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Design Strategies of Outdoor Recreational Spaces for Preoperational Stage Children based on Embodied Cognitive Perspective

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Abstract: This article, based on an embodied cognitive perspective, focuses on the design of outdoor recreation spaces for children in the preoperational stage. It explores the embodied cognitive theory and the specific requirements of children's outdoor recreation spaces, highlighting the suitability of embodied cognition for current design needs. By analyzing the embodied cognitive characteristics of children in the preoperational stage and reviewing relevant research, this study proposes design elements based on embodied cognition. Six design strategies for children's outdoor recreation spaces are presented, including children's participation, sensory experiences, spatial layout, natural elements, image and symbol representation, and safety considerations. The aim is to provide insights for the design of children's outdoor recreation spaces in related fields.

Keywords: Embodied Cognition Perspective; Preoperational Stage Children; Outdoor Recreation Spaces; Design Strategies.

1. Introduction

In contemporary times, outdoor recreation has become a common behavior mode of children in cities, and outdoor recreation is of great significance for children's physical and mental development. It not only promotes the physical development and health of children, but also stimulates their desire to explore and curiosity. Among them, children's outdoor recreation space has naturally become an important carrier for children to carry out recreation activities. Through the outdoor recreation space, children can enjoy a rich and diverse experience, and obtain comprehensive development and happiness. Children's experience and perception needs should be fully considered in the design of children's outdoor recreation space. The interaction and integration between people and the environment emphasized in embodied cognition is very suitable for the design of children's outdoor recreation space. Therefore, this paper will introduce the theory of embodied cognition, focus on the children in the preoperation stage, and explore the design strategies of the outdoor recreation space according to their characteristics and the design needs of the outdoor recreation space.

2. Physical Cognition and Children's Outdoor Recreation Space

2.1. Overview of the Embodied Cognitive Theory

Physical cognition (embodied cognition) is also known as the "body-related" cognitive [1]. The central meaning is that the body plays an important role in the cognitive process of the organism. Cognition is a [2] formed through the experience of the body and the way it moves itself. The core idea of embodied cognitive theory is that cognition does not only rely on information processing within the brain, but is closely related to our body and environment. Our sensory input and action output are closely related to our cognitive processes. Through our sensory system, we receive information from the environment and interact with it through the movements of the body. Such body-environment interactions go beyond just passive reception and execution, they actually shape our cognitive processes.

2.2. Overview of the Outdoor Recreation Space for Children

Children's Outdoor Recreation Space is an outdoor venue designed for children to provide a safe, fun and beneficial gaming and leisure experience. These spaces are characterized by a diversity of facilities, safety considerations, natural environment integration, accessibility, education, social interaction, and sustainability. By providing rich game facilities, pay attention to security, into the natural elements, provide barrier-free environment, into education elements, promote social interaction and pay attention to environmental sustainability, children outdoor recreation space aims to promote children's physical, cognitive, social and emotional development, and provide a positive game experience, to meet the needs of children and improve their all-round development.

3. The Physical Cognitive Characteristics of Children in the Preoperational Stage

The definition of children in this paper is based on the theory of cognitive development developed by Swiss psychologist Jean Piaget. He believes that children's cognitive development goes through four main stages: Sensorimotor Stage, Preoperational Stage, Concrete Operational Stage and Formal Operational Stage. Each stage is related to the child's age and cognitive ability, and each stage marks important changes in the child's thinking structure and logical reasoning (see Table 1). The preoperational phase (2-7 years) is an appropriate age to study children's physical cognition. In the preoperational phase, children's cognitive development is in its infancy. They constantly interact with their outside world through perception and motor activities, integrating these experiences into their cognitive patterns. By touching, exploring, moving, and manipulating objects, they establish a connection between perception and motion, gradually

developing the perception of object properties, spatial relationships, and action abilities. At this stage, children begin to combine perception and movement with cognitive processes to construct cognitive structures through personal experience. They solve problems through motion and perception, explore the environment, and gradually develop cognitive patterns and modes of thinking about the world. At the same time, the development of image and symbolic representations provides them with tools to further understand and express the world. Children have the characteristics of embodied cognition at this stage, and they construct the cognitive structure through the interaction with the environment and the experience of their own actions, which lays the foundation for the development of the subsequent cognitive stage, as shown in Figure 1.

Table 1. Characterization of children at different stages of cognitive development theory

Stage	Age ranges	Characterizations
Sensorimotor Stage	birth to 2 years	Receiving information through the senses and exploring the environment through movement.
Preoperational Stage	2 to 7 years	Development of basic cognitive abilities such as attention, memory; Understanding the world through perceptual-motor activities and object manipulation; Development of imagination and symbolic representation.
Concrete Operational Stage	7 to 11 years	Acquisition of logical thinking abilities and skills in object manipulation; Emergence of concrete mathematical concepts and problem-solving skills.
Formal Operational Stage	11 years to adulthood	Development of abstract thinking and logical reasoning skills; Development of the ability to perform symbolic operations and abstract concepts.

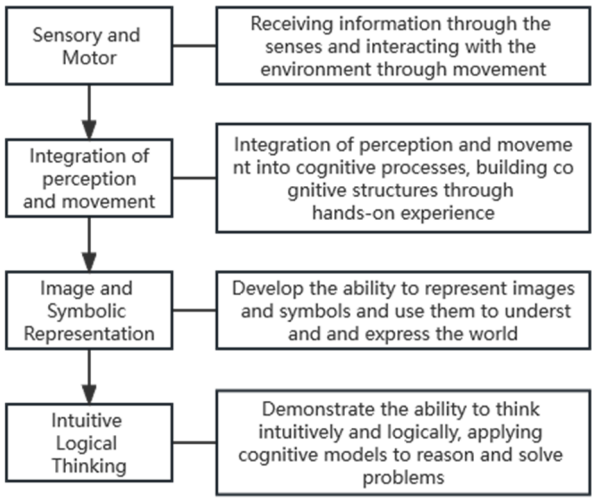


Figure 1. Cognitive processes in children in the preoperational stage

Agformed cognitive theory emphasizes that children construct cognitive structures through experiences of interactions with the environment and their own actions. In the preoperational stage, children's cognitive development is in their primary stage, and they constantly interact with the outside world through perceptual motor activities and integrate these experiences into their cognitive patterns. Studying children's embodied cognition provides insight into how they build their understanding and knowledge of the world through physical activity and interaction, which has important implications for the cognitive development of children in the preoperational stage.

4. Design Elements of Children's Outdoor Recreation Space under the Physical Cognitive Perspective

Agformed cognitive theory emphasizes that children construct cognitive structures through experiences of interactions with the environment and their own actions. Therefore, the design strategy of children's outdoor recreation space from the embodied cognitive perspective will comprehensively consider multiple factors comprehensively. Among them, child participation is one of the key factors. Designers will creatively design interactive and participatory recreation spaces to encourage children to actively participate in various activities and exploration. In addition, the design will also focus on children's five-sense experience, through creative design and appropriate material selection, to provide a rich variety of sensory stimuli, so that children can feel and experience the surrounding environment through touch, hearing, vision, smell and taste. Another important factor is the spatial layout. The designer will rationally divide the different functional areas based on the child's physical activity and perceived motor ability, and provide appropriate structures and facilities to meet the different activity needs of the child. In addition, natural elements will also be incorporated into the design, such as green plants, water features and natural materials, to create environments close to nature and promote children's interaction and experience with nature. Finally, safety considerations will be an integral part of the design. The designers will take steps to ensure the safety of the children, including avoiding sharp and dangerous edges, providing appropriate guardrail and protective facilities, and ensuring the stability and durability of recreational facilities and structures.

By combining the principles of physical cognition and the above factors, we create a creative, interactive and sensory experience of outdoor recreation space for children to promote their cognitive development, physical development and positive interaction with the environment.

5. Design Strategies of Children's Outdoor Recreation Space from a Physical Cognitive Perspective

5.1. Participation of the Children

Specific cognitive design strategies to achieve children's participation can be realized through diversified methods. In the planning stage, some children can be invited to participate in the design, organize special activities, and children can be invited to participate. Or through games, paintings, model making and other ways, guide them to express their ideas, needs and preferences for outdoor recreation space, and even can add the pictures drawn by children into future designs. This allows children to participate directly in the design process and incorporate their voices into the planning.

5.2. Five-sense Experience

Children in the preoperational stage have a high demand for perceptual stimulation and motor exploration. The sensory

and perceptual experience and motor experience acquired by children's body interaction with the outside world jointly promote the formation of children's cognitive [3]. Therefore, children's five senses (vision, hearing, touch, taste and smell) will play a key role in the design of children's outdoor recreation space. Physical cognitive theory emphasizes the interaction of perception and action, and children's five senses are the main way through which they perceive and interact with their environment. Through their five senses, children are able to perceive, explore, and understand the world around them, while also being able to make emotional, cognitive, and social interactions with the environment and others. Therefore, a deep understanding of the importance of children's five senses in the design of an outdoor recreation space is crucial for creating positive, rich and meaningful child experiences.

Visual experience: in the preoperation stage, children's recognition, discrimination and choice of things are mostly [4] based on the colors with strong appeal of vision. Therefore, in the design of outdoor recreation space, we should focus on grasping children's visual feelings and psychological effects. Different colors have different effects on children's emotions and emotions. Bright colors increase a child's mood and vitality, while soft colors bring quiet and relaxed feelings. According to children's emotional needs of children, appropriate colors are used in the recreation space to create a positive and pleasant atmosphere. At the same time, bright colors and clearly contrasting color matching can guide children's attention and help them to better observe and find the details in the environment. Pay attention to the design of color, shape, light and visual landscape. Using bright colors and contrasting color schemes, create interesting shapes and contours, using light changes and projection effects to create visual attraction to attract children's attention and stimulate their curiosity and desire to explore.

Auditory experience: In children in the pre-arithmetic phase, auditory experience is closely related to physical cognition, and children in the pre-arithmetic phase are developing the ability to position and feel the direction of sound. You can use the stereo effect or through the direction and distance of the sound to create a sense of positioning in the environment. For example, setting up multiple sound sources or using sound technology allows children to accurately identify the source and location of the sound, thus developing their auditory positioning ability. Sound games and interactions: Provide children with sound games and interactive devices to perceive and participate in games through hearing. For example, designers can set up touch-sensitive sound devices that produce interesting sound effects when children touch or come near. Such a design can promote the integration of children's tactile and auditory perception, and cultivate their coordination and response ability. Both music and rhythm are of great significance to children in the pre-arithmetic stage. Designers can provide simple musical instruments or musical installations that allow children to participate in music creation and playing. By interacting with music, children are able to feel changes in rhythm, beat and tone, developing their musical perception and expression abilities. In the outdoor recreation space, it can also provide some opportunities for children to express and communicate with their voices. For example, design a sound wall or sound device so that children can express their own thoughts, feelings and expressions through the sound. Such designs encourage children to express themselves through their voice, promoting their language development and emotional expression skills.

By considering the correlation of auditory experience and the embodied cognitive characteristics of children in the prearithmetic stage, an outdoor recreation space beneficial to children's auditory development and embodied cognition can be created. Such a design can stimulate children's curiosity, the desire to explore and creativity, help them to interact with the environment through auditory perception, and promote their cognitive and physical development. Create a rich auditory experience through sound and music.

Touch experience: Touch is the fifth sense of human beings, containing at least 11 distinct senses. It is the earliest system in the process of human development and the most widely distributed and complex sensory system in the human body. For the importance of touch, as Aristotle thought: "there can be no other feeling without touch" [5]. In children in the preoperational stage, tactile experience plays an important role. They explore the world by touching and feeling objects, establishing their cognition and understanding of the environment. Children in the pre-arithmetic phase like to explore the surrounding objects and environments through touch and manipulation. When designing an outdoor recreation space, it can provide a rich tactile experience, such as surfaces of different materials, touch devices and sensory walls. Such a design can promote children's active participation and interaction, helping them to build their perception and cognition of the world through touch. Children in the preoperational phase integrate perception and movement to construct an understanding of object properties and relationships through physical activity and touch. Rich tactile stimuli such as different textures, temperatures and shapes can help children perceive the properties of objects through touch and further develop their perceptual motor integration. Tactile experience can elicit emotional responses in children. A soft, warm touch brings a soothing and relaxing feeling, while a rough, cool touch brings energy and stimulation. Designers can create different tactile experiences in the recreation space according to children's emotional needs to promote children's emotional development and emotional expression. Children in the preoperations stage often recognize and remember things through touch. Designers can use tactile elements such as colors, textures and shapes to help children build tactile memories and associations of objects in the environment. For example, using soft materials to represent comfort and safety, and using rough materials to represent stimulation and adventure, this can help children perceive and remember different environmental features through touch.

By considering the relevance of tactile experience to the embodied cognitive characteristics of the prearithmetic stage children, one can create an outdoor recreation space that is beneficial to children's cognitive development and body perception. Such a design can stimulate children's curiosity and desire to explore, help them to interact with the environment through touch, and gradually establish the perception and understanding of the world.

Smell and taste experience: Smell and taste are key components of childhood perception and cognitive development in early childhood. Through smell and taste, children are able to perceive and discriminate different odors and tastes and link them to relevant experiences and memories. This facilitates the development of children's exploration and cognition of the world. In the design of outdoor recreation space, this part is more natural. By

introducing natural flowers and plants, flowers and grass smells, it provides rich and various natural odors for children to explore, so that children can connect with the natural environment through olfactory perception. Also consider setting up a fragrance device in specific areas or providing some smelling materials to enhance children's olfactory experience. Such a design can stimulate children's curiosity and encourage them to proactively explore, identify and describe the differences in various odors. If conditions permit, a small vegetable garden or water orchard can also be set up for children to personally participate in the process of planting and picking vegetables, and try the taste of fresh fruits and vegetables to experience the taste and taste of the food. Such an experience not only promotes children's smell and taste perception of food, but also cultivates their sense of responsibility and dietary health awareness. At the same time, you can grow some safe herbs and spices in the space, such as mint, basil, lemon grass, lavender, etc. But at the same time, relevant education and supervision should be provided to ensure that the plants used are non-toxic and suitable for the use of children, understand the correct use method and appropriate number of plants, avoid excessive use, and avoid the use of allergic plants, especially children allergic to pollen or fragrance. It is best to consult a specialist herbiest or pediatrician for advice before use to ensure safety and applicability. Ensure that children understand and use these plants correctly, and avoid accidental ingestion or inappropriate use.

5.3. Spatial Layout

In the design of the spatial layout, it is very important to associate with the children in the preoperational stage. Children at this stage are constructing their cognitive structure through perception and movement, so the design should be able to promote their perceived motor development and cognitive improvement. In terms of regional division, we can divide diversified activity areas, such as climbing area, game area, sand pool area, etc. each area provides different types of activities and challenges to attract children's participation. These areas can be designed according to the child's age and competence level, and provide appropriate facilities and devices to stimulate their curiosity and desire to explore. For example, providing large areas of perceived motor activity, such as climbing structures, gaming facilities, and mazes. These facilities can stimulate children's physical movement and coordination, helping them to develop spatial awareness and motor skills. Provide exploratory areas, such as natural exploration areas, sensory gardens, and small independent activity areas. These areas provide a wealth of materials and elements that encourage children to touch, explore, and operate, facilitating their observation, exploratory spirit, and creativity. It can also create some role-play space or provide relevant game props, encouraging children to play different roles in the game, using their imagination and creativity. Such ways of participation can help children establish situational awareness and social skills while increasing their emotional connection with recreational space. Secondly, it can also provide opportunities for independent choice and decision-making, and can provide some optional activities and games, so that children can choose according to their own interests and preferences. In this way, they can feel a certain degree of autonomy and initiative in the process of participating in the activities, and enhance their willingness and enthusiasm to participate. Encourage collaboration and social interaction: incorporate elements of collaboration and social interaction into the design, such as a device for group games, group activities, or multiperson play. This can encourage cooperation and communication between children, and promote their social skills and teamwork spirit. You can also set up some challenging activities and tasks on the premise of ensuring safety. This can be achieved by increasing the height, introducing a balance beam, setting up obstacles, etc. Challenging activities can stimulate child motivation and engagement and provide a sense of accomplishment to enhance their confidence and self-esteem. Moreover, the cognitive level and ability of children in the precomputing stage should be considered in the design of game activities. Make sure that the rules of the game are simple and clear, easy to understand and participate in. At the same time, cooperation and sharing are encouraged to cultivate children's social skills and teamwork spirit. Finally, make sure that the spatial layout is in line with the scale and proportion of children, so that they feel comfortable and safe. Appropriate height, size, and proportion can promote children's hands-on participation and autonomous exploration, allowing them to better understand and adapt to the environment.

5.4. Natural Elements

Children have a deep integration relationship with nature. This fusion is the "basis point" [6] of children's spiritual growth. In the operational stage, the perception of nature is an important aspect of their cognitive and emotional development. They are often curious about the natural world, and they want to proactively explore their surroundings. They may develop a strong interest in natural elements such as plants, animals, sky, weather, and understand and understand them by observing, exploring and asking questions. Natural vegetation and landscape elements, such as trees, flowers, shrubs, and lawns, can be integrated in the design of the outdoor recreation framework. These natural elements can provide a cool and green environment, let children feel the beauty of nature, and have intimate contact with nature. At the same time, they also provide a rich tactile and visual experience, promoting children's perceptual development. A variety of natural materials and textures, such as wood, stone, soil, etc., can be used to build elements such as game facilities and seats. These materials can bring a natural texture and touch, allowing children to interact with nature, and enjoy the warmth and intimacy brought by different natural materials. Water elements can also be introduced into the landscape, such as fountains, streams and pools. The flow and sound of water can attract children's attention and stimulate their desire to explore and curiosity. Interacting with water not only provides tactile and auditory stimulation, but also cultivates children's observation and environmental awareness.

By integrating natural elements into the design of children's outdoor recreation space, it can provide an environment to interact with nature and promote children's perceptual, cognitive, and emotional development. Natural elements not only create beautiful and vibrant scenes, but also provide a rich sensory experience, allowing children to establish closer ties with nature and enjoy the benefits of nature.

5.5. Image and Symbol Representations

In preoperational children, they begin to develop image and symbolic representations, which set the foundation for their thinking and language development. Therefore, image and symbolic representations can be utilized in the design of

outdoor recreational spaces to promote children's cognition and participation. For example, using graphical identifiers in space, such as patterns, symbols, and icons, to represent different recreational areas or activities. This helps children to understand and identify the functions and characteristics of the various regions. Through visual and symbolic presentation, children can transform perception and motor experience into more symbolic forms to better understand and express their cognition more deeply. Images and symbols can serve as a medium for children to interact and communicate with their environment, helping them to construct meaning and understand things in their environment. Another example is to design some interactive elements, such as colorful patterns or mazes depicted on the ground, so that children can interact with the graphics by walking or chasing. Such a design can stimulate children's curiosity and desire to explore. By interacting with the image, they can establish the association with the image through the body's perception and movement, and further deepen the cognition and understanding of the environment.

5.6. Safety Considerations

Safety considerations are crucial in the design of children's outdoor recreation space. First, establish clear boundaries to ensure that the recreational space has safe boundaries and to avoid children walking out of the area or getting in contact with external traffic or dangerous objects. Second, select ground materials such as soft rubber floors or lawns to reduce the risk of falls and injuries and to ensure the ground is level and accessible. Meanwhile, safety facilities such as handrails, railings and guardrails to help them maintain balance and stability. In addition, the game equipment that meets the safety standards is selected to ensure that its structure is solid and stable, without sharp edges or protruding parts, to avoid scratching or pinching children. In addition, different areas or devices are designed according to the cognitive and motor abilities of children of different ages to ensure their applicability and safety. Provide good visibility to ensure that parents or guardians can clearly see the child's activities, set up observation points or adopt an open design to pay timely attention to the child's situation. At the same time, emergency exit signs, first aid equipment and emergency communication equipment should be set up to deal with possible emergencies. Finally, regularly check and maintain the equipment and structure of the recreation space to ensure its safety, and repair or replace the damaged parts in time. During the design process, work with safety experts, child psychologists, and related professionals to comply with local safety standards and regulations to ensure the safety and health of children in outdoor recreation spaces.

6. Conclusion

There is no established form of children's outdoor recreation space, but the core of its design should start from children's perceptual experience and emotional characteristics. This paper introduces the theory of embodied cognition into children's outdoor recreation space, which is the way for children to understand the world with their body in the pre-computing stage. Agembodied cognitive theory emphasizes the importance of children constructing cognitive structures through physical activity and interaction with the environment. In the pre-operation phase, children integrate these experiences into cognitive patterns. Therefore, integrating the embodied cognitive perspective into the design of children's outdoor recreation space can promote children's all-round development and improve their motor skills, sensory development, coordination ability and cognitive ability. At the same time, a creative and challenging recreation environment is designed to stimulate children's curiosity and desire to explore, and to construct the understanding and knowledge of the world through personal experience. Focus on children's five-sensory experience, provide rich sensory stimulation, help them establish the integration of perception and movement, and improve their perception and cognitive ability of the environment. At the same time, create a natural and safe environment, integrate natural elements, so that children can interact with nature and protect their physical and mental health. To sum up, the application of embodied cognitive perspective can provide meaningful experience in children's outdoor recreation space design in the pre-operation stage, promote children's comprehensive development and actively participate in recreational activities, and provide important guidance for the design of safe and creative children's recreation space. Between the stage and uncertainty of children's growth, specific problems need to be analyzed in the actual design process. There are still many research shortcomings for the specific design methods, so I hope to further practice and explore in the future.

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