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Article

Exploring the transition from domicentric to heterocentric environments: Children's cognitive thresholds in urban spaces

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ABSTRACT

Using the cognitive mapping method, this research examines the spatial and cognitive factors shaping children's perceptions of the journey from home to school and interprets the results from the perspective of the architectural discipline. Conducted with 52 first-grade students (22 girls, 30 boys) from a primary school in Istanbul, it analyzes children's drawings through mapping typologies and Kevin Lynch's five elements-paths, edges, districts, nodes and landmarks (1960). Drawing on Piaget's theory of cognitive development (1954) and Hart & Moore's concept of spatial thresholds (1973), the method integrates qualitative interpretation of drawings with quantitative Pearson's chi-square testing, situating the study within broader research on mobility, gender, and environmental perception. Three mapping typologies were identified: scattered, linked, and patterned. Most children produced scattered maps, suggesting fragmented spatial understanding, whereas those living closer to school included more paths in their drawings, highlighting the role of proximity in spatial perception. Some gender-related patterns were observed within this sample (n=52) for example, relatively more structured maps among some girls and more scattered layouts among some boys. Given the small sample and the limited power of Pearson's chi-square tests with sparse categories, these should be treated as exploratory, sample-specific tendencies rather than generalizable effects. Beyond these statistical tendencies, the analysis of developmental thresholds revealed that, most children demonstrated emergent heterocentric spatial perception features at 6–7 years (within the domicentric stage, early signs only), corresponding to meso-environments, with fewer displaying egocentric (micro-environment) or Euclidean (macro-environment) perspectives. Given that the sample is 6–7 years old, heterocentric indicators are interpreted as early/emergent features rather than full stage attainment. These results highlight the transition from domicentric to heterocentric spatial understanding. Ultimately, the study provides insights into the interplay of spatial cognition, gender, and proximity in shaping children's maps, offering practical implications for designing child-oriented urban and architectural environments that foster spatial understanding and cognitive development.

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INTRODUCTION

The home and its surrounding environment contribute to human emotional and psychological well-being, serving as both shelter and foundation for early development. The home space represents a critical area for children in the sensory-motor stage, the first stage of Piaget's theory of cognitive development (1954). Children begin to understand and interact with their environment at this stage. This progression and transition highlights the importance of an interdisciplinary approach that integrates environmental psychology, sociology, pedagogy, and architecture, as architecture plays a key role in meeting children's evolving needs and ensuring their seamless integration with their environment. Since the 1960s, both architecture and psychology have examined how spatial organization and environmental design affect children's cognitive and social development. Both disciplines provide complementary perspectives on the interaction between design and human development, revealing how physical environments influence cognitive and social processes, particularly in childhood development. Foundational sociological concepts such as Cooley's (1909) distinction between primary and secondary environments and Tönnies's (1887) notions of *Gemeinschaft* and *Gesellschaft* provide the groundwork for understanding human-environment relations. Building on these sociological foundations, environmental psychology further explains how spatial organization influences behavior. Subsequent theories - including Hall's (1966) and Altman's (1975) explorations of personal space, Bronfenbrenner's (1979) ecological systems framework, and Oldenburg's (1989) theory of the "third place"- further elucidate how spatial contexts shape social interaction, behavior, and a sense of belonging. These foundational theories also implicitly emphasize the importance of designing environments that nurture children's cognitive and social development.

The home, as the primary environment, forms the foundation of children's earliest social experiences and identity development. Within Piaget's (1954) cognitive development framework, a secure environment supports emotional attachment and the emergence of self-awareness. Expanding on this view, Hart and Moore (1973) conceptualized spatial cognition through four developmental thresholds: egocentric (0–3), domicentric (3–8), heterocentric (8–12), and Euclidean (12+). These stages illustrate the progression from immediate, home-centered experiences toward broader and more abstract spatial systems. In this study, Piaget's cognitive stages (pre-operational 2–7; Concrete operational 7–11; Formal operational 11+) and Hart & Moore's spatial stages are treated as distinct but complementary frameworks. The participant group (ages 6–7) corresponds primarily to the late pre-operational/early Concrete and domicentric stages; any heterocentric elements observed are considered early or emergent rather than fully realized characteristics.

As children gradually move beyond the familiarity of the home environment, the school emerges as the first social extension of their spatial world, marking the beginning of their interaction with structured public spaces. Schools, as secondary settings, represent children's first experiences with broader social structures and norms. Tönnies' (1887) conceptualization of the transition from natural will (home space) to rational will (school space) emphasizes the critical role of this process in children's cognitive and social development and their interactions with public spaces. Piaget's model of cognitive stages provides the foundation for understanding how children perceive and represent their environments.

Lynch (1960) introduced the basic concepts of paths, edges, nodes, districts, and landmarks in environmental orientation, which form the basis of spatial mapping.

Another contribution about the subject, Appleyard (1970) categorized children's maps into scattered, linked, and patterned types., while Ladd (1970) classified children's neighborhood maps as graphic, schematic, connected, and nodal maps. Hart and Moore (1973) described spatial development through egocentric, domicentric, heterocentric, and Euclidean stages.

Later research (İmamoğlu, 1979; Herman, 1980; Doherty & Pellegrino, 1985) emphasized age, socioeconomic context, and environmental exploration as key influences on spatial awareness.

Since the 2000s, research has increasingly explored how children's spatial cognition interacts with environmental, social, and individual variables such as mobility, gender, socioeconomic background, and environmental legibility. These studies collectively emphasize that cognitive mapping is shaped by freedom of movement, family support, and neighborhood characteristics, highlighting the dynamic relationship between spatial experience and development (see also Ünlü & Çakır, 2002; Risotto & Tonucci, 2002; Yavuzer, 2003; Öztürk, 2009; Çanakçıoğlu, 2011; Türel & Gür, 2019; Burkut & Köseoğlu, 2022; Coşkun & Kaymaz, 2022).

Cross-cultural and contextual perspectives have further enriched this field, revealing how social belonging, cultural identity, and environmental familiarity influence children's representations of space (see also Thommen et al., 2010; Mohsenin, 2011; Koç, 2012; Park & Kim, 2012; Damayanti & Kossak, 2016; Gillespie, 2010; Öztürk, 2015; Den Besten, 2017; Baksi, 2018; Rzhanova et al., 2020; Seyhan, 2021; Lowrie et al., 2022).

Building upon these cumulative findings, this study examines the cognitive mapping abilities of first-grade primary school students in Istanbul during their daily journeys from home to school and how these abilities influence spatial

thinking thresholds. The research draws on the cognitive mapping typologies of Appleyard (1970), Lynch (1960), and Downs & Stea (1973), as well as Piaget's (1954) theory of cognitive development. The environments on the routes that children regularly use between home and school are analyzed, from housing to creating child-centered spaces and even implementing urban-level planning concepts.

Within the continuum of primary (home) and secondary (school) environments, this study investigates how these domains are perceived and represented in children's spatial cognition. The question thus arises as to how these settings manifest themselves in the child's perceptual world. Building on Hart and Moore's (1973) spatial organization stages, this study investigates how the boundaries of primary and secondary settings are interpreted within egocentric, domicentric, and heterocentric stages, and how these perceptions relate to Piaget's (1954) age-based developmental stages.Within this framework, variables such as gender, mode of transportation, and school proximity are examined for their influence on children's spatial perception. Supported by Tönnies' (1887) distinction between Gemeinschaft (community) and Gesellschaft (society), the study explores how spatial design can facilitate children's transitions between home and school environments. This interdisciplinary approach aims to contribute to the development of inclusive and supportive spatial models that align with children's cognitive and social growth.

By addressing these relationships empirically, the study not only clarifies children's perceptual thresholds but also contextualizes them within the broader framework of environmental design. Analyzing children's heterocentric spatial perceptions might offers a foundation for understanding the relationship between developmental psychology and architectural design. Despite extensive research on children's cognitive development and spatial mapping, further work is needed to examine diverse cultural and urban contexts and to translate findings into child-centered design strategies.

While previous studies have explored children's transitions from domicentric (home-centered) to heterocentric (urban and social) spaces, few have connected these shifts to architectural or urban design practice. Addressing these gaps, this study aims to deepen the understanding of the spatial and environmental factors that shape children's cognitive development. Integrating Tönnies's (1887) Gemeinschaft–Gesellschaft framework, the study examines how spatial design can support children's transitions between community (home) and society (school).

THEORY

The 6-7-year-old age group examined in this study is positioned at the intersection of Piaget's pre-operational and concrete operational stages and on the threshold of Hart & Moore's domicentric and heterocentric stages. Therefore, this group bears traces of both home-centered perceptions and early urban environmental sensitivities.

This framework is based on Piaget's (1954) theory of cognitive development and Hart and Moore's (1973) stages of spatial perception. According to Piaget, children interact with their environment through knowledge and experience and progress through four developmental stages. Children's cognitive development is influenced by biological, cultural, and experiential factors; adaptation processes occur through assimilation and adaptation (Ormrod, 2013; Wadsworth, 2015). The age categories used in this study are summarized in the Table 1 below:

Standardization Note: Piaget and Hart and Moore are distinct frameworks and are not treated as equivalent. The 6–7 year old group examined in this study is positioned at the intersection of Preoperational/Concrete (Piaget) and on the threshold of Domicentric (Hart–Moore), with emergent heterocentric features possible but not assumed as full stage attainment.

For consistency, scale references are standardized as follows: Egocentric & Domicentric=micro; Heterocentric=meso; Euclidean=macro.

Figure 1 illustrates the four spatial stages of environmental cognition- egocentric (0-3 years), domicentric (3-8 years), heterocentric (8-12 years), and Euclidean (12+ years) as conceptualized by Hart and Moore (1973) building on Piaget's developmental framework.

Building on previous section, the transition from domicentric to heterocentric perception, reflecting children's early movement from home-centered to city-oriented spatial understanding. This shift also mirrors a broader transition from community to society.

Table 1. Cognitive development and spatial perception stages according to Piaget (1954) and Hart & Moore (1973)

Hart and Moore's Stages	Piaget's Cognitive Stages	Key Spatial and Cognitive Traits
Egocentric Space (0-3)	Sensorimotor (0-2)	Immediate bodily interaction; no external references.
Domicentric Space (3-8)	Preoperational (2-7)	Home-centered awareness is characterized by early symbolic thought.
Heterocentric Space (8-12)	Concrete Operational (7-11)	This involves interaction with larger environments and logical reasoning.
Euclidean Space (12-14)	Formal Operational (12+)	Abstract reasoning; structured and metric understanding.

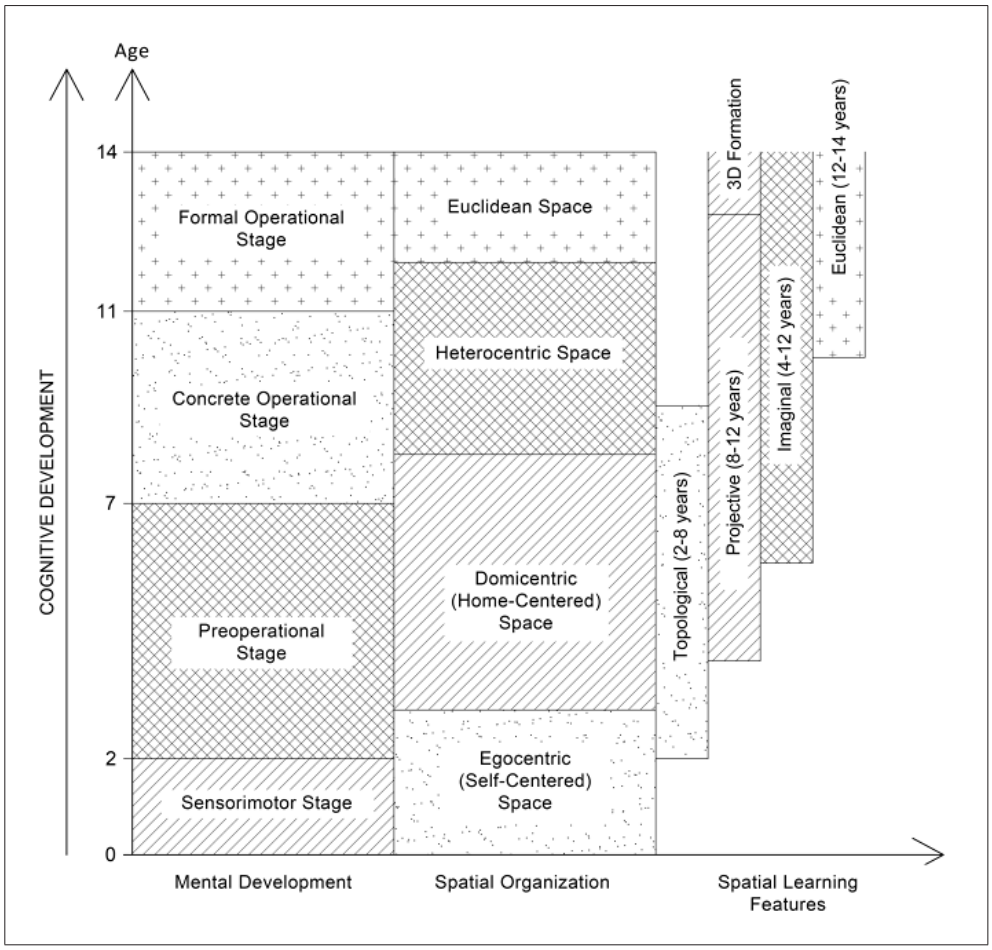

Figure 1. Mental and spatial relationship in the child's perception (Ünlü & Çakır, 2002; adapted from Hart & Moore, 1973).

The literature highlights age, gender, socioeconomic status, and transportation in shaping spatial perception. Studies show that walking enhances spatial awareness (Herman, 1980), mobility fosters better mapping skills (Risotto & Tonucci, 2002), and sociocultural context influences environmental cognition (Gillespie, 2010; Nikitine-Den Besten, 2010). Research also indicates gender differences in spatial tasks (Ünlü & Çakır, 2002; Rzhanova et al., 2020) and links socioeconomic status to differing preferences and cognitive responses to indoor vs. outdoor environments (Baksi, 2018; Öztürk, 2009, 2015).

Within these contextual influences, cognitive maps serve as, cognitive maps serve as key indicators of children's spatial understanding. Appleyard (1970) categorized them as scattered, linked, or patterned. Empirical studies (e.g., Park & Kim, 2012) show sequential maps dominate children's representations, with increased complexity and environmental awareness associated with age and mobility. This study adopts cognitive mapping to explore how children perceive urban settings and whether digitalization is shifting developmental thresholds toward earlier ages.

METHOD

Before presenting the methods, the research design is outlined as a qualitative–quantitative mixed strategy, linking theoretical inquiry with an empirical case study to ensure consistency between data collection, analysis, and the study's overall aims.

Research Design and Methods

This research begins by establishing a theoretical background and then developing a hypothesis. Building on this foundation, preparations for cognitive mapping are conducted, with a selected case study as the basis for data collection. The data is then analyzed, and the results are evaluated to test the initial hypothesis. Each stage is carefully interconnected, facilitating a systematic examination of the theory from its conceptual groundwork to the analysis of findings; see Figure 2.

The overall research process is structured as illustrated below Figure 3.

Based on this methodological structure, the case study has identified significant correlations around the following questions:

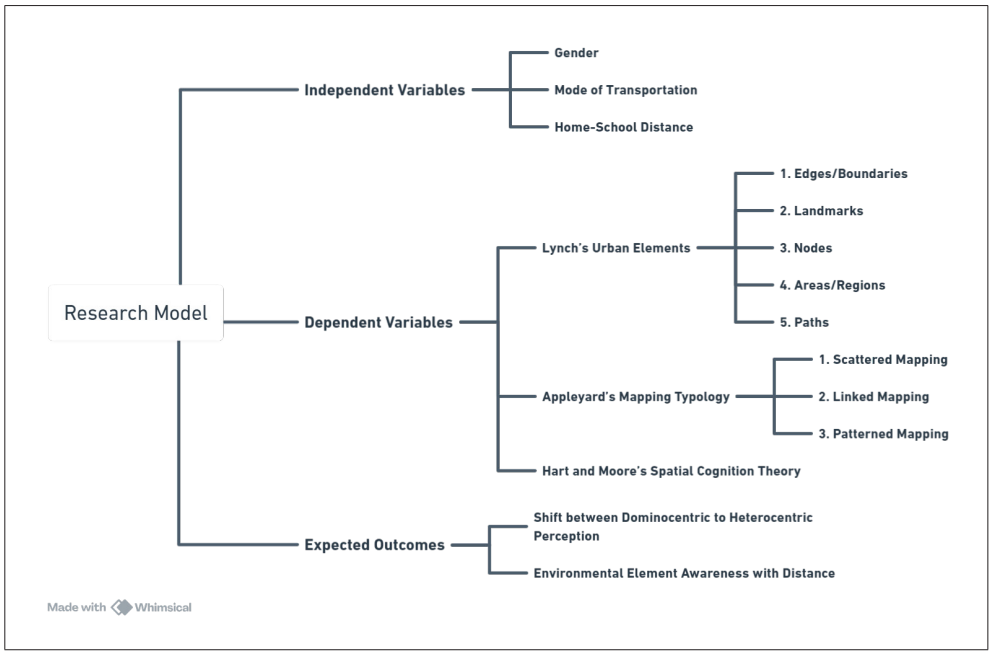

Figure 2. Methodological framework of the study.

- What are the cognitive and spatial boundaries of environmental and imaginative elements perceived by children at home or on their way to school and in their surroundings?
- According to Piaget (1954), what types of environmental image parameters do children present during the late pre-operational/early concrete period (6–7 years), and how do these relate to Hart and Moore's domicentric stage (3–8 years) with emergent heterocentric features?
- How does the domicentric stage (3–8, Hart and Moore) shape cognitive learning or understanding of spatial boundaries at ages 6–7 years, and which emergent heterocentric features appear?
- What are the effects of transportation types and itineraries between home and school on children's perceptions of environmental image parameters?

All drawings are coded and organized in three steps: (1) Each drawing is examined for the presence or absence of Lynch's five elements and Appleyard's mapping typologies. (2) Identified elements are categorized (e.g., type of boundary, type of landmark) and entered into structured coding sheets. (3) Scores and categorical values are transferred into a dataset for statistical analysis. This systematic procedure ensured consistency and comparability across all 52 participants.

Coding is performed by the first author. Inter-coder agreement reached 87%, which is considered satisfactory for qualitative-quantitative mixed coding.

All coding data are first compiled in a Microsoft Excel file. This file included both independent variables (e.g., gender, transportation type, parental education, screen time, distance) and dependent variables (e.g., Lynch's elements,

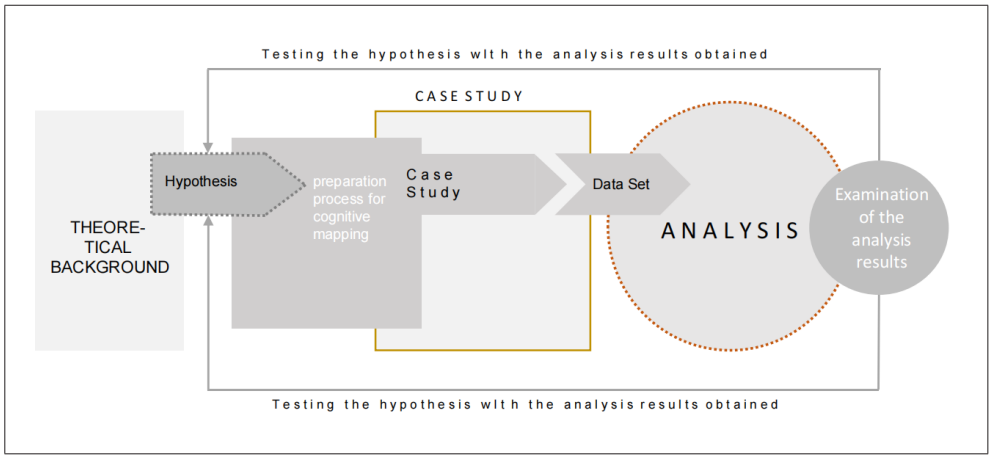

Figure 3. Research diagram.

Appleyard's typologies, Hart and Moore's thresholds). The finalized dataset was then exported into an SPSS file, forming the basis for statistical analyses.

Variables and Analysis

Expected frequencies met chi-square assumptions (>80% of cells >5); therefore, Pearson's chi-square was applied, and

Table 2. Independent and dependent variables for Pearson's chi-square analysis

Variable Type	Variable Name	Description
Independent Variables	Gender	Categorical variable representing the student's gender (girl/boy).
	Type of Transportation	Mode of transportation used between home and school (e.g., walking, private vehicle, school bus).
	Home–School Distance (km)	Measured distance (in kilometers) between the child's home and school.
	Parental Education Level	Educational attainment level of parents, categorized for analysis.
	Screen Time	Average daily screen exposure of the child, used as a cognitive engagement indicator.
Dependent Variables (Based on Lynch's Urban Image Elements)	Boundaries (Presence/Absence)	Indicates the presence of spatial boundaries such as ground lines, fences, roofs in children's drawings.
	Boundaries (Categorical)	Categorical classification of drawn boundary elements (e.g., enclosed gardens, property lines).
	Landmarks (Presence/Absence)	Identifies whether children represented distinctive landmarks such as home, school, sun.
	Landmarks (Categorical)	Types of landmarks drawn (e.g., natural, architectural, symbolic).
	Nodes (Presence/Absence)	Indicates the presence of spatial nodes such as intersections or gathering points.
	Nodes (Categorical)	Classification of node types (e.g., junctions, squares, courtyards).
	Paths/Lines (Presence/Absence)	Determines whether sequential or connecting paths are drawn between elements.
	Paths/Lines (Categorical)	Types of drawn paths (e.g., straight route, fragmented lines, circular paths).
	Regions/Districts (Presence/Absence)	Identifies spatial zoning or grouping, such as green areas, parking, building clusters.
	Regions/Districts (Categorical)	Categorization of districts based on function (e.g., residential, educational, recreational).
Theoretical Constructs	Mapping Typology (Appleyard)	Classification of children's drawings into mapping types Scattered / Linked / Patterned.
	Cognitive Development Threshold (Hart and Moore)	Developmental classification based on spatial complexity and organizational hierarchy in drawings Egocentric / Domicentric / Heterocentric / Euclidean.

Figure 4. Case study area (Google Earth, 2025).

Fisher's exact test was not required. Descriptive frequency/percentage tables were used to cross-check robustness (see Table 2).

This approach allowed for a detailed analysis of how spatial elements in children's drawings relate to cognitive mapping processes. The dependent variables in this study encompass a range of spatial and cognitive elements, assessed for their presence or absence and categorized based on mean scores. These include edges and landmarks (such as home or school representations), areas or districts, topological nodes (like rooms or domains), and paths or lines, all recorded in tally sheets. Additionally, the study evaluates the type of mapping used and a cognitive development threshold, both categorized similarly to assess developmental insights. This approach allows for a detailed analysis of how these spatial elements relate to cognitive mapping processes.

Case Study Description

In line with this methodological structure, the study focuses on a specific sample group—primary school children residing in the metropolitan city of Istanbul.The research aims to shed light on the environmental factors shaping children's perceptual world. It aims to examine how various environmental and imaginal influences impact the cognitive and perceptual development of 6-7-year-old children, particularly within the context of their daily experiences between home and school; see Figure 4.

The research was conducted at a primary school in Kadıköy, Istanbul with a sample of 52 first-grade students, including 22 girls and 30 boys.

Data Collection Procedure

Children were asked to draw their homes and schools in two stages: first using lead pencils and then blue pencils. This method enabled the analysis of memory processes in early and later stages. Drawings were completed under the supervision of the class teacher and the researcher over two days.

Parents provided sociodemographic data regarding gender, mode of transportation, screen time, home–school distance, and parental education. Distances were categorized into three groups: 0–4 km, 5–7 km, and 8–40 km.

Analysis Framework

Children's drawings are initially examined through Lynch's (1960) spatial elements (paths, edges, districts, nodes and landmarks) and Appleyard's (1970) typologies (scattered/linked/patterned). A standardized framework for scale mapping and typology is adopted to ensure consistency across interpretations. Micro-scale corresponds to egocentric and domicentric stages, meso-scale to heterocentric, and macro-scale to Euclidean. Non-framework terms (e.g., allocentric) are avoided, and Appleyard's triad is uniformly retained as scattered/linked/patterned.

This standardization ensured that the analysis remained theoretically grounded while guaranteeing comparability across the different spatial representations produced by the children.

Illustrative Case

To exemplify the process, Table 3 below presents the data coding for a 6-year-old girl (Participant 11) who drew her home-to-school route; see Figure 5.

Table 3 shows the variables and their values used in the coding process of Participant 11's drawing representing her journey from home to school.

Participant 11, A Girl's Route Mapping Interpretation

The drawing analysis in Figure 6 represents the spatial journey of a 6-year-old child (Participant No: 11) between home and school. The child illustrates the daily routine using key visual elements, notably placing a ground line as a boundary separating the home, school bus, and school buildings. Home and school are represented as landmarks, while the route connecting them forms a sequential pattern. The representation indicates a "linked type" mapping typology, reflecting a heterocentric spatial perception.

Landmarks Home and School

The child represents "home" and "school" as clear landmarks (Count: 2), indicating the early recognition of fixed reference points within their environment. A path connecting these landmarks reflects a linked-sequential mapping typology (Appleyard Typology), where spatial awareness emerges through direct experiential references rather than abstract reasoning. This aligns with Hart and Moore's heterocentric stage of spatial perception (1973). These stable points also signal developing spatial permanence, associated with late memory.

Path and Route

The presence of boundaries (fences and roads, Count: 2) reinforces the concept of spatial partitioning. However, understanding of nodes remains limited, with only one vaguely suggested by a crowd in front of the school. By linking home and school on the same plane, the child reflects Appleyard's "linked-sequential mapping" typology.

Edges (fence, road, home–school boundary) illustrate this ability to divide space—an indicator of late-memory abstraction.

Node: The group of people near the school functions as a nascent nodal point, showing emerging awareness of complex spatial functionality (late memory).

The drawing omits complex relational elements such as road networks and functional intersections, suggesting that relational spatial logic is still forming.

Natural features (Cloud, butterfly, bird, tree); these are simple environmental elements directly observed by the

Figure 5. Home-to-school drawing of participant 11.

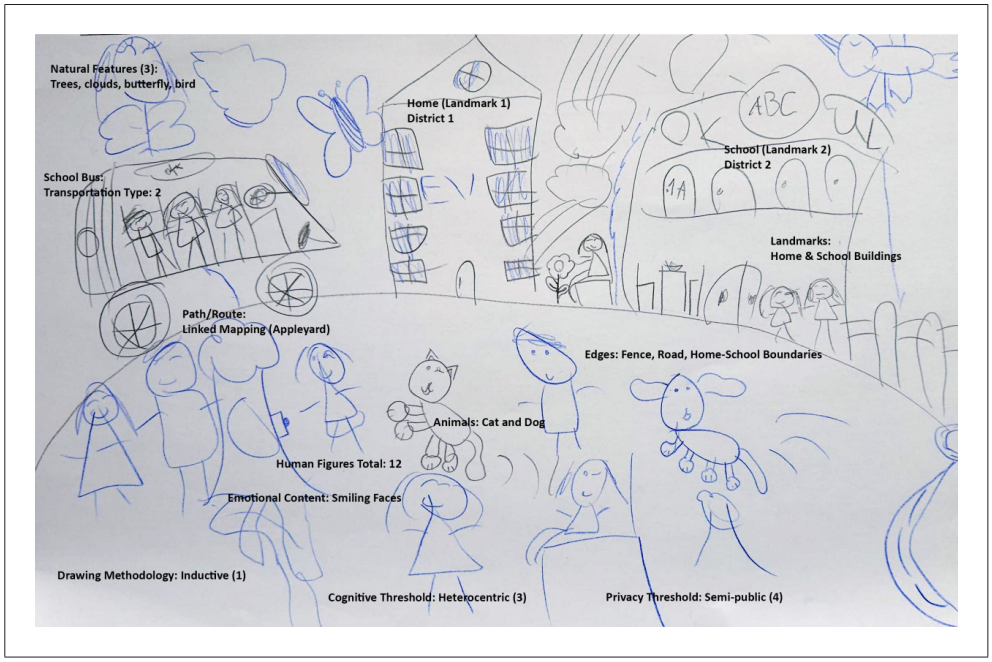

Figure 6. Interpretation of participant 11, a girl's route map.

child, reflecting early memory based on visibility. Animals (cat and dog); familiar and concrete figures from everyday life, belonging to early memory.

Human figures (Approx. 12 in total); friends, family, or groups of people are represented based on direct experience rather than abstraction, thus linked to early memory.

School bus (Transportation type: 2); a routine and directly observed feature of daily life, categorized as early memory.

Emotional content (Smiling faces); simple emotional markers derived from observation, indicating early memory.

Collectively, these details show emerging social awareness while remaining concrete and observational. The drawing methodology is inductive (child-centered, spontaneous structure). The privacy threshold is categorized as semi-public (Category: 3), implying an intermediate sense of accessibility and openness. Overall, the drawing illus-

Table 3. Data coding for Participant 11's home-to-school route

Variable	Value
Participant No	11
Gender	1[1]
Type of Transportation	2[2]
Daily Screen Time (Hours)	2[3]
Screen Time Category	2[3]
Out-of-Home Activity Frequency	2[4]
Out-of-Home Activity Category	2[4]
Home–School Distance (km)	1[5]
Home–School Distance Category	1[5]
Home–School Travel Time (min)	12
Home–School Travel Time Category	2[6]
Neighborhood Type	2[7]
Parental Education Level	3[8]
Lynch's Elements – Edges	Present[10]; Total Category: 2[9]
Lynch's Elements – Landmarks	Present[10]; Total Count: 2; Category: 2[9]
Lynch's Elements – Districts	Present[10]; Total Count: 2; Category: 2[9]
Lynch's Elements – Nodes	Present[10]; Total Count: 1
Lynch's Elements – Paths/Lines	Present[10]; Total Count: 2; Category: 2[9]
Spatial Representation Typology (Appleyard)	2[11]
Virtual World Integration	2[12]
Nature Attributes	Present[10]; Total Count: 8; Category: 3[13]
Emotional Attributes	Present[10]; Total Count: 4; Category: 3[13]
Human Attributes	Present[10]; Total Count: 12; Category: 3[13]
Drawing Methodology	1[14]
Cognitive Development Threshold (Hart and Moore)	3[15]
Privacy Threshold	3[16]

a. Gender: 1=Girl; 2=Boy; b. Type of Transportation: 1=Walking; 2=Vehicle Travel; c. Screen Time: 1=0–2 hours; 2=3–4 hours; 3=5–6 hours; d. Out-of-Home Activity Frequency: 1=0–2 hours; 2=3–4 hours; 3=5–6 hours; e. Home–School Distance: 1=0–4 km; 2=5–7 km; 3=8–40 km; f. Home–School Travel Time: 1=0–12 min; 2=13–24 min; 3=25–50 min; g. Neighborhood Type: 1=Urban Center; 2=Planned Urban Area; 3=Suburban Area; h. Parental Education: 1=Primary; 2=Secondary; 3=Undergraduate; 4=Postgraduate; i. Lynch's Elements Categories: 1=Basic; 2=Moderate; 3=Complex; j. Presence/Absence: 0=Absent; 1=Present; k. Appleyard Typologies: 1=Scattered; 2=Linked; 3=Patterned; l. Virtual World Integration: 1=Absent; 2=Present; m. Attributes (Nature, Emotional, Human): 1=Low; 2=Medium; 3=High; n. Drawing Methodology: 1=Inductive; 2=Deductive; o. Cognitive Development Thresholds (Hart and Moore): 1=Egocentric; 2=Domicentric; 3=Heterocentric; 4=Euclidean; p. Privacy Thresholds: 1=Private; 2=Semi-private; 3=Semi-public; 4=Public.

trates an observational and fragmented spatial representation, where immediate experience shapes the environmental image.

Early-memory elements dominate (nature, animals, vehicles, people), while late-memory elements appear in the home–school link, path, boundaries, and node, indicating emerging relational abstraction. These findings support the gradual progression of spatial understanding through cognitive growth and environmental interaction.

Participant 36, A Boy's Route Mapping Interpretation

The drawing in Figure 7 represents the spatial perception of a child who depicts his environment through a catalog-like arrangement of distinct elements. The composition follows

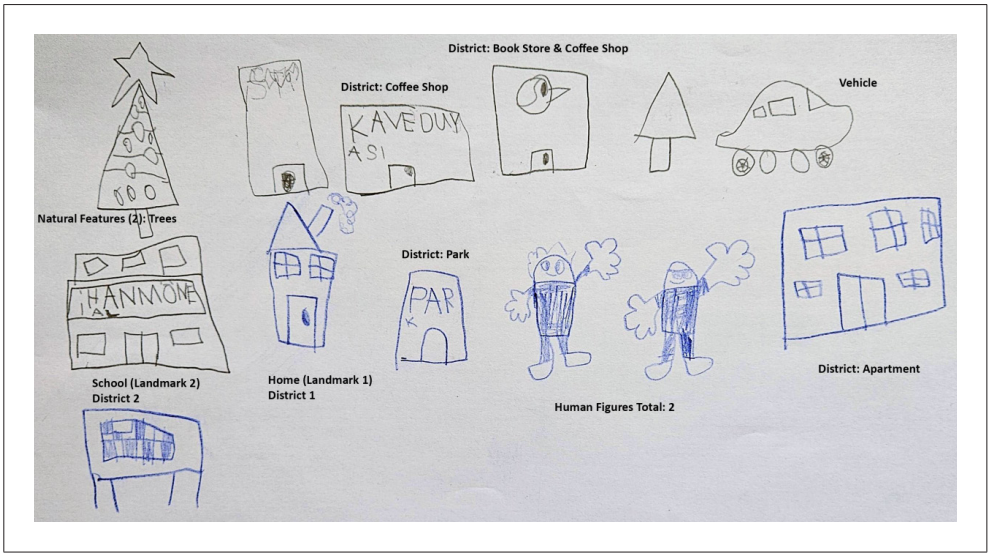

Figure 7. Interpretation of participant 36, a boy's route map.

a scattered mapping typology (Appleyard 1970), with multiple landmarks placed independently, without continuous routes or a connecting ground line. This scattered structure indicates an early stage of heterocentric perception, where places are cognitively recognized and named but not yet integrated into a relational system.

The child includes a series of symbolic buildings, a "park" gate, a car, trees, and two human figures. The use of labels and names on buildings emphasize recognition and memory coding rather than sequential representation. The absence of a defined path suggests that relational spatial abstraction is still developing.

Landmarks and Emotional Markers

The drawing features multiple landmarks—at least five distinct buildings, some labeled with words, and a "PARK" entrance. The symbolic use of writing demonstrates the child's effort to identify and codify specific places, reflecting permanence and advanced spatial awareness. Such labeling processes are associated with late memory.

Path and Route

No connecting path or ground line is depicted between the landmarks. The scattered typology highlights the absence of sequential mapping and emphasizes the listing of places rather than their interconnectedness. This indicates that relational spatial logic remains limited.

Edges and Nodes

The drawing omits explicit dividing elements such as roads, fences, or boundaries, showing that the concept of spatial partitioning is not yet present. The "PARK" entrance functions as a symbolic node, serving as an access or gathering point. In the absence of routes, this node remains isolated, reflecting an emerging awareness of nodal function.

Early Memory Elements

Natural features (trees, decorated tree): simple environmental symbols directly observed, categorized as early memory.

Human figures (2): large, central figures reflect social awareness but are not integrated into a wider spatial context (early memory).

Vehicle (car): drawn as an isolated object without a road network (early memory).

Late Memory Elements

Labeled buildings: writing on facades shows symbolic coding and permanence (late memory).

Park entrance: functions as a symbolic gateway and node (late memory).

Building facades (doors/windows): the regularized architectural representation suggests structural abstraction beyond simple observation (late memory).

The drawing methodology is additive and enumerative, with elements placed individually rather than relationally integrated. The privacy threshold corresponds primarily to public/semi-public domains (shops, institutions, parks), with no representation of private domestic interiors.

In this drawing, early-memory elements dominate in natural and social features, while late-memory elements appear in labeled buildings, the park gate, and structured facades, reflecting growing symbolic abstraction.

Overall, the child demonstrates the ability to recognize, name, and codify multiple landmarks but has not yet established systematic spatial connections between them. This

scattered typology and symbolic labeling together suggest a transitional heterocentric stage, where places are recognized but relational logic is only beginning to form.

Comparison of Spatial, Social, and Emotional Elements in Two Mapping Styles

Table 4 below comparatively demonstrates how the drawings of two students evolved into different cognitive mapping typologies in terms of spatial, social, and emotional components. Specifically, the female student's drawing exhibits a relational and connected structure, while the male student's drawing is more object-oriented and based on a scattered typology.

Participant 11 (girl) demonstrates a more integrated depiction of routes, landmarks, and boundaries, indicating an early heterocentric tendency in which relational spatial abstraction begins to emerge. Participant 36 (boy) primarily emphasizes naming and cataloging landmarks without showing relational connections, reflecting a symbolic, label-based memory stage. These individual patterns represent variations within the sample rather than gender-specific tendencies.

RESULTS

Pearson's chi-square tests are applied to all cross-tabulated variables using IBM SPSS Statistics 28.0. The frequency distributions within contingency tables are checked to verify adequate cell counts, and statistical significance is set at $p<0.05$. As the minimum frequency requirements are satisfied across categories, no Fisher's Exact tests are performed. These procedures ensure the robustness of the reported correlations. The analyses reveal the relationships between children's drawings and the independent variables (gender, mobility, home–school distance, and parental education), as presented in Figure 8, highlighting how these factors affect children's spatial perceptions and cognitive development.

In the analysis of children's drawings cognitive maps, the distribution of cognitive image analyses under the home-school route analysis can be explained in Figure 8 as follows:

Boundaries-Edges: The distribution shows that 98% of the examined students included boundaries in their early memory drawings, while 2% did not. These ratios indicate that students commonly reflect the concept of boundaries in their cognitive maps. According to early memory in the students' drawings, boundaries such as ground lines, sky

Table 4. Comparative Table of Cognitive Mapping Features

Category	Participant 11 (Linked Mapping), A Girl Student	Participant 36 (Scattered Mapping), A Boy Student
Landmarks (Late)	Home and School clearly depicted as fixed reference points (2 landmarks).	Multiple labeled buildings, "PARK" entrance; naming/writing shows symbolic coding.
Path/Route (Late)	Linked-sequential mapping (Appleyard Type 2); path connects home–school.	No connecting route; scattered typology, places listed individually.
Edges (Late)	Fences, road, home–school boundaries represented; spatial partitioning visible.	No edges or boundary elements; spatial partitioning absent.
Nodes (Late)	Crowd in front of school acts as an emerging node.	"Park" entrance functions as symbolic node, but isolated.
Natural Features (Early)	Clouds, butterfly, bird, tree (Count: 8).	Simple tree and decorative "Christmas tree."
Animals (Early)	Cat and dog included.	No animals.
Human Figures (Early)	~12 people; smiling faces, social awareness.	2 large figures; central placement but limited social context.
Transportation (Early)	School bus (Transportation type: 2); daily routine symbol.	Car without road; isolated object.
Emotional Content (Early)	Smiling faces → positive affect, emerging social awareness.	Absent (no clear emotional indicators).
Privacy Threshold	Semi-public (Category 3).	Public/semi-public; institutional/park spaces dominate.
Mapping Typology	Linked, relational connections emerging.	Scattered typology, catalog/enumerative layout.
Cognitive Development Thresholds	Heterocentric	Heterocentric
Drawing Methodology	Inductive	Inductive
Memory Balance	Mix of early + late	Early dominates (objects, people), with pockets of late memory (labels, symbolic coding).

boundary lines, garden fences, building roofs, and building frames are more frequently included.

Landmarks: The home environment is accepted as the first landmark and the school environment as the second landmark in the children's drawings. The distribution shows that 86% of the examined students included these landmarks in their primary early memory drawings, while 14% did not. These ratios indicate that students reflect the concept of landmarks in their cognitive maps.

Areas-Districts: The urban areas located between home and school, including home gardens, school yards, shopping areas, and parks, are examined in the drawings. This-distribution indicates that 90% of the examined students' memory drawings were present for districts, while 10% were absent. These ratios show that the students have the concept of districts and areas in their maps.

Nodes: Nodes are the intersections of roads and streets near home and school. The distribution indicates that 92% of the examined students did not include nodes in their drawings, while 8% did. These results show that nodes are predominantly absent in the students' drawings. Nodes and junctions are elements expected in children's drawings as extensions of heterocentric space and Euclidean space (see Ünlü & Çakır 2002).

Paths-Lines: Roads, streets, and connecting elements between home and school were examined. The distribution indicates that 68% of the examined students did not include roads/lines in their drawings, while 32% did. This shows that lines (roads) are less frequently observed in the students' drawings. This outcome may be expected as it indicates that higher age groups typically deal with projective and Euclidean spatial solutions.

Mapping Typologies: The drawing typologies vary according to children's spatial responses. Based on Appleyard's (1970) spatially dominant maps, the scattered typology includes drawings with unconnected, free-floating objects. The linked typology features paths or connecting lines between the home and other elements, while the patterned typology shows organized groupings of connected elements forming district-like areas.

According to this typological analysis, on an urban scale, based on the mapping data analysis, 54% of the children's drawings fall under scattered mapping, 16% under linked mapping, and 30% under patterned mapping. This result shows that spatial perception is relatively higher at this age threshold, and the presence of patterned typology as a secondary level demonstrates that children transition from scattered to patterned drawings at this age. The fact that children from this age group use spatial mapping typologies, as defined by Appleyard (1970), more than sequential typologies suggests that they need more time to place experiences and information sequentially and consecutively. This aligns with Piaget's (1954) theory, which shows that

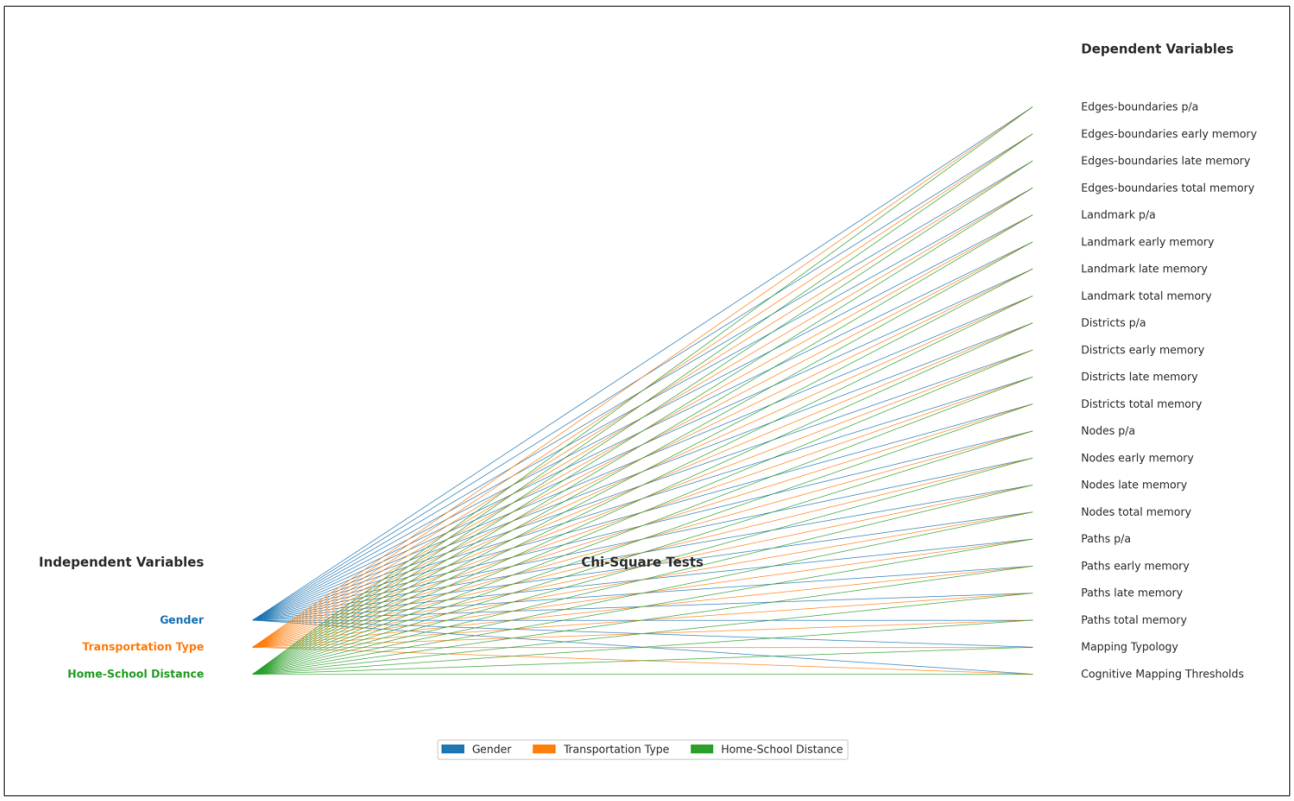

Figure 8. Correlation overview.

the children in the pre-operational stage still need to be ready for sequential and consecutive drawings related to the concrete operational stage.

Cognitive Thresholds: This analysis is based on Hart and Moore's (1973) approach and their definitions of children's spatial cognition theory development. According to the distribution, 64% of the examined children are at the heterocentric cognitive development stage threshold, indicating a solid perception of their homes and surroundings (meso environment). Because heterocentric is theorized as 8–12, these findings are interpreted as early/emergent features at ages 6–7. The next threshold is the domicentric stage, related to perception within the home (micro-environment), which accounts for 18%-an expected result. However, the egocentric threshold (personal space) follows at 16%, which is surprising. According to Piaget (1954), this stage corresponds to the 0–3 age group, so it is concerning that 16% of children still exhibit traits of this infantile stage in their cognitive perception; these are considered residual features rather than age-appropriate dominance. Only 2% of the children are at the Euclidean threshold, indicating perception at the urban (macro) scale. Taken together, these thresholds reveal a developmental progression across the manuscript using the scale labels: micro (egocentric/domicentric), meso (heterocentric), and macro (Euclidean).

These results align with Piaget's (1954) theory and Hart and Moore's (1973) framework of children's spatial cognition, indicating a developmental shift from natural to rational perception and individual to collective awareness. The findings highlight the significance of the child's position within both home and community settings. Within the scope of this study, the transition from domicentric space at ages 3–8 to heterocentric space at ages 8–12 can be interpreted as a shift from "natural" to "rational" will and from "community" to "society." This progression reflects a movement from individuality and egocentrism toward an emerging sense of public consciousness. The study underlines the importance of the child's role within domestic and communal environments in contemporary urban contexts.

Correlations

In the second part of the field study, the significant correlations obtained in the urban-centered-school-centered part are shown in Figure 9. Six significant results at the 0.05 probability level were obtained out of sixty-six correlations.

Figure 9 above summarizes the significant correlations between independent and dependent variables, while Table 5 presents the detailed Pearson's chi-square test results, highlighting the statistically significant relationships between various variables and the spatial elements depicted in children's drawings.

As detailed in Table 5, all significant results met the statistical validation criteria (χ^2 values reported with degrees of freedom and p-values<0.05). These findings' robustness is verified by cross-checking frequency distributions, ensuring that the statistical significance reflects consistent patterns in the underlying data. *However, given the small sample size (n=52), these Pearson's chi-square test results should be*

Table 5. Correlations and Pearson's Chi-Square Results

Variable	Statistical Test & Value (Pearson Chi-Square)	p-Value <0.05	df	Key Findings
Gender-Paths	χ^2= 4.695	0.030	1	Girls drew more lines/paths than boys in the area between home and school, showing a statistically significant relationship.
Gender-Mapping Typology	χ^2= 12.836	0.002	1	Boys predominantly use scattered mapping; girls favor linked typologies, showing significant correlation between gender and typology.
Transportation/Mobility Type-Landmarks	χ^2=4.578	0.032	1	Children using vehicles highlight landmarks more prominently in drawings compared to those walking.
Home-School Distance - Recognition of Nodes	χ^2= 4.554	0.033	1	Longer home-school distances correlate with more nodes in drawings, suggesting increased node perception with travel duration.
Home-School Distance - Edges/Boundaries	χ^2= 12.474	0.050	6	Students closer to school include more boundaries (e.g., fences, roofs), indicating proximity influences spatial perception.
Home-School Distance - Cognitive Development Stages-Thresholds	χ^2=13.658	0.034	6	Proximity to school impacts cognitive thresholds: shorter distances show detailed perceptions, longer distances indicate broader spatial awareness.

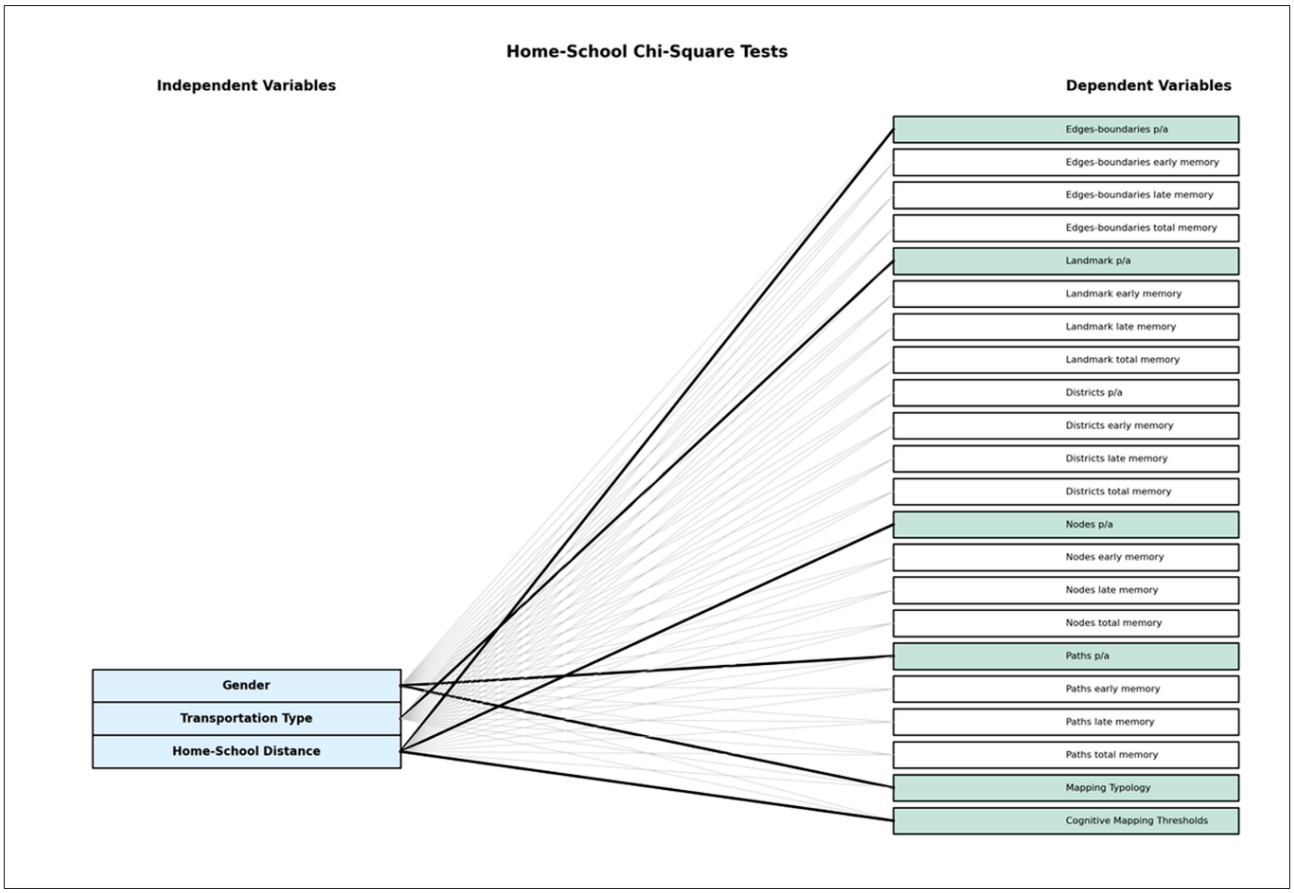

Figure 9. Significant Pearson's chi-square correlations between home, school, and urban areas.

interpreted cautiously. The statistical relationships observed are indicative rather than conclusive, providing exploratory insights into potential trends within the studied group.

Gender-Paths: The Pearson chi-square test (χ^2=4.695, df=1, p=0.030<0.05) indicates a statistically significant but moderate association between gender and including lines/paths. Within this sample, a higher proportion of girls' drawings included paths than boys', suggesting a slight variation in the depiction of movement routes. However, this result should be interpreted cautiously, given the small sample size and the differing findings reported by Ünlü & Çakır (2002), who observed an opposite tendency. Given the sample size and context-specific literature reporting mixed patterns, this association should not be generalized beyond this cohort.

Gender-Mapping Typology: The Pearson chi-square test (χ^2=12.836, df=1, p=0.002<0.05) reveals a significant association between gender and mapping typology. In this dataset, scattered mapping appeared more frequently in boys' drawings, whereas linked mapping was more common among girls. These tendencies are statistically significant within this case study; however, given the sample size and context-specific literature reporting mixed patterns, this association should not be generalized beyond this cohort.

Transportation/Mobility Type-Landmarks: The test indicating the transportation type used by children during the home and school itinerary and the existence of landmarks in their drawings presented a significant correlation χ2=4.578, df=1, p=0.032<0.05. The Pearson chi-square test result indicates a significant relationship between the transportation children use to travel to school and the existence of landmarks in drawings. According to this result, children who come to school by vehicle include landmarks more prominently in their drawings, as shown in the total memory analysis.

Home-School Distance-Recognition of Nodes: Nodes' recall has a statistically significant relationship with the distance between home and school. χ^2=4.554, df=1, p=0.033<0.05. The analysis of the relationship between home-school distance and the presence of nodes in children who draw the area between home and school shows a p-value of 0.033, indicating significance. Nodes are rarely seen in the drawings of students with a short home-school distance. However, in children with a longer home-school distance, the presence of nodes increases, and their distribution spans a wider range. This can be interpreted as follows: children perceive more nodes as the travel duration between home and school increases.

Home-School Distance-Edges/Boundaries: This correlation indicates a significant relationship between the distance from home to school and how children perceive and draw boundaries. The distance they travel daily may influence their understanding and representation of spatial boundaries. Students living closer to school include more boundaries and edges in their drawings, suggesting proximity influences spatial perception.

The categorical distribution according to observed frequencies as the mean scores of the distance from home to school for students drawing their home environment and surroundings are as follows: 0-4 km is the first categorical value, 5-7 km is the second categorical value, and 8-40 km is the third categorical value. The relationship between home-school distance and the boundaries category is found to have a Pearson chi-square value of $x^2=12.474$ with p=0.050", df=6 indicating a marginal association (p=0.050). According to this data, students who live closer to the school tend to include more boundaries in their drawings, such as ground lines, sky boundary lines, garden fences, building roofs, and building frames. This finding suggests that the proximity of students' homes to their schools influences how they perceive and depict boundaries in their drawings. Understanding this relationship provides insights into how everyday experiences, such as commuting distances, impact children's spatial cognition and representation.

Home-School Distance-Cognitive Development Stages-Thresholds: This correlation highlights a significant relationship between the distance from home to school and the cognitive development thresholds, such as egocentric, domicentric, heterocentric, and Euclidean spatial perceptions. The distance they travel may influence their cognitive development regarding spatial awareness and understanding. Children living closer to school show more detailed spatial perceptions, while those farther away develop broader spatial awareness. The categorical distribution (according to mean scores) of the distance from home to school for students drawing their home environment and surroundings is as follows:

0-4 km is the first categorical value, 5-7 km is the second categorical value, and 8-40 km is the third categorical value. The case study examines how this distance influences various cognitive development thresholds: egocentric, domicentric, heterocentric, and Euclidean spatial perceptions.

The relationship between home-school distance and cognitive development thresholds is significant, with a Pearson chi-square value of $\chi^2=13.658$ and $p=0.034<0.05$, df=6. The analysis suggests that children living closer to school (0-4 km) exhibit heterocentric and domicentric perceptions, indicating a more detailed understanding of their immediate home and surrounding environment (semi-public, fragmented). In contrast, children living farther from school (8-40 km) may develop a broader spatial perception, potentially due to their exposure to a more comprehensive range of environments during their home-school route. The distance from home to school children's cognitive development is related to spatial awareness and understanding. Those with shorter commutes may have a more focused perception of their immediate environment, while those with longer commutes might develop a broader understanding of space. This finding suggests that the distance between home and school significantly shapes children's cognitive development and spatial perception. Understanding these relationships can provide insights into how daily experiences and environmental exposure influence children's cognitive and spatial development.

This study examines children's cognitive mapping abilities and spatial perception, focusing on urban analysis. The summary findings of this study, which investigates the elements children use to understand and represent their environment, are as follows:

Cognitive Image Analysis: Children's cognitive maps were analyzed using five essential elements: boundaries/edges, landmarks, areas/districts, nodes, and paths/lines. Children frequently represented edges and landmarks in their drawings; more than 90% of students included these elements. This shows that boundaries (edges) and landmarks are critical to how children perceive and map their home-school route environment.

Mapping-Drawing Typology: Children's drawings are classified using three mapping typologies: scattered, linked, and patterned. The scattered mapping type is the most common; more than 50% of students use this typology in city-related analyses. The patterned mapping type is the second most used type by about 30% of students; the linked mapping type is the least common, with about 16%. This shows that, regardless of the context, children tend to perceive spaces in a fragmented or non-linear way rather than connecting roads or paths.

Cognitive Development Thresholds: The analysis shows that most children (about 64%) are at the heterocentric threshold, demonstrating their ability to relate to broader environments such as home and surroundings (meso-environment). A smaller proportion display predominantly egocentric perceptions (micro-environment), while only 2% reach the Euclidean threshold, reflecting an urban-level understanding (macro-environment).

The Effect of Distance Between Home and School: Children living closer to school included more roads/lines in their drawings, suggesting that proximity directly influences their spatial perception.

Gender Differences: The analysis related to the home indicates a statistically significant correlation between gender and the depiction of districts. In the home-centered drawings, girls more frequently included a variety of interior and exterior areas.In the city-centered drawings, male participants more often represented elements such as playgrounds, nearby cafés, and ice cream shops.

While these differences are not uniformly pronounced across all cases, they suggest that individual factors, including gender, may influence certain spatial representation tendencies.

In summary, the two-stage case study reveals several overarching findings regarding children's cognitive mapping abilities, spatial perception typologies, and the effect of proximity on their spatial understanding. These findings emphasize the significance of boundaries, landmarks, and familiar spaces in children's cognitive development within the urban context. In addition, they emphasize that children's spatial perception is primarily heterocentric.

According to this study, although distance from school and mobility are essential factors in how children perceive the city, the recognition of heterocentric space by a high percentage of children aged 6-7 years may reflect early exposure to public and shared environments. In this sense, changes in cognitive development thresholds and early perception of heterocentric public spaces are detected in this case study. However,approximately 16% of first-grade participants still displayed egocentric tendencies in spatial perception related to educational and pedagogical contexts.

DISCUSSION

This study identifies gender-related variations in children's spatial representations. Some girls produced more detailed and connected drawings, whereas some boys tended to depict more fragmented or scattered forms. These differences are context-dependent rather than inherent, reflecting variations in environmental exposure, mobility opportunities, and task framing. Boys in this sample often incorporated urban-scale elements such as playgrounds, cafés, and shops, suggesting a broader yet more fragmented perception of space. Overall, the findings align with previous studies (Ünlü & Çakır, 2002; Rzhanova et al., 2020; Lynch, 1960), emphasizing that children's spatial representations are shaped by environmental interaction rather than gender itself.

Moreover, Matthews (1983) found that young children's ability to understand and represent large-scale environments varies with age, highlighting the developmental nature of spatial cognition. Children's capacity to mentally organize and represent complex environmental spaces increases as they grow. This aligns with Hart and Moore's (1973) spatial cognition framework, which indicates that children aged 6-7 years develop heterocentric spatial awareness and demonstrate early sensitivity to public spaces. This progression partially corresponds with Piaget's (1954) stages of cognitive development, particularly the concrete operational stage (ages 7-11). The earlier emergence of heterocentric spatial awareness in this sample is discussed as early/emergent rather than full stage attainment and can be analyzed through environmental parameters and digital mediation.

This early emergence, also noted in the literature, some 6–7-year-old children in our sample displayed early signs of heterocentric perception. These can be interpreted as emergent rather than fully developed features. Similar tendencies have been noted in the literature: Ünlü & Çakır (2002) emphasized gender-based differences in spatial focus, Rzhanova et al. (2020) observed developmental variability in spatial and cognitive tasks, and Coşkun & Kaymaz (2022) found that urban environmental complexity influences spatial awareness in older children (7–11 years). While our case study suggests that heterocentric indicators may appear earlier than Hart and Moore's (1973) framework predicts, such interpretations remain context-specific and should be treated cautiously.

These findings, which challenge traditional developmental timelines, suggest that children transition from home to urban spaces earlier, with virtual environments playing a pivotal role. Although virtual environments offer fragmented and distorted spatial experiences compared to physical interactions, they allow children to view environmental parameters from broader perspectives in their memory and representations. Furthermore, digital media is suggested to enhance visual-spatial skills, such as recognizing patterns and understanding spatial relationships, potentially altering perceptions of environmental boundaries. Integrating digital media with real-world activities offers new perspectives that enrich spatial concepts and cognitive development.

The impact of environmental exploration on children's cognitive maps is shaped by factors such as distance and freedom of movement. Walking and longer routes support node recognition and broader spatial awareness, while shorter commutes emphasize boundaries and local edges. Children who walk and observe their surroundings improve the accuracy of their spatial models, while their mobility enhances their ability to acquire environmental knowledge effectively. This leads to better performance in mapping tasks and improves their spatial awareness. The distance between home and school significantly influences children's cognitive representations; children living closer to school tend to depict more boundaries and edges (e.g., fences and rooflines), while those living farther away develop broader spatial awareness, emphasizing nodes and landmarks. These findings align with Herman's (1980) study on the impact of environmental exploration on spatial cognition, highlighting that active interaction with the city enhances children's spatial awareness.

This study is consistent with the mobility-focused research of Damayanti and Kossak (2016), showing that children covering longer distances perceive their environments with a broader perspective. However, it contrasts with Park and Mi-Hui's (2012) findings that children's perception dis-

tance is limited to 100-500 meters. It was also found that the type of transportation children use correlates significantly with the presence of landmarks in their drawings. Children who commute by car emphasize landmarks more than those who walk. This supports Risotto and Tonucci's (2002) findings that freedom of movement impacts environmental learning. The results also contribute to Appleyard's (1970) sequential mental maps theory, explaining how vehicle-based journeys shape spatial perception.

The study further reveals that socioeconomic status and cultural context influence spatial cognition. Öztürk's (2009, 2015) studies indicate that children from lower socioeconomic backgrounds experience perceptual challenges, and Gillespie (2014) highlights the role of cultural context in shaping neighborhood perceptions. These findings are consistent with this study, which integrates individual variables to provide a holistic perspective on gender, mobility, and distance. For instance, children from higher socioeconomic backgrounds appeared to have broader environmental exposure, which may contribute to more structured mapping typologies. The findings align with Piaget's (1954) principles of assimilation and accommodation in adapting to the environment but suggest that modern environmental factors may alter traditional developmental processes, leading to earlier heterocentric spatial awareness. Lynch's (1960) theory on spatial elements such as paths, edges, and landmarks confirms their central role in children's cognitive maps and spatial perception.

This study contributes to understanding how gender, mobility, and spatial familiarity shape children's cognitive representations of their everyday environments. While the findings provide meaningful insights into these relationships, the relatively small sample size limits the statistical generalizability of the results. Given the small sample (n=52), single-school context, and categorical sparsity that can affect chi-square test stability and power, the findings should be considered exploratory. While expected-cell assumptions were checked, restricted generalizability remains a key limitation. Coding achieved satisfactory agreement (87%), yet single-site sampling and potential unmeasured confounds such as neighborhood form, parental trip patterns, and digital exposure granularity may have influenced outcomes. Future research should employ larger, multi-site samples, pre-registered analysis plans, and models that can accommodate covariates (e.g., logistic or multinomial regression) to test whether observed tendencies persist after adjustment. Longitudinal designs and mixed-methods triangulation (drawings, interviews, GPS/route audits) would help differentiate developmental change from context effects.

CONCLUSION

This study reveals the interaction between children's spatial cognition and variables such as gender, mobility, and cognitive thresholds. The findings suggest that contemporary environmental and social conditions enhance children's spatial awareness and support cognitive growth. Grounded in the theoretical frameworks of Piaget (1954), Lynch (1960), and Hart & Moore (1973), the research emphasizes the relationship between children's cognitive mapping abilities and their everyday environments.

To create child-friendly cities, educational and urban design strategies should be developed in an integrated manner. Policies encouraging outdoor activities and environmental exploration can strengthen children's spatial awareness, while urban planning should prioritize safe pedestrian networks, legible layouts, and sensory-accessible public spaces. Incorporating insights from children's cognitive mapping into design processes will help planners create more comprehensible and engaging environments for all young users, acknowledging gender-related spatial preferences in the process.

At the policy level, although this study did not directly measure policy outcomes, the findings-together with insights from previous literature-suggest that encouraging alternative modes of transportation, such as walking and cycling, may strengthen children's independent mobility and spatial familiarity by increasing their interaction with their surroundings. Similarly, the proximity between home and school, while not quantitatively assessed in this research, emerges as an important consideration for supporting children's daily spatial routines; this highlights the potential value of planning at the neighborhood level and improving the accessibility of local schools.

From an architectural perspective, the implications drawn from the findings point to the potential benefits of creating flexible modular spaces on the ground floors of residential buildings, which may serve as transition spaces for play, learning, and community interaction. These spaces should include interactive and sensory-rich elements suitable for the child's scale to enhance children's engagement with the built environment and support sensory learning opportunities.

Furthermore, the spatial elements identified in children's drawings may offer useful guidance for design considerations. The relatively limited depiction of roads suggests the importance of providing continuous and safe pedestrian routes around schools. The frequent inclusion of landmarks underlines the benefit of incorporating visible, child-scaled reference points-such as playgrounds, colorful façades, or distinctive trees-that can support wayfinding and strengthen the legibility of children's spatial environments.The scarce representation of nodal points indicates that intersections and gathering areas near schools could be designed with greater clarity and safety, serving as recognizable anchor points for children. These insights demonstrate how cognitive mapping findings can inform practical design solutions that improve child mobility, orientation, and comfort in urban areas.

As a result, designing urban areas based on childhood experiences requires an interdisciplinary approach that includes architecture, urbanism, education, and environmental psychology. Recognizing children as independent individuals and urban actors and including them in participatory design processes may contribute to constructing inclusive, resilient, and sustainable cities. In this context, child-friendly urban design that enhances legibility, safety, and sensory richness can foster cognitive development and create more livable, equitable, and future-oriented urban environments.

Given the study's exploratory scope and limited sample, the reported associations should be considered hypothesis-generating rather than confirmatory. Design implications are practice-informed suggestions that warrant testing in larger and more diverse settings.

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