Research on Child-Friendly Public Space Based on Embodied Cognitive Science

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Abstract: Based on embodied cognitive science, it explores the relationship between children’s perception and the public space environment, advocates that children have the right to play in public space, and understands the real needs of children in the activity space. At the planning and design phase, children’s transition from passive role to active decision-making, the whole process of participating in the creation of space helps to build a child-friendly city. From the three aspects of non-standardized game facility configuration, activities that integrate adventure games to explore space and outdoor play venues that contact natural elements, children’s preferences for activities and game learning in public environments are studied, and design points are proposed to improve the role of outdoor public spaces in promoting children’s comprehensive development. Finally, through two examples at home and abroad, the strategies for creating child-friendly public spaces are demonstrated from the perspectives of planning process and space design, and the reference and reflection on the construction of child-friendly cities in China are provided.

Keywords: Embodied cognition, Environment-aware, Child-friendly public space, Play learning.

1. Introduction

In cognitive science, researchers often use the term “environmental perception” to describe the human ability to understand, interpret, and evaluate the physical world[1]. Cognitive psychology is a sub-discipline of psychology that explores internal mental processes and is the study of human perception, memory, thought, speech, and problem solving[2]. Embodied cognition has its roots in cognitive psychology in the late 20th century, and is generally an interdisciplinary field of study that extends from psychology and cognitive neuroscience to education, architecture, and related disciplines. Recent agendas such as child-friendly cities and the rise of participatory design approaches involving youth and children have highlighted a shift toward treating children as active rather than passive subjects in the design and creation of spaces. At the same time, there is a growing interest in the impact of built outdoor public spaces on children’s learning and physical and mental health, with research on “children, play and the built environment” linking for the first time the creation of built environments with children to embodied cognitive science[4]. This paper explores the relationship between children’s perception, learning and play and urban public spaces from the perspective of embodied cognitive science, and provides a theoretical basis for the design of child-friendly public spaces through the reading and analysis of several academic papers.

2. Understanding Children's Real Needs from Embodied Cognitive Science

Embodied cognitive theory emphasizes that what we perceive, think and experience about the world does not just happen in the mind, but instead it is the whole body, together with all its neurological and physiological systems, including the brain, heart, senses, muscles and joints, hormones and chemical processes that determine the way we perceive, understand and interact with our environment[5]. In order for children to become creative problem solvers, able to cope with the rapid changes in society, a holistic approach to their learning and development is required. Research has shown that children’s learning through play plays an important role in children’s social, emotional and cognitive development[6]. In addition, play is increasingly recognized as a way to learn and acquire a wide range of skills, such as critical thinking, creativity, communication, and collaboration[7]. These recognized benefits of “learning through play” have raised awareness of the fact that children learn in the whole range of life settings, from school and home to community and public spaces. Learning and play in the environment are embodied, multi-sensory, emotional and movement-based activities, and play and learning do not occur in isolation or exclusively within “formal play”[4]. Therefore, in the past few years, a growing number of scholars have applied embodied cognitive knowledge to various design fields, including interactive space design, architecture and urban design[8][9], calling for a serious approach to children’s real needs and experiences.

2.1 Children’s Right to Play in Public Spaces

In 1989, UNICEF introduced the Convention on the Rights of the Child, which called for the provision of age-appropriate public spaces for play, leisure, recreation, cultural and artistic activities for children of all ages. It is increasingly recognized that health problems such as childhood obesity and diabetes are related to insufficient physical activity in children. Many studies have validated the potential of physical or active play interventions to promote and increase children’s physical activity in public spaces[10], and active play does help to meet children’s daily physical activity needs as well as the development of basic motor skills and is training for building resilience in response to unexpected or unpredictable situations. On the other hand, the increase in children’s mental health problems is related to the decrease in children’s
opportunities to play, especially with other children, due to the decreasing space and time for play in public spaces[11]. More importantly one of the key features of play as a pleasurable activity is associated with increased levels of dopamine, an important neurotransmitter involved in the central nervous system of the human brain, which has a positive effect on enhancing memory, attention, creativity and intrinsic motivation[6].

Based on such health and developmental benefits, play is seen as an essential child right, rather than a luxury that follows closely behind. From improving play environments through to considering how urban spaces can be places that provide opportunities for play, these are consistent with embodied cognitive science perspectives that emphasize that the environmental context of play is particularly important and inextricably linked to children’s emotional and physical responses. In this sense, public space can be seen as one of the relevant factors in promoting and influencing children’s health and well-being. The question therefore arises: How can planning practitioners and designers help address the lack of opportunities for play and playful learning in public spaces?

Children have right to get healthy and sustainable play opportunities in diverse environments in the context of children’s urban power. There are extensive research literatures and a wealth of initiatives by planners to define and create child-friendly environments, such as Kevin Lynch’s Growing Cities movement in the 1970s, the Child-Friendly Cities Initiative (CFCI) beginning in the 1990s. And Shenzhen has recently been the first city in China to put forward the goal of systematically building child-friendly cities and has issued the first local action plan “the Shenzhen Strategic Plan for Building Child-Friendly Cities (2018-2035)” for building child-friendly cities. In 2010, Wales, UK, was the first government in the world to legislate for children’s right to play[12], reflecting the protection of children’s right to play at different levels. safeguards for children’s right to play. Various regions and countries have launched many practices for child-friendly city building, such as the playful city USA by KaBoom platform[13] and the master plan of play in Germany. All these initiatives and strategies propose solutions to local conditions and contexts, and child-friendly city building takes a child’s perspective and builds environments that are adapted to children’s needs will also be healthier, safer, and more inclusive for all citizens.

2.2 Children’s “Unconscious” Co-creation of Play Spaces

Typically, children’s designated play areas include three traditional settings, namely the home, school and recreational spaces such as playgrounds, understood as ‘formal play spaces’. With increasing concerns about safety, there is a growing trend to restrict children’s access to certain play spaces in public spaces with various measures, and these conscious regulations segregate children and young people into designated areas for play in a way that may impact on their physical and mental health[14]. These practices limit children’s opportunities to move freely and play in public spaces and different environments, undermine children’s social skills and prevent children and young people from participating in urban public life. In short, children and young people have the right to access the whole city, to get opportunities for physical development and to build a sense of belonging in formal and informal play spaces.

Children’s appropriation of space becomes an agent of change through play that generates creative interactions, playing in existing public spaces, such as children’s ability to engage in “role-play” games in abandoned or vacant spaces, turning spaces forgotten by adults into situational theaters[15]. Children’s play is contextualized, spontaneous, and set as behaviors in sociocultural settings that allow children to learn how to participate in collective social practices and become active citizens. Children’s emotional experiences have been used as a resource, or “emotional reports”, to communicate children’s perceptions of space in participatory planning and design processes. As a result, children build awareness of everyday space in the environment and establish multisensory interactions through their own practices in the environment.

Children are seen as co-creators of spaces and places, and several studies have shown that children’s active participation in the design of public environments helps to promote and enhance play, fun learning, and creativity in children and youth. Children are seen as agents who actively explore and creatively engage in the construction of their environments, in which play becomes a means of co-creating spaces, places, and children’s knowledge and understanding of the world around them. Designing cities and spaces with children enhances the possibilities for creativity and play, a better understanding of children’s opportunities to use urban spaces, and the use of temporary structures or installations to encourage learning and child development. The scale of children’s participation and the duration of their active involvement are critical to the success of any space design involving children.

2.3 Mental Cognitive Maps Turn Passivity into Initiative

The way children perceive and interact with space is always relevant and depends on the child’s skilled physical and cognitive abilities. Mental imagery is considered a cognitive process that is essential for constructing models to seek solutions to complex problems, and the pictures formed in such a process are called cognitive maps. Mental cognitive maps contain all the internal processes that enable a person to acquire and manipulate information about the nature of his or her spatial environment; they are internal representations of incomplete, segmented and mentally distorted representations of the environment, and they are also continuously updated. Thus, in any case they provide a snapshot of the knowledge of the physical environment, and these cognitive processes are part of the individual design process. More and more urban planning authorities are not limited to the traditional “professional design-child use” model of spatial planning for children, but are involving children in advance in higher-level planning through, for example, children’s mental cognitive maps. For example, the master plan of play in Regensburg, Germany conducted preliminary planning research in the form of neighborhood walks led by children and organized by adults to obtain children’s daily trajectories and record their real feelings about urban public space, and draw psychological cognitive maps to convert children’s perceived environmental experiences into real spatial discourse and understand children’s real needs. The real needs of children
can be transformed from passive participation to active design, and different play opportunities can be provided for children of different ages, genders, body sizes and body movement abilities, so as to propose child-friendly environmental strategies for public space optimization[16]. At the same time, children’s active presence in the local public space environment may also lead to interactions between adults, thus constituting a source of social cohesion in the neighborhood, which is one of the key indicators of a child-friendly environment[17].

3. Designing Child-friendly Public Space based on Needs

3.1 Non-standardized Configuration of Play Facilities

Carefully planned games and interesting learning experience sites provide availability for children’s actions, and formal and informal play spaces differ in terms of play availability. Standardized play spaces generally have a single configuration of play equipment, fencing, and mats[18], where play facilities have equal or constant dimensions, climbing heights, cross gaps, etc., meaning that they are only suitable for groups of children of a specific age and size. By introducing more variety and play possibilities in play spaces, it will create opportunities for children with a range of physical movement abilities to play, and enhance children’s agency and the way they interact with architecture and urban space. Appropriate empty space in the design of public spaces may contain a variety of open possibilities for action and play, which the designer even unknowingly offers.

Dutch architect Aldo van Eyck took the initiative to consciously design children’s outdoor spaces in a minimalist manner, never putting up fences, a relatively rare practice in the 1950s and 1960s. Through modular play elements-sandpits, stepping stones, slides, etc.-that are constantly reassembled according to the requirements of the site environment, children can interpret the space according to their own understanding and fully stimulate their imagination. The “interstitial” nature of the children’s play space in the city allows the users’ initiative and autonomy to be better utilized.

A series of experiments were conducted to test the relationship between children’s reactions and their spatial environment in the context of embodied cognitive science for the “Jumping Stones” playground designed by Aldo van Eyck. The Jumping Stones playground consists of several circular stones placed in a symmetrical configuration resembling the number 8, with two different gap widths for children to cross, and has been installed in many public playgrounds in the Netherlands and elsewhere, and is considered as standardized formal play space. The researchers envisioned an alternative, non-standardized playground and engaged children in an experiment to design their own playground configuration by arranging six jumping stones at their disposal. This allowed the researchers to compare children’s play in relation to their physical motor abilities on standardized and non-standardized playground configurations through the variability of gap widths between the jumping stones. The findings suggest that children’s use of the playground environment is directly related to their physical ability to act on play availability. Children sought availability that corresponded to their own perceived and actual physical abilities, such as maximum jump and stride distances, maximum block heights to climb on and straddle, and the average span distance that children chose to straddle[19]. Furthermore, children did not just seek to maximize the spanning gap, rather the study showed that all children spanned narrower gaps more frequently and that this was more challenging for them, highlighting the nature of play as a pleasurable activity and that children found enjoyment in the movement itself. Interestingly non-standardized playground configurations were more attractive compared to standardized ones, as children spent more time playing in the former than in the latter, either alone or in groups of four[20]. It is noteworthy that when children acted as play space designers, they created “messy” jumping stone configurations with gap widths that contrasted with Aldo van Eyck’s original standardized design with only two gap cross-widths.

The advantage of non-standardized configurations is the variability in movement and motor movements provided over time, which is essential for children’s motor learning and the development of established child motor skills is critical. Overall, non-standardized play public spaces set an important priority for the study of child-friendly play availability and point to a valuable research direction for future empirical studies. These studies not only contribute to the empirical examination of many long-standing children’s play space design practices, but also demonstrate the potential for children’s active participation as co-researchers.

3.2 Space for Activity Exploration Integrated into Adventure Play

Taking risks in play allows children to test their limits, try new skills and activities, and learn about their bodies and abilities. Rather than innately seeking risky activities, these curious behaviors of children should be seen as part of children’s exploratory environment as an exploratory mode of play that is their own. Adventurous play is divided into six categories based on the physical activity and risk involved: high play-such as climbing and jumping off; high speed play-such as sliding and swinging at high speed; playing with dangerous tools-e.g., cutting wood with a saw, etc.; playing near dangerous elements-e.g., near deep water or fire; jostling-e.g., fighting, fencing with a stick, etc.; playing in places where there is a risk of getting lost-e.g., exploring unknown areas, etc[21]. Depending on the characteristics of the physical environment, different types of play and adventure opportunities can be provided, such as developing adventure games on different surfaces such as rocks to satisfy children’s curiosity. Children’s curiosity in play is an inherent part of their exploration and interaction with the environment, and adventure play responds to children’s agency and need to explore the environment, its possibilities and boundaries.

Children’s public spaces in different countries have different perspectives on risky play, with the U.S. standard-setting guidelines for children’s playgrounds promising full physical protection, a sense of “excess safety” that beyond what is reasonable, and an emphasis on reducing harm from children’s activity spaces. In contrast, Europeans give children freedom, as mentioned in the 2008 European Voluntary Standards for Playground Facilities, to consider the
characteristics of children’s play and how it can benefit their development, and the need for children to learn how to cope with the risks associated with risky play, which is unavoidable in children’s quest to improve their social and intellectual skills[18]. The illusion of danger is attractive to children’s curiosity triggers, such as the Tokyo Misty Forest where children can play special hide-and-seek in the fog, which is a fun adventure for them to feel isolated and cycle through losing and regaining their vision[18]. Children will learn to conquer risks and explore in adventure play to promote children’s social and cognitive development.

3.3 Outdoor Playgrounds Exposed to Natural Elements

Children’s exposure to nature has recognized benefits for their physical and mental health, emotional regulation, and motor development, so initiatives are being made to emphasize natural features in children’s activity environments to promote free play. Newly designed children’s public spaces incorporate a number of natural elements, often including vegetation and water features, malleable and loose natural materials—such as sand, branches, rocks, topographic variations—such as mounds, terraces, slopes, climbable elements such as smooth rocks, logs and wood, etc. Children’s play time in natural site spaces is longer and more diverse than in public spaces based on fixed play facilities[18]. Children’s experience of nature is a process of embodied cognition, and playing freely in nature provides physical, emotional and sensory access to nature in many ways. The Danish landscape architect Helle Nebelong worked on the development of nature playgrounds, using rocks, stumps, plants, water, hillsides, and other elements, arguing that in nature encounters children must explore their surroundings with their whole bodies and heads[18]. Children need “material” mediators in their interaction with nature. These material mediators are natural elements such as rocks and mud[22].

Many researchers in China also believe that more exposure to the natural environment can promote children’s emotional development and social skills, as well as improve attention and imagination. The role of natural elements on children’s healthy development was confirmed by means of quantitative studies in cognitive studies of nature-based children’s playgrounds in urban outdoor spaces, and the evaluation results showed that scattered sand and gravel were the most acceptable natural materials, followed closely by approachable bodies of water, undulating terrain, insects and small animals, and diverse plants; the role of nature in promoting children’s physical fitness was the greatest, followed by the enhancement of creativity and intellectual development. The effect of nature on children’s physical strength is the greatest, followed by the enhancement of creativity and intellectual development[23]. However, the results of a study of children’s play spaces in 87 urban parks in four cities, Beijing, Shanghai, Guangzhou, and Chengdu, indicate that there is a general lack of naturalness in children’s playgrounds in China[24], emphasizing that children’s space design should be combined with natural elements, calling for more frequent use of natural materials in future public space design, proposing the creation of outdoor playgrounds suitable for children’s healthy growth, and promoting child-friendly city construction.

4. Empirical Analysis of Child-friendly Public Space

4.1 Children’s Cognitive Map Oriented Design-Lichtenrade Area in Berlin, Germany

In the last decade of urban development in Germany, the probability of children playing and experiencing nature in public open spaces has changed considerably, as it has become increasingly difficult to explore the community environment independently and play safely on the street or in a wireless field, and meeting friends or reaching the playground is often only possible with a parent. As outdoor spaces that are attractive and safe for children and young adults become less available, children lack public spaces where they can play and exercise spontaneously, thus reducing the potential for children’s mobility, senses, natural experiences, and the development of motor skills. In order to change this situation and improve the space for children and young people, the German federal states have developed master plan of play.

Master plan of play is sustainable and environmentally friendly development planning for cities and local communities based on the needs and perspectives of children and young people[25]. The whole city or local community is considered as a linked potential play, experience and recreation area, and master plan of play records, evaluates and considers all places and areas where children and young people stay and are active, such as streets, urban open spaces, green spaces, housing entrances or wireless sites. The results of the survey, assessment and development prospects of these places and areas are used to make recommendations for further development. In this process, children and young people know best what their needs are and which areas are lacking in space and potential. Therefore, the participation of children and young people is a central part of the game master plan, in which the participation process and the spatial planning process are systematically interlinked and the results of the participation process are translated in a transparent way to the planning level and implemented on the ground.

In 2015 the Berlin Lichtenrade district set strategic development goals for child-friendly and family-friendly areas, including enhancing the quality of life in the area, creating attractive public spaces, maintaining social cohesion and promoting a rich cultural development. By improving its living environment in a child-friendly and family-friendly manner and improving the corresponding infrastructure, it ensures development as an attractive place for families and children to live. This includes focusing on the needs of children, improving pathways to connect activities, enabling independent and safe mobility for children and young people, and making appropriate use of underutilized areas to upgrade and transform them into child-friendly spaces. Master plan of play was used as a planning tool to capture the needs and interests of children and youth in the area using questionnaires and cognitive maps. A survey of 200 third, fifth, seventh and ninth grade students was conducted to include transportation modes, danger zones, outdoor preference locations and reasons for them, and needs for change; professional planners organized 20 workshops with 100 children to assess the
outdoor environment around the children’s lives, including 3.5 hours of neighborhood walks and 1.5 hours of poster creation and short presentations to each other. Children’s perceptions were better understood in the field environment, where they were able to explore play spaces by nature, both in formal and informal playgrounds, and where paths, likes and dislikes were clearly marked on maps during the neighborhood walks. The results of the survey were analyzed and summarized in terms of “play and playground”, “traffic and movement”, “conflict and safety” and “potential areas”. The results of the survey were analyzed and summarized in the areas of “play and playground”, “traffic and movement”, “conflict and safety”, and “potential areas”, and were used to develop improvement measures and action plans. The project’s master plan of play shows how to improve the child and youth friendliness of the Lichtenrad area, and the mater plan process is repeated every two years to review the effectiveness of the project implementation and to assess the child friendliness. The child-friendly tract is created through child participation and cognitive map-oriented spatial renewal design.

4.2 Children’s Interaction Creates Space-Shenzhen Baihua No.2 Road Child-Friendly Neighborhood
Shenzhen took the lead in 2016 to put forward the goal of “building China’s first child-friendly city”, and regulated the space, culture, services and operation. The documents such as “Shenzhen Strategic Plan for Building Child-Friendly Cities (2018-2035)”, “Opinions on Demonstrating Child-Friendly Cities (2021-2025)”, “Shenzhen Guidelines for Children’s Participation” and “Shenzhen Guidelines for Building Child-Friendly Practice Bases” have been issued. Based on the research of children’s participation, the Shenzhen Baihua No.2 Road Child-Friendly Neighborhood proposes “from 1 meter to see the world” as the construction standard guided by children’s needs, from the perspective of child-friendly travel and healthy growth, combining space for slow travel, fun experience, and natural humanities to create the first child-friendly model neighborhood in Shenzhen. It meets the diversified needs of children in the area for safe travel, outdoor games, embracing nature and experiencing culture. The success of the project lies in the child-friendly public space from the perspective of embodied cognition, applying Aldo van Eyck’s playground theory, which does not follow the rules of play as conceived by adults, but mainly allows children to sense the environment through various interactive play facilities, and provides an adventurous activity space for children to climb and jump freely. On-site interviews and observations show that every non-standardized facility is very popular, including bouncing piles with different gaps, climbing facilities of different heights, and especially the ball-turning interactive scenic wall in the Children’s Dreamland, where children freely turn the blue and yellow spheres embedded inside the scenic wall and unconsciously play creatively to create a blue and yellow scenic wall with different combinations. The site sets up a rain garden, fully using gravel, water bodies, diverse plants and other natural elements, so that children can learn in nature, understand the relationship between rain and land, so that children can also sense nature in the urban environment. The child-friendly neighborhood of Baihua No.2 Road sets a model for child-friendly neighborhoods, confirming the necessary factors for creating child-friendly public spaces from child participation in planning and design based on children’s needs.

5. Conclusion
In Beijing and Changsha, China, child-friendly cities are also being built one after another. What is the public space that children really need is a question worthy of deep consideration by urban policy makers and planning and design practitioners. It is important to explore the relationship between embodied cognitive science and public space because children use their whole bodies to experience and participate in the outdoor environment and learn through interaction and perception with the environment. From the perspective of embodied cognition, based on the views of industry researchers and empirical case studies, we call for the reshaping of child-friendly public spaces in terms of children’s power, children’s participation and children’s needs, with a view to improving the friendliness of outdoor spaces and promoting children’s comprehensive development.

Firstly, a comprehensive system of children’s participation in planning and design should be established to create public spaces with children from preliminary research, site use to evaluation and feedback. Shenzhen is the first city in China to establish guidelines for children’s participation in the construction of a child-friendly city. It has clearly proposed the content, form and process of children’s participation, and standardized the composition of the children’s council, the content, type and process of the council, as well as the organization and implementation of the council. In the process of implementation, it is necessary to avoid the formalistic workflow of children’s participation, and to learn from foreign research methods such as mental maps and stage reviews to strengthen the connection between policy makers, planning designers and children, and to identify the real needs of users.

Secondly, public space site design based on children’s needs primarily includes non-standardized, adventurous, and natural elements, and also places a strong emphasis on the availability of play in both formal and informal play spaces. Movable play equipment and open-ended facilities to support creativity and diversity in play behavior, design open and non-standardized play spaces for children of different ages, physical and cognitive abilities, and promote the development of children’s social, perceptual, and motor skills. Children prefer novelty and the possibility of change, as well as the unpredictability of what happens in their play space, which is achieved in part through the freedom to manipulate and change the environment.

And the advantage of urban public spaces is that these environments can bring about a duality of play, both as a process of constructing meaning, learning the rules of social and cultural practice, and creatively changing the world. The transformation of public spaces, especially open spaces, is very much in line with the idea of temporary urbanism and the recognized potential for short-term use to provide play opportunities for children. The potential for place-making through play transforms unexpected places in the city into
opportunities for fun learning, meaningful play experiences, and opportunities for children and parents to come together. In line with children’s embodied cognitive science, a rational design of public spaces will be more conducive to the exploration and development of children’s potential. It is hoped that the relationship between cognitive science and children’s spaces can be further sorted out, and that friendly public spaces can be designed to help children play and learn to their full potential.

References


