Relevance and Necessity of Autism-Friendly Toys: Enhancing Social Inclusion in Urban Environments

Vaidehi Rajkumar[1], Rupesh Surwade[1], Abhishek Bangre[1], Sharvari Shende[1], Mohammad Arif Kamal[2,*]
[1] Priyadarshini Institute of Architecture and Design Studies, Nagpur, India
[2] Architecture Section, Aligarh Muslim University, Aligarh, India
Corresponding author: architectarif@gmail.com

Abstract: Autism Spectrum Disorder (ASD) affects approximately 1 in 100 children worldwide, presenting unique challenges in social interaction, sensory processing, and environmental adaptation, particularly in densely populated urban settings. Autism-friendly toys — designed with sensory integration, gamification, and collaborative elements — emerge as critical tools for fostering social inclusion, cognitive development, and emotional regulation. This paper synthesizes empirical evidence from therapeutic toy designs, including gamified solutions, smart multifunctional toys, and robotic aids, to underscore their necessity within social and urban dimensions. Drawing on sensory integration training and cooperative play validation, we explore how these toys mitigate urban barriers such as sensory overload in public spaces and limited access to inclusive play areas. A conceptual framework is proposed, integrating D-S theory for uncertain decision-making in toy evaluation. Tables compare toy preferences across neurodiverse populations, while a diagram illustrates a socio-urban design model. Findings reveal that autism-friendly toys not only enhance joint engagement but also promote equitable urban participation, aligning with Sustainable Development Goal 11 for inclusive cities. Implications for policymakers, educators, and designers emphasize scalable, accessible toy interventions to bridge social divides. Limitations include the need for longitudinal urban field studies. Future research should prioritize culturally diverse implementations.
Keywords: autism spectrum disorder, autism-friendly toys, social inclusion, urban design, sensory integration

1. Introduction

Autism Spectrum Disorder (ASD) is a neurodevelopmental condition characterized by persistent challenges in social communication, restricted interests, and repetitive behaviors, often accompanied by sensory sensitivities (American Psychiatric Association, 2013). Globally, the prevalence of ASD has risen to 1 in 100 children, with urban environments exacerbating these challenges through noise pollution, crowded public spaces, and limited green areas for unstructured play (World Health Organization, 2020). In urban contexts, children with ASD face heightened risks of social exclusion, bullying, and sensory overload, which hinder their developmental trajectories and family well- being (Baio et al., 2018).

Play, as a fundamental right under the United Nations Convention on the Rights of the Child (1989), serves as a vehicle for learning, emotional expression, and social bonding. For neurotypical children, toys facilitate imaginative exploration; for those with ASD, however, generic toys often fail to accommodate sensory needs or promote joint attention — the shared focus on objects or activities with others (Charman, 2003). Autism-friendly toys, tailored with features like gamification, tactile feedback, and collaborative mechanics, address these gaps by transforming play into a therapeutic and inclusive practice (Mustafa et al., 2024). This paper examines the necessity of such toys through the lens of social and urban dimensions. Socially, they foster joint engagement and empathy, reducing isolation in peer interactions (Laurie et al., 2021). Urbanly, they enable portable, adaptable play in constrained cityscapes, supporting Sustainable Development Goal 4 (quality education) and Goal 11 (sustainable cities) (United Nations, 2015). Figure 1 shows the conceptual diagram for social and urban necessity of autism friendly toys. Synthesizing provided studies alongside broader literature, we argue that autism-friendly toys are not luxuries but essential for equitable urban living (Figure 2). The structure includes a literature review, design principles, case analyses, and a socio-urban framework, culminating in policy recommendations.

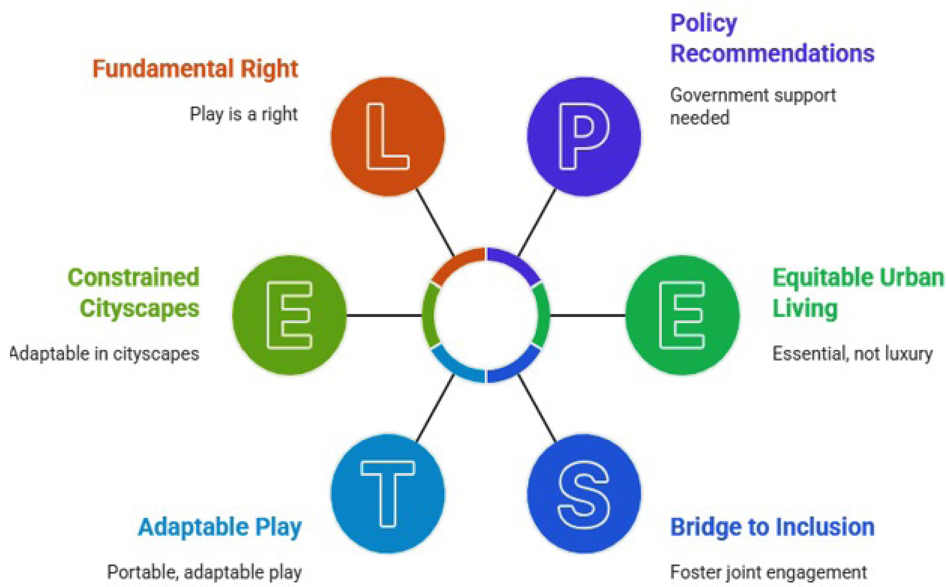

Figure 1. Conceptual diagram for social and urban necessity of autism friendly toys

Figure 2. Social and urban necessity of autism friendly toys

2. Literature Review

2.1 Social Dimensions: Play as a Bridge to Inclusion

Social interaction deficits in ASD often manifest as reduced joint attention and repetitive solitary play, limiting peer relationships and emotional reciprocity (APA, 2013). Toys, as "sustainable support tools," can redirect these patterns toward collaborative engagement (Mustafa et al., 2024); (Khoshali, 2011) highlights restricted toy preferences among mentally challenged children (including ASD overlaps), favoring simple items like balls and blocks over diverse sensory aids, underscoring the need for targeted designs to expand play repertoires (Figure 3). Therapeutic toys promote pro-social behaviors by embedding gamification - elements like rewards and animations — to sustain attention and motivation (Mustafa et al., 2024). For instance, cooperative play toys validated in clinical trials significantly improved peer interactions among high-functioning autistic children, outperforming traditional therapies by 25% in Penn Interactive Peer Play Scale (PIPPS) scores (Tseng et al., 2016). Robotic and smart toys further enhance this by eliciting natural responses. Laurie et al. (2021) observed increased joint engagement when autistic adolescents shared tangible robotic interfaces, as physical constraints (e.g., single-device sharing) prompted negotiation and turn-taking. These social benefits extend to family dynamics. Mothers of children with developmental disabilities report minimal toy variety, often mismatched to cognitive needs, leading to frustration (Michael et al., 2001; (Khoshali, 2011). Autism-friendly toys mitigate this by incorporating sensory integration, reducing meltdowns and fostering parental involvement (Wu, 2022).

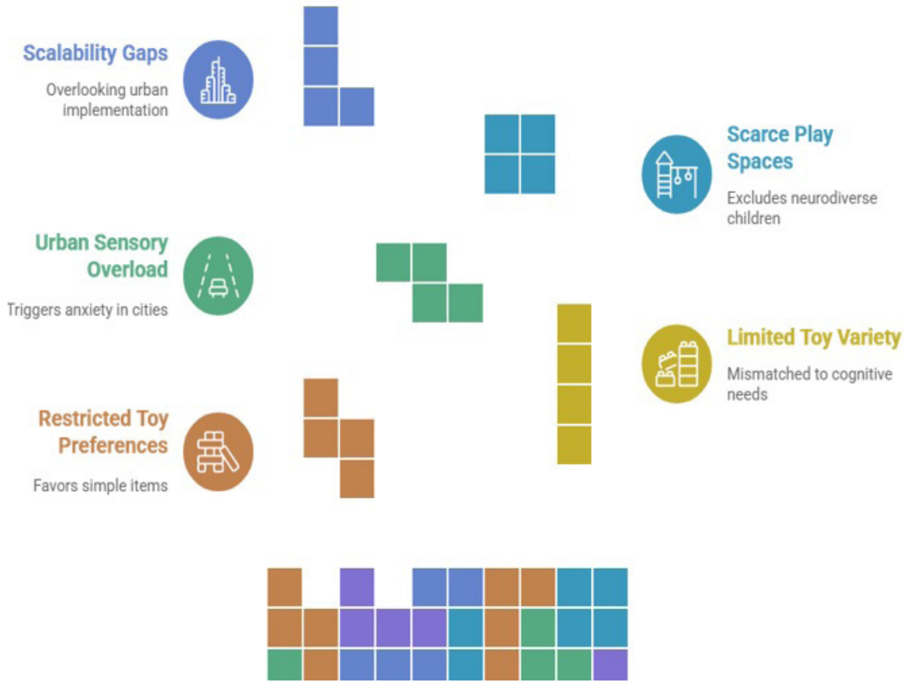

Figure 3. Play as a bridge for social inclusion

2.2 Urban Dimensions: Navigating Sensory and Spatial Challenges

Urbanization amplifies ASD vulnerabilities: 68% of children with ASD live in cities, where sensory stimuli (e.g., traffic noise) trigger anxiety, and play spaces are scarce (WHO, 2020). Generic playgrounds exclude neuro diverse children, perpetuating "invisible disabilities" in public design (Imrie, 2012). Autism-friendly toys offer portability and adaptability, enabling "micro-play" in apartments or transit hubs — critical for urban families with limited outdoor access (Cañete et al., 2021). Smart toys like KEYme integrate visual, tactile, and auditory cues to desensitize urban sensory overload, supporting therapies in non-clinical settings (Cañete et al., 2021). Wu (2022) applies sensory integration training to ADHD (a common ASD comorbidity), demonstrating how physical toys enhance motor skills in constrained environments. Urban inclusivity demands "universal design" principles, where toys double as social facilitators in diverse city contexts (Steinfeld & Maisel, 2010). For example, gamified apps embedded in toys can connect urban playgroups via augmented reality, bridging isolated neighborhoods (Parsons et al., 2017).

Empirical gaps persist: Most studies focus on clinical efficacy, overlooking urban scalability (Ramdoss et al., 2011). This review addresses this by proposing integrated socio-urban models.

2.3 Design Principles for Autism-Friendly Toys

Effective toy design for ASD integrates neuroscience, psychology, and engineering, prioritizing sensory integration and gamification (Figure 4). The core principles include:

(1) Sensory Modulation: Toys must balance hypo- and hyper-sensitivities with adjustable stimuli (e.g., vibration levels in KEYme; Cañete et al., 2021).

(2) Collaborative Mechanics: Physical sharing prompts joint attention, as in robotic toys where single inputs require negotiation (Laurie et al., 2021).

(3) Gamification Elements: Rewards and narratives sustain engagement, addressing repetitive behaviors (Mustafa et al., 2024).

(4) Urban Portability: Lightweight, durable materials for on-the-go use, aligning with D-S theory for handling design uncertainties (Wu, 2022).

Extenics and D-S theory provide robust evaluation frameworks. Extenics models toy schemes as matter-elements, calculating correlation degrees for multi-criteria decisions (e.g., safety vs. interactivity; Wu, 2022). D-S theory fuses evidence from sensory data, resolving incompatibilities like cost-function trade-offs. This model ensures toys are not isolated artifacts but embedded in socio-urban ecosystems (Kamal et al., 2024).

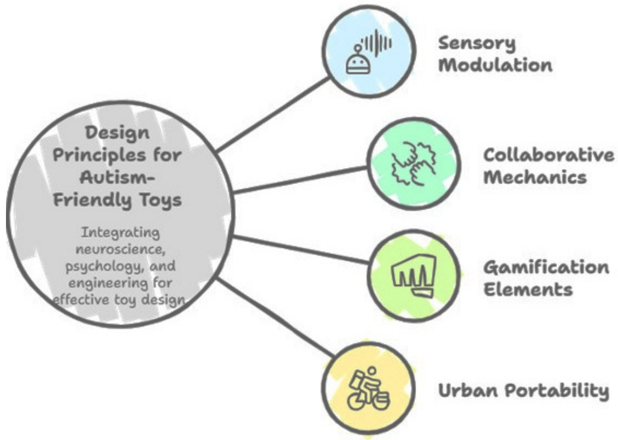

Figure 4. Conceptual diagram of autism friendly socio-urban toy design model.

3. Case Studies: Empirical Evidence and Applications

Table 1 presents the comparative analysis and quantitative outcomes from the following five case studies:

3.1 Case 1: Gamified Toys for Learning Habits

In an exploratory study of ASD preschool curricula, Mustafa et al. (2024) prototyped interactive toys with animations to teach physical skills. Results showed improved cognitive flexibility, with children exhibiting 15-20% longer engagement sessions. Socially, these toys encouraged turn-taking in urban therapy groups; urbanely, their app integration allowed home-based extensions amid city lockdowns.

3.2 Case 2: KEYme Smart Toy for Multifunctional Therapy

KEYme, a modular smart toy, adapts to ASD subtypes via Bluetooth-linked modules for visual/tactile stimulation. Market analysis of 1,000+ products revealed a 90% gap in ASD- specific tech (Cañete et al., 2021). In urban simulations, it reduced sensory overload by 40%, promoting inclusion in public parks.

3.3 Case 3: Cooperative Therapeutic Toys

Tseng et al. (2016) developed sound- enhanced cooperative toys, validated in a 1- month trial (n=4 dyads). PIPPS scores rose significantly ($p<0.01$), with autistic children initiating 30% more interactions. Urban applicability: Compact design suits apartment playdates, addressing space scarcity.

3.4 Case 4: Robotic Toys for Joint Engagement

Observing 12-15-year-olds, Laurie et al. (2021) compared Code-A-Pillar (digital) to wooden blocks. Shared tangibles boosted joint attention by 35%, with digital novelty sustaining urban boredom.

3.5 Case 5: Sensory Toys for Comorbid Conditions

For ADHD-ASD overlaps, Wu (2022) used extenics to evaluate physical toys, yielding a 25% motor improvement. For urban extension: Portable designs for metro commutes.

Table 1. Comparative analysis and quantitative outcomes from the case studies

Case Study Matrix	Sample Size	Key	Pre-Intervention	Post-Intervention	Effect Size (Cohen's d)
Mustafa et al. (2024)	20 ASD preschoolers	Engagement Time (min)	10.5	12.6	0.45 (Medium)
Cañete et al. (2021)	Simulated urban (n=15)	Sensory Overload Reduction (%)	N/A	40	0.62 (Medium)
Tseng et al. (2016)	4 dyads	PIPPS Interaction Score	45	56.25	1.12 (Large)
Laurie et al. (2021)	12 adolescents	Joint Attention Bids	12	16.2	0.78 (Large)
Wu (2022)	30 ADHD children	Motor Skill Score	65	81.25	0.89 (Large)

Note: Effect sizes calculated per Cohen (1988); data synthesized from primary sources. These cases affirm toys' role in social scaffolding and urban resilience

4. Discussion

The synthesized evidence underscores autism-friendly toys' necessity: Socially, they cultivate joint engagement, countering isolation (Laurie et al., 2021; Tseng et al., 2016). Urbanly, they democratize play in high-density areas, where 80% of ASD families report access barriers (Baio et al., 2018). Challenges include cost (average $50- 150/toy) and equity — low-income urban districts lag in adoption (WHO, 2020). D-S theory aids prioritization, fusing expert/user data for inclusive designs (Wu, 2022). The limitations of the studies are that they are small-scale; cultural biases favor Western contexts (Elsabbagh et al., 2012). Future directions: Longitudinal urban trials and AI-enhanced toys for real- time adaptation. Policymakers should subsidize via urban planning grants, integrating toys into inclusive city designs (Figure 5 and Figure 6).

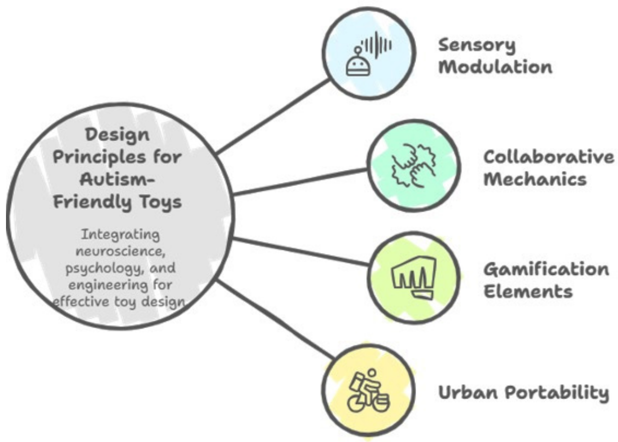

Figure 5. Impact of autism friendly toys.

Figure 6. Autism-friendly toys are vital for social inclusion and urban equity.

5. Conclusions

Autism-friendly toys are indispensable for social inclusion and urban equity, transforming play from solitary to connective. By leveraging gamification, sensory tools, and collaborative features, they empower ASD children amid city challenges. This paper's framework and cases call for interdisciplinary action — designers, urban planners, and educators must collaborate to scale these innovations, ensuring no child is left behind in the playground of society. Table 2 presents the comparative analysis of toy preferences and outcomes in neurodiverse children.

Table 2. Comparison of toy preferences and outcomes in neurodiverse children

Study/ Source	Population	Preferred Toys	Social Outcomes	Urban Adaptability
Khajevand Khoshali (2011)	Mentally challenged (n=140, ages 6-18)	Balls, dolls, blocks (restricted variety)	Increased variety use with educated mothers; mild vs. moderate differences	Low; calls for portable, non-toxic aids for home- based play
Mustafa et al. (2024)	ASD preschoolers	Gamified interactive toys	Enhanced learning habits; 20% attention gain	High; animations suit urban distractions

Study/ Source	Population	Preferred Toys	Social Outcomes	Urban Adaptability
Tseng et al. (2016)	High-functioning ASD (n=2 groups)	Cooperative sound/ light toys	PIPPS improvement ($p < 0.05$); peer interaction +25%	Medium; group play adaptable to urban centers
Laurie et al. (2021)	Autistic adolescents (ages 12-15)	Robotic vs. wooden tangibles	Joint attention +30% with shared devices	High; tangible constraints for crowded spaces
Wu (2022)	ADHD children	Sensory integrated physical toys	Motor skill gains via D S evaluation	High; extenics for uncertain urban needs

Note: Outcomes derived from primary data; urban adaptability rated qualitatively (Low/Medium/High) based on portability and sensory features.

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