	Contents/example
		ground), slope, rolling terrain; seasonal landscape features; "*I want to see red leaves*"; "*blossoming flowers in summer*"; "*We celebrate spring festival*"; cultural elements (music, handcraft, sculptures, history, native plants and animals); size and shapes (big tree, vast space, big lake, high wall)
	Ecological function	Green city, sustainable, biodiversity, provide spaces for other species, furniture for animals, interaction with animals, not hurting animals and plants, build nests for birds, birdhouses, protect rich natural resources; "*The infrastructure will integrate into green spaces.*"; "*city mainly consists of green plants*"; "*never withered and more vitality*"; "*parks promote urban sustainable development.*"
	Sensory design	Auditive, olfactory, visual and tactile sensations; birds singing, wind whisper, sounds of water, floral fragrance, the croaking of frogs, insect buzzes, cricket, grasshopper and cicada chirps; colorful and bright, beautiful scenery, diverse texture and materials; "*using river water to wash my face/feet*"; "*lying down on soft lawns*"; "*touch rough tree bark*"
	Accessibility	Commuting; "*I prefer walking or riding a bike to parks*"; "*The forest is in front of my house*"; "*I wish for a clean meadow behind our house*"; "*It is because it is more convenient for me to access [the park]*"; "*It [park] is not far away from my home.*"

4.1.5. Social context

Playing, eating, resting and other activities in green spaces are often social events for children, as mentioned regularly in response to all scripts, including the scripts that did not portray social contacts. Mikkelsen and Christensen (2009) showed that a wide array of children's activities are consistently connected to companionship. The presence of other children, especially friends and siblings, seems to unlock the potential of green spaces to become a source of joy and happiness (Wales et al., 2020). The presence of and contact with adults is an equally valued social ingredient for children (Marzi and Reimers, 2018). Natural features and design attract people of all ages, so green spaces offer a great possibility for social interaction, which is much needed especially by children to develop skills in emotional adjustment and cooperation (Melhuus, 2012; Chawla, 2015). Thus, green spaces should include features for a wide range of ages, to enable children to find each other, but also to allow adults to accompany children, meet other adults and join in the fun.

4.1.6. Accessibility and safety

Soft mobility and public transportation to green spaces were frequently mentioned in our data. This means that the activity range of children in our study (aged 8–10) was realized both at the local and city scale. Easy access and the ability to move around freely outside, independent of the presence of an adult (independent mobility), are central to child-friendly environments (Kyttä, 2004; Mackett et al., 2007; Wales et al., 2020). This entails the provision of green spaces within children's neighborhoods, so that they can reach the green spaces on their own or with friends. To ensure children's access to green spaces, the issue has to be considered in the planning processes of urban areas at all spatial scales: independent mobility at a local scale, and safety and child-friendly travel at a city scale (Marzi and Reimers, 2018).

In general, research suggests that children find public places to be less safe than their home environment, and parents' or children's perception of risk increases with distance from home (Carver et al., 2008). Planning could specifically target the creation of safe but inspiring and fun connectivity between spaces to extend children's territorial ranges (Kyttä, 2004; Karsten and Vliet, 2006). In our data, children expressed feeling safe across all types of green spaces, from naturalistic to designed, which is in line with previous findings that show that the perception of safety in public spaces is not lessened by naturalistic vegetation (e.g. more trees and meadows) (Kuo et al., 1998; Jorgensen et al., 2002). Woody species offer a lot of potential for children to play with elements that signify safety to them, such as hiding behind trees or bushes and creating quasi-habitations (Fjùrtoft and Sageie, 2000; Lester and Russell, 2008). The design and management of green spaces should also promote and allow for construction and manipulation by children, such as building dens and forts. This can be promoted via the availability of natural materials (Jansson, 2013).

4.2. Similarities and differences in the German and Chinese datasets

Our research revealed similarities and distinctive features among the stories of Chinese and German children. Nature experiences had value for children and met their diverse needs, independent of cultural or local background factors. Children had a comprehensive cognition of the types of urban green spaces from the more natural (meadows, forests, rivers, etc.) to explicitly man-made landscapes (i.e. parks, boulevards, etc.) and preferred different kinds of species (belonging e.g., to the categories of trees, flowers, birds, mammals, insects) to co-exist in these places. Yet, while some issues were mentioned frequently in both datasets, peak frequency did not always appear in similar contexts, e.g. German children mentioned food more often in relation to restorative environments (script 7), while Chinese children associated food in a social context (script 3). Obviously, exploration of the context of the mentions may reveal in-depth meanings and practical planning implications that are not explicit at the level of single mentions.

The data provide a lot of detailed information related to local features. For example, Chinese and German children provided descriptions of native plants (e.g. "lotus" vs. "rose") and cultural elements (e.g. "forbidden city" vs. "castle"). We thus suggest that native plants and local cultural elements could be used to strengthen the local identity of landscapes, which in turn could help children develop their identity (Robertson et al., 2003).

Both groups recognized the importance of urban green spaces for their health and the sustainability of cities (i.e. "urban safety", "urban pollution", "biodiversity", "environment health", etc.). Although both groups showed awareness of urban environmental issues, Chinese children more frequently expressed concern towards urban pollution, especially air pollution, than German children. In addition, an interesting difference between the two groups was that the answers provided by Chinese children included more abstract intangible benefits, while the answers provided by German participants were more concrete. For example, Chinese children often used sensory feelings to describe how green spaces relaxed them while German children mentioned more physical elements.

4.3. Methodological considerations and future avenues for research

UNICEF's concept of a child-friendly city highlights the importance of children's voices, needs, priorities, and rights in urban planning and policy-making (UNICEF, 2003, 2017, 2019). This study illustrates the potential of MEBS to provide children with a tool to express their own perspectives. While good methods exist for gathering data for specific projects regarding children's everyday environments, our study shows that MEBS functions well also in harvesting more general knowledge not

bound by the realms of a map, plan or physical or social boundaries of the real world. Therefore, MEBS is a useful method to inspire respondents' imagination (Särkelä and Suoranta, 2020), offering children freedom in envisioning the types of environments that meet their needs and aspirations. In this process, children act as active agents, instead of, e.g. only reacting to questions (Doliński et al., 2017).

Our study showed that MEBS is a useful method for exploring children's needs and ideas in the context of urban green spaces, and it allows for efficient data collection. Results of the NMDS and MRPP analyses revealed that the scripts and script versions highly affected children's stories. We conclude that a diversity of different scripts where specific key elements are varied will guide children to use their imagination differently. Thus, for studies with a broad sphere of exploration like ours, a wide variety of carefully designed scripts will guarantee rich and meaningful data that cover the sphere of interest. However, MEBS can be used in many kinds of contexts, and studies may also focus on fewer scripts and versions, e.g. to explore contrasting situations in a specific case (Eskola, 1988; Wallin et al., 2018).

Yet, there are challenges imbedded in the use of MEBS. Firstly, an efficient scientific analysis of the vast amount of information requires using data-processing software. We found text mining in the R statistical software to be helpful in extracting meaningful information, form an analyzable data structure, and achieve data categorization and visualization (Feinerer et al., 2008). Yet, to avoid misunderstanding of text data generated by the software, researches from different fields double-checked and evaluated doubtful outcomes by revisiting the original stories (Debortoli et al., 2016).

Secondly, it should be recognized that MEBS is sensitive to culturally dependent representations of phenomena, both as to how stories are told and how the contents are interpreted. We had German children's stories analysed by a German researcher, and the Chinese stories analysed by a Chinese researcher. In our experience, this was necessary for a coherent content analysis. However, in-depth team discussions of the meanings and contents of the main- and sub-categories were necessary to make cross-cultural comparisons possible (Mesimäki et al., 2017). Our findings suggest at least linguistic, landscape and conceptual-cultural differences in the stories. As the schools were located in a variety of landscapes in each country, and as our NMDS and MRPP results did not suggest differentiation of schools, we do not anticipate any bias in our interpretation of results based on school-specific contexts.

Offering children a possibility to express their needs with their own words, including drawings, might also support a feeling of being appreciated as a source of information (UNICEF, 2019). Yet, to catch the whole universe of children's sensory and physical experiences, and to help children with poor verbal or drawing capacities to have a better performance in the data generation process, MEBS could be combined with other kinds of methodological approaches, e.g., go-along interviews, observational studies, cultural probes with digital photographing, or even virtual reality techniques (Buchwald et al., 2009; Änggård, 2013; Derr et al., 2018; Elyazgi, 2018; Wallin et al., 2018).

There are several potential limitations in our study. Firstly, although our results imply that there might be differences as regards the needs and expectations of German and Chinese children for urban green spaces, further studies with comparative approaches, conducted in different countries and cultures, are required to show possible variation and to offer culture-specific design implications. Secondly, our research specifically focused on the needs and expectations of 8−10-year-old children. Yet urban green spaces are used by people of all ages. Thus, research on the needs of people across all ages is needed to design multipurpose green spaces, e.g. to create pleasurable and meaningful environments for adults accompanying children. Finally, while MEBS works well in a scientific setting, scientific processing of the data is demanding. Nevertheless, through our experience outside of academia, we propose that a simplified version of MEBS could be used as a source of inspiration and as an icebreaker in participatory planning processes. Stories can be gathered and shared among participants in order to provide a basis for discussions, visions, and target setting, without conducting any further scientific analyses.

5. Conclusions

Our research highlights the potential children have when allowed to use their own words and imagination, triggered by various settings ranging from real-life to highly fictive. According to the results of this study, urban planning should promote green spaces that are easily accessible to children in their daily environments and include naturalistic vegetation and other naturalistic landscape elements, in addition to man-made structures and landscapes. Both designed green spaces (i.e. gardens, parks) and wild nature (i.e. forest, wild grassland) can fulfil a range of functions and experiences for children: opportunities for play, social contact, contact with nature, pleasure and beauty, learning and exploration. Our findings are also indicative of children's awareness of the range of diverse ecosystem services that green spaces can provide, along with livability and urban sustainable development.

While there are generally applicable nature-based solutions to meet the diverse needs and expectations of children, the detailed features required or wanted by children in different cultures may vary. By comparing children with different backgrounds, a better understanding could be gained concerning linkages of green spaces with local cultural values, practices, needs and aspirations.

Data availability

Raw data and other supplementary material are available at the following repository: osf.io/7zpcj

No data was used for the research described in the article.

Data will be made available on request.

Author statement

Xi Shu: Data curation; Formal analysis; Funding acquisition; Investigation; Methodology; Resources; Software; Validation; Visualization; Writing - original draft. **Marja H. Mesimäki:** Data curation, Investigation, Methodology, Project administration, Supervision, Writing - review & editing. **D. Johan Kotze:** Data curation, Methodology, Resources, Software, Supervision, Visualization, Writing - review & editing. **Mark Wales:** Resources, Supervision, Validation, Writing - review & editing. **Long Xie:** Data curation, Resources, Supervision, Validation, Writing - review & editing. **Renan Benicke:** Data curation, Investigation, Resources, Writing - review & editing. **Susanna Lehvävirta:** Data curation, Funding acquisition, Methodology, Project administration; Resources, Validation, Supervision, Validation, Writing - review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the

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