城市儿童空间设计中的认知科学
THE COGNITIVE SCIENCE OF URBAN SPACE DESIGN FOR CHILDREN

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摘要
在设计城市儿童空间时，一个重要的考量因素是思考空间将如何助益儿童的成长和学习。大量认知科学研究表明，各类基于实证的游戏可促进儿童的社交、认知和运动能力的发展。本文回顾了认知和发展科学中有关游戏对学习的裨益的知识体系，并鼓励城市设计师对其加以利用。文章首先指出了各类游戏可提供的不同学习裨益。若要在城市空间中最大程度地通过游戏促进儿童学习，那么设计师应考虑设计的功能可供性——即设计能够激发什么样的游戏。其次，文章梳理了相关的认知科学证据，指出挑战性和模糊性可以促进儿童的学习和探索性行为，而挑战性和模糊性设计可以提升儿童的学习和创造力。再次，游戏对儿童的社交学习至关重要，为儿童进行社交活动创造了机会。城市设计可以通过营造游戏空间或引入游戏设施——既包括儿童间的游戏，也包括亲子游戏——来激发社会学习。此外，本文还结合实际案例说明了基于认知科学的城市空间的设计过程。

关键词
城市设计;儿童;认知科学;学习;游戏

ABSTRACT
An important consideration in designing urban spaces for children is that it should aid children's development and learning. An extensive literature from Cognitive Science has established that children's social, cognitive, and motor development is promoted by various, well-researched types of play. This article reviews the body of knowledge from Cognitive and Developmental Science concerning the benefits of play for learning and explains that it can and should be harnessed by urban designers. First, the review shows that different types of play confer different learning benefits. Urban space design that attempts to maximize learning from play should consider design's affordance — what types of play are afforded by the design. Second, evidence from Cognitive Science show that children's learning and exploration are fostered by challenge and ambiguity. Design that embraces these increases learning and creativity. Third, play is critical for children's social learning, as it gives children the opportunity to practice social interaction. Urban design can catalyze social learning by creating spaces and structures that invite play among peers, as well as parent-child play. Beyond this theoretical review, this article also illustrates how to realistically implement these Cognitive Science-oriented urban design with an authentic case study.

KEYWORDS
Urban Design; Children; Cognitive Science; Learning; Play

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1 Introduction

Urban design matters because it directly impacts children’s development. This direct link is most obvious when we think about aspects of design such as safety and health. Children who live in areas with poor access to sanitation and clear water are more susceptible to diseases and their development is stymied; those who live in unsafe, crime-ridden areas face emotional and mental health challenges[1]. Designing a child-friendly city or urban space is not limited to issues of health and safety, however. This article highlights evidence from cognitive and developmental sciences, which shows that urban environment also impacts children’s learning.

In the most traditional sense of learning — going to school and learning arithmetic in a classroom — the link between urban design and learning is straightforward. For example, cities that provide good access to schools (safe walkable distances or efficient transportation links) have better school enrollment and retention[2]. But Cognitive Science informs us that learning is not limited to schooling. Children learn language before they attend school[3][4] and the brain undergoes the most profound changes in the early years of life, prior to schooling[5]. School does not teach children explicitly the concepts of friend or foe or other complex social roles, neither does it give explicit instruction on how to be creative and adaptive in life. Where do children learn these and other important life skills?

There is clear evidence that they do so during play[6]~[8]. While play seems to be merely unstructured activities that children do for fun, there is enormous evidence that play is necessary for social, emotional, and cognitive development. Published and peer-reviewed studies have established that children who play more benefit from better language development[9]~[11], improved number knowledge[12], stronger social skills[13] and better emotional control[14][15]. However, as many other things in development, play — especially beneficial play — does not happen automatically; it is influenced by the environment and the opportunities it affords.

An ideal urban design elicits more play activities, which then bring about learning benefits. For example, children play more in outdoor green spaces than in non-green spaces, and the presence of green environments positively correlates with greater working memory[16]. This article is to make explicit the link between play and learning as it is relevant in the context of urban design. What kind of play results in what kind of learning, and what designs usher the most beneficial play behavior? By understanding the cognitive link between...
play and learning, urban designers and policy makers can make informed decisions about urban infrastructure and optimize them for best learning outcomes.

2 Urban Design Elicits Play

Play is characterized by its voluntary and spontaneous nature. The players themselves initiate the play, often doing so without overt goals other than to have fun. This voluntary and spontaneous nature is precisely what makes play so effective as a learning medium because the children themselves are the agents of learning. Spontaneity, however, needs catalyzing and physical environment can act as this catalyster. A bouncy mattress inspires jumping activities; nooks in the house draw children to play hide-and-seek. Environment as a catalyst of spontaneity is critical to play — so that play happens, and so the right type of play happens the most.

A skeptical reader might ask: why need design? All humans live in definite physical environments, do not they all catalyze play? In some sense the answer is yes: children are remarkably creative in making use of whatever they have in their environment to play with. For example, many readers who are parents themselves perhaps recall that despite being surrounded by many great toys, babies seem to find just as much joy in knocking around the cardboard wrappers of their toys. On the other hand, play comes in many forms, which confer various learning benefits. Children who run around playing tag with friends get physical benefits, but a quiet solitary play building blocks also confers benefits of its own, such as creativity and problem-solving skills. Design, then, can shape the environment so that it channels play into its more useful forms. If the aim is to optimize learning opportunities, urban design is a strategic means for achieving it through play.

Because the focus in this article is on urban outdoor environment, we chart four types of play that can be catalyzed by outdoor urban design: 1) functional play, 2) constructive play, 3) pretend play, 4) games with rules.

Functional play is when children do repetitive muscle movement, such as running, climbing, chasing, with or without objectives. This type of play is typically the kind of play that designers have in mind when thinking about child-specific facilities: such a facility is designed for a specific function, for example a slide is for sliding or a swing is for swinging. Sometimes, the design can afford many functions. For example, rocks on the ground can be used for walking, stepping, or jumping. The rocks’ spatial arrangement, such as spacing distance, can catalyze different play behaviors. For example, the
same distance apart may be walked by the older children, but younger children need to jump across.

Constructive play involves creating things with materials, for example, using sand and water to make a castle. Children tend to do constructive play when they have access to manipulative props — materials that they can pick up, sort, arrange, and collect. These loose materials act as catalyzers for constructive play. For example, one study found that children did more constructive play when loose objects like tire and stackable blocks were available in the playground. When these materials were removed from the playground, children engaged less in constructive play[20].

Pretend play involves imagination and “as-if” thoughts. For example, children pretend to be someone else — superman, a princess, or a doctor — and take up the corresponding personality of their pretend character. Studies found that enclosed spaces, such as playhouses, elicit pretend play[20].

Games with rules are play under prearranged rules. There are many games with rules, like chasing games, hide-and-seek, or basketball games. Some games — like sports games — need specific facilities and design (e.g., courts, nets). But some games are catalyzed by nature and green spaces, for example, children play hide-and-seek more in the woods than in plain manufactured zones[21].

3 Play is Learning

Jean Piaget, widely considered the father of the study of cognitive development, believed that “play is the answer to the question: how does anything new come about?”[22]. Since human development is fundamentally characterized by learning new things — from language to numbers to social roles — Piaget’s assertion implies that play is at the very core of development. Yet, despite a widespread belief that play is good, many parents and educators are reluctant to view play as learning. Most parents will be distressed if their children cannot get access to school, but few will lament if their children do not have access to play. Play, then, is often considered “the fun thing you do if you have extra time” and not as an important and critical aspect of one’s growth and learning. Indeed, few parents and educators are concerned that children’s development will be lacking if they lack play. This thinking is incorrect. Extensive evidence from Developmental and Cognitive Sciences clearly shows that play is not just a side accompaniment to instructional learning. Rather, play is self-motivated learning. In fact, some learning outcomes are mostly accomplished through play and not through instructional learning.
3.1 Learning Mechanisms through Play

To help urban designers and policy makers in creating environments ideal for learning, we wish to convey more than a list of learning benefits of play. To impart a true understanding of the issue, this article will discuss the specific mechanisms by which play constitutes, or is converted to, learning, involving the four types of play listed above.

3.1.1 Mechanism 1: Physical Opportunities and Challenges

Some types of play, such as functional play (such as climbing a wall, sliding down a slide, and swinging) and games with rules (such as running after a ball and play catch) provide plenty of opportunities for children to move their bodies and exercise their motor skills. There is no doubt that doing physical activities of any kind results in better health outcomes. But when children do that through play, they are more likely to initiate and repeat the physical movements, rather than only doing so when instructed, for example in physical exercise lessons. One study shows that children who reported more outdoor play time had higher Moderate to Vigorous Physical Activity (a standard measure of physical activity) and higher cardiorespiratory fitness [23]. This evidence is particularly important in urban contexts where child obesity has become a growing problem in recent years [24]. A recent meta-review shows a lack of physical activity among Chinese children and adolescents, leading to various health problems [25]. It is possible that this lack of physical activities is directly correlated to lack of play among Chinese children—Tsinghua Laboratory of Brain and Intelligence is actively researching this issue at the moment. If this is indeed the case then urban design which elicits play may be instrumental in reversing the current negative trends in children’s health. As an interesting side note, Chinese cities are acutely aware of the link between design and health among the elderly population: we see an abundance of free exercise equipment for senior citizens in many areas in urban China. At the same time — in stark contrast to virtually all the rest of the world — it is very challenging to find free public playgrounds in Chinese cities.

Beyond opportunities, play also presents physical challenges. A child may find a high and steep slide challenging or discover that it is difficult to catch a ball in a throwing game. Doing so induces learning about one’s own limits and strengths. This awareness often results in meta learning skills that make one confident and adaptive in facing further challenges. For example, Ann Lavrysen et al. [26] found that children who were involved in risky-play activities (e.g., play with great heights, rough and tumble play) for three months were better able than their peers in a control group to detect changes and risks when presented...
3.1.2 Mechanism 2: Active Exploration

Common wisdom holds that play makes one creative. This belief is evident, for example, in companies like Google, which design their offices in playful tones and with kaleidoscopic bright colors, ostensibly to draw out the creative juices of their employees. What exactly happens during play, which fosters creativity? First, play is active and self-directed\(^\text{[28]}\)~\(^\text{[30]}\) as opposed to passive; second, it is an exploration as opposed to following instructions or directions. When an individual engages in exploring novel surroundings, he or she is bound to deploy creative ways of proceeding\(^\text{[31]}\)~\(^\text{[32]}\). This is evident in everyday play situations, such as a one-year-old exploring Mom's phone and pressing buttons to change the phone's display. Eventually, the active exploration results in causal learning\(^\text{[33]}\): after a while the baby knows what button to press to take a picture! The baby's discovery of a causal structure of the phone may prompt her to make further discoveries about the world, including how other items work.

Explorations of the world inevitably expose new problems that need solving, which often results in creative solutions. In pretend play, children have to solve the problem of “making something out of nothing.” For example, they need to creatively use common household objects as stethoscopes when they are pretending to be doctors. Likewise, in constructive play, children think creatively about how to build structures from limited available materials. Indeed, studies show that children who engage more in pretend play or constructive play are more imaginative and creative: they can do more out-of-the-box thinking when solving problems\(^\text{[34]}\)~\(^\text{[36]}\). How can design induce active exploration? Evidence from Cognitive Science suggests that children explore more when they are confronted with ambiguous situations\(^\text{[37]}\)~\(^\text{[38]}\). For example, when preschoolers were shown either a toy that had a clear causal mechanism or a toy with an ambiguous mechanism, they explored the ambiguous toy longer\(^\text{[37]}\). Even infants explore longer when they encounter surprising events\(^\text{[39]}\). We can harness this evidence for design optimization: designs that feature elements of ambiguity or surprise can drive active exploration.

3.1.3 Mechanism 3: Social Interactions

One of the most important skills of life that children have to learn is how to interact with others. Humans are social by nature and much of our successes are attributed to how well we
navigate the complex social networks we live in. Yet this is a subject rarely taught at schools; children do not receive explicit instruction on how to conduct their social transactions. How do children learn to communicate, negotiate, resolve differences, argue, cooperate with or persuade others? By and large, we expect children to learn all these social skills on the go. Is there an effective means to learn social skills? Evidence suggests that play is just the right tool for learning social skills. Children who play have better theory of mind (TOM) — the capacity to understand that others have thoughts, goals, and desires different from our own. TOM is critical for social interactions; it is necessary for us to empathize and anticipate what others will think and do. Without it, even simple everyday communication becomes difficult, as is the case with autistic children. Not surprisingly, children who play develop demonstrably better friendships and social competence with peers.

The fundamental reason for why play is effective for learning social skills is that it gives children an opportunity to practice social approaches. Unlike in rigid social settings with clear boundaries — parents vs. children, teachers vs. students — play gives children the freedom to take up different roles and approach social others in a relatively low-cost way. For example, when a child pretends to be the mother, she puts herself in a mother's shoes, imagining what she thinks and how she feels. Over many pretend plays, she becomes more adept in perspective-taking — seeing the world from another's perspective. This is difficult to achieve in non-play situations as most of us — even children — have fixed roles in our lives. Indeed, study shows that pretend play increases children's perspective-taking ability.

3.2 Guided Play

At times, play partners can also be adults — parents, grandparents, or teachers — who have a lot more knowledge than the child. In such play, the more knowledgeable partner can guide and scaffold children's active exploration and discovery. The key to this guided play is that adults use their better knowledge of the world to help children learn on their own,
rather than to tell children what to learn. In guided play, the autonomy of the active, self-directed child is preserved, but the exploration is bolstered by others.

Guided play is effective because oftentimes children face a whole barrage of potential hypotheses about how the world works. Parents can prompt, ask, give hints, and otherwise direct the learning process so that children narrow these hypotheses down to the most plausible subset. For example, in order to acquire the geometric category of triangles children need to learn that all figures with three sides and three angles are triangles; the sides do not have to be of equal length. If young children are merely told the mathematical definition of triangles, it will be exceedingly hard for them to learn it. At the same time, discovering on one’s own what does and does not count as a triangle takes a really long time. And this is just about one geometric shape, let alone the myriad things children have to learn. Adults can help this learning by presenting the right comparisons to children. For example, when shown typical and atypical triangles together, children are intrigued to think about similarities and differences and this comparison helps them to discover what is common to all triangles. Indeed, Kelly R. Fisher et al. found that 2 or 3-year-olds in the guided play condition learned geometric shapes better than their peers in the didactic condition. In another study, children who participated in guided play improved their locomotor and object-control skills (e.g., running, jumping, doing stationary dribble) compared to those in the control group.

Even exploratory behavior can be increased by guided play. For example, adults can prompt children to use objects in novel ways in pretend play, or hint at solutions to problems encountered in a challenging game. Adults can also create ambiguous situations or conflicting evidence through questions and prompts (“Hmm, I wonder how this thing actually works?” “What would happen if you press that button?”), which induces children to explore. In sum, a large body of evidence shows that guided play is beneficial to learning. At the same time, guided play is often the most difficult outcome to elicit by design: parents either simply instruct or do not play at all. This article gives concrete examples of how design can induce guided play in later section.

3.3 Summary of Design Guidelines

Thus far, we have reviewed the evidence from Cognitive Science showing that play makes learning, as well as the mechanisms by which play benefits motor, social, and cognitive development. We believe that these mechanisms can and should be translated into guidelines for urban design for children.
基于认知学习机制的经验指南的指导下，城市儿童空间设计将进一步提升寓教于乐的学习效果。然而，这些原则并非简单地规定应该或不应修建哪些设施，而是旨在为设计师提供各类工具及相关概念，以优化儿童的学习效果。

3.3.1 功能可供性设计

游戏的形式多种多样，每种游戏形式都会带来不同的学习裨益。因此，基础设计原则之一就是考虑设计的功能可供性[57]。“功能可供性”（affordance）是一项认知科学专业术语，用于描述环境与使用者之间的双向关系，即基于使用者的身体条件和其他限制因素，环境能为使用者提供哪些功能。例如，椅子对于成年人来说是一个座位，而对于婴儿来说则是学步工具，对于调皮的幼童来说则是攀爬对象。那么就城市儿童空间设计而言，我们必须思考：什么样的设计能够激发什么样的游戏？例如，秋千和滑梯适宜儿童进行机能游戏而非扮演游戏，松散材料适合搭建游戏[20]，封闭空间适合扮演游戏[20]，而绿地则适合某些规则游戏[21]。抛开具体设计不谈，优先功能可供性这一设计原则对于打造具有综合学习效果的空间设计非常有帮助：为了全面提升空间对于儿童学习的裨益，设计应考虑多重功能可供性。这一点虽显而易见，但实际上，我们发现很多游乐场内仅包含机能类游戏设施（秋千、滑梯、可供孩子骑玩的木制动物/汽车等），而忽略了其他类型的游戏。为了提升空间的功能可供性，设计方案还可以包含适合搭建游戏的沙坑、适合扮演游戏的小屋，以及适合捉迷藏的绿地等。

3.3.2 挑战性设计

体力挑战性游戏设施能够促进儿童的身体活动，并鼓励他们进行适应性和冒险性行为。体力挑战往往表现为儿童遇到了无法实现的目标，每到这种时候，儿童常常会通过反复练习来达成目标——这种解决问题的能力也是一项重要的认知技能。这意味着，与其直接设计具有某项功能的设施（如通往滑梯顶部的阶梯），设计师可以考虑加入一些体力挑战性设施（如绳梯）。

挑战性设计中的“挑战”在于如何使同一个设施为不同的使用者提供不同程度的挑战性：绳梯对2岁的孩子来说非常具有挑战性，但对10岁的孩子来说却相当容易。为了解决这一问题，设计师可针对不同

We offer such a translation below: rules of thumb informed by cognitive learning mechanisms, by which urban design for children can optimize play-learning benefits. These guidelines do not simply prescribe what should and should not be built; instead, they give tools and a conceptual vocabulary for designers interested in maximizing learning outcomes.

3.3.1 Affordant Design

Play comes in several varieties, each of which confers different learning benefits. As such, a fundamental design guideline is to consider the design’s affordances[57]. Affordance is a Cognitive Science term which captures the bidirectional relation between an environment and users — what the environment offers to users given their bodily and other constraints. For example, a chair provides a sitting place for an adult, but it can be an anchor for an infant learning to walk or a climbing structure for an active toddler. Translating this to children’s urban design, we must ask what kinds of designs afford what kinds of play? For example, swings and slides afford functional play but not pretend play while loose materials afford constructive play[20]. Enclosed spaces afford pretend play[20] while green spaces encourage some games with rules, though not all[21]. Specific designs aside, the guideline of prioritizing affordances is useful if designers want to achieve comprehensive learning benefits: to obtain a gamut of learning benefits the space should feature multiple affordances. This point may seem obvious but, in fact, our observation is that many playgrounds contain facilities only for functional play (swings, slides, wooden animals / vehicles for riding, etc.) and ignores other types of play. A more comprehensive and affordance-centered design would also include, for example, a sandbox for constructive play, a shed for pretend play, some green areas for hide-and-seek, and so on.

3.3.2 Challenging Design

Facilities that provide physical challenges catalyze physical activities as well as adaptive and risk-taking behaviors. Physical challenge is also often a form of problem to be solved, so children who encounter them habitually get regular practice in problem-solving skills — an essential cognitive skill. Thus, rather than designing straight functionality (e.g., a staircase to the top of a slide), designers can instead embed some physical challenge such as a rope ladder.

A “challenge” for challenging design is that one structure may afford different challenges for different users: a rope ladder may be really hard for a two-year-old but easy for a 10-year-old. One solution is to design a range of structures with different challenges for different age groups; another is to create one
年龄段的儿童分别设计不同的挑战性游戏设施，也可以在一个游戏设施内设计多重挑战。例如，可将绳梯分为两段，其中一段梯级间距较小（对学步幼童颇具挑战性，但对6~7岁的孩子来说很轻松），另一段梯级间距较大，对大童具有一定的挑战性。当然，不同年龄段儿童的游戏方式有时也存在差异[58]~[60]，但挑战性游戏对所有年龄段的儿童来说都大有裨益。

3.3.3 模糊性设计
认知科学相关证据表明，模糊性事物更易激发儿童进行积极探索[37]~[39]，而此类主动性探索有助于锻炼他们的问题解决能力和创造力。实现模糊性设计的途径有很多：例如在草坡背面设置一座滑梯或一些无法一眼识别其功能的玩具。模糊性设计更适于进行扮演类和搭建类游戏。例如，木头或石块等松散材料可提供不止一种功能，这种功能上的模糊性有助于激发孩子发挥创造力实现多种搭建。周身有洞的圆顶小屋也具有功能模糊性（既可以攀爬，也适合捉迷藏），此类设施可以激发具有挑战性的机能游戏或扮演游戏。

3.3.4 社交性设计
游戏还有助于儿童的社交学习，即通过游戏来锻炼他们的社交技能。那么，如何设计可以激发儿童社交活动的空间呢？首先，设计师需要考虑能够促进儿童亲密接触的功能设置及空间距离。秋千显然不合适——虽然可以并排设置两三个秋千，但荡秋千依然是单人游戏活动。摇摆桥（三五个人可以一起晃动桥体）是个不错的选择：近期一项研究表明，诸如摇摆桥之类的集体游戏活动有助于提高学龄前儿童的协作能力[61]。

实现社交性设计的另一种方式是与挑战性设计相结合。设计具有多重挑战性的游戏设施（如富于变化的绳梯）能够促进不同年龄段的儿童在一起玩耍，从而促进孩子间的社交活动。理想状态下，当游戏设施的挑战性过高时，年龄较大的孩子会帮助年龄较小的孩子，从而形成良好的社交互动。

4 在城市设计中融入认知科学：案例研究

本文将以一个正在进行中的设计项目为例，介绍上述认知科学知识在景观设计实践中的运用。该项目由认知科学与发展心理学者斯黛

structure that affords many levels of challenge. The rope ladder, for example, can have two sections: the left section with small distances between rungs (challenging for toddlers, easy for 6 or 7-year-olds) while the right section with large distances intended to challenge the older children. Of course, children of different ages play somewhat differently[58]~[60], but children of all ages benefit from challenging play.

3.3.3 Ambiguous Design
Evidence from Cognitive Science shows that children actively explore more when they are faced with ambiguity[37]~[39]. These active explorations result in turn in problem-solving skills and creativity. There are many avenues to design ambiguity, for example, by hiding a slide behind a grassy slope or installing toys with functions that are not obvious at first sight. Some types of play, such as pretend play and constructive play, are more receptive to ambiguity. For example, loose materials like pieces of wood or rocks do not afford just one function and their ambiguity allows them to be constructed into many different things. An igloo-like shed with holes all around is ambiguous (is it to be climbed or to hide inside?). Such structures afford challenging functional play but also pretend play.

3.3.4 Social Design
Play confers many social learning benefits because it gives an opportunity for children to practice social interactions. How to elicit social design — design that catalyzes social interactions? First, designers can consider functionality and / or spatial distance that affords physical togetherness. A swing is solitary, though if you put two or three swings side-by-side you can swing together. Even better, perhaps, is a swinging bridge — three or more people can swing the bridge in unison. Interestingly, a recent study shows that swinging together in unison increases preschoolers’ cooperative acts[61].

A second way to elicit social design is to incorporate it with challenging design. A structure that affords challenges of many levels, such as a rope ladder with diverse sections, can elicit social interactions, with younger and older children playing together. Ideally, when the challenge gets too hard, older children may help the young ones — a wonderfully beneficial social interaction.

4 Implementing Cognitive Science in Urban Design: A Case Study

An ongoing case study described here implements some of the knowledge of Cognitive Science above in a landscape
拉·克里斯蒂教授和景观设计师韩西丽教授共同完成，二人受委托对
于北京市中心的一处大型户外空间进行了重新设计。目前项目场地上
已有一处儿童活动中心，但需要进一步提高场地的功能性和支持性，
以促进儿童学习。

基于认知科学的空间设计最重要的一点——也是首要目标——便
是确立设计目标，即空间应实现哪些功能。设计师往往会构想出多重
设计目的和多样化的设施设计方案，旨在调和相冲突的设计目标。该
项目主要关注基于认知发育的设计目标，不过和其他委托项目一样，
项目的设计方案也需要服务于儿童活动中心利益相关方的需求。为了
实现这一点，项目运用了认知科学原则，以期实现最有效的循证设
计。换言之，介绍该设计方案的目的并非要描述一种理想的状态，而
是分享从实际设计过程中总结出的经验：在此过程中，认知科学原则
的运用必须综合考量外部限制因素和约束条件。

4.1 目标一：设计适宜儿童的空间

这项目标虽然不言而喻，但在实际操作过程中，由于涉及多个
利益相关方，目标的沟通和确立却极具挑战性。由于决策者都是成年
人，他们在处理空间问题时往往仅关心成年使用者的利益。例如，设
计儿童活动中心的入口区域时，项目的利益相关方要求我们设计一个
类似于芝加哥千禧公园“云门”的，吸引眼球的装置设施。令人眼前
一亮的设计固然重要，但是我们还要权衡考量儿童成长的需求：项目
的空间设计不仅应对儿童具有吸引力，更要能够促进儿童对空间的
使用。

为了整合视觉体验目标与功能性目标，项目首先运用了功能可
供性原则。芝加哥“云门”装置的功能可供性非常有限——虽然“云
门”对成年人来说很有吸引力，但却没有与儿童用户形成良好互动。
认知科学研究表明，儿童天生具有好奇心，当遇到模糊性事物或与既
有认知冲突的事物时，他们的探索本能便会得到激发。为了设计既具
吸引力又能激发孩子探索欲望的空间和设施，我们需要考虑到儿童的
architecture project. This project is a collaboration between
Professor Stella Christie (a cognitive scientist and developmental
psychologist) and Professor Han Xili (a landscape architect),
who were tasked to redesign an existing large outdoor space
in central Beijing. This space is currently already occupied by a
children’s center. However, the space needs a transformation to
become more functional and supportive for children’s learning.

The most important anchor of Cognitive Science-informed
design is to start with the goals. What ends should the space
achieve? Designers contend with multiple goals and deliver
structures aimed to compromise among many competing
objectives. This project focuses on the goals stemming from
their understanding of cognitive development. But like any
commissioned project, this project also involves goals mandated
by the stakeholders of the children’s center. The project adapts
the Cognitive Science principles to a broader context of these
mandated goals, in order to achieve the most effective evidence-
based design among all feasible options. That is, the design is not
to describe an ideal situation, but rather to share our experience
from a real world implementation, in which our desire to apply
Cognitive Science principles had to be reconciled with external
constraints and mandates.

4.1 Goal 1: To Design a Space for Children

This goal may seem obvious, but it is in fact the most
challenging one to be communicated and established with
various stakeholders of the project. Because decision makers
are adults, they tend to view spaces through the lens of adult
concerns. As an example, in designing the entrance area to the
children’s center, we were mandated to create an impressive
or imposing structure, with the Chicago Bean given as a
benchmark. An inspiring design is certainly an important goal
and we would now have to reconcile it with optimizing the
benefit for children: the child users should be inspired, and
specifically inspired to use the space.

To achieve a synergy between inspirational and functional
objectives, first, we considered the guideline of affordant design. The
benchmark structure, the Bean, has very limited affordances — it
may be inspiring for adults but offers limited interactions to child
users. Evidence from Cognitive Science tells us that children are
naturally curious and their exploratory instinct is piqued when they
encounter objects ambiguous or different from prior beliefs, viz.
ambiguous design guideline. As such, to design space and facilities
that are both inspiring and inviting to be explored, we need to
consider children’s existing knowledge: what do children know
and recognize? The kind of ambiguous appearance that elicits
children’s exploration may be most easily achieved by starting
with familiar concepts and re-purposing them in novel ways. But if the design begins with a concept familiar to adults, and re-works it in a way that seems novel to adults, it will not induce children to explore.

Using this principle, Prof. Han proposed a design using wooden sheep — familiar animals for children across a wide range of ages — but arranged the herd in a spatial configuration unfamiliar to children (Fig. 1). While static, the spatial configuration of the sheep gives a perception of action and interaction. Furthermore, the action / interaction appears ambiguous — the sheep can be perceived as running together towards a common destination or chasing each other. Such ambiguity invites exploration from children: they can hop on the sheep riding them (pretend play) or do various runs between the sheep. There is a potential for a game with rules with the sheep as props, e.g., a racing game where you have to jump over every other sheep that you pass. Children will not only be enticed to use these structures, they also learn to be imaginative and creative in their interactions with the sheep. Impressive as it is, the Chicago Bean alone does not induce this behavior.

4.2 Goal 2: To Design Space that Elicits Parent-Child Interactions

Social interaction, in particular parental interaction and involvement in children’s activities, is the original mandate of this project. One of the project’s stakeholders noticed that parents visiting the children’s center often stayed uninvolved in their children’s activities. Even when visiting the neighboring, excellent children’s museum, many parents just sat on the side, not interacting with their children. This is a missed learning opportunity because, as we have seen in a large number of studies, guided play is extremely beneficial for children’s learning. Parents and caregivers (grandparents or teachers) can engage children in playful learning interactions. For example, parents can be the play partner in a pretend play, or they may encourage the child to take up challenges in a functional play (to climb higher or to try a more difficult slide).

Our observations reveal a psychological barrier in that many adults think that kids’ space is only for kids — it looks infantile and should be used by children only. To entice parental involvement and to result in guided play, the design can break perceived barriers with structures that awaken adults’ curiosity and taste for exploration. The elements of ambiguous design that enhance children’s exploration can also be deployed to awaken adults’ desire to play. A great example of such a design is the Magical Harps installed at the Magical Bridge Playground,
装置便是一个很好的例子。该装置的主体是一个由金属拱架构成的“24弦竖琴”（图2），当有人从拱架下经过或移动（变换身体姿势、跳、跑等）时，竖琴便会发出美妙的音乐。这个装置设计简单但却可以发出声响，成年人也会为之吸引，好奇装置的发声原理。克里斯蒂教授经过观察发现，家长会自然而然地参与其中，与孩子们一起探索装置的工作原理。魔法竖琴的成功还在于其运用了社交性设计原则：这一游戏设施可供不同的人群同时使用，当很多人一起在拱架下玩耍时，竖琴便会演奏出一曲“交响乐”。这一集体游戏方式既有趣又具互动性，对孩子和家长来说都是一种学习体验。在我们的设计方案中也可以引入类似的游戏设施，并融入京剧乐器等中国语境元素。

带动父母和孩子们一起游戏的另一方式是运用空间邻近性。空间上的邻近可以促进心理上的亲近：当距离孩子较近时，父母更容易与孩子进行互动。很多游乐场所周边都设有长凳，在孩子玩耍期间，父母往往只是坐在一旁，不参与孩子的活动。而本项目建议在游戏区域内部设计休息设施。例如，我们在一处区域内部设计了一条东西向的长凳。并以长凳为中轴线，南北两侧均为游戏空间。家长既可以在长凳上休息，也可以随时加入到孩子的游戏中去。同时，孩子们也可以

Palo Alto, the United States. This installation is a 24-string-laser harp encased in a metal arch (Fig. 2) that can be activated by moving underneath it, including gesturing, jumping, or running. Because the arch is simple-looking but produces music, adults are intrigued to play with it and try to figure out what actually produces the music. During Professor Christie’s observations, parents were naturally enticed to play with the musical harp and they often conversed with their children to figure out how the magical harp worked. Through its functionality, the Magical Harps has also incorporated the guideline of social design — a single structure that invites many types of users to play together. When many bodies moved underneath the harp, the resulting play was an orchestra-like music. Playing together is fun and interactive; it is a learning experience for children and adults alike. In our design, we proposed to implement a structure similar to the Magical Harps but modified to the Chinese context — for example by using sounds from Beijing opera’s musical instruments.

A second way to invite parental involvement in children’s play is by using spatial proximity. Spatial proximity increases psychological proximity: it is obviously easier to interact with your child if you are nearby. In many playgrounds benches are placed on the periphery, which makes parents to sit aloof, unengaged with children’s activities. In our design, we proposed to place resting structures within the play area. For example, in one area we designed a long sitting bench along the east-west line. There are play areas both to the north and south of the bench, so our placement made the bench into a central axis of the play space. Parents can rest but they can also easily interrupt their resting to take part in their children’s play. At the same time, children can hop on the bench or jump through it. Such spatial proximity encourages closer interactions between parents
4.3 Goal 3: Moral Education

The stakeholders stated as their main goal that the children's center provide moral education for children. The stakeholders view this goal as distinct from the goal for parent-child interactions that aims at increasing parental involvement in children's play, i.e. to increase Guided Play, but not for the parents to teach the children. Stakeholders who mandated the goal for moral education believe that children need to be taught moral values through explicit design, for example, using educational boards or exhibitions containing moral teachings.

We share the stakeholders’ view that moral education is important for child development. However, Cognitive Science informs us that such direct instruction about moral values is not the most effective means of learning. Instead, active learning, rather than passive instruction, benefits children’s moral development more strongly. First, purely from a design usage perspective, active learning makes sense: we are designing not classrooms but outdoor spaces, which afford active explorations best. Second, evidence from Cognitive Science shows that active learning results in better generalization (children apply what they learn to more situations) and a longer retention of benefit. This kind of outcome is particularly desirable for learning complex concepts like morality. Clearly, we want children to be able to use their moral knowledge in a variety of situations throughout their lifetime, not limited to the here and now. We will not achieve this outcome merely by designing instructional boards telling children the values of community sharing or honesty, even when these good words are inscribed in beautiful designs. The design must encourage children (or other learners) to actively gain information, ask questions, or solve problems requiring moral judgement.

How to elicit active moral learning? Evidence from Cognitive Science shows that when children play with others, they have to practice prosocial behaviors (to share, to reconcile differences, to cooperate, etc.) which builds an intrinsic moral foundation applicable to the full spectrum of life situations. To provide social approach opportunities, we combine guidelines of challenging design and social design and design play structures with varying levels of challenges to invite children of many ages to play together. For example, in one design Prof. Han proposed a “volcano” structure (Fig. 3) whose topography provides varying levels of climbing challenges. The younger

3.  A "volcano" structure whose topology provides varying levels of climbing challenges, inviting children of all ages to play together, fostering children's learning of social and emotional skills (Designed by Han Xili).
施具有不同的攀爬难度。年龄较小的孩子可以爬到“火山”中部，大一些的孩子可以快速地冲到“火山”顶部。这些活动发生在同一空间内，这种空间邻近性能够促进儿童的社交活动。例如，当看到别人遇到困难时，擅长攀爬的孩子可能会伸出援手，这就锻炼了儿童帮助他人和传达善意的能力。同样，在讨论问题的解决办法的过程中，儿童的沟通合作能力也会得到锻炼。此外，不同于学校环境，户外游戏中的小伙伴是不固定的，大家彼此间也不熟悉，这将有效锻炼孩子们的问题解决能力和社交技能，并且这种变化的游戏情景有助于儿童不断地践行他们的品行标准。

5 结论

城市环境对于包括儿童在内的城市居民的身心健康具有重要影响。认知科学和发展心理学的相关研究表明，设计不仅会影响健康和安全等基本福祉，还会对儿童的学习能力和发展水平产生深远影响。城市设计能够激发儿童的游戏热情，儿童能够通过游戏来了解世界，学习那些传统课堂上不教授的知识。因此，有助于激发儿童游戏热情的城市空间设计能够为孩子创造宝贵的学习机会，使其更健康、更具创造力，并更好地融入社会。如果一座城市缺乏游戏机会，那么它也剥夺了儿童通过游戏进行学习的机会。

如果孩子代表未来，那么城市设计师和政策制定者在为孩子创造尽可能多的学习机会方面肩着重大责任。通过明确了解游戏对于学习的作用机制，城市建设者可将相关知识应用于设计决策的过程中。本项研究希望能够进一步加强所有利益相关方（政策制定者、设计师、认知学者、教育工作者和父母）之间的合作，打造有助于儿童进行充分学习的城市设计。

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children can climb up to a middle level while the older ones can try running fast to the top. But because the activities take place in one space, social interactions are guaranteed through spatial proximity. For example, seeing that others have climbing difficulties, a good climber may give his / her hand to pull the less able climbers, practicing help and kindness. These challenges also translate to problem solving situations; in discussing how to solve problems together, children practice their communication and cooperation skills. Furthermore, unlike within-school interactions where children already know each other, outdoor play such as this presents problem solving and social approach opportunities with different players every time. This prepares children to exercise their moral intuitions in wider-ranging real life situations.

5 Conclusion

There is no doubt that urban environment has a significant impact on the well-being of its inhabitants, including children. Analysis of evidence from Cognitive Science and Developmental Psychology clearly shows that design not only impacts basic well-being such as health and safety, but that it can shape children's learning and development. Urban design can catalyze play—a critical mechanism by which children learn much knowledge about the world, including knowledge that is not explicitly taught in traditional instructional settings. Consequently, cities that catalyze play foster critical learning opportunities for its child inhabitants so they become healthier, more creative, more adept social players. Cities that lack play opportunities deprive children of these learning benefits.

If children are the future then urban designers and policy makers have a great responsibility to furnish learning opportunities whenever possible. By understanding the precise mechanisms by which play brings about learning, city builders can use evidence-based information in their decision-making about design. We hope this review gives impetus to future collaborations between all stakeholders — policy makers, designers, cognitive scientists, educators, and parents — to create urban designs that maximize learning for children.

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