Exploring Urban Affordances Through Children's Perceptions

– A Practical Tool for Child-Centred Urban Planning Based on the Perceived Sensory Dimensions Model

Explorando posibilidades urbanas a través de la Percepción Infantil. Una herramienta práctica para la planificación urbana centrada en los niños basada en el modelo de Dimensiones Sensoriales Percibidas

Nicole Bórquez

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Swedish University of Agricultural Sciences, SLU
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A Practical Tool for Middle Child-Centred Urban Planning Based on the Perceived Sensory Dimensions Model

Nicole Bórquez

Supervisor: **Jonathan Stoltz, SLU, Department of People and Society**
Examiner: Elizabeth Marcheschi, SLU, Department of People and Society
Co-examiner: Fredrika Mårtensson, SLU, Department of People and Society

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Swedish University of Agricultural Sciences
Department of People and Society
Group of Environmental Psychology

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Abstract

Children's perceived sensory qualities of green spaces can be particularly influential. UNESCO, guided by Kevin Lynch, has emphasised the importance of working with interdisciplinary groups to address the needs of children and adolescents, primarily in vulnerable urban areas. The Child-friendly Cities initiative created by UNICEF addresses the importance of children's rights, and this study sheds light on those facts, mainly when considering that over half of the global population is estimated to be living in urban areas and the increase in mental health issues among children.

This thesis explored the applicability of a practical and evidence-based framework for improving children's health and well-being in urban natural settings. It integrated theory-based models such as the Perceived Sensory Dimensions Model (PSDs) and established evidence linking children's development and nature to create an evidence-based child-centred model. Additionally, the study underscored the significance of utilising tools in planning and engaging in collaborative placemaking to address the need for knowledge to enhance children's well-being in urban green environments.

Keywords: Urban Affordances, Children's Perceptions, Urban Planning Tool, Child-Centred Design, Child-friendly Cities, Evidence-Based Design Model, Environmental Psychology, Health and Well-being.

Preface

Urban affordances are crucial in how children perceive and interact with their surroundings. Through thoughtful planning and design, I aim to shape urban environments that offer diverse opportunities for children to engage with their surroundings meaningfully. By focusing on child-friendly design, my passion lies in creating urban environments that prioritise the youngest generation and developing child-centred urban spaces that promote psychological well-being and inspire healthy behaviours. This involves providing children with opportunities for exploration, creativity, and thriving physically, mentally, and emotionally. My vision reflects my commitment to creating spaces that offer choice, meaning, and empowerment, particularly for society's youngest members.

As an architect with design and urban planning expertise, I aim to bridge the gap between research and practical application in urban planning. Additionally, I had the opportunity to co-run a sustainable social company called *Ett hem att trivas I*, a non-profit interior design studio founded in September 2017, which gave me the acknowledgement of social inclusion and children's needs. I conceptualised and developed design strategies to improve the lives of children in low-income situations. I also conducted workshops for women and schoolchildren focused on sustainability and creativity. It inspired me to develop new strategies and knowledge to design better places for children.

In this thesis, I emphasised developing a practical tool that integrates the principles of environmental psychology with urban planning strategies. Evidence-based design enables the creation of spaces that support not only the physical needs of children but also their emotional and psychological development. Environmental psychology explores how the physical environment shapes our experiences, actions and perceptions, and it has valuable contributions to designing a healthier environment. This understanding is integral to my work.

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Abbreviations

SLU	Swedish University of Agricultural Sciences
SRT	Stress Recovery Theory
ART	Attention Restoration Theory
EBD	Evidence-Based Design
PSD(s)	Perceived Sensory Dimensions
QET	Quality Evaluation Tool
OPEC	Outdoor Play Environment Categories
UNICEF	United Nations International Children's Emergency Fund
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFPA	United Nations Population Fund
WHO	World Health Organization
UNCRC	UN Convention on the Rights of the Child

1. Introduction

In the context of unprecedented urbanisation challenges, the significance of green spaces and infrastructure in enhancing human health and well-being cannot be overstated (Stoltz & Grahn, 2021). It is thus relevant to introduce children to nature, which positively impacts their cognitive, emotional, and overall health and well-being (Koga & Iwasaki, 2013; Chawla, 2020). In natural settings, people perceive opportunities based on their understanding of affordances, which are influenced by their sensory and physical experiences. This highlights the unique perspective everyone, especially children, brings to their understanding of affordances (Heft, 1988; Gibson, 1977; Kyttä, 2004; Jørgensen, 2014).

Thus, children interact with the environment using their senses. They create a strong emotional link, which leads to a better understanding of their surroundings and is rooted in personal connections and sensory interactions (Bartos, 2013). This connection is established as they engage with the environment through physical movements and bodily experiences (Jørgensen, 2016).

Researchers in high numbers have highlighted the significance of giving children a healthy and nurturing environment. Badland (2016) suggested that a child's cognitive development is shaped by the social and physical environments they encounter daily. By exploring outdoor green areas, children's confidence, adaptability, and navigation skills, as well as improvement of their fine and gross motor skills, are favourable in their development. Furthermore, studies have indicated that spending time in nature can enhance attention span, problem-solving abilities, creativity, and prosocial behaviour (Wells, 2000; Fjørtoft, 2004; Chawla, 2020). In this regard, Chawla (2020) also highlights the long-term impact of childhood nature experiences on environmental attitudes. This addresses concerns about the decline of such experiences due to urbanisation and underscores the significance of outdoor activities in fostering a strong connection with nature.

Moreover, memories of a positive childhood of outdoor play shape strong place attachments, influencing emotional development and identity (Morgan, 2010). Koller and Farley (2019) describe the importance of place attachment for children, illustrating how children form emotional bonds with specific places. Additionally,

the sense of place and the embodiment of wonder, as well described by Jørgensen (2016), brings a sensibility towards the environment. Which may develop affective attachments. In essence, a sense of place involves emotional attachment and cognitive significance attributed to a specific location (Stedman, 2016; Raymond et al., 2017). It is thus important to investigate how the perceived sensory qualities help better navigate, understand and shape a strong sense of place in an urban context for children's health and well-being.

In this way, it becomes essential to understand spatial cognition, which is crucial for environmental awareness, as it involves comprehending and recalling environments such as buildings, streets, and landscapes (Lynch, 1960). In that context, given the diverse spatial perceptions across age groups and the significance of familiarity with a setting, it is crucial to acknowledge the inherent complexity and interdependence of human needs within the built environment.

While the broader context recognises the importance of green spaces in improving health and well-being (Grahn et al., 2010; Stoltz & Grahn, 2021), prioritising environments that cater to the specific needs of vulnerable populations, such as children, becomes paramount as urban areas expand (UNFPA, 2023).

Grahn and Stigsdotter (2010) and Stoltz and Grahn (2021) have already developed practical tools for urban planners, investigating the importance of essential qualities in natural settings and identifying eight factors called PSDs summarised by the Perceived Sensory Dimensions model. To design and plan for salutogenic environments, one should consider incorporating a variety of PSDs to cater to the population's diverse needs (Stolz, 2019). Therefore, the primary focus of this research study is to explore the effectiveness of the evidence-based model of perceived sensory dimensions when considering children's perspectives specific in urban areas, how its applicability must be considered when designing child-friendly urban spaces and how those qualities shape children's cognitive map of the urban natural attributes.

2. Aim

Expanding on Chawla's (2020) suggestion to employ theory-based models to establish a link between children's relationships with nature and their development. This study delves into the role of scientific evidence in shaping children's perception of the environment. Thus, it adopts the evidence-based Perceived Sensory Dimensions framework, as reviewed by Stoltz & Grahn (2021), linked with positive health and well-being outcomes, when considering children's perception in urban areas from a salutogenic perspective.

Through an explorative review of scientific evidence, this study explores the potential of applying the PSD model to enhance children's well-being through urban development. By exploring how children perceive sensory dimensions in natural urban environments from an evidence-based design perspective and how its applicability must be considered when designing child-friendly urban spaces. The primary objective is to create a framework based on the PSD model, focusing on children aged 6-11, that converts research findings into practical strategies to improve children's relationship with nature and their well-being in urban environments. To contribute to the development of more inclusive and child-friendly policies. The framework is developed by addressing the following questions.

1. How can a literature review of green urban settings be mapped to support children's (aged 6-11) experiences through the four axes of the perceived sensory dimensions model?

2. How are children's perceptions and experiences within green urban settings shaped and influenced by the four axes of the Perceived Sensory Dimensions?

3. In what ways can children's interplay of the eight perceived dimensions in urban green environments be adapted into new attributes for a child-centred model?

3. Theoretical Background

The theoretical approaches are essential for drawing conclusions that give coherence and significance to specific observations about person-environment relationships. One of those is Environmental psychology, which focuses on analysing the interplay between individuals and their physical surroundings, where both entities influence each other. It provides theoretical approaches such as *Stimulation Theories*, which emphasise the significance of the physical environment as a primary source of sensory input. These theories cover simple and complex stimuli when changing the stimulation level can lead to interpretation changes (Gifford, 2014). In this session, it explores the impact of such stimuli when considering child-friendly approaches.

3.1. Aesthetic Perspectives on Greenspaces

The understanding of greenspace aesthetics has evolved from ancient times when beauty was linked to divine ideas and the Enlightenment's focus on subjective experience in art. Today, when one speaks of aesthetics, it can be seen as more than just beauty, it includes and embraces the sensory experiences derived from our interaction with the natural world (Stoltz & Grahn, 2021).

Accordingly, in their study, Grahn et al. (2010) described how people's senses, emotions, and cognition significantly impact their perceptions of the environment. They found that an individual's well-being significantly influences their experiences and perspective of their surroundings. Therefore, establishing a meaningful connection with the environment is vital when nature is a primary source of comfort and support. Ulrich (1999) suggests that nature's healing effects operate on unconscious processes and emotions in the brain, providing essential information about the environment's context in seconds. Nature's aesthetic impact can rapidly influence our feelings and affective state.

Stoltz's (2019, p. 32) research well emphasises the importance of perceiving nature as a holistic experience that incorporates various elements such as *clouds, trees,*

rivers, bushes, flowers, and animals, aligning with the principles of Gestalt psychology. When people perceive elements of nature, they see meaningful wholes or complete forms instead of individual parts. It recognises how our interaction with natural environments goes beyond the mathematical beauty of patterns, which is about the holistic experience of nature that comprehends various elements and together creates a meaningful and potentially health-promoting environment. However, rather than specific environmental conditions, beauty experiences are influenced by one's genetic background, cultural upbringing, early life experiences, education, and current emotions and needs, all of which shape one's traits and characteristics (Stoltz & Grahn, 2021).

According to Mather's (2011) study, human perception involves two main processes. Bottom-up perception is the initial sensory detection of external stimuli. In contrast, top-down perception combines sensation with cognitive interpretation and is influenced by our prior knowledge and thoughts, helping us interpret sensory information. In the same study, Mather underscores the active nature of perception, emphasising the brain's dynamic integration of sensory input, memory, and knowledge.

3.1.1. Restoration Through the Aesthetics of Green Urban Settings

With projections indicating that over half of the global population will reside in urban areas by 2030, there is an immediate need to re-evaluate design practices to assess their impact on physical and mental health (UNFPA, 2023). Moreover, the number of new cases of mental illness among young adults appears to be declining in 2023, as evidenced by a decrease in antidepressant prescriptions. However, this decline is not observed among children, where new cases continue to rise. It is premature to determine if this represents a trend shift, but a sustained decrease could help mitigate the rise in mental health issues among the young generation (Socialstyrelsen, 2024). Becoming an important issue to acknowledge.

Various studies emphasise the importance of nature and outdoor spaces for human well-being, providing insights into the intricate relationship between individuals and their environments. In addition, urban green spaces, such as parks and gardens, offer many benefits that are instrumental in addressing the complexities of urbanisation. Extensive research has identified pivotal sensory dimensions that contribute to human well-being in green spaces (Stoltz & Grahn, 2021).

Previously, Gestalt theory investigated how humans perceive *order and hierarchies* in their surroundings (Perls et al., 1970). According to it, Grahn and Stigsdotter

(2010, p. 265) have articulated that depth perception is essential for perceiving the real world, which integrates easily with surface perception. A comprehensive aesthetics model should consider all senses related to our perception of the environment and physical movements when contemplating green spaces.

Moreover, Ulrich (1983), the *Stress Reduction Theory* (SRT) suggests that humans have evolved to assess quickly whether a situation is dangerous. Certain stimuli, such as high cliffs, darkness, snakes, spiders, alarming noises, and odours, trigger heightened vigilance and stress levels. Additionally, Ulrich (1999) also presented the *Theory of Supportive Gardens*, focusing on the relevant role of gardens and natural environments in reducing stress and highlighting crucial components such as perceived control and privacy, social support, physical activity, and exposure to nature.

Accordingly, Kaplan (1995) posits that natural environments allow directed attention to rest, reducing stress as they do not demand complicated decisions or information sorting. By exposure to a natural environment, one can benefit from a fresh respite from the cognitive demands of our daily lives, instilling a sense of optimism about the potential benefits of such environments. Additionally, Wilson (1984) highlights humans' innate tendency to seek a connection with nature and further emphasises Kellert and Wilson's (1993) biophilic design theory, which links natural elements to human-made spaces for well-being and scoring the importance of nature in promoting human well-being (Kellert, 2018).

Kaplan and Kaplan (1989) introduced the Attention Restoration Theory, which addresses restoring fatigue in the natural environment (Kaplan, 1995, 2001). ART theory proposes a means of facilitating the recovery of directed attention damaged from the impact of urban density by indirect attention (Kaplan & Berman, 2010). For instance, satisfaction experiences may lower the necessity of directed attention (Kaplan & Kaplan,1989). In contrast to Kaplan and Kaplan (1989), Ulrich et al. (1991) suggest that encountering nature elicits automatic emotional responses, such as feeling calm or anxious. These reactions rooted in human evolution, help us decide whether to approach or avoid a situation, ultimately influencing our well-being. Bengtsson, A. & Grahn, P. (2014) highlighted that Kaplan and Ulrich's theories emphasise the importance of natural environments for mental restoration, with Kaplan focusing on cognitive benefits and Ulrich on emotional responses.

According to Appleton's *Prospect-Refuge Theory* (1975a), humans naturally prefer landscapes that offer the opportunity to see without being seen (prospect) and places of refuge. In a subsequent work (Appleton, 1975b), Appleton proposed an approach to delve into the underlying principles of landscape aesthetics. This study shed light

on the reason edge features and skylines play crucial functional roles in the aesthetic perception of landscapes. Even though this theory is rejected, the need to continue the search to understand remains essential. Moreover, Appleton (1984, p.92) acknowledged the risks it has by simplifying the experience of landscape preferences through a biological and behavioural sciences lens. He highlighted the tendency of theory to isolate common characteristics and ignore others, potentially distorting the holistic image of individual circumstances. The challenge, among other theories, is the criticism of the prospect-refuge theory, which usually derives from a failure to recognise its role as a simplification agent for explanatory purposes.

Another perspective introduced by Grahn et al. (2010), the *Supportive Environment Theory* (SET), emphasises the importance of environmental support for overall well-being. *The Pyramid of Executive Functions* is a four-level model based on the Scope of Meaning/Scope of Action theory. At the bottom of the pyramid, individuals require less executive function and rely more on external environmental support. In comparison, the top level involves higher executive function and active engagement, requiring less external support (Grahn et al., 2010, p.150). Moreover, Bengtsson and Grahn (2014, p.881) highlighted that individuals at different points on the *triangle of supporting environments* have varying needs, from gentle fascination to higher demands on directed attention. This challenge gradient is crucial for promoting health in healthcare garden design, providing a continuum of environmental qualities for passive nature experiences to active interactions.

3.2. Urban Affordances and Well-being

Kevin Lynch's *The Image of the City*, published in 1960, introduces influential theories on how individuals perceive and navigate through spaces, focusing on spatial cognition and behavioural navigation by introducing the term *wayfinding*, explaining that mental maps, formed from memories of environmental features, guide our movements in cities. Children and adults use similar visual cues for wayfinding, and Lynch's five elements help analyse child-friendly urban spaces. To serve as effective landmarks, buildings and features must engage children's interest, emphasising the need for complexity and variety in neighbourhood design (Johansson et al. 2020). Regarding those fundamental concepts, Lynch highlights the concepts of *Legibility*, which refers to the effortlessness of understanding and organising the components of a built environment, and *Imageability*, which pertains to an object's ability to create a solid mental image. This study also identified five vital physical elements, *Paths, Edges, Districts, Nodes, and Landmarks*, collectively shaping a city's legibility (Lynch, 1960, p.47.48).

Consequently, Gibson's *ecological approach to visual perception* explains how people perceive sensory dimensions. This emphasises the inherent qualities of the environment, well known as *affordances*, and their direct perception through stimulus information, which is valuable in understanding how we adapt to specific situations. It grounds the relevance of the observer's role in perceiving and utilising *affordances* and the significance of invariances in understanding how we perceive the visual world (Gibson, 1979). Our ecological niche, rich in physical structures and a diverse repertoire of human abilities, is a treasure trove of possibilities for action, offering many potential outcomes. An *affordance* we perceive as a value-rich ecological object where every substance, surface, or layout has the potential to benefit or be risky (Rietveld & Kiverstein, 2014; Gibson, 1979).

Affordances Theory by Gibson was introduced in 1977, which underscores the relationship between a person and their surroundings and how the perceived opportunities in that environment shape their behaviour. Gibson (1977) emphasises the dynamic interaction between humans and their environment, suggesting that surroundings present opportunities to influence positive behaviours for sustainability. This theory is useful for guiding the design process for urban planners and environmental psychologists, which promotes sustainable behaviours. Moreover, when planning, it is relevant to keep in mind that every culture has its values and norms, so design elements in one culture may not be as practical in another (Gibson, 1977; Clapper et al., 2018).

3.2.1. Children's Affordances in Urban Settings

Heft (1988) conducted a study with a focus on outdoor play and learning and found some key elements, utilising the functional affordances approach to delineate children's interactions with their outdoor environments. This study developed a taxonomy outlining the relationships between the physical environment's features and the immediate experiences of the children within it. In the same study, affordances were categorised into ten different physical environments. See Table 1. Moreover, depending on the observer's needs and desires, the same object can offer various affordances (Johansson et al., 2020). For instance, Tree affordances enable children to create diverse play spaces, develop risk management skills, and connect with nature (Jørgensen, 2014).

As stated above, people perceive various opportunities based on their understanding of affordances in the interconnection with landscapes. For instance, a child seeking play areas will see these possibilities differently from adults. These opportunities can have positive or negative impacts. When children interpret those opportunities of affordances, they do it through their sensory and physical experiences, which are

heavily influenced, and where the personal experiences shape their perceptions and play a crucial role. It grounds the unique perspective everyone brings to their understanding of affordances (Jørgensen, 2014). Kyttä (2002) also explained how children from different environments perceive different opportunities based on their knowledge about affordances. For instance, urban children may develop a dual environmental identity, while rural environments might encourage children to create their affordances.

3.3. Attachment and Meaning in Sense of Place

The relationship between self and place involves emotional and cognitive development. Casey (2001) suggests that the connection between individuals and their surroundings comprehends a deep relationship, emphasising that the association between oneself and the place goes beyond simple influence, bringing one to a significant bond. Casey (1993) also suggests that our physical movements contribute to the formation and organisation of places, a process known as *emplacement* rather than *displacement*, which involves moving away from a place

A *sense of place* involves attachment to a place and the meanings one associates with places, a syntonising with emotions *of place as a locus of attachment* and cognition *of place as a centre of meaning.* This attachment is shaped by the gradual development of emotional connections and the attribution of significance to a place within the social context (Stedman, 2016; Raymond et al., 2017, p. 54). Further, Raymond et al. (2017) expand the understanding of the *sense of place* by differentiating between *fast* and *slow* processes, acknowledging the interplay of immediate and long-term meanings, and emphasising the dynamic and transactional nature of the human-place relationship, shaped by emotional, cultural, and environmental influences.

To well understand our emotional bonds to places, it is essential to acknowledge the spectrum of negative and positive emotions and discern how diverse experiences can influence our evolving connections to a place over time (Manzo, 2003). Recognising that our attachments to places are dynamic and subject to change based on our experiences and sentiments towards a particular location. In this regard, Lewicka (2014) suggests that strong place attachment can arise from long-term residence and active interest in a place's history and participation in its community. Accordingly, facilitating several opportunities for social interaction and cultivating a sense of belonging can strengthen residents' social cohesion (Chan et al., 2006), it plays a vital role in fostering a profound and meaningful understanding of a place.

To understand it, the phenomenological field describes a place as any environmental circumstances that spatially and temporally gather human experiences, meanings, and actions (Seamon, 2018). Moreover, *Place attachment* is understood as an individual's emotional bond with a particular place (Giuliani, 2003). Seamon (2013) also describes *place attachment* as a geographical, social, and personal interconnected factor. Where the recognition of this complex relationship is essential, lifting the role of routines in building lasting connections. This concept involves both *inward* and *outward* aspects, influencing the intensity of attachment based on individual experiences.

Chawla initially explored the concept of place attachment theory in childhood in 1992, highlighting the importance of outdoor places during mid-childhood. The areas where children spend their formative years hold significant sway over their present opportunities, well-being, and even long-term outcomes beyond childhood (Hester, 2014; Manzo, 2005; Morgan, 2010). The theory's emotional aspect underscores our environment's profound effects on our well-being, evoking a deeper understanding of its significance. Further, a sense of place and the embodiment of wonder, as described by Jørgensen (2016), fosters a sensibility towards the environment. This sense of wonder propels children to explore, investigate, and develop affective attachments. Their bodily expressions, movements, and sounds are crucial in meaning-making.

3.3.1. Childhood Experiences and the Sense of Place

Bartos's comparative study in 2013 revealed the significance of sensory experiences, emotional attachment, and the development of a sense of place in childhood. The complex relationship between sensory experiences and various aspects of human development is underlined in this study and sheds light on the interconnected nature of sensory engagement, emotional experiences, and social interaction. Furthermore, by experiencing them through their senses, children develop strong emotional ties to various spaces and places. Smelling, tasting, hearing, touching, and movement at the same time memory, emotions, smell, and taste also play a crucial role in our connection to the environment. It underscores the importance of these senses in shaping our emotional experiences in different places. Similarly, various materials and surfaces contribute to a sensory interaction with landscapes, engaging multiple senses (Jørgensen, 2014).

Moreover, Jan Gehl focused on studying public space by publishing *Life Between Buildings*. His urban design philosophy was influenced by his observations of life in public spaces and his wife's psychological understanding. He believed that by

observing how people used urban affordances, we could learn much about design simply and systematically. Jan also believes that Copenhagen has many children in the streets, squares, and parks, indicating a high quality of urban life (Matan & Newman, 2016). Furthermore, Mårtensson (2004, p.132) and previous studies have highlighted the importance of the surroundings of play equipment for outdoor play. In Nordic regions, the playground is seen as a primary stop and a practical gathering spot before entering a larger outdoor environment, especially with a sparse building structure and proximity to natural-like environments (Gehl, 2003).

3.3.2. Finding Wonder in Childhood Places

According to Jørgensen's study (2016, p. 1140), *[e]xistential encounters with landscapes and places and environmental consciousness connect to the notion of a sense of wonder as it relates to sensory experiences and emotional involvement.* Accordingly, the child creates meaning and is influenced by interactions with peers and surroundings. Environmental consciousness plays a crucial role in children's agency (Fig. 1), controlling their actions and comprehension of the environment. Thus, children's experiences connecting with their environment through sensory engagement are crucial for their health and well-being, whether inside a building or in the broader neighbourhood (Bartos, 2013).
Below is a visual representation that illustrates the relationship between children's interaction with landscapes and their environmental consciousness, derived from an understanding of Jørgensen's study (2016).

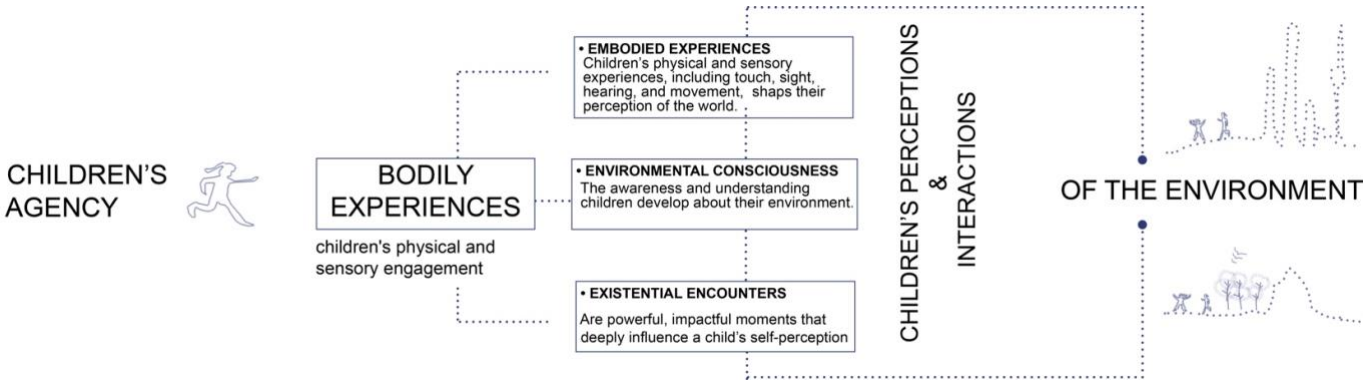

Figure 1. *Based on the literature by Jørgensen (2016). It shows an overview of the dynamic interplay of how children interact with their surroundings. Modelled by the author of this thesis.*

3.4. Evidence-Based Models for Design and Planning

Evidence-based models effectively incorporate research findings into urban green space design, planning, and management (Grahn, 1991; Bengtsson & Grahn, 2014; Bengtsson, 2015; Stoltz & Grahn, 2021). In addition, Bengtsson and Grahn (2014) found that despite relevant research, environmental psychology theories need to be translated into practical design guidelines for enhancing settings. To do this, Nordregio (2024) has developed a practical handbook that emphasises the significance of considering high-quality evidence regarding nature's impact on human health and well-being when making informed decisions about planning, managing, and designing urban green spaces (Borges et al., 2024, p. 28)

Another broader perspective has been adopted by Bengtsson & Grahn (2014). The Quality Evaluation Tool (QET) prioritises qualities to emphasise the environment, allowing for environmental diversity and user choice based on mood and activity preferences. It highlights the importance of involving users in designing healthcare gardens and encourages dialogue with the user group. In the initial step of applying the Quality Evaluation Tool (QET), the landscape architect or designer thoroughly examines each environmental quality within the larger context of the entire environment. In the second step, the various attributes are carefully analysed in collaboration with the users, including staff, residents, patients, and their visitors. Finally, the landscape architect or designer faces the challenge of balancing the findings from both steps to estimate *the measures needed to design or redesign the outdoor environment* (Bengtsson & Grahn, 2014, p. 890). By integrating *salutogenesis* and *pathogenesis* approaches, the tool encompasses 19 environmental qualities, categorised under comfortable and inspiring design and gradient challenge.

3.4.1. Practical Models for Enhancing Children's Well-Being in Urban Environments

Heft (1988, p.36) identified essential outdoor play and education elements (Table 1). Similarly, Jørgensen (2014, p.4) emphasises these elements as foundational for effective outdoor play and education. The elements highlight the multisensory engagement of green spaces, promoting diverse sensory experiences and physical interactions. It reinforces the educational use of affordance theory, which states that *the functionally significant properties of the environment are perceived qualities that emerge from person-environment relations* (Heft, 1988, p. 32).

Table 1. *The essential elements for outdoor play and education. Based on Heft (1988, p. 32), modified by the author of this thesis.*

Essential Elements of Outdoor Play and Education	
Incomes	**Outcomes**
Flat, relatively smooth surfaces	(for walking, cycling, skating, and skateboarding)
Smooth surfaces	(for coasting, rolling, sliding, running, or rolling objects)
Graspable/detached objects	(for drawing, scratching, throwing, hammering, etc.)
Attached objects	(for sitting, jumping on/over/down from)
Non-rigid, attached objects	(for swinging on)
Climbable features	(for exercise/mastery, lookout points, and passage)
Aperture	(for movement, observation, and auditory experiences)
Shelter	(creating microclimates, perspective, refuge, and privacy)
Mouldable materials	(for constructing objects and modifying surfaces)
Water	(for splashing, pouring, floating objects, swimming, etc.)

Moreover, Kyttä (2004, p. 185) developed a schema known as actualised affordances (Table 2) to examine how children experience different environments. She identified four types: Wasteland, Cell, Bullerby, and Glasshouse. Data were collected through interviews with 8- to 9-year-old children and questionnaires administered to both children and their parents. The number of actualised affordances was assessed using a 29-item scale developed by Kyttä (2002). *The original affordance interview was derived from Heft's (1988) functional taxonomy of children's outdoor environments, complemented by a subscale of affordances for sociality (Gaver, 1996). That subscale was inspired by van Andel's (1984/1985) activity categories for children's outdoor play.*

Table 2. *The 29 distinct opportunities for action scale were developed for individual interviews with children. Based on Kyttä (2004, p. 185), reprinted by the author of this thesis.*

A classification system of 29 affordances	
1. Affords cycling	16. Affords coasting down relatively smooth slopes
2. Affords role playing	17. Affords skateboarding
3. Affords running	18. Affords to throw graspable/detached objects
4. Affords to play rule games	19. Affords to dig graspable/detached objects
5. Affords skipping	20. Affords building of structures
6. Affords playing home	21. Affords using plants in play
7. Affords skating	22. Affords to swing on nonrigid, attached object
8. Affords playing war	23. Affords to hang on nonrigid, attached object
9. Affords playing hopscotch	24. Affords climbing climbable feature
10. Affords being noisy	25. Affords being in peace in shelter
11. Affords skiing	26. Affords moulding something with mouldable material (dirt, sand, snow)
12. Affords following/sharing adult's businesses	27. Affords building of snow with mouldable material
13. Affords playing football	28. Affords swimming in water
14. Affords playing ice-hockey	29. Affords fishing in water
15. Affords playing tennis or badminton	

The four types of environments studied include wasteland-type, cell-type, and glasshouse-type. The wasteland-type exhibits freedom but limited exploration opportunities, while the cell-type restricts mobility, leading to decreased interest in surroundings. The glasshouse type was not a prominent focus of the study, but it may become more familiar with increasing urbanization. While the Bullerby-type offers perceived and utilised affordances, children's mobility licenses and opportunities create a positive cycle, supporting independent performance. However, the percentage of such environments decreases with higher urbanisation. Schools can play a role by creating Bullerby-type environments to address parental concerns. However, some schools lean towards restrictive environments due to safety worries.

A recent study by Mårtensson (2013) introduces the Outdoor Play Environment Categories (OPEC) tool for assessing children's play areas. This tool is created to design outdoor environments that support physical and mental well-being, promote social interaction, problem-solving, and inclusivity, and ensure safety. It evaluates preschool outdoor play environments based on three dimensions. It supports open-ended and flexible play and highlights design with abundant vegetation, which can make outdoor spaces more resilient for children's active play. Implementing the OPEC tool's framework can transform schoolyards into enriching outdoor play spaces that promote children's health and contribute to sustainability goals. This assessment considers three key factors (Table 3) based on observing children's play in preschool environments. It is essential to recognise that older children may have different preferences.

Table 3. *Key factors and considerations for assessment of Outdoor Play Environments for Children OPEC Outdoor Play Environment Categories. Based on Mårtensson (2013, p.662), modified by the author of this thesis.*

Assessment of Outdoor Play Environments for Children.	
Total Size of the Outdoor Area	The extent of the play area impacts children's ability to engage in various activities, fostering a sense of exploration and adventure. Additionally, a significant amount of vegetation can enhance the outdoor space's resilience to withstand children's active play.
Proportion of Area with Shrubs, Trees, or Hilly Terrain	This dimension examines the presence of natural elements, which not only expand play options for children but also facilitate their negotiations and conflict resolutions.
Integration Between Vegetation, Open Areas, and Play Areas	Different settings within the outdoor area are assessed to promote open-ended and flexible play sequences, encouraging dynamic movement among children.

3.5. The PSD Model

The Perceived Sensory Dimensions Model (PSDs) was developed by Grahn and Stigsdotter (2010) and reviewed by Stoltz and Grahn (2021). The PSD model has eight factors universally linked to human needs for perceived sensory environmental information that urban planners can use as practical tools. This framework is based on statistical data analyses from numerous studies involving diverse individuals that aim to provide a universal understanding of general human needs and highlight their universal importance in people's daily lives. Additionally, Stoltz (2019) emphasises that *salutogenic* environments should include a variety of PSDs to meet the diverse needs of the population.

Moreover, the PSD framework is consistent with Ulrich's *Stress Recovery Theory* (SRT) (1983), Kaplan and Kaplan's *Attention Restoration Theory* (ART) (1989), as well as Appleton's *Prospect and Refuge Theory* (1975). Focuses on aesthetic analysis, like the stress-reducing and restorative effects of natural environments highlighted in SRT and ART. This highlights the importance of personalised design approaches to meet diverse user needs and promote well-being (Stoltz, 2019, p.33).

Therefore, when planning health-promoting environments, it is essential to incorporate various PSDs. A study that evaluated the PSD features in people's neighbourhoods showed that residents reported higher satisfaction when more PSDs were present (Björk et al., 2008). It has been suggested that the eight PSDs result from adaptations made during transitional phases of human evolution, shaping modern perceptual biases and needs in a layered yet integrated structure (Stoltz, 2022).

Urban green spaces have traditionally been examined in terms of their aesthetic qualities, overall popularity, and ability to accommodate different activities. However, Stoltz and Grahn (2021, p.8) suggest a new way to assess urban green spaces by comparing the Perceived Sensory Dimensions (PSDs) model to colours. This unusual approach can be reliably evaluated in environments regardless of personal preferences and cultural background. As described, like colours, the PSDs can be pronounced in each environment and can mix or interfere with each other.

Moreover, preferences for these PSDs may change depending on a person's current needs. However, unlike colours, which we perceive visually, the PSDs rely on all our senses. They are based on the sum of our integrated sensory perception and aspects of our higher cognition. In addition, the PSD framework highlights the importance of green spaces in addressing environmental inequalities (Stolz, 2019). This approach’s benefits could positively affect people’s well-being.

Considering all this evidence, Stoltz and Grahn (2021) suggest that certain qualities can be connected within the model (Fig.2), including four opposing axes: Natural – Cultural, Cohesive – Diverse, Sheltered – Open, and Serene – Social. As described in this study, the model content synergies and tensions between the qualities have significant implications for design green space planning, recommending supporting three close qualities to achieve strong aesthetic functions.

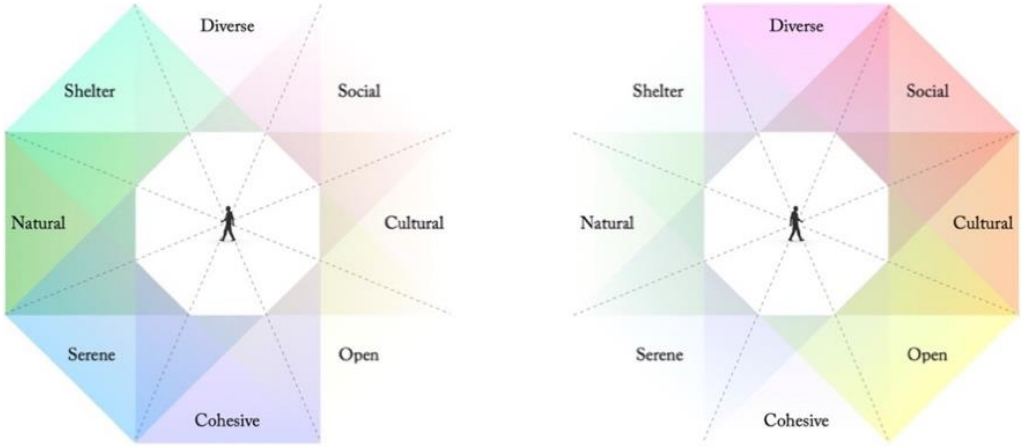

Figure 2. *Contrasting dynamics between attributes that are considered crucial for restorative processes (on the left) and qualities that are typically seen as stimulating and valuable but less restorative (on the right). Figure Caption Derived from Stoltz & Grahn (2021, p.07).*

Finally, the characteristics mentioned are universally relevant. Thus, this thesis study supports the validity of the PSD framework by highlighting the importance of green spaces in addressing environmental inequalities when it refers to children's perspectives. To do it, it specifically concentrates on exploring literature concerning children between the ages of 6 and 11. This age group is in middle childhood and requires a support system for outdoor environments to better prepare for the transition to adolescence and overall health and well-being (Chawla, 2020; Wales et al., 2021).

Children could benefit from having access to the eight recognised sensory qualities, especially if we incorporate specific needs for the intended user groups and the design should correspond with each aspect mentioned previously, accommodate the existing attributes (see Table 4) and adopt the new attributes described later in Table 14.

Table 4. *Perceived sensory dimensions (PSDs) and the descriptive attribute associated with each dimension. Based on Stoltz & Grahn (2021), modified by the author of this thesis.*

Eight Factors for Creating a Positive Urban Environment: Perceived Sensory Dimensions (PSDs) Model		
Qualities		**Attributes**
PSD 1: Natural Quality	General user	Focuses on the power of nature without human intervention.
PSD 2: Cultural Quality		Includes human culture and cultivation, such as art, artefacts, and socially transmitted living patterns.
PSD 3: Cohesive Quality		Creates a sense of being in a unified space.
PSD 4: Diverse Quality		Portrays a feeling of diversity and variety.
PSD 5: Sheltered Quality		Offers a sense of shelter and protection.
PSD 6: Open Quality		Allows for various activities, views, and panoramas.
PSD 7: Serene Quality		Describes a need for peaceful and tranquil surroundings.
PSD 8: Social Quality		Indicates places for social interactions, gatherings, and activities.

4. Method

The methodology in this study explores theories and evidence from specific research focused on children's health and well-being, especially regarding the potential benefits of green sensory dimensions in urban environments, by defining those aspects from a child-centred viewpoint. The potential to apply it requires the creation of a framework, like a tool, that integrates essential attributes to enhance the meaningfulness of PSD qualities adapted for children. This framework can be beneficial to develop for application in designing environments and urban planning to assess children's health and well-being.

The outcome first presents the model's theoretical principles and justifies its practical construction corresponding to the four axes of the PSDS model from a child's perspective. Then, it describes the attributes of each perceived sensory dimension based on the PSDS model by Stoltz and Grahn (2021) by integrating the new attributes of each quality according to children's needs.

Embracing evidence-based design is a physical decision and a commitment to improving the design in a holistic way that ensures user well-being, safety, and satisfaction (Ulrich, 2006). By incorporating empirical evidence into the design process, designers should be able to make informed decisions that balance aesthetic and functional requirements, ensuring the best possible result for users.
According to Stoltz (2019), four main stages are required to approach Evidence-Based Design (see Figure 3). This approach is used to create a methodology for this study, which will be analysed below.

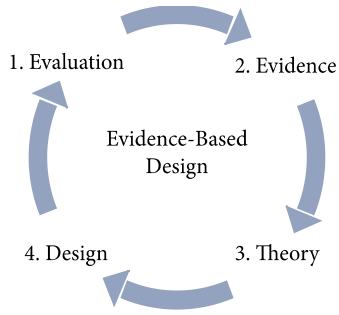

Figure 3. *Four main stages to approach evidence-based design, based on Stoltz (2019, p.23). Slightly modified by the author of this thesis with permission from Jonathan Stoltz.*

4.1. Data Collection Processes

To gain a deeper understanding of how children in the middle childhood age range (6-11 years) interact with and are influenced by outdoor green urban environments concerning each dimension and their interplay with it. I propose a four-phase readability study. However, two of them were limited due to the lack of observation of children aged 6-11, which is essential for gaining a valuable understanding of its applicability when considering their perspectives. It is thus Phases I and II I developed in this study, and future research may establish Phases III and IV, involving consistent readability literature investigations, qualitative observations like children's child-led walks and field observations.

The age group targeted in this research study is curious about activities, often utilises local places, and is in a transitional stage with well-developed verbal and social abilities (Cele, 2006). This is a critical age to which this study aims to contribute.

The I and II phases are conducted to develop the new framework. The research design (Fig. 04) is developed as follows.

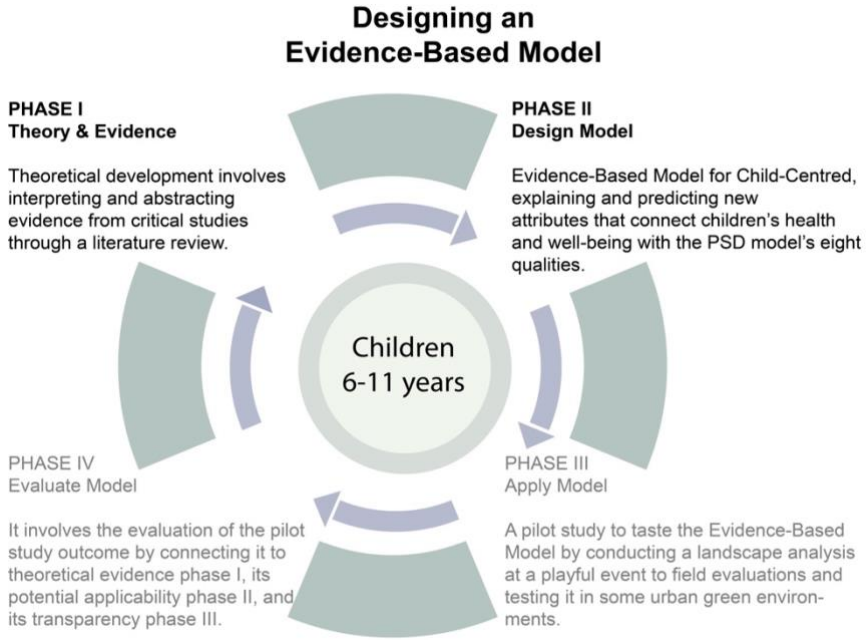

Figure 4. *The design and procedure of the evidence-based model, by the author of this thesis.*

4.2. Procedure

This study procedure explores the fundamental theoretical principles of the tool. It involves gathering data from relevant studies. This approach ensures that each element identified by the PSD model is effectively incorporated into the adapted tool, forming the foundation for further development. However, implementing this model, which aims to explore the potential of applying the PSD model to enhance children's well-being through urban development, requires a deep understanding of its procedures.

Doing it resulted in an evidence-based child-centred model with two types of outcomes (phase I & phase II). Its practical construction is described below.

4.2.1. Phase I – Theory & Evidence

In this phase, the theoretical development involves exploring data from critical studies through an exploratory literature review. The research investigates the impact of greenery in urban settings on children's health and well-being, the impact on sensory stimulation and environmental perception, the significance of a sense of place for their development, and how children perceive sensory dimensions in urban environments, all from an evidence-based approach.

Evaluating Evidence

In the initial phase of the analysis, this study examines academic literature on the benefits of each PSD to identify the core attributes that shape children's perceptions, health and well-being of the natural urban environment. This extensive exploration is mostly grounded in the literature I have gathered throughout my master's program, during which I intentionally focused on the topic of children's health and well-being in urban natural settings across all my courses. Additionally, I utilise two main methods for the literature searches.
The search method for conducting the literature exploration also involves using specific search terms, while the other focuses on reviewing citations (Sage Research Methods, 2017). At this point, I include more literature specifically targeting the study group to gather empirical material. Both approaches require access to online databases through the SLU library, as well as physical resources available at the Alnarp camp.

Conceptualisation and Operationalization of the literature outcome

The presentation of findings for each dimension of the Perceived Sensory Dimensions (PSD) model begins with an objective description of each axis. This is followed by insights into the interplay between the dimensions to compare how the qualities interact and influence one another, particularly from the perspective of children. I critically evaluate and select literature that explores how various elements interact in creating engaging environments for children. In essence, it provides a clearer understanding of the PSD model's complexities through empirical findings to later facilitate a deeper explorative discussion of its implications.

Children and Aesthetic Qualities: Insights from a PSD Colour Wheel

Additionally, I utilise the concept from PSD adjacent and opposing qualities like the colour Wheel. To summarise and gain a deeper understanding of the interplay between each dimension and how the PSDs interact and influence one another, particularly from the general perspective.

4.2.2. PHASE II - Design Model

This process transforms the evidence into a coherent theoretical framework to create an Evidence-Based design, child-centred Model. It explains and predicts some attributes connecting children's health and well-being outcomes with the PSD model's eight qualities.

Data Analysis Methodology

Additionally, I utilise the concept of PSD to refine and operationalise each dimension and summarise children's insights from a PSD's opposing qualities. This process involves comparing in a table existing research findings (Tables 6, 8, 10 & 12) with the original descriptions (Tables 5, 7, 9 & 11) to gain a deeper understanding of the interplay between each axis to compare how the PSDs interact and influence one another, particularly from the perspective of children. Organising the review thematically to structure the literature around identified themes of PSDs also allowed me to review the initial research questions to investigate further (Sage Research Methods, 2017). This process is essential because it establishes a solid foundation for transforming evidence into a coherent theoretical framework. As a result, it leads to a clear, critical, and well-supported literature exploration focused on the research questions.

Conducting a Deductive Approach

The method primarily employs a semantic approach, facilitating the analysis of new data, identification of quality themes, and determination of specific attributes for each PSD. The thematic analysis follows the guidelines outlined in "Thematic Analysis: A Step-by-Step Guide" by Braun and Clarke (2006). (See appendix). This includes identifying and categorising themes related to how children perceive the urban natural environment. In this context, the PSD serves as themes, while the attributes function as sub-themes. I gathered raw information by focusing on the eight qualities of the PSD model, which I used to create a final text for discussing each quality. Additionally, this approach assisted in the coding process, producing a list of several new attributes tailored to the age group of focus (Table 14).

4.2.3. A New Framework for Understanding PSD Dimensions in Children

In this session, the original PSD model is adapted to better align with children's perspectives for developing a framework for the new conceptualisation. This involved decomposing the original dimensions into more relatable components, considering how children perceive and experience each quality, and creating new operational definitions for each dimension. Thus, the outcomes help to create an adapted framework for comprehending the specific new attributes (Table 14).

This theoretical framework makes us understand and analyse, thus predict how children's health and well-being outcomes are connected to the eight qualities of the PSD model's new attributes, offering insights relevant to the research question and objectives.

4.2.4. Practical Implementation of the Tool Process

Mapping Sensory Qualities and Scale

This session explores the framework's conceptualisation through the lens of sensory mapping. It focuses on identifying and categorising distinct types of green urban settings based on the newly defined attributes of eight perceived sensory dimensions. This analysis aims to establish a recommended scale and assess its potential applicability for understanding the sensory experiences within these diverse urban green spaces.

5. Result

5.1. Phase I – Theory & Evidence

5.1.1. Attributes Enhancing the Perceived Sensory Dimensions Model from a Child's Perspective

The text examines each dimension of the PSD by presenting the empirical findings of each quality. Additionally, it presents the interplay between these dimensions to compare how the qualities interact and influence one another, particularly from the perspective of children. This comprehensive approach provides a clearer understanding of the PSD model's complexities through empirical findings to discuss its implications.

1.- Exploring Evidence Between the Axe Natural and Cultural Sensory Dimensions for Children

Table 5. *Perceived Sensory Dimensions (PSDs) Model. Natural and Cultural factors for creating a salutogenic environment. Based on Stoltz & Grahn (2021), modified by the author of this thesis.*

PSD 1 Natural	**PSD 2 Cultural**	**References**
- Focuses on the power of nature without human intervention. Natural attributes such as: old trees, wild, natural biotope, free growing, safe, not too many people, native plants, untamed aspects of the environment, where a high-value natural place imparts **a sense of freedom.**	**- Includes human culture and cultivation, such as art, artefacts, and socially transmitted living patterns. attributes such as:** history, cultivated, artwork, culture, human efforts, heritage, exotic, which emphasises the importance of **encountering meaning** within the cultural contexts of the surroundings.	(Stoltz & Gran, 2021).

According to Stoltz & Grahn (2021), the natural quality emphasises experiences of the inherent power of nature without human intervention. It refers to environments that appear to be untouched and not artificially cultivated, typically associated with

large areas. This area evokes a sense of freedom from societal demands and everyday life and potentially produces significant restorative effects. See Table 5.

When examining natural qualities from a child's perspective, it is important to understand how children perceive and benefit from them. For example, children aged six to eleven typically enjoy playing in their neighbourhoods, value personal space, and love exploring natural landscapes (Chawla, 1992, 2020).

Research suggests that early positive experiences have a lasting impact on future development, underscoring the importance of early childhood experiences for lifelong well-being (Hertzman & Power, 2004; Gluckman & Hanson, 2008).

The absence of nature in such experiences in urban settings is underscored by Louv (2005), who introduced the concept of *nature deficit disorder*, highlighting urbanisation's negative effects on children's well-being. Consequently, Jarvis et al. (2022) found that higher levels of vegetation, tree cover, and grass cover in urban areas are associated with increased early childhood development scores, while there is a negative association with paved surfaces. Reinforcing the critical role of natural elements in fostering children's growth and well-being, even more so when it refers to urban environments.

Spending time in natural environments and the positive impact this connection with nature has on children's cognitive and emotional development is also relevant in enhancing children's physical activity and motor development. This connection is also influenced by factors such as children's age, gender, and family relationships, making middle childhood a critical development stage (Fjørtoft, 2004; Chawla, 2020). This highlights the importance of providing natural environments, mostly when it refers to children's healthy development.

Moreover, Kuo and Faber Taylor (2004) suggest that nature has a therapeutic effect on children with Attention-deficit/hyperactivity disorder (ADHD). Individuals with ADHD benefit from nature’s attention-restoring effects, as attention fatigue and ADHD may be linked to the underlying mechanism involving the right prefrontal cortex. Therefore, incorporating nature into children's daily lives and providing green spaces in schools and around the neighbourhood can alleviate these effects, offering calmness and promoting emotional well-being and resilience (Chawla et al., 2014).

A child-centred design may ensure green spaces have diverse features, such as hills, slopes, and varied vegetation, to support wayfinding and mobility (Johansson et al.,

2020). Encouraging playful interaction with green spaces in attractive settings can increase physical activity and play among children (Mårtensson et al., 2014).

Consequently, the cultural quality contrasts the previously described Natural PSD (see Table 6), where cultural can be linked to smaller areas, like those around a monument. This quality factor pertains to the traces of human efforts and creative powers, including spiritual or artistic pursuits, artistic or historical artefacts, plantations, or socially transmitted ways of life (Stoltz & Grahn, 2021).

Children's multimodal approach to their surroundings enhances their ability to manage complexity, encouraging them to utilise subtle cues from detailed environmental objects that capture their interest (Johansson et al., 2020). Additionally, existential experiences with landscapes and settings and heightened environment awareness are intrinsically linked to a sense of wonder. Existential encounters are powerful and impactful moments that significantly shape a child's self-perception and worldview, influencing their values, beliefs, and behaviours (Jørgensen, 2016).

To foster complexity in child-oriented planning and design, it is important to incorporate vibrant colours and bold expressions in buildings, signage, urban furniture, and strategically placed playgrounds (Johansson et al., 2020). Furthermore, Kyttä (2002) emphasises the differences between boys and girls who may perceive different affordances based on their surroundings.

As children transition to middle childhood, they benefit from planting and caring for plants. For example, creating a herbarium can help foster a deeper connection to nature and environmental stewardship (Nebelong, 2017). Additionally, creating dedicated garden spaces where children can plant, and nurture crops can instil a sense of responsibility and provide practical, hands-on learning experiences in food cultivation (Blair, 2009).

Furthermore, a comprehensive study conducted by Kyttä (2004) revealed that parents and institutions play a crucial role in promoting children's healthy development and positive outdoor experiences, which is essential for children to have access to supportive environments that allow them to explore independently for their healthy development. Children's well-being is closely tied to diverse opportunities and the freedom to explore. Highlighting the significance of well-being, freedom of movement and establishing strong support systems for outdoor activities is crucial (Wales et al., 2021).

Table 6. *Considerations when analysing Natural and Cultural qualities from a children's perspective. Derived from literature review, by the author of this thesis.*

Outdoor	**Children's interplay**	
-PSD 1 Natural	**-PSD 2 Cultural**	**References**
Microenvironment. To minimise the negative impact of urbanisation and increase exploration. **Emotional natural trails.** It improves emotional well-being and resilience **Tree cover and climbable trees.** Higher levels of vegetation and tree cover in urban areas increase early childhood development. **Play and Exploration adventure.** It promotes dynamic movement, and open-ended play sequences. **Multisensory Engagement.** Outdoor play influence positive place attachment such as throwing, digging, and climbing. **Natural loose parts.** Promote embodied experiences such as touching textures, smelling scents, feeling temperatures	**Sustainability and place making.** By balancing environmental quality, economic development, and social equity **Child-Cantered Design**. Incorporate vibrant colours and bold expressions in buildings, signage, urban furniture, and strategically placed playgrounds. Shapes a child's self-perception and worldview, influencing their values, beliefs, and behaviours. **Non-structured areas.** With colours and bold designs in structures and playgrounds. **Safety and Accessibility.** Safe and pedestrian-friendly infrastructure is crucial for children's independence and mobility **Cultural heritage.** Creating spaces that foster Social intercultural **Play and Learning.** Play, creativity, and learning experiences in food through elements like mouldable materials, outdoor play spaces, and interactive elements	-(Louv, 2005; Roberts, 2009). -(Victoria Derr et al., 2018). -(Chawla et al., 2014). -(Bartos, 2013; Laaksoharju & Rappe, 2017). -(Jarvis et al., 2022). -(Chawla, 2020; Nebelong, 2017). -(Mårtensson, 2013). (Johansson et al., 2020). -(Babb et al., 2017). -(Kyttä, 2004; Heft, 1988; Jørgensen, 2014; Morgan, 2010). -(Kyttä, 2002). -(Jørgensen, 2016). -(Heft, 1988; Mårtensson, 2013; Blair, 2009).

2.- Exploring Evidence Between the Axe of Cohesive and Diverse Sensory Dimensions for Children

Table 7. *Perceived Sensory Dimensions (PSDs) Model. Cohesive and Diverse factors for creating a salutogenic environment. Based on Stoltz & Grahn (2021), modified by the author of this thesis.*

-PSD 3 Cohesive	**-PSD 4 Diverse**	**References**
- Creates a sense of being in a unified space. **Cohesive attributes such as:** Another world, a coherent whole, spacious, not crossed by road, wandering around, free, linked to **freedom and connection** within natural areas.	**- Portrays a feeling of diversity and variety.** **Diverse attributes such as:** Rich in variation, rich in species, several animals, many different plants, flowers, ponds, and water, it underscores the significance of **encountering biodiversity**, including diverse flora and fauna.	(Stoltz & Gran, 2021).

The perceived cohesive quality in spatial design refers to an environment's ability to create a unified and extended space. This PSD emphasises immersive experiences within a unified space rather than mere observation. It allows for extended exploration but notes that disruptions, like roads, can hinder spatial unity. This experience (see Table 7) is often described as *being in another world* and is enhanced by larger, cohesive areas (Stoltz & Grahn, 2021, p.05).

Children's perception and understanding of the world are enhanced through engaging with different textures, smelling various scents, feeling temperatures, and exploring their surroundings. These experiences are crucial for developing children's awareness, perception, and knowledge of the natural environment, fostering a deeper connection, care, and responsibility towards nature (Jørgensen, 2016; Chawla, 2020).

A cohesive quality among children may be perceived as an area to explore and move independently. For instance, Babb et al. (2017), children's independent mobility is particularly influenced when street environments are free from traffic. Moreover, a sense of wonder is closely linked to embodied experiences and the sense of place among children. This emphasises the importance of nurturing a sense of wonder, as it is vital for helping children establish connections to their surroundings, encouraging them to explore, learn, and form meaningful emotional bonds with their environment. In essence, it may be achieved by creating unstructured areas for instance, formless gardens allow children the freedom to explore and foster creativity, igniting *a sense of wonder* about the natural world (Jørgensen, 2016, p. 1154).

In contrast, the diverse quality provides spatial design and embodies a sense of diversity, complexity, and liveliness. It contrasts with the cohesive quality (see Table 8), emphasising diversity and structural variation over unity and coherence. This quality is essential for places like schools and preschools (Stoltz & Grahn, 2021).

As Nebelong (2017) explains, during the transition to middle childhood, children can actively shape and transform their play environments using abundant loose materials for building and movement. They benefit from areas where they can dig in the soil and spaces where rainwater collects to create puddles and mud holes. Plant life enhances the area's ability to withstand active play, promoting dynamic movement and open-ended play sequences (Mårtensson, 2013). Johansson et al. (2020) also emphasised the importance of incorporating natural elements, such as multi-stemmed trees, diverse plant species, water features, boulders, and tree trunks when designing a play space for children. These elements can provide sensory

experiences, offer many opportunities for children's play and exploration, learn about nature, and experience seasonal changes. In addition, worn paths in the grass between the stones also offer exciting possibilities for children's play.

Moreover, in a study by Laaksoharju and Rappe (2017), the interaction between children and natural materials, particularly trees, in play environments was examined. Children were observed using various parts of trees for imaginative play, such as using leaves as play food and branches as tools for construction. The stages of children's connection with the natural environment were also explored, from seeking privacy and comfort around trees to engaging in long-lasting, imaginative play as they became more familiar with the space.

It thus includes natural elements such as trees, shrubs, water, boulders, and sand, which can offer more play options and increase environmental interaction. Moreover, Laaksoharju and Rappe's (2017) study found that children became more familiar with the environment as they gathered under mature apple trees for relaxation and socialising. This setting promotes unstructured play, which is crucial for cognitive and emotional development (Cox et al., 2018). Thus, children's well-being is closely tied to diverse opportunities and the freedom to explore. Highlighting the significance of well-being, freedom of movement and establishing strong support systems for outdoor activities is crucial (Wales et al., 2021).

Table 8. *Key considerations when analysing cohesiveness and Diversity qualities from a children's perspective. Derived from literature review, by the author of this thesis.*

Outdoor	**Children's interplay**	
-PSD 3 Cohesive	**-PSD 4 Diverse**	**References**
Existential Encounters to Exploration. By nurturing a sense of wonder in children to help them connect with their surroundings, foster exploration, and develop deep emotional bonds with their environment.	**incorporate a variety of vegetation.** Such as multi-stemmed and old trees. Create worn paths in the grass between stones.	-(Jørgensen, 2016). -(Johansson et al., 2020).
Child Health and Safety Measures. Taking steps to prevent injuries from road traffic accidents, drowning, falls, burns, and violence is vital for improving child health.	**Diverse plant life species.** Helps the area withstand active play and promotes dynamic movement and open-ended play sequences.	-(Jørgensen, 2014; Jørgensen, 2016). -Mårtensson, 2013).
Cars-free City Planning. Collaboration across different sectors is essential to address issues related to child health and safety.	**Water features.** Incorporating water features, boulders, and tree trunks. Features for splashing, pouring, and floating objects to provide sensory experiences.	-(Heft, 1988: Johansson et al., 2020; Herrington & Brussoni, 2015).
Addressing risk factors and Inequity. Particularly environmental injustices areas.	**Features to support play.** Provide loose materials, areas for digging, and spaces for puddles and mud. Mouldable. materials such as dirt, sand, and snow for creative activities.	-(WHO, 2024; WHO, 2023). -(Nebelong, 2017; Kyttä, 2004). -(Heft, 1988).

3.- Exploring Evidence Between the Axe Sheltered and Open Sensory Dimensions for Children

Table 9. *Perceived Sensory Dimensions (PSDs) Model. Sheltered and Open factors for creating a salutogenic environment. Based on Stoltz & Grahn (2021), modified by the author of this thesis.*

-PSD 5 Sheltered	-PSD 6 Open	References
- Offers a sense of shelter and protection. Sheltered attributes such as: feeling safe, hideaway, undulations, trees, hills, slopes, bushes, picnic areas, play, those represent a space that provides a **secure shelter** where individuals can **engage in interactive eye connections** with one another.	**- Allows for various activities, and views. Open attributes such as:** Vistas, open, large, prospects, overview, lawns are cut, light, plane, free, sports, grass, those are related to the ability to **perceive the vastness** of a site in terms of **amplitude and openness**.	(Stoltz & Gran, 2021).

The concept of Sheltered quality highlights the importance of environments that provide a sense of shelter and protection. This idea is linked to enclosed spaces, which are essential for restoration. People often seek out places that create a feeling of safety and refuge, where they can experience tranquillity in solitude or engage in intimate social interactions. These cosy, enclosed hideaways (see Table 9), offer privacy and the opportunity for personal reflection (Stoltz & Grahn, 2021).

When evaluating shelter quality for children, prioritising security and safety is essential. A well-designed shelter must create a safe environment to protect children from potential hazards. For instance, meticulous planning is essential for urban spaces to ensure children feel safe and comfortable. The built structures and greenery design should prioritise clear views and visibility of nearby buildings. Striking a balance between creating engaging environments and guaranteeing safety is paramount to promoting independent, active mobility for the well-being of children (Johansson et al., 2020).

Laaksoharju and Rappe (2017), found that climbing trees is popular among children, helping them develop essential skills and seek recognition. As related to a study by Fjørtoft & Sageie (2000), the research also discovered that the physical appearance of trees played a significant role in various play activities. Pine, deciduous, and mixed pine and spruce trees were famous for climbing. Deciduous trees are mainly used for symbolic and construction play, especially during winter. The presence of shrubs influenced play activities such as hiding and building shelters, while the topography played a role in more challenging activities like climbing rocks and sliding, like places on steeper and rougher terrain.

On the other hand, the Open quality (see Table 10), describes a need for unobstructed environments with ample space for activities and an emphasis on views (Stoltz & Grahn, 2021). This quality become very important among children's needs, who often prefer areas that offer open space and shelter, allowing them to feel secure while observing their surroundings (Mårtensson et al., 2014).

Urban design should potentially create child-friendly environments that encourage and support high levels of independent mobility among children. These areas should be filled with opportunities that invite and enable children to participate in various activities (Kyttä, 2004; Johansson et al., 2020). Furthermore, Babb et al. (2017) also emphasised the importance of independent mobility for children and highlighted the role of parks and play areas in promoting children's well-being, highlighting that green open spaces promote children's independent mobility.

Viewing open spaces as unsafe can hinder children's connection to these environments, limiting their opportunities to explore their neighbourhoods and navigate independently. Thus, by considering children's needs, the built structures and greenery design should prioritise clear views and visibility of nearby buildings as well as striking a balance between creating engaging environments and guaranteeing safety is paramount to promoting independent, active mobility for the well-being of children (Johansson et al., 2020).

Young children are attracted to complex green open spaces that spark their curiosity. While for play and socialising, they prefer locations that provide visibility and shelter, allowing them to observe their surroundings while also having places to hide. Additionally, engaging gender-based areas for physical activity on school grounds and encouraging playful interaction with green spaces in attractive settings can increase physical activity and play among children of various ages and genders, which could extend into adolescence (Mårtensson, 2004; Mårtensson et al., 2014).

Table 10. *Key considerations when analysing Shelter and Open qualities from a children's perspective. Derived from literature review, by the author of this thesis.*

Outdoor	Children's interplay	
-PSD 5 Sheltered	**-PSD 6 Open**	**References**
Use building techniques. Constructing "huts", meet children's needs for group competence, physical activity, goal achievement, and curiosity.	**Green open spaces.** Support children independent mobility by limited traffic around.	-(Johansson et al., 2020).
Ensure tree cover and shadows. Considering tree physiognomy, vegetation types to play, and comfort to promote early childhood development. Finding peace in shelter.	**Reduced traffic.** Grass cover in urban areas to promote early childhood development scores, while there is a negative association with paved surfaces.	-(Jarvis et al., 2022). -(Fjørtoft & Sageie, 2000). -Babb et al., 2017).
A variety of topographies. Climbing rocks and sliding activities in slightly steeper and rougher terrain. Play and building structures.	**A strong sense of community.** Children's engagement with urban activities. Affordances playing hopscotch.	-(Johansson et al., 2020). -(Mårtensson et al., 2014; Kytta, 2004).
Provide places for children to play and hide. Create microclimates, perspective, refuge, and privacy such as shrubs.	**Visibility & safety.** Designing the park to ensure children feel safe and have places to play and hide while being visible.	-(Heft, 1988). -(Laaksoharju and Rappe, 2017).
Create safety balancing areas. Safety during light and dark hours especially in darkness.	**Movement and auditory experiences.** Promote physical activity and play.	-(Kytta, 2004).
Utilise various parts of trees. Such as leaves as play food and branches as tools for construction.	**Gender-inclusive sports facilities. G**ender-based areas for physical activity.	(Mårtensson et al., 2014).

4.- Exploring Evidence Between the Axe Serene and Social Sensory Dimensions for Children

Table 11. *Perceived Sensory Dimensions (PSDs) Model. Serene and Social factors for creating a salutogenic environment. Based on Stoltz & Grahn (2021), modified by the author of this thesis.*

-PSD 7 Serene	-PSD 8 Social	References
- Describes a need for peaceful and tranquil surroundings. Calm, silent, no people, clean, peaceful, secluded, undisturbed, no traffic, safe, it refers to a quiet, relaxing, safe space.	**- Indicates places for social interactions, gatherings, and activities.** Plenty of people, movement, events, shops, restaurants, bustling, play, and sports. The dimension involves providing equipment that encourages social connections.	(Stoltz & Gran, 2021).

The Serene quality describes a preference for peaceful and calm surroundings, soothing natural sounds, and the ability to focus inwardly. This quality is often associated with the need for stress relief and is related to the Natural and Cohesive PSDs (Stoltz & Grahn, 2021). As it described in table 11.

Although access to tranquil green spaces can differ for children compared to adults, it may provide unique opportunities for children to engage in calming activities. Such an environment can reduce stress, foster resilience, and promote emotional regulation as children learn to navigate their feelings and experiences. Green spaces within schools are required, as they provide peaceful havens that offer a break from busy urban life (Chawla et al., 2014). Laaksoharju and Rappe's (2017) study found that children became more familiar with the environment as they gathered under mature apple trees for relaxation and socialising.

Additionally, Babb et al. (2017) research revealed that only a small number of children can walk or bike independently, leading to concerns about their overall health. Changes in children's outdoor play and increased parental restrictions can hinder their development. The rise in sedentary indoor activities competes with outdoor pursuits, and children who use public spaces often face resistance from adult residents. Moreover, concerns about perceived dangers or risks associated with unsupervised activities have led to parents limiting children's independent exploration of their neighbourhoods, significantly decreasing such activities (Loebach & Gilliland, 2010).

On the other hand, social quality (see Table 12), emphasises the presence of other people and opportunities for social interactions. This quality contrasts with the serene quality and is related to the cultural and diverse PSDs (Stoltz & Grahn, 2021). The influence of urbanisation and cultural context can vary significantly, leading to diverse values and expectations that may affect the practicality of urban design features (Kyttä, 2002; Jørgensen, 2014). Children form and sustain emotional connections between physical attributes and social elements, specifically in developing a solid attachment to their neighbourhood. It significantly shapes the main sense of place and community well-being (Johansson et al. 2020).

When assessing outdoor play environments, factors such as the size, natural elements, security and arrangement of different settings enhance children's play experiences (Mårtensson, 2013). Improving spaces for children could make cities more sustainable and better for everyone. Effective city planning should create stress-free and relaxing environments for urban residents (Aerts, 2018). Thus, urban planning becomes a consideration when designing physical features such as building density, green spaces, architectural aesthetics, and social aspects, including security and opportunities for social interaction (Bonaiuto et al., 2003, 2006), are essential. Thus, when designing outdoor play spaces for children, focus on creating diverse play opportunities rather than just promoting physical activity. Including natural elements such as trees, shrubs, water, boulders, and sand can offer more play options and increase environmental interaction (Herrington & Brussoni,

2015; Fjørtoft, 2004). Further, programs involving children in activities like gardening can instil a sense of environmental responsibility and promote sustainable behaviours. They foster belonging among all societal groups, promote social cohesion, and facilitate knowledge exchange and mutual understanding (Blair, 2009; Chawla et al., 2014).

Urban design should potentially create child-friendly environments that encourage and support high levels of independent mobility among children (Kyttä, 2004; Johansson et al., 2020). The variation of the influence of urbanisation and cultural context may lead to diverse values and expectations, and it could affect the practicality of urban design features (Kyttä, 2002; Jørgensen, 2014). In this regard, a compelling study by Babb et al. (2017) discusses children's concerns regarding pedestrian infrastructure, increasing the importance of addressing these issues in child-friendly neighbourhoods. Emphasising the importance of independent mobility for children and highlighting the role of parks and play areas in promoting children's well-being. Thus, accessing outdoor environments for children requires spaces that offer plenty of play opportunities while promoting interaction with nature, which influences children's health and encourages active lifestyle development (Mårtensson, 2013).

Table 12. *Key considerations when Serene and Social qualities from a children's perspective. Derived from literature review, by the author of this thesis.*

Outdoor	**Children's interplay**	
- PSD 7 Serene	**-PSD 8 Social**	**References**
-Stress-free City Planning. Creating stress-free and relaxing environments for urban residents, which can impact how young people perceive their city surroundings. **Safe and quiet zones.** During middle childhood, children seek natural spaces for reflection and play, but there is a concern that these opportunities have declined. **Good visibility of nearby areas.** Prioritising clear views and visibility in the greenery design to balance creating engaging environments and ensuring safety. **Mature trees such as apple trees.** Children gathere under mature apple trees for relaxation and socialising **Independent mobility strategies.** Children develop their support system for outdoor life, helping them adapt independently.	**- Play for Mind and Body.** Affordances for skating and running. Support healthy connections within their communities. **Community interaction with children.** Participatory placemaking to integrate isolated populations and foster a sense of ownership. **Facilities that are gender specific.** Flat surfaces with smooth features. For walking, cycling, scooter, and skateboarding. **Climbable Features.** For exercise/mastery, lookout points, and passage. **Use of vibrant colours and expressive designs.** For located playgrounds, and green areas to support wayfinding and mobility. **Activities like gardening.** For social cohesion **Inclusive design.** Sufficient lighting, surveillance systems, unobstructed sightlines, emergency call points.	-(Aerts, 2018). -(Chawla, 2020). -(Johansson et al., 2020). -(Herrington & Brussoni, 2015). -(Koller & Farley, 2019). -(Mårtensson et al., 2014). -(Johansson et al., 2020). -(Victoria Derr et al., 2018). -(Laaksoharju & Rappe (2017). -(Kytta, 2004; Heft, 1988). (Blair, 2009; Chawla et al., 2014). -(Johansson et al., 2020) - (Wales et al.,2021)

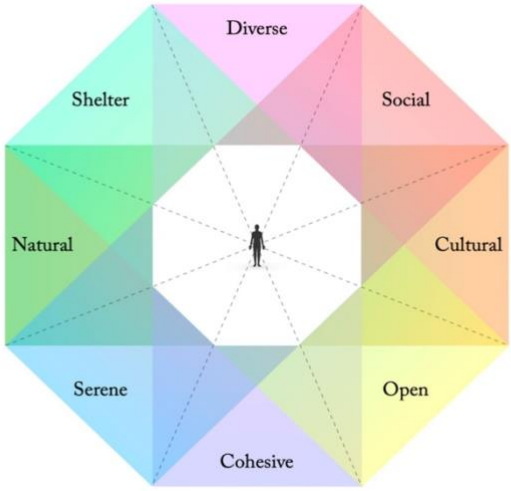

Figure 5. *The PSD model describes how different qualities relate to one another in an environment. Figure Caption Derived from Stoltz & Grahn (2021, p.06).*

The PSD model (Fig. 5) describes how different qualities relate to one another in an environment. Adjacent qualities are closely linked and can be easily supported together. Perpendicular qualities are neutral. In contrast, if two qualities are positioned opposite in the model, achieving a balance that aligns with individualised goals necessitates greater effort because of its opposing dynamic. Consequently, it is advantageous to concentrate on enhancing qualities that are closely related, as this approach significantly elevates the overall value of the space. To achieve it, supporting three related qualities concurrently is a strategic method for creating environments that function cohesively while minimising potential conflicts. However, adding a fourth quality may introduce challenges, requiring careful balancing of opposing characteristics. In practice, such combinations have been successful, as seen in the Alnarp Rehabilitation Garden (Stoltz & Grahn, 2021).

Table 13. *Shows the relational connection between qualities while the supporting adjacent qualities enhance the overall environment, and combining three related qualities can foster strong synergy with minimal conflict. Based on Stoltz & Grahn (2021, p.06), modified by the author of this thesis.*

Opposing Qualities	Perpendicular Qualities	Adjacent Qualities
PSDs: Contradictory/conflict	**PSDs: Neutral**	**PSDs: Strong synergy**
Natural – Cultural axis	**Natural Cultural axis to the**	**Natural - Serene – Cohesive**
Cohesive – Diverse axis	**Cohesive– Diverse axis**	**Serene - Cohesive – Open**
Sheltered – Open axis	**Sheltered – Open axis to the**	**Diverse – Social – Cultural**
Serene – Social axis.	**Serene– Social axis**	**Sheltered - Diverse – Social …**

5.2. PHASE II - Design Model

This process transforms the evidence explored into a coherent theoretical framework to create the initial stage of developing an evidence-based, child-centred model.

5.2.1. A New Framework for Understanding the Dimensions of PSD in Urban Green Spaces for Children's Health and Well-being

Collectively, these studies outline a critical role in children's perception and their perceived sensory qualities. This tool provides a nuanced understanding of the benefits the spaces can provide for their health and well-being. The evidence from the studies presented so far merges new attributes described below in Table 14.

Table 14. *Key attributes and considerations when analysing urban green spaces from a child's perspective. Derived from this study and created by the author of this thesis.*

Tool for Child-Centered Urban Planning Based on the Perceived Sensory Dimensions Model

SENSORY QUALITIES	ATRIBUTES	KEY REFERENCES
-PSD 1 Natural	-Diverse Natural Landscapes - Microenvironments around schools/neighbourhoods -Madure Tree Canopy - For early childhood development -Exploratory Trails - Natural trails hat fosters emotional well-being and resilience -Wild Ponds - Explorative natural wild ponds for discovery -Natural Loose Parts - Interaction with various textures, scents, and temperatures -Sensory Wild Gardens - Gardens designed for sensory experiences	-(Mårtensson, 2013) -(Louv, 2005; Roberts, 2009) -(Chawla et al., 2014) -(Jarvis et al., 2022) -(Kyttä, 2004) -(Heft, 1988; Jørgensen, 2014, 2016) -(Bartos, 2013).
-PSD 2 Cultural	- Sustainable plans and place making events - Interpretive signage - Elements for orientation and wayfinding - Educational landmarks like the Child Safety Input Tool - Affordances for shared use by children and adults -Play and Educational Elements, textures, scents, temperature variations and malleable materials. - Cultural heritage trails and Interactive art installations - Non-structured playground and gardens - Sensory gardens areas, Garden plots, Herbarium and Native plant species - Safety and pedestrian infrastructure	-(Victoria Derr et al., 2018). -(Bartos, 2013). -(Laaksoharju & Rappe, 2017) -(Johansson et al., 2020). -(Kytta, 2004). -(Heft, 1988). -(Chawla, 2020). -(Blair, 2009). (Nebelong, 2017). -(Fjørtoft, 2004). -(Babb et al., 2017).
-PSD 3 Cohesive	- Nurturing Wonder - Existential Encounters to Exploration - Child Health and Safety Measures - Cars-free City Planning - Addressing risk factors and Inequity	-(Jørgensen, 2016). -(Jørgensen, 2014; 2016). -(WHO, 2024). -(WHO, 2023).
-PSD 4 Diverse	- Multi-stemmed trees - Worn paths in the grass between stones - Educational learning about nature and seasonal changes - Diverse plant life species, Water features, Boulders and Tree trunks - Provide loose materials, areas for digging, and spaces for puddles and mud - Features to support play with dirt, sand, and snow - Features for splashing, pouring, and floating objects -Organic Pathways with fractal-inspired patterns Multisensory Engagement - Including throwing, digging, and climbing	-(Johansson et al., 2020). -(Mårtensson, 2013). -(Johansson et al., 2020; Herrington & Brussoni, 2015). -(Nebelong, 2017). -(Kyttä, 2004). -(Heft, 1988).
- PSD 5 Sheltered	- Addressing personal safety during light and dark hours and shadows for climate change - Ensure tree cover, climbable pine, like deciduous, mixed pine, and spruce trees. - Provide places for children to play and hide, such as shrubs. - Provide loose materials for building techniques like huts to promote group competence, physical activity, goal achievement, and curiosity. - Include climbing rocks and sliding activities in slightly steeper and rougher terrain - Shelter to create microclimates, perspective, refuge, and privacy. - Create safety balancing areas that are not too isolated to minimise risk. - Utilise various parts of trees, including leaves and branches.	-(Johansson et al., 2020). -(Fjørtoft & Sageie, 2000). -(Laaksoharju and Rappe, 2017). -(Jarvis et al., 2022). -(Heft, 1988). -(Heft, 1988). -(Laaksoharju & Rappe, 2017). -(Kytta, 2004).
-PSD 6 Open	- Green open spaces and grassy areas - Fewer paved surfaces - Reduced traffic - A strong sense of community and place - Clear visibility and easy visibility to others - Visibility of nearby buildings to promote a sense of safety - Openings for movement, observation, and auditory experiences	-(Jarvis et al., 2022). -(Babb et al., 2017). -(Johansson et al., 2020). -(Mårtensson et al., 2014). -(Kytta, 2004). -(Heft, 1988).
-PSD 7 Serene	- Stress-free City Planning - Safe and quiet zones with inclusive and open seating areas - Good visibility of nearby areas - Clear visibility and easily seen by others.	-(Aerts, 2018). -(Chawla, 2020). -(Johansson et al., 2020).
-PSD 8 Social	- Play facilities and sports facilities that are gender-specific - Use of vibrant colours and expressive designs - Inclusive design for people of all abilities - Sufficient lighting - Surveillance systems - Unobstructed sight-lines & Emergency call points - Events promoting community interaction, children participatory placemaking - Mature trees such as apple trees - Flat surfaces with smooth features - Climbable Features - Systems that support children's independent mobility - Safe paths for pedestrians and cyclists	-(Herrington & Brussoni, 2015). -(Kytta, 2004). -(Koller & Farley, 2019). -(Mårtensson et al., 2014). -(Johansson et al., 2020). -(Victoria Derr et al., 2018). -(Laaksoharju & Rappe (2017). -(Heft, 1988). -(Johansson et al., 2020, p.226) - (Wales et al.,2021)

Children 6 - 11 years old

5.2.2. Practical Implementation of the Tool

Mapping Sensory Qualities and Scale

The relationship between the perceived qualities and physical features of green spaces is complex and scale dependent. While perceived spatial dimensions (PSDs) reflect our experiences, physical attributes significantly influence these perceptions. High-quality stimulating green spaces can exist in smaller areas, especially regarding Sheltered, Diverse, Social, and Cultural PSDs. Nevertheless, restorative opposite qualities, such as Natural, Cohesive, Serene, and Open are typically found in larger spaces. Urban densification often leads to the reduction of green areas for construction, undermining their restorative benefits. Thus, it is essential to consider how reduced green space sizes affect their ability to provide relaxing environments (Stoltz & Grahn, 2021).

Large areas	Small areas	References
- Stimulative	**- Restorative**	(Stoltz & Gran,
Natural, Serene, Cohesive, and Open	**Sheltered, Diverse, Social, and Cultural**	2021).

Children's mental maps are shaped by their experiences and interactions within their environment. To serve effectively as landmarks, buildings and features must be engaging and stimulating, highlighting the need for diverse and complex neighbourhood designs (Johansson et al. 2020). For children, the perceived sensory qualities of green spaces can be particularly influential, and this relational approach is described visually below to understand the fundamental elements required to acknowledge PSD from a child's perspective to support their needs.

From Stimulative to Restorative Implications.

Figure 6. *The PSD Natural Quality. This area (Malmö, Sweden) appears to fully embrace the power of nature with minimal human intervention in large size. It showcases the resilience of the ecosystem (Photo by the author).*

Figure 7. *The PSD Cultural Quality. The Opera Park is a microenvironment space situated by the Copenhagen harbour. It boasts organic pathways adorned with fractal-inspired patterns of natural elements and native plant species. Visitors can explore natural trails that offer open-ended sequences of wonder (Photo by the author).*

Figure 8*. Cultural and Social Qualities. The surrounding microenvironment is depicted with natural wild ponds, pathways featuring fractal-inspired patterns of natural elements, native plant species, and a heritage landmark installation, as described in the images in Slottsträdgården Malmö (Photo by the author).*

Figure 9. *PSD Cultural Quality. The surrounding microenvironment is depicted with Garden plots, as described in the images in Slottsträdgården Malmö (Photo by the author).*

Figure 10. *PSD Cohesive Quality illustrates the factor of perceiving an environment as a unified and extended space, nurturing wonder and exploring existential encounters without being crossed by roads. It is located in Kungsparken, Malmö (Photo by the author).*

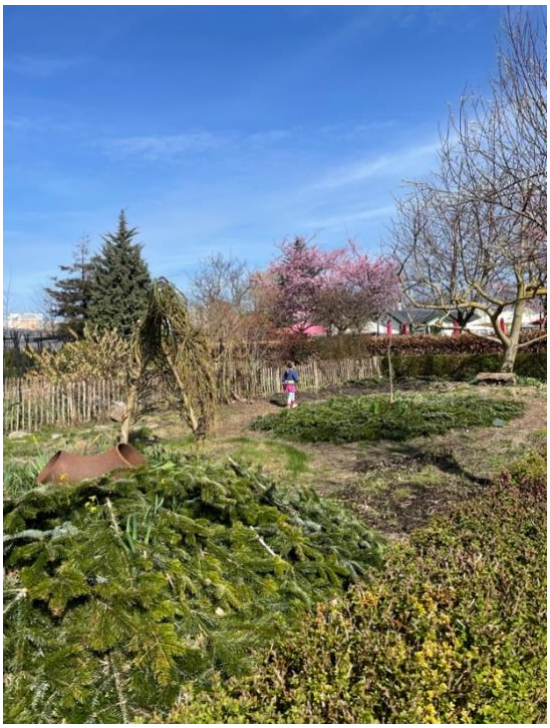

Figure 11. *PSD Diverse Quality. Emphasised the diversity surrounding and structural variation over unity and coherence. It provides loose materials, tree trunks, areas for digging, and spaces for puddles and mud so that children can shape their play environment, as described in the images in Slottsträdgården Malmö. (Photo by the author).*

Figure 12. *PSD Cohesive and PSD Diverse Qualities. This image depicts the nurturing of wonder and existential encounters through exploration. It showcases diverse plant life species, wild water features, boulders, and tree trunks. Additionally, the figure illustrates features for splashing and floating objects located in Bokskogen Torupsvägen, Bara (Photo by the author).*

Figure 13. *PSD Sheltered and PSD Open Qualities. The figure illustrates the contrasting characteristics of quality environments, prospects and refuge. Sheltered environments provide a sense of refuge and protection through enclosed spaces, while open environments offer unobstructed spaces with ample room for activities and emphasise serene surroundings, highlighting their role as safe havens and spaces for children. It is located in Afrikaparken, Bunkeflostrand, Malmö (Photo by the author).*

Figure 14. *PSD 5 Sheltered Quality. Provide areas for refuge and play, such as "huts" in the park, as illustrated in the images. It also provides shadow areas to mitigate climate changes. (Slottsträdgården Malmö, Photo by the author).*

Figure 15*. PSD 5 Sheltered Quality. Constructing "huts" in the park meets children's needs for group competence, physical activity, goal achievement, and curiosity, as illustrated in the image. Klagshamnsudden Malmö (Photo by the author).*

Figure 16. *PSD Sheltered. As shown in the image, climbing multi-steamed trees develops essential skills and seeks recognition. Located in Kungsparken, Malmö (Photo by the author).*

Figure 17. *The PSDs Serene and PSD Social. The image shows stress-free, good visibility of nearby areas, flat surfaces with smooth features, climbable features and play facilities. It is located in Sagolekplatsen, malmö (Photo by the author).*

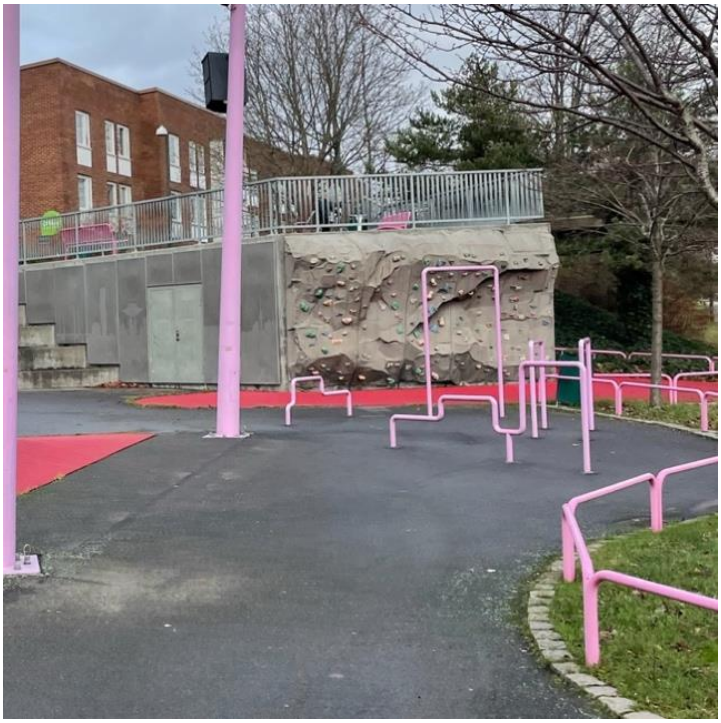

Figure 18. *The PSD Social. The image shows climbing features, as well as play and sports facilities. It is located in Rose's Red Carpet, Rosengård, Malmö (Photo by the author).*

Figure 19. *The PSDs Open and Social. The image shows a Stress-free area, with good visibility of the nearby regions and events promoting community interaction, particularly with children. It is located in Slottsträdgården Malmö (Photo by the author).*

Figure 20. *The PSDs Social, Diverse, Sheltered, and Cultural are included. The image depicts a sensory and pollinator garden with educational and interpretive signage, affordances for play, and wonder. It also has an overview of the surroundings. However, it is a bit enclosed between bushes, which is even noticed during summertime. It is located in Slottsträdgården Malmö (Photo by the author).*

6. Discussion

This study aimed to develop a practical approach to improve the health and well-being of children in urban settings. This study has provided valuable insights into designing friendly environments for children by considering Chawla's (2020) suggestion of using theory-based models to establish evidence linking children's development and nature. Thus, the principles outlined in this study explored the interaction of urban affordances and the evidence-based design implications when considering the health and well-being of the youngest generation. Considering that over half of the global population is estimated to be living in urban areas (UNFPA, 2023) and the increase in mental health issues among children (Socialstyrelsen, 2024), it has become crucial to consider new strategies to acknowledge those factors. For instance, adopting the Evidence-Based Model of Perceived Sensory Dimensions (PSDs) by Grahn et al. (2010) and Stoltz & Grahn (2021) has revealed a significant outcome, even more so when considering children at the forefront of this model; the study's outcomes are presented below.

Nevertheless, the research methodology recommends a four-stage approach for participants to analyse observed attributes without preconceived assumptions. It is worth noting that the study has only completed the first two stages, and those two stages are discussed below.

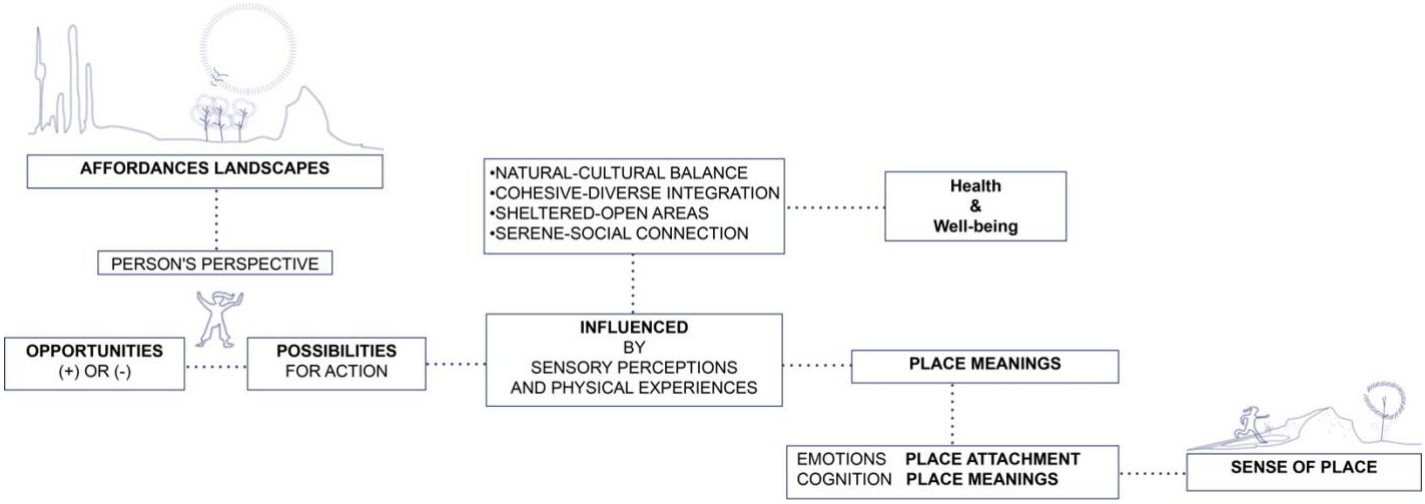

Figure 21. *Overview of the relational concepts based on the literature review. Modelled by the author of this thesis.*

6.1. Phase I

6.1.1. Exploring the Integration of Specific Attributes into Perceived Sensory Dimension Model from a Child's Perspective

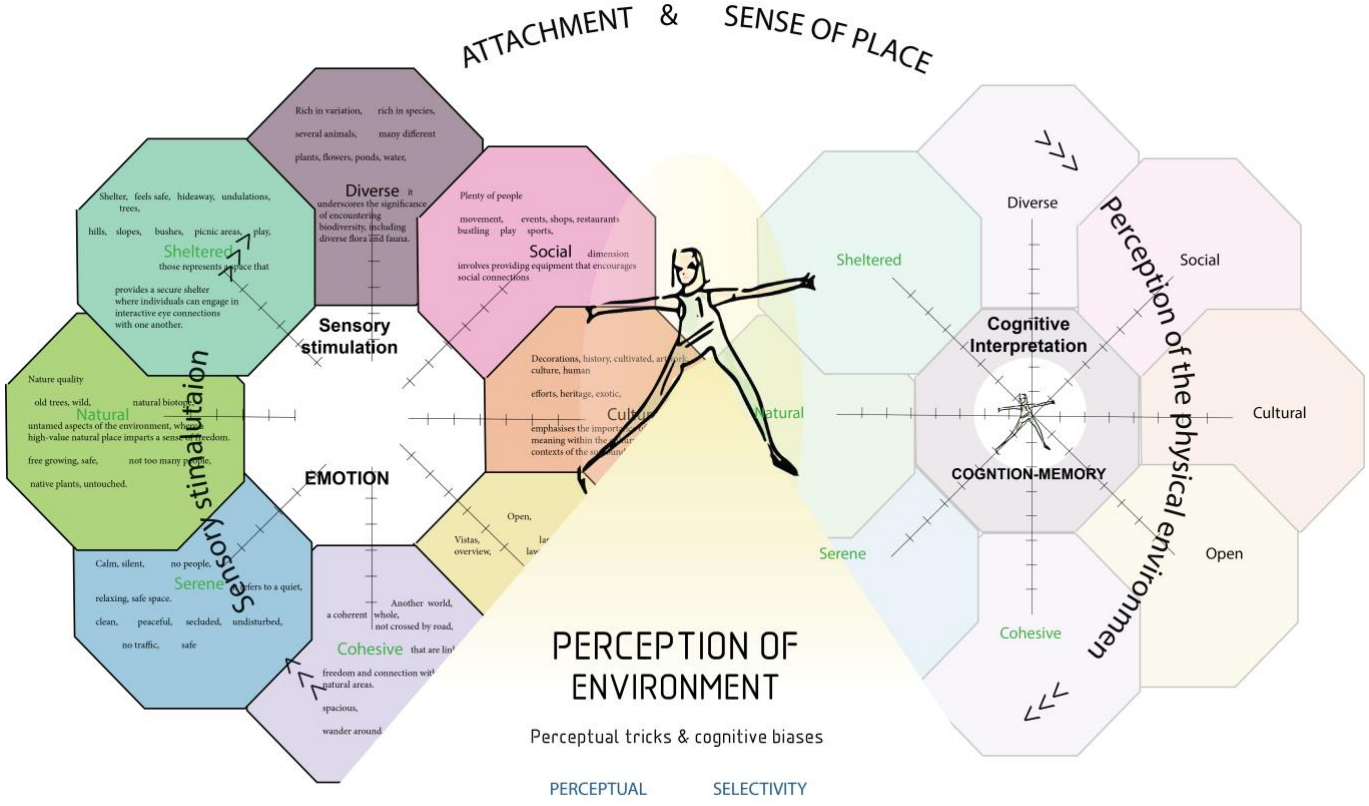

Figure 22. *Rates the relationship between children's perceptions and PSDs. It is visualised from the general to the specific user group of children. Remodelled by the author of this thesis with permission from Jonathan Stoltz.*

This study has found important findings regarding the impact of natural environments on children's development and well-being and how the possible applicability of the PSD model could enhance the urban natural environment if the model adapts to children's needs discussed among the four axes.

1. Integrating Evidence Between the Natural and Cultural Sensory Dimensions for Children

By emphasising the significance of experiencing the inherent power of nature, based on the outcome of the result, this quality associated with large areas should evoke a sense of freedom from daily life stressors, which promotes restorative outcomes (Stoltz & Grahn, 2021), It may be that children benefit from carefully considering various methods to promote children's health and well-being. To do it, the study underscores the importance of considering sustainable practices to enhance the connection with nature, even more during middle childhood, which is described as an essential age. However, this connection is influenced by age, gender, and family relationships (Fjørtoft, 2004; Chawla, 2020) and must be acknowledged when designing a nature-based approach.

A strong relationship between nature and well-being has been reported in the literature. Nature's healing effects are rooted in unconscious brain processes and emotional responses (Ulrich, 1999), suggesting that individuals rapidly and subconsciously gather essential information about their environment. This connection has a positive impact on children's cognitive and emotional development and enhances children's physical activity and motor development. Nature also has a therapeutic effect on children with Attention-deficit/hyperactivity disorder (ADHD) (Kuo & Faber Taylor, 2004). Therefore, nature is relevant to children's daily lives, providing green spaces in schools and around the neighbourhood (Chawla et al., 2014). It also minimises the negative effects of urbanisation's impact on children's well-being when the absence of nature in urban settings is increasing (Louv, 2005).

To acknowledge this, the result pointed out that urban planning strategies should increase higher levels of vegetation, tree cover, and grass cover in urban areas, which were associated with increased early childhood development scores (Jarvis et al., 2022) when positive early experiences have a lasting impact on future development (Hertzman & Power, 2004; Gluckman & Hanson, 2008). In essence, a child-centred design when focusing on the inherent power of nature without human intervention, should include hills, slopes, and varied wild vegetation, to support children's wayfinding, mobility physical activity and playful interaction with green spaces (Mårtensson et al., 2014; Johansson et al., 2020).

Most prominent was the substantial importance of the Cultural quality factor (see Table 15), which requires traces of human efforts and creative powers that contrast with the Natural quality (Stoltz & Grahn, 2021). As described in this study, it is hypothesised that natural and cultural qualities are very important among children.

Children may benefit when natural and cultural settings interact and support each other because human efforts are required to re-establish the absence of nature into their daily lives, while at the same time, a well-structured supportive system is present.

As reviewed in the literature, previous studies have demonstrated the importance of multisensory engagement in outdoor play and education, aligning with affordance theory. This framework, which utilizes the concept of functional affordances, emphasizes how children interact with their outdoor environments based on the perceived possibilities for action offered by the environment (Heft, 1988; Jørgensen, 2014). For instance, one of the most significant findings was how urban children develop a dual environmental identity, while rural environments encourage children to create their affordances. When the same object can offer various affordances depending on the observer's needs and desires, it has been noticed that in cities, children adopt more malleable behaviour, which has increased even more due to urban challenges, density, and climate issues. Therefore, a supportive and educational strategy that prioritises children should be considered a crucial cultural issue to acknowledge (Heft,1988; Johansson et al., 2020).

These findings are particularly noteworthy when compared to the PSD model, when this exploration shed light on being more susceptible to cultural and individual biases in assessing environmental quality. In contrast, Stoltz & Grahn's (2021) study shows how the significance of non-normative qualities lies in their potential for reliable evaluation across diverse environments, largely independent of subjective personal taste or cultural biases. Further research is needed to better understand how these non-normative qualities relate to children's needs and how the statement that children from different environments perceive and utilise different opportunities is based on their understanding of affordances (Kyttä, 2002).

This finding is consistent with that of Johansson et al. (2020), who state how a multimodal approach, which involves using multiple senses simultaneously, enables children to effectively navigate complex environments by enhancing their ability to recognise subtle cues from environmental attributes and fostering a sense of interest and engagement (AQR, 2013). For instance, the study revealed that providing existential experiences with landscapes such as powerful and impactful moments and heightened environment awareness, shapes a child's self-perception and worldview, influencing their values, beliefs, and behaviours. That experience is intrinsically linked to a sense of wonder (Jørgensen, 2016). Those attributes serve as a clue that is essential to consider when designing urban planning strategies.

Therefore, supporting freedom of movement and establishing robust support systems for outdoor activities among the young population are vital (Wales et al., 2021). However, this study has highlighted how parents and institutions are responsible for promoting children's healthy development and positive outdoor experiences, the concerns of dangers or risks associated with unsupervised activities have led to parents limiting children's independent exploration of their neighbourhoods, significantly decreasing such activities. Furthermore, the rise in passive indoor activities competes with outdoor pursuits, and children who use public spaces often face resistance from adult residents when the changes in children's outdoor play and increased parental restrictions can hinder their development (Loebach & Gilliland, 2010; Kyttä, 2004; Mårtensson, 2004).

To do it, Mårtensson (2013) has also revealed crucial insight regarding the access to outdoor environments for children, which require supportive areas with abundant play opportunities and ample interaction with nature, positively impacting children's health and encouraging the adoption of an active and healthy lifestyle. This balance is even crucial in developing children's health and well-being because, at this age, children require diverse opportunities and the freedom to explore their neighbourhood. In essence, children benefit from planting and caring for plants to help foster a deeper connection to nature and environmental stewardship (Nebelong, 2017). Opportunities for children to plant and nurture crops instil a sense of responsibility and hands-on learning experiences in food cultivation (Blair, 2009). It is also relevant to incorporate vibrant colours and bold expressions in buildings, signage, urban furniture, and strategically placed playgrounds while emphasising differences in affordances between boys and girls (Johansson et al., 2020; Kyttä, 2002).

Finally, this study highlights how our environment affects our learning, health, and well-being, coupled with the challenges posed by urbanisation and restrictions on children's outdoor activities, underscores the importance of empowering young individuals to access a healthy outdoor environment and confront environmental issues. This empowerment not only instils hope but also prepares them for ongoing ecological action (Bishop & Corkery, 2017; Chawla, 2020).

The relational factor is described in a comparative table of those two axes in Table 15 below.

Table 15. *Factors to consider when analysing children's experiences with Nature and Culture through outdoor exploration and interplay. By the author of this thesis.*

Outdoor exploration and	Children's interplay
-PSD 1 Natural	**-PSD 2 Cultural**
Middle childhood is a crucial period for fostering children's connection with nature through sustainable practices. This connection, influenced by age, gender, and family relationships, is essential for their cognitive and emotional development. Enhancing urban outdoor environments requires: - Empowering children to address environmental concerns cultivates hope to enhance them with nature. - Providing green spaces in schools and neighbourhoods to increase physical activity and motor development. - Minimizing the negative effects of urbanization by increasing vegetation, tree cover, and grass cover. - Focusing on the inherent power of nature, including hills, slopes, and varied wild vegetation, to foster a deep and meaningful connection with the natural world.	- Promote open-ended play by creating spaces that encourage exploration, wonder and imagination. - Prioritize vegetation by utilizing diverse vegetation, considering size and integration of plants. - Consider cultural needs by addressing the diverse needs and perspectives of children from different cultural backgrounds. - Foster existential experiences by providing opportunities for children to connect deeply with nature, shaping their worldview. - Support freedom of movement by reconsidering concerns about dangers or risks associated with unsupervised activities and establishing robust support systems for outdoor activities. - Ensure community acceptance by creating a welcoming and inclusive environment for children using public spaces. - Provide access to nature by increasing access to green spaces with abundant play opportunities. - Promote active lifestyles by encouraging physical activity and healthy living through outdoor spaces. - Empower environmental stewardship by engaging children in activities like planting and caring for plants.

2. Integrating Evidence Between the Cohesive and Diverse Sensory Dimensions for Children

Understanding the cohesive quality in spatial design among children, this quality, which involves perceiving an environment as a unified and extended space (Stoltz & Grahn, 2021), may differ when it refers to children’s perspective. For instance, a serene environment was presented as essential for creating a sense of belonging and security outdoors, especially for children exploring the world independently. However, children's independent mobility is particularly influenced when street environments are free from traffic (Babb et al., 2017). Thus, it demands a variety of attributes that should be considered, and this study explored also those elements.

This study is consistent with those who state that children perceive spaces differently than adults. These relations are supported by children's interpretation of landscapes and the opportunities they present because their sensory and physical experiences heavily influence their perceptions of their surroundings, highlighting the significant role of personal experiences. Children understand the world by engaging with different textures, smelling scents, feeling temperatures, and

exploring their environment. These experiences are profound and transformative, challenging children's beliefs and encouraging them to explore new ideas and perspectives, which foster a deep connection, care, and responsibility towards nature (Jørgensen, 2014; Jørgensen, 2016; Chawla, 2020). This finding shed light on the critical role of creating stimulating cities where sensory engagement is crucial for healthy development

In this regard, Bartos's study (2013) also shows the interconnection of a sense of place, sensory experiences and emotional attachment in the positive impact of childhood experiences on children's connection with their environment. To understand it, another possible explanation for this is that the sense of place and the embodiment of wonder foster sensibility towards the environment. This sense of wonder is linked to embodied and situated experiences and the sense of place among children. Therefore, their bodily expressions, movements, and sounds are crucial in making meaning. Peer interactions and the profound connection, care, and responsibility towards nature also influence these meanings. The interconnectedness of living organisms and appreciation of nature's beauty and diversity are essential factors in cities' surroundings. The study also highlights the unified and extended space by designing non-structured areas that allow children to explore and encourage creativity, sparking a sense of wonder in the natural world (Jørgensen, 2016).

Providing a better environment for children's health becomes an urgent need. For instance, this study shed light on the prevalence of non-communicable diseases among children, which is increasing due to risk factors of daily unhealthy incomes, particularly in areas with environmental injustices. It is crucial to prioritise improving child health (WHO, 2024). When lifestyle and stress impact global health issues, our daily choices and the pressures we face are the principal factors to pay attention to (WHO, 2023).

Another finding was by Babb et al. (2017), which shows that children's health and well-being should be considered by designing parks and play settings with green open spaces to facilitate independent mobility. At the same time, it stated that street environments should be constrained by traffic to support their security and freedom. Addressing these issues requires collaboration across different sectors and integrating cohesive environments focusing on it, which may better meet children's needs. This outcome is contrary to Diversity quality (see Table 16), which emphasises the importance of proving children's diverse surroundings and structural variation over unity and coherence. This quality is essential for places like schools and preschools (Stoltz & Grahn, 2021), where children spend most of

their daily time. The study underscores this factor and reveals diverse elements where children can find support while encountering healthy development.

The finding was reported by Johansson et al. (2020), who emphasised the importance of incorporating natural elements that can provide sensory experiences, opportunities for learning about nature, and seasonal changes when designing a play space for children. They also encourage adapting a variety of vegetation that may offer many opportunities for children's play and exploration. Plant life improves the area's ability to withstand active play, promoting dynamic movement and open-ended play sequences where children can shape and transform their play environment (Mårtensson, 2013; Nebelong, 2017). These results reflect those of Laaksoharju and Rappe's (2017), who also found that the interaction between children and natural materials, particularly trees, in play environments encourages the use of various parts of trees for imaginative play, seeking privacy and comfort around trees to engaging in long-lasting, imaginative play as they become more familiar with the space.

The present results of this quality are significant in at least two major respects. A diverse setting promotes unstructured play, which is crucial for cognitive and emotional development while establishing strong support systems for outdoor activities (Cox et al., 2018; Wales et al., 2021). For instance, when designing outdoor play spaces for children, it is crucial to focus on creating diverse play opportunities rather than just promoting physical activity, including natural elements as a primary factor (Mårtensson, 2004; Herrington & Brussoni, 2015). Therefore, outdoor settings may promote children's physical activity and motor development, as well as environmental responsibility and sustainable behaviours (Fjørtoft, 2004; Blair, 2009; Chawla, 2020).

In this regard, it is important to recognise that the PSDs can interact and even potentially interfere with one another. To better acknowledge those different approaches, see Figure 23 to understand the potential conflicts.

The relational factor is described in a comparative table of those two axes in Table 16 below.

Table 16. *Factors to consider when analysing children's experiences with Cohesive and Diversity through outdoor exploration and interplay. By the author of this thesis.*

Outdoor exploration and	Children's interplay
-PSD 3 Cohesive	**-PSD 4 Diverse**
- Improve children's independent mobility by creating street environments free from traffic to support their security and freedom. - Engage children with their environment by allowing them to experience different textures, smells, and temperatures, challenging their beliefs and encouraging exploration of new ideas and perspectives. - Foster a deep connection to nature by taking attention to the interconnection of a sense of place, sensory experiences, and emotional attachment in the positive impact of childhood experiences. - Develop a sense of place and wonder by focusing on embodied and situated experiences, recognizing the link between the sense of wonder and the sense of place among children. - Encourage meaningful expression by supporting bodily expressions, movements, and sounds, recognizing their importance in making meaning. - Promote environmental stewardship by emphasizing the interconnectedness of living organisms and appreciation of nature's beauty and diversity. - Designing unified and extended spaces, non-structured allow children to explore and encourage creativity.	- Enhance sensory experiences by incorporating natural elements that can provide sensory experiences, opportunities for learning about nature, and seasonal changes. - Support cognitive and emotional development by promoting unstructured play. - Increase play opportunities by encouraging the adaptation of a variety of vegetation that offers many opportunities for children's play and exploration. - Promote active and imaginative play by incorporating plant life that improves the area's ability to withstand active play, promoting dynamic movement and open-ended play sequences. - Foster imaginative play by providing interaction between children and natural materials, particularly trees, using various parts of trees for imaginative play. - Encourage prolonged play by engaging children with privacy and comfort around trees to engage in long-lasting, imaginative play as they become more familiar with the space. - Encourage outdoor activity by establishing strong support systems for outdoor activities.

3. Integrating Evidence Between the Sheltered and Open Sensory Dimensions for Children

One of the critical challenges to embrace is the balance between Shelter and open qualities, mainly when we focus on children's safety and well-being. Even more, by considering the current challenge regarding climate issues, it becomes imperative to consider it from different angles. For instance, access to Sheltered quality environments that offer a sense of protection is associated with enclosed spaces, which are vital for restoration (Stoltz & Grahn, 2021). However, for children, it requires careful consideration. It is an important aspect to consider for their safety.

It is well described by Stoltz, (2019) how the PSD framework is consistent with Appleton's *Prospect-Refuge Theory* (1975a) as the instinct of humans to prefer landscapes that offer the opportunity to see without being seen as prospects and places of refuge. However, children, who are the focus of this study, have distinct

preferences. They prefer playing in their neighbourhood, valuing personal space, and exploring natural landscapes. When urban open spaces, ensure they feel safe and comfortable. The built structures and greenery design should prioritise clear views and visibility of nearby buildings (Mårtensson et al., 2014; Chawla, 1992, 2020). Therefore, to recognise and respect these preferences, it is imperative to design a friendly environment that provides them with a supportive outdoor system with plenty of opportunities to grow and joy (Chawla, 2020; Wales et al., 2021). Positive early experiences have a lasting impact on future development, underscoring the importance of early childhood for lifelong well-being (Hertzman & Power, 2004; Gluckman & Hanson, 2008).

These relationships may partly be explained by Laaksoharju and Rappe (2017), who explain that children connect with the natural environment by using various parts of trees for imaginative play, and they also seek privacy and comfort around trees. Climbing trees are popular among children, helping them develop essential skills and seek recognition. In addition, the physical appearance of trees played a significant role in various play activities (Fjørtoft & Sageie, 2000). The finding also revealed that the shrubs influenced play activities such as hiding and building shelters. In contrast, the topography played a role in more challenging activities like climbing rocks and sliding (Heft, 1988). Those factors are even more relevant when considering Jarvis et al. (2022) study, which found that higher levels of vegetation, tree cover, and grass cover in urban areas are associated with increased early childhood development scores compared to paved surfaces.

The finding also suggests more attributes to enhance children’s shelter by providing loose natural material which allows children to have building techniques, such as constructing huts in the forest, that meet children's needs for group competence, physical activity, goal achievement, and curiosity (Laaksoharju & Rappe (2017). To promote those factors, it is crucial to find a balance between creating secluded play areas and ensuring they are not isolated to pose a safety hazard is vital. In addition, designers need to consider the shift from daylight to darkness, especially in regions with high latitudes during the winter session (Johansson et al., 2020), which emphasises the importance of considering affordance in outdoor space policies and planning (Fjørtoft & Sageie, 2000), to encourage children to engage in outdoor activities, regardless of the season or time.

On the other hand, this shelter quality outcome is partially contrary to Open (see Table 17) regarding its need for small, enclosed spaces essential for restoration. The Open quality, well explained by (Stoltz & Grahn, 2021), relates to large, ample space for activities with an emphasis on views and unobstructed environments.

Children often prefer areas that offer open space and shelter to feel secure while observing their surroundings (Mårtensson et al., 2014).

There are several possible explanations for this by understanding how child-friendly environments encourage and support high levels of independent mobility among children. When they provide opportunities for children to participate in various activities, considering green open spaces promotes children's independent mobility (Kyttä, 2004; Johansson et al., 2020; Babb et al., 2017), prioritise clear views and visibility of nearby buildings while also having places to hide, engaging gender-based areas and ensuring children's safety and freedom within a traffic-free environment. The study shows increased physical activity and play among children (Johansson et al., 2020; Mårtensson, 2004; Mårtensson et al., 2014). Additionally, providing a larger play area allows children to participate in a wider range of activities, encouraging exploration and a sense of adventure. Furthermore, a variety of spaces in the outdoor area should be evaluated based on how well they support adaptable and unstructured play, thereby encouraging children to move actively. Underscoring that nature, open areas and play spaces should be arranged together (Mårtensson, 2013).

The relational factor is described in a comparative table of those two axes in Table 17 below.

Table 17. *Factors to consider when analysing children's experiences with Shelter and Open through outdoor exploration and interplay. By the author of this thesis.*

Outdoor exploration and	**Children's interplay**
-PSD 5 Sheltered	**-PSD 6 Open**
-Create supportive outdoor systems with plenty of opportunities for growth and joy. -Design refuges by incorporating clear views and visibility of nearby buildings in the built environment. -Encourage imaginative play by providing various parts of trees for imaginative play and creating privacy and comfort areas around trees and shrubs for activities like hiding and building shelters. -Provide varied terrain by incorporating topography for activities like climbing rocks and sliding. -Prioritise natural and loose that allow children to build and explore the settings. -Ensure safety in secluded areas by finding a balance between creating secluded play areas and ensuring they are not totally isolated. Consider seasonal changes from daylight to darkness, especially in regions with high latitudes during the winter season.	-Support open green areas by designing spaces that allow children to play in their neighbourhood, valuing personal space and opportunities for exploring natural landscapes. -Promote active play by creating open environments that increase physical activity and play among children. -Encourage independent mobility by designing child-friendly environments that encourage and support high levels of independent mobility among children. -Provide safe and secure open spaces that allow children to feel secure while observing their surroundings. -Designing green open spaces that prioritize clear views and visibility of nearby buildings while also offering places for children to hide.

4. Integrating Evidence Between the Serene and Social Sensory Dimensions for Children

One of the challenges we face in the urban environment is to perceive serene natural qualities, with a preference for peaceful and calm surroundings, soothing natural sounds, and the ability to focus inwardly, which are linked to stress relief, nature and cohesive dimensions (Stoltz & Grahn, 2021). In this regard, Kaplan (1995) suggests that exposure to natural environments can serve as a respite from the cognitive demands of our daily lives while offering restorative experiences. By acknowledging biophilic design principles, integrating natural elements into human-made spaces for well-being (Kellert, 2018) is a crucial factor in promoting human well-being.

The results of this study show the importance of empathetic urban planning for children's needs. Johansson et al. (2020) study suggests four key frameworks to improve open spaces and promote independent mobility, foster emotional bonds with neighbourhoods, understand the affordances of physical features and enhance children's orientation and control (Table 18). Parents and institutions should promote children's healthy development and positive outdoor experiences by providing supportive environments with diverse opportunities and the freedom to explore independently (Kyttä, 2004; Wales et al., 2021).

Table 18. *The elements of Urban planning, design, and management should consider accommodating children's specific needs. Based on Johansson et al. (2020, p.230), reprinted by the author of this thesis.*

Urban planning, design and management need to
(i) consider and provide physical features and social aspects that enable children to develop and maintain emotional bonds, such as attachment to their neighborhood;
(ii) seek to understand what various places and physical features might offer, or afford, to children, what patterns of behavior these objects may trigger, and how these affordances can build and support children's independent active mobility;
(iii) understand how the urban environment facilitates children's orientation and wayfinding and thereby provide control in the urban environment; and
(iv) address how the environment supports the perception of personal safety during light and dark hours by attending to prospect and refuge.

One other interesting finding is the importance of creating peaceful havens within schools by incorporating green spaces, which can offer unique opportunities for children to engage in calming activities. These spaces can reduce stress, foster resilience, and promote emotional regulation by providing children with a place to

navigate their feelings and experiences (Chawla et al., 2014). This finding was also reported by Wales et al., (2021), where the importance of natural spaces for reflection requires a combination of play, which helps them to develop their support system of routines, practices, and norms to adapt to their childhood environment.

On the other hand, in contrast with the serene quality is the social quality, which requires the presence of other people for social interactions, it is also related to the cultural and diverse dimensions (Stoltz & Grahn, 2021). In these results (see Table 19), the study found that the main principle to acknowledge is recognising meticulous planning, as emphasised by Johansson et al. (2020). It means creating a balance between engaging environments that enhance safety, which is paramount to promoting independent and active mobility for the well-being of children. Chawla (2020) sheds light on the negative impacts of spending excessive time indoors and decreased connection in adolescence and encourages emphasis on nature's connection to positive experience, creativity, and pro-social behaviour, which fosters a willingness to conserve nature and engage in pro-nature behaviours. This finding is reassuring since the study shows variation between the ages of 6 to 11 and adolescence, where the youngest develops a sense of self-identity, often influenced by their physical abilities and skill in creating things that society values. They also begin to form relationships with animals, objects, and people and usually prefer to play and socialise with peers of the same gender. They enjoy playing in their yards and on the streets near their homes, exploring their local surroundings, and appreciating natural landscapes (Chawla, 1992). This finding can effectively contribute to children's health and development, emphasising the irreplaceable role of social play, independent mobility, and nature as essential components.

A note of caution is due here since children often prefer play and socialising areas with various play settings with green open spaces and shelter for their activities and age-based interaction, as I mentioned. It is relevant because it makes them feel secure while observing their surroundings and increases connection among them (Mårtensson et al., 2014). Johansson et al. (2020) also show how physical attributes, and social elements play a pivotal role in aiding children in forming and sustaining emotional connections, specifically in developing an attachment to their neighbourhood. That is even more relevant concerning Morgan's (2010) study of *Place Attachment Theory* when the emotional connection with places fosters a sense of belonging and self-identification between a person and place.

By considering city planning needs, the study highlights that carefully considering physical features such as building density, green spaces, architectural aesthetics, and social factors, including security and opportunities for social interaction (Bonaiuto et al., 2003, 2006) is essential when approaching child-centred design.

For instance, children harbour genuine concerns regarding pedestrian infrastructure and safety (Babb et al. (2017). It highlights the importance of addressing these issues to create safe and healthy neighbourhoods to encourage social skills.

The relational factor is described in a comparative table of those two axes in Table 19 below.

Table 19. *Factors to consider when analysing children's experiences with Serene and Social through outdoor exploration and interplay. By the author of this thesis.*

Outdoor exploration and	**Children's interplay**
-PSD 7 Serene	**-PSD 8 Social**
-Acknowledge the negative impacts of excessive indoor time by emphasizing nature's connection to positive experiences, creativity, and pro-social behaviours.	-Balance safety and engagement by creating stimulating environments that prioritize safety to promote independent and active mobility.
-Design empathetic urban planning that considers children's needs.	-Design inclusive play areas with diverse settings, green spaces, and shelters to accommodate various activities and age-based interactions, fostering social connections while observing surroundings.
-Enhance children's understanding of their environment by understanding the affordances of physical features and enhancing their orientation and control.	-Promote social and emotional development by incorporating physical features and social elements that help children form emotional connections and a sense of belonging to their neighbourhood.
-Promote mental well-being by creating peaceful havens within schools that offer opportunities for calming activities, reducing stress, and fostering resilience.	-Plan for children's needs by considering physical features like building density, green spaces, and safety alongside opportunities for social interaction in urban planning approaches.
-Support healthy development by providing natural spaces for reflection and play, helping children develop supportive routines and adapt to their environment.	-Prioritize safe pedestrian infrastructure to address children's safety concerns and encourage social interaction.
-Foster a sense of self-identity by encouraging children to explore their abilities and engage in activities valued by society.	-Foster inclusive and healthy cities through placemaking in collaboration with communities and professionals.
-Encourage social interaction by encouraging relationships with animals, objects, and people.	-Address needs of vulnerable youth by working with interdisciplinary groups to acknowledge the perspectives of children and adolescents in disadvantaged areas.
-Design inclusive spaces by avoiding gender-based areas for play and socialization.	-Promote sustainable and inclusive cities through cross-cultural and interdisciplinary collaboration.
-Promote neighbourhood play by designing nearby areas for children to enjoy playing in their yards and on the streets.	

Therefore, these findings collectively emphasise the crucial role of perceived sensory qualities in shaping children's environmental understanding, with significant implications for Child-Cantered environmental design for urban environments.

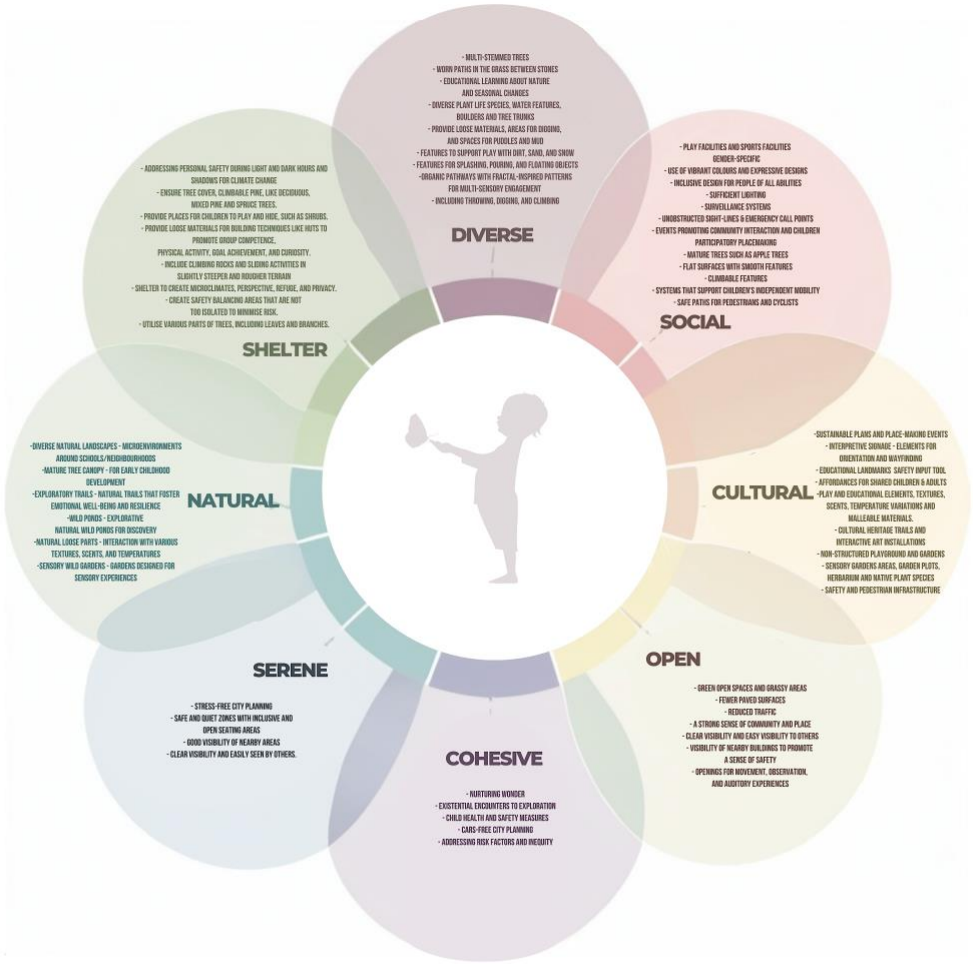

Figure 23. *Supporting adjacent qualities enhances the overall environment, and combining three related qualities can foster strong synergy with minimal conflict. Based on the result of this study and inspired by the PSD model from Stoltz & Grahn (2021), modified by the author of this thesis.*

Similar to colours, the PSDs can manifest differently in each environment and may interact or even interfere with one another. This exploration may support the hypothesis that the relationship between Nature and Culture exemplifies the intricate interconnectedness of children's environments. While Table 15 may initially suggest a predominance of cultural influences, it is crucial to acknowledge the simultaneous need for human effort to integrate nature into more sustainable practices.

The interaction between diversity and cohesion highlights the importance of providing opportunities for diverse and unstructured play within a safe and supportive environment that considers children's needs for comfort and independence during outdoor activities. As you see in Table 16, it initially

emphasises the importance of diverse elements. It is also crucial to acknowledge the simultaneous need for a cohesive environment that provides a sense of security and belonging for children.

Recognising the potential conflicts among opposing PSDs is essential. However, the findings reported in Table 17 suggest that a supportive system integrating Sheltered and Open qualities is crucial for child-centred urban planning. Thus, this should imply that prioritising three adjacent PSDs, such as Natural, Sheltered, and Diverse (Fig, 23), may be more effective than attempting to equally support two opposing qualities. Thus, incorporating a fourth quality, such as openness, requires careful consideration for balancing them and mitigating potential conflicts with existing priorities.

Urban planners, architects, landscape designers, and policymakers are responsible for creating child-friendly environments. Their decisions must carefully consider the interplay of these PSDs (Table 20) to ensure the well-being and development of children in urban areas. Further research is needed to fully understand the synergies and tensions among these dimensions in various urban contexts when considering children at the forefront.

Understanding PSD Synergies and Conflicts.

Finally, to inform design decisions for urban planners and designers, they should focus on potential synergies and conflicts between different PSDs. The guideline below is derived from Stoltz and Grahn's (2021) study.

- Recognise that within this model, some PSDs are inherently opposing. When Natural might oppose Cultural, Cohesive might oppose Diverse, Sheltered might oppose Open, and Serene might oppose Social.
- Recognising potential conflicts of opposite qualities may be necessary to have careful attention to balance such a conflict.
- Perpendicular axes may be considered neutral in their relationship within the model. Such as the Natural-Cultural axis concerning the Cohesive-Diverse axis, and the Sheltered-Open axis to the Serene-Social axis.
- Prioritise adjacent qualities that share common and related associations to enhance urban green spaces which are less conflictive with each other. For instance, it supports three adjacent qualities: natural, sheltered, and diverse.
- Adding a fourth quality may create significant tensions that require careful balancing if it is directly opposite one of the three already supported qualities. Fourth or more qualities might involve emphasising existing qualities or finding creative solutions to mitigate potential conflicts.

6.2. PHASE II

6.2.1. Exploring the New Framework of Understanding the Dimensions of PSD in Urban Green Spaces for Children's Health and Well-Being

While the PSDs are defined primarily in terms of perceived qualities rather than specific physical attributes, a strong correlation often exists between those qualities. Certain physical attributes may consistently evoke specific PSDs, regardless of context, and this is particularly evident in the case of physical scale (Stoltz & Grahn, 2021). While high-quality green spaces can be achieved within smaller areas, the feasibility varies across PSDs. Sheltered, Diverse, Social, and Cultural qualities may be enhanced by denser planning and design. However, opposing qualities like Natural, Cohesive, Serene, and Open often necessitate larger green spaces for optimal expression (Berggren-Bärring & Grahn, 1995).

An initial objective of this study was to identify how children aged six to eleven perceive and experience outdoor environments. Findings suggest that these children typically enjoy playing in their neighbourhoods, value personal space, and love exploring natural landscapes, while empowering the younger generation to tackle environmental concerns is crucial. This approach not only cultivates hope for a sustainable future but also enhances cognitive and emotional development (Bishop & Corkery, 2017; Chawla, 1992; Chawla, 2020). This finding reveals a vital stage for city planners and policymakers to consider.

To understand it, this study explored the complexity of urban outdoor dimensions and found the relevant outcomes when planning a supportive environment for children. A possible explanation for this might be the Outdoor Play Environment Categories (OPEC) tool, which assesses preschool play areas based on three key factors: Outdoor play area size influences children's activity engagement and sense of exploration. Ample vegetation enhances the space's resilience. The proportion of shrubs, trees, and hilly terrain affects play options and social interaction. Integrated settings promote flexible play sequences and dynamic movement. This tool emphasises the role of vegetation in creating resilient and engaging outdoor environments for children (Märtensson, 2013).

It is pertinent also to mention how various studies have widely acknowledged the crucial role of placemaking in collaboration with communities, professionals, and organisations to create inclusive and healthy cities. Giving voice to and understanding the needs of residents are essential factors to consider in urban planning. In this regard, the Child-Friendly Cities initiative by UNICEF has a valuable framework that addresses children's rights, also offering culturally enriching experiences for children's socialisation (Child-Friendly Cities, 2022). UNESCO, which connects the work by Kevin Lynch, also highlights the importance of working with interdisciplinary groups to address the needs of children and adolescents in vulnerable urban areas. It is even crucial for city leaders to acknowledge this interest in the perspectives of young people (UNICEF, 1989). To create sustainable practices and inclusive cities, cross-cultural and interdisciplinary collaboration becomes essential.

Nevertheless, the 1989 UN Convention on the Rights of the Child (UNCRC) established new policies to protect children from harm, provide basic needs, and allow them to participate in decisions that affect their lives. Sweden recently recognised the UN Convention on the Rights of the Child as law in January 2020. It emphasises the significance of involving children and youth in urban planning (Victoria Derr et al., 2018). That establishes the foundation for approaching child-friendly cities in Sweden's governance.

Finally, understanding the intricate relationship between individuals and their environment through sensory experiences is pivotal for examining the impact of environmental factors on overall well-being. Investigating the chemical senses offers valuable insights into how ecological components influence well-being. This process facilitates the formation of coherent and meaningful experiences from disparate sensory data, deepening our comprehension of the world. For instance, when observing an apple, the brain amalgamates visual, olfactory, and tactile cues, culminating in recognising the fruit and often triggering associated memories (Mather, 2011). This is essential as children's perceptions of their environment are deeply influenced by their sensory experiences.

Based on the result, the study suggests a potential link between PSDs and enhanced children's mental maps, thereby contributing to their independent mobility within the neighbourhood. These mental maps, crucial for independent movement, may form through experiences and interactions within the perceived qualities of the urban environment. However, this finding requires further investigation to confirm its significance. Although some association exists between adult and child environmental preferences, the comparative literature review in Table 20 underscores significant differences in these preferences.

Table 20. *A comparative framework for analysing children and general users in their exploration and interplay with PSDs. Created by the author of this thesis.*

PSD	**Exploration**	**and**	**Interplay**
Sensory Qualities	**Research Report on Child Preferences**	**Research Report on General Preferences**	**Main Differences**
-PSD1 Natural Stimulative & large areas	- A varied landscape, mature trees, exploratory trails, wild ponds, natural loose parts, and sensory gardens foster holistic child development for their health and well-being in a natural urban environment.	- Environments shaped by natural forces, independent of human intervention, evoking a sense of inherent power, spontaneity, and freedom, wilderness, though individual natural elements can contribute to this quality in smaller spaces. For stimulative outcomes in large areas.	Children need a multisensory engagement outdoors for play; activities such as throwing, digging, and climbing foster positive place attachment, while natural loose parts encourage embodied experiences through tactile, olfactory, and thermal stimulation.
-PSD2 Cultural Restorative & small areas	- It considers a plan for creating child-friendly and engaging public spaces by integrating sustainable practices, interpretive elements, educational tools, shared-use affordances, diverse play and learning opportunities, cultural connections, natural play areas, sensory experiences, and robust safety infrastructure.	- It is perceived as traces of human activity and cultivation, encompassing values, beliefs, and efforts evident over time, contrasting with the "Natural" quality and often associated with specific areas. For restorative outcomes in small areas.	A sustainable place-making balances; environmental, economic, and social factors. While non-structured areas with vibrant designs, encourage play with safe and accessible infrastructure to support children's independence and integrated play and learning experiences, including food-growing, fostering creativity and development.
-PSD3 Cohesive Stimulative & large areas	- This approach prioritises fostering children's curiosity and exploration through existential encounters with nature while ensuring their health and safety through measures like car-free city planning and addressing risk factors and inequities.	- It reflects the perceived capacity of an environment to create a unified and immersive spatial experience, fostering a sense of being within a cohesive whole, often associated with spaciousness and requiring uninterrupted areas. For stimulative outcomes in large areas.	It aims to enhance children's independent mobility via traffic-free streets, stimulate sensory engagement with diverse elements to broaden perspectives, cultivate wonder through embodied learning to foster meaningful expression and design unified but non-structured areas for exploration and creativity.

-PSD4 Diverse Restorative & small areas	- This approach prioritises engaging natural play spaces for children, incorporating multi-stemmed trees, worn paths, nature-based learning, diverse natural elements (boulders, tree trunks), loose materials, digging and water play areas, all-weather play features (dirt, sand, snow), organic pathways, and multi-sensory activities.	- It reflects the perceived variety and complexity of an environment, encompassing biodiversity, structural variation (e.g., textures, colours, elements), and spatial alterations, contrasting with the "Cohesive" quality and highly valued in spaces for schools, preschools, and elderly care. For restorative outcomes in small areas.	For children, this approach enhances their sensory, cognitive, and emotional development by incorporating diverse natural attributes especially loose natural elements and trees, to foster unstructured and imaginative play. It also increases play opportunities and establishes strong support systems for their outdoor activities and development.
-PSD5 Sheltered Restorative & small areas	- This approach prioritises children's safety and well-being in all lighting conditions, incorporates diverse tree species, and fosters diverse play (hiding, shelter building) in varied terrain for group competence and physical activity.	- It reflects the perceived need for protective and private spaces, offering refuge and solitude, often associated with enclosed environments, and related to both the "Natural" and "Diverse" qualities. For restorative outcomes in small areas	For children, this approach prioritises safe refuges, encourages imaginative play, supports skill development, fosters diverse play, and ensures safety by considering seasonal light.
-PSD 6 Open Stimulative & large areas	- This approach prioritises creating safe and vibrant public spaces minimising paved surfaces and traffic, fostering a strong community, ensuring clear visibility for safety and connection, and providing opportunities for movement, observation, and auditory engagement.	- It reflects the perceived need for unobstructed environments with ample space for activities and expansive views, encompassing both panoramic vistas and open areas for roaming, contrasting with the "Sheltered" associated with "Cultural & Cohesive" qualities. For stimulative outcomes in large areas.	For children, this promotes active play and exploration, encourages independent mobility in child-friendly environments, provides safe and secure open spaces for observation, and prioritises safety and visibility in green spaces by balancing clear views with secluded areas.
-PSD7 Serene Stimulative & large areas	- This urban planning approach prioritises creating stress-free environments for children, promotes social interaction with animals, objects, and people, designs inclusive spaces by gender-based areas, and encourages neighbourhood play interaction in nearby areas.	- It reflects the perceived need for peaceful, calm environments, free from disturbances but not devoid of natural sounds, well-maintained, and conducive to introspection and restoration, requiring a sense of solitude. For stimulative outcomes in large areas.	For children, this highlights nature's vital role in counteracting the negative impacts of excessive indoor time by fostering positive experiences, creativity, and pro-social behaviours. It supports exploration, self-identity, and healthy routines.

-PSD8 Social Restorative & small areas	- This approach aims to create engaging and safe public spaces for children by incorporating community-building events, gender-specific play, and sports facilities with vibrant colours and expressive designs. Inclusive features for all abilities with adequate lighting, clear sightlines, surveillance and emergency call systems. Social engagement by using mature trees (e.g., apple trees), smooth surfaces, climbable structures, and systems supporting independent child mobility with safe pedestrian and cycling paths.	- It reflects the perceived importance of the presence and interaction with other people, encompassing social gatherings, passive observation of others, and opportunities for active engagement in social activities, typically associated with urban environments and contrasting with the "Serene" quality, while relating to the "Cultural" and "Diverse" qualities. For restorative outcomes in small areas	For children, it balances safety and engagement for independent mobility, creates inclusive play areas for diverse activities, is gender-age-based to promote social-emotional development and belonging, prioritises safe pedestrian infrastructure, fosters inclusive cities through collaborative placemaking, and addresses vulnerable youth needs through interdisciplinary collaboration.

6.3. Limitations

Despite the constraint of a limited sample size, this study's findings may hold significant value, underscoring its unique contribution to the field.

The research methodology recommends a four-stage approach for participants to analyse observed attributes without preconceived assumptions, drawing from literature findings. Challenges such as logistical issues that may impact the study's validity or reliability must be addressed, and rigorous efforts should be made to minimise bias and ensure credibility. However, it is worth noting that the study has only completed the first two stages.

The research methodology prioritises allowing children to express themselves artistically and interact with the research environment to better align with their concerns and routines (Cele, 2006). However, challenges such as time limitations, resource constraints, and logistical issues have impacted the validity or reliability of the study outcomes. For example, coordinating with children's ethical approval and parental consent has led to data collection denial. Despite its limitations, this study compellingly reminds us of the importance of involving children and youth in planning. It offers practical insights that can inform future urban planning strategies.

Further, the researcher's bias and how to minimise bias should be carefully acknowledged regarding the assumptions of the researcher's preconceived notions that should not influence the interpretation of the data. While considering children observed, it might be imperative not to ask them how they perceived each of the PSD's qualities directly due to their instincts to react accordingly to the observer and by considering the selective perception that appears among their unconscious. Additionally, interviews with children must consider language proficiency, safeguarding and research ethics, and self-reflective facilitation skills to minimise power imbalances and perceived expectations by children for a *right* answer (Cox et al., 2018).

The research suggests using walking interviews as a form of child-led research. These interviews give participants more control, help them integrate into everyday life, and help them express their thoughts better and express multi-sensory experiences of landscapes. These unique benefits make child-led walks a powerful tool for gaining insights into children's connections with their surroundings. Therefore, walking interviews offer a unique perspective on the environment because the interviewee interacts with the surroundings (Loebach & Gilliland, 2010; Evans & Jones, 2011, p. 850).

It is important to note that this study's findings may not readily apply to all populations or environments due to individual differences and cultural variations, which could limit the generalizability of the results (Kyttä, 2002; Gifford, 2014), which is highly recommended during such a study.

The study also thoroughly encourages the integration of the scope's limitations when the impact of weather conditions may influence how each quality is perceived. For instance, the Four Zones Model assesses environmental attributes to inspire design by evaluating different qualities. Accordingly, considering various weather conditions is crucial for designing sheltered and comfortable places (Borges et al., 2024, pp. 93-94). At the same time, the Quality Evaluation Tool (QET) may be used as an example to analyse and balance environmental qualities in collaboration with users to design or redesign outdoor environments (Bengtsson & Grahn, 2014). Different user groups have diverse needs and perspectives, so it is crucial to collaborate with the target user group to investigate the tool's application, which should also be part of the tool.

While the study aimed to comprehensively explore children's sensory experiences in urban environments, certain aspects of the research topic are limited by constraints such as time and resources. Additionally, the depth and breadth of the analysis have varied based on the available data and methodologies employed.

6.4. Future Research Develops Phases III and IV

Recognising the study's limitations, future research could build upon the current study's findings by addressing specific gaps or expanding the scope of inquiry. For example, longitudinal studies could be conducted to track children's sensory experiences over time or explore the effectiveness of interventions designed to enhance access to green urban spaces for children's well-being by researching different phenomena and scenarios (Chawla, 2020). While the research methodology recommends a four-stage approach, it is important to note that this study has only completed the first two stages. However, stages III and IV are briefly described below.

6.4.1. PHASE III - Apply Model

Participatory data collection with children. Pilot study

Future research should ensure participatory and inclusive data collection in the design process to further develop and validate this thesis study. This thesis establishes a proposal that should first creatively engage the targeted user group to obtain more valuable outcomes, it pertains to children aged 6-11. A pilot study may collect data from children by employing a child-led methodology to complement the findings of the literature. It also emphasises that children can be categorised into different age groups: Early Childhood (3-6 years old), Middle Childhood (7-10 years old), Adolescence (10-17 years old), and After Adolescence (15-24 years old). Which could also be studied and perhaps adapting the tool to those different groups.

As demonstrated in the study by Loebach and Gilliland (2010), Child-directed hands-on methods and tools have the potential to do more than collect data. They can ignite tremendous enthusiasm and skill development among children, empowering them and inspiring us with the possibilities of their active participation in the research process. In fact, according to Wales et al. (2021), child-led walks, where children take the lead in exploring their neighbourhood, are now a standard method for investigating children's use and perceptions of their neighbourhood's interconnectedness for positive and sustainable environments. As Cele and van der Burgt (2015) suggest, planning should consider children's competencies. Notably, participating in such activities can also provide them with valuable educational benefits.

Techniques such as drawings, maps, diaries, storytelling, and auto-photography are used in environmental studies, demonstrating that these expressive tools may better capture a slice of a child's lived experience (Loebach & Gilliland, 2010). Additionally, According to Derr et al. (2018), drawing is a great way to encourage children to express their thoughts and ideas. Thus, engaging in discussions with children when analysing their drawings is essential (Bishop & Corkery, 2017). Thus, the pilot study should start by applying such a creative methodology.

Landscape analyses of two locations to apply the tool

Another approach is to apply the model by conducting a landscape analysis at a playful event, conducting field evaluations, and testing it in different scenarios. Hence, I could conceivably hypothesise that playful events could effectively utilise all components of the PSD model, potentially distributing equally across the perceived sensory dimensions. Additionally, certain qualities within the PSD model may hold more significance than others regarding children's perspectives. Thus, the idea is to gain insights into its relevance from the user's perspective, effectively *testing* how it performs. Thus, a landscape analysis should be conducted by delving into two different locations. Each scenario should be unique and offer a captivating glimpse into two distinct realities: low-income and high-income areas or rural and urban areas. This comparative approach allows us to draw insightful conclusions about the impact of the environment on children's perceptions and cultural backgrounds. And practical applicability of the tool. It could be shown as a spider from a field evaluation of each quality conducted in two different scenarios in a playful event in an urban green setting.

Finally, considering ethical considerations, the study will require approval from the school and parents without institutional review boards or ethics committees (Swedish Research Council, 2017). Research has shown that including children and youth in the investigation is relevant to the approach and influences their commitment to the analysis. The respect we give them preponderantly affects their healthy development by avoiding negative stereotyping. While participatory research can effectively gather information on the lives and views of vulnerable and powerless groups, it raises ethical questions. However, it is essential to address issues of inequality and inclusion to avoid raising expectations that may leave children disillusioned with researchers' promises (Alderson & Morrow, 2011). The participants should be recruited and selected, including any inclusion/exclusion criteria. Considering that children exhibit diverse personalities and abilities. It is essential to recognise their individuality rather than treat them as a homogeneous group (Cele, 2006).

6.4.2. PHASE IV - Evaluate Model

This phase involves evaluating the pilot study outcomes by connecting them to theoretical evidence, applicability, and transparency. It involves connecting the pilot study outcome to theoretical evidence in Phase I, potential applicability in Phase II, and transparency in Phase III.

Analysis of the pilot study

According to Loebach and Gilliland (2010), the researchers should carefully review the initial themes derived from the guided walks, considering the clarifications and revelations uncovered by this follow-up activity. All narrative comments and photographs should be meticulously coded according to the revised themes. The researchers may identify themes associated with neighbourhood perception and use the children's narratives and photo elicitation exercise (Loebach & Gilliland, 2010). Moreover, the thematic analysis should examine the data collected from children during the research. For the narrative of the workshop, the visual representation and illustrations should capture and convey narratives or stories (Jørgensen, 2014), and a thematic analysis of the collected data observed with a spatial analysis of the narratives and photographs provided (Loebach & Gilliland, 2010).

Evaluating the Impact of the Framework on children's health and Well-being

Additionally, the final stage of the study should analyse and examine the data collected from the tool's applicability. The result may describe a narrative observation of each quality, providing a comparative score of the eight perceived qualities following the child-led walk and landscape analysis observations. The thematic and spatial analysis of the findings could provide valuable insights into children's environmental behaviours and perceptions within urban settings (Loebach & Gilliland, 2010). Those findings should complement the framework and redefine the tool. It may need to analyse the reliability of the tool's output and adjust it if necessary.

6.5. Ethical Considerations

The ethical considerations were not acknowledged in this study. However, in most of the pictures, the child shown is the researcher's son, and by its content and approval, I still consider it ethical to carefully take pictures without revealing faces to use in this study. The researcher, as the main responsible for the child, has

ensured that the child is aware of the purpose of these pictures and the child's collaboration by his consent.

In conducting further studies related to this thesis, ethical considerations are paramount, especially when research involves children. Any proposed research must undergo a thorough ethics review and meet specific permit requirements. Important aspects to consider include the potential for physical engagement and the management of personal data. Ethics boards play a crucial role in ensuring that all research upholds human dignity and prioritizes participant welfare. Informed consent is explicitly required for any projects that may impose physical risks or involve the collection of sensitive data (Swedish Research Council, 2017).
Moreover, researchers must obtain participant's consent and ensure the confidentiality of the information gathered in observational studies. It is worth noting that passive observations designed to analyse public environments may not require ethics review and could potentially be conducted without consent or direct interaction (Gifford, 2016).

Finally, the use of AI has improved this thesis by enhancing readability and language clarity. Employing AI tools like Grammarly ensured clear and understandable writing. Additionally, AI helped to understand complex academic texts, contributing to the overall quality of the research findings.

7. Conclusion

This study aimed to develop a practical approach to improve the health and well-being of children in urban settings. It provided valuable insights into designing child-friendly environments by applying theory-based models to establish evidence linking children's development and nature. The master's thesis transformed the evidence into a coherent theoretical framework to explore the possibility of adapting this model into a child-centred tool.

The study aimed to explore how a literature review on the attributes of green urban settings can be mapped to support children's (aged 6-11) experiences through the four axes of the perceived sensory dimensions model. However, certain aspects of the research topic were limited by constraints such as time and resources. As a result, the depth and breadth of the analysis varied based on the available data and methodologies employed. It is important to note that the findings of this study may not apply to all populations or environments due to individual differences and cultural variations, limiting the generalisability of the results. Nevertheless, this study lays the groundwork for further development by prioritising children's health and well-being. Overall, these types of studies play a critical role in understanding children's perception and interpretation of sensory qualities. This approach provides a comprehensive understanding of how children perceive and interact with urban green spaces, leading to a more nuanced understanding of the benefits these spaces can offer for their health and well-being.

Furthermore, the second question related to children's perceptions and experiences within green urban settings shaped and influenced by the four axes of the Perceived Sensory Dimensions were interpreted as a fundamental factor to help children to create mental maps which guide their independent movement through their neighbourhood and around school, formed through personal experiences and interactions with the environment. Children, like adults, utilise similar visual cues for wayfinding, relying on these internal maps. To effectively serve as landmarks, buildings and features must engage children's interest, emphasising the need for complexity and variety in neighbourhood design. However, for children, the perceived sensory qualities of green spaces can be particularly influential. This study sheds light on how children create mental maps of their neighbourhoods by

focusing on the adaptability of the eight qualities of the PSD model, which is an essential factor to consider for their independent mobility and supportive system to better navigate in urban areas for their health and well-being. Additionally, UNESCO, guided by Kevin Lynch, has emphasized the importance of working with interdisciplinary groups to address the needs of children and adolescents in vulnerable urban areas. Together with the Child-Friendly Cities initiative created by UNICEF that addresses children's rights, this may be imperative to acknowledge. Considering that over half of the global population is estimated to be living in urban areas and the increase in mental health issues among children, the study's future development becomes even more crucial.

The study also highlighted that recognising children's rights in urban planning should involve inclusive processes that prioritise children's voices and needs. It encouraged a practical approach based on Sweden's incorporation of the UNCRC into its legal framework. The research highlights the positive impact of nature on the health and well-being of children, underscoring its significance in planning strategies. Utilising and creating tools in the planning process, as well as engaging in collaborative placemaking, can address the need for knowledge and is a crucial consideration.

Finally, the last question related to how the interplay of the eight perceived dimensions in urban green environments can be adapted into new attributes for a child-centred model. The findings explained and integrated new attributes connecting children's health and well-being outcomes with the PSD model's eight qualities for improving urban environments. Yet, Stoltz's (2019) research highlights that our interaction with nature transcends mere aesthetic appreciation. It is a holistic experience encompassing diverse elements, creating a meaningful and potentially health-promoting environment. We perceive nature, recognising complete forms rather than isolated parts. In essence, beauty experiences are not solely determined by specific environmental conditions but are influenced by individual factors such as genetics, cultural background, and personal experiences. Thus, the study recognises the complexity of such an approach, and it highlights the importance of adapting this useful tool, which serves as a foundation approach to have important consideration when designing a child-friendly environment. By having used such a huge model, the importance of adopting a new model to children's perspective could improve even more the readability of such framework accepting the different required of development children grow and encourage the adaptability into a new model based on the main age group: Early childhood (3-6 years old), Middle childhood (7- 10 years old) and Adolescence (10-17 years old) of the youngest generation.

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Appendix

Identification of quality themes and determination of specific attributes for each PSD. "Thematic Analysis: A Step-by-Step Guide" by Braun and Clarke (2006) as follows.

1.-Exploring Evidence Between the Natural and Cultural Sensory Dimensions for Children.
PSD 1: Natural Quality
Subthemes. Untamed Nature (Nature quality, old trees, wild, natural biotope, free growing, safe, not too many people, native plants, untouched). Children's interplay: - Nature deficit disorder and the negative impact of urbanisation on children's well-being. -(Louv, 2005; Roberts, 2009) -Incorporating nature into children's daily lives and providing green spaces in schools and around the neighbourhood to promote emotional well-being and resilience. -(Chawla et al., 2014) -Higher levels of vegetation and tree cover in urban areas associated with increased early childhood development scores -(Jarvis et al., 2022) -The design of play areas that encourages exploration and adventure, promotes dynamic movement, and open-ended play sequences. -(Mårtensson, 2013) -Natural qualities that afford throwing, digging, and climbing. -(Kyttä, 2004) - Elements for outdoor play and education, highlighting multisensory engagement, green spaces influencing place attachment, especially in childhood (Heft, 1988; Morgan, 2010; Jørgensen, 2014) -Embodied experiences such as touching textures, smelling scents, feeling temperatures, and exploring the environment (Jørgensen, 2016).
PSD 2: Cultural Quality
Subthemes. Human Intervention (Decorations, history, cultivated, artwork, culture, human efforts, her, exotic) and Cultural Heritage. Children's interplay: -Sustainable plans that aim to balance environmental quality, economic development, social equity, and vibrancy among the young generation. -(Victoria Derr et al., 2018). -Children's primary means of expression, including their sense of movement and voice, significantly impact their emotional experiences. -(Bartos, 2013).

-Involvement of children in rulemaking and risk assessment to promote safety and resilience. -(Laaksoharju & Rappe, 2017)

-Understanding how the urban environment facilitates children's orientation and wayfinding to provide control in the urban environment. -(Johansson et al., 2020).

-Affordances for following and sharing adult's businesses. - (Kytta, 2004).

-Mouldable materials for constructing objects and modifying surfaces. -(Heft, 1988).

- Facilitating intercultural exchanges among children from different backgrounds enhances understanding and promotes respect for cultural diversity.

- Establishing individual garden plots for children to grow and tend to crop fosters responsibility and practical knowledge in food cultivation. - (Chawla, 2020).

- Involving children in planting and caring for the plants and creating a herbarium can foster a deeper connection to nature and environmental stewardship. (Nebelong, 2017).

- Integrating native and seasonal plants into the garden enhances its appeal, educates children about biodiversity, and supports local wildlife preservation (Fjørtoft, 2004).

- Safety and pedestrian infrastructure are key concerns for children. -(Babb et al., 2017).

2.-Exploring Evidence Between the Cohesive and Diverse Sensory Dimensions for Children.

PSD 3: Cohesive Quality

- It is crucial to nurture a sense of wonder in children to help them connect with their surroundings, foster exploration, and develop deep emotional bonds with their environment. -(Jørgensen, 2016).

- Providing meaningful and transformative experiences that challenge children's beliefs and encourage exploration can lead to a deeper engagement with their surroundings.

-(Jørgensen, 2014; Jørgensen, 2016).

- Taking steps to prevent injuries from road traffic accidents, drowning, falls, burns, and violence is vital for improving child health. Collaboration across different sectors is essential to address issues related to child health and safety. -(WHO, 2024).

- Addressing risk factors, particularly in areas with environmental injustices, is important for promoting children's health and well-being.

(WHO, 2023).

PSD 4: Diverse Quality

Subthemes. Biodiversity (Rich in variation, rich in species, several animals, many different plants, flowers, ponds, and water).

Children's interplay:

- To encourage play and exploration, incorporate a variety of vegetation, such as multi-stemmed trees. Additionally, create worn paths in the grass between stones to provide exciting play opportunities for children. -(Johansson et al., 2020).

- Plant life helps the area withstand active play and promotes dynamic movement and open-ended play sequences. Mårtensson, 2013).

- Enhance sensory experiences and learning about nature and seasonal changes by incorporating diverse plant species, water features, boulders, and tree trunks. This will also increase environmental interaction. -(Johansson et al., 2020; Herrington & Brussoni, 2015).

- Provide loose materials, areas for digging, and spaces for puddles and mud so that children can shape their play environment-(Nebelong, 2017).

-Affording the use of plants in play and providing mouldable materials such as dirt, sand, and snow for creative activities. Kyttä, 2004).

-Incorporating features for splashing, pouring, and floating objects to provide sensory experiences and opportunities for water play. -(Heft, 1988).

3.- Exploring Evidence Between the Sheltered and Open Sensory Dimensions for Children

PSD 5: Sheltered Quality

Subthemes. Safety and Refuge (Shelter, feels safe, hideaway, undulations, trees, hills, slopes, bushes, picnic areas, play).

Children's interplay:

- Addressing how the environment supports the perception of personal safety during light and dark hours by attending to prospect and refuge especially in high-latitude areas during the winter. -(Johansson et al., 2020).

- Considering tree physiognomy, vegetation types, and topography to provide specific opportunities for play activities. -(Fjørtoft & Sageie, 2000).

- Interaction between children and natural materials, particularly trees, to support imaginative play and connection with the natural environment such as using leaves as play food and branches as tools for construction. Climbing trees develop essential skills and seek recognition. Building techniques, such as constructing “huts” in the forest, meet children’s needs for group competence, physical activity, goal achievement, and curiosity. -(Laaksoharju and Rappe, 2017).

- Higher levels of vegetation, tree cover in urban areas to promote early childhood development. -(Jarvis et al., 2022).

- Graspable/detached objects for drawing, scratching, throwing, hammering, etc. to support diverse play activities. -(Heft, 1988).

- Shelter to create microclimates, perspective, refuge, and privacy.

- Balancing providing secluded areas for play while ensuring they are not so isolated as to pose a safety risk. -(Laaksoharju & Rappe, 2017).

- Affordances for playing home, war, skiing, coasting, building structures, and finding peace in shelter. -(Kytta, 2004).

PSD 6: Open Quality

-Grass cover in urban areas to promote early childhood development scores, while there was a negative association with paved surfaces. - Jarvis et al., 2022).

-Children value parks and play areas for their well-being, and green open spaces support their independent mobility while street environments are limited by traffic. Babb et al., 2017).

-Designing the park to ensure children feel safe and have places to play and hide while being visible to others. -(Johansson et al., 2020).

-Considering the overall sense of place and community well-being, with an empathetic approach towards children's engagement with urban open spaces.

-Prioritising clear views and visibility of nearby buildings in the built structures and greenery design to balance creating engaging environments and ensuring safety. -(Mårtensson et al., 2014).

-Green open spaces that support children's independent mobility and promote physical activity and play. -(Kytta, 2004).

-Affordances playing hopscotch.

-Aperture for movement, observation, and auditory experiences. -(Heft, 1988).

4.- Exploring Evidence Between the Serene and Social Sensory Dimensions for Children

PSD 7: Serene Quality

Subthemes. Physical Safety and relaxation (Calm, silent, no people, clean, peaceful, secluded, undisturbed, no traffic, safe).

Children's interplay:

-Creating stress-free and relaxing environments for urban residents, which can impact how young people perceive their city surroundings. -(Aerts, 2018).

-During middle childhood, children seek natural spaces for reflection and play, but there is a concern that these opportunities have declined. -(Chawla, 2020).

- Prioritising clear views and visibility in the greenery design to balance creating engaging environments and ensuring safety. -(Johansson et al., 2020).

PSD 8: Social Quality

Subthemes. Social Interaction (Plenty of people, movement, events, shops, restaurants, bustling, play, and sports).

Children's interplay:

- Encourage various play opportunities instead of focusing on physical activity. -(Herrington & Brussoni, 2015).

-Emphasise the importance of children forming emotional bonds with specific places, feeling secure and belonging, expressing creativity, and exploring. -(Koller & Farley, 2019).

- Support diverse play settings and address gender-based aspects of physical activity on school grounds.

- Promote physical and social elements that help children build emotional connections within their communities. -(Johansson et al., 2020).

- Engage the community in the design of urban spaces through participatory

placemaking to integrate isolated populations and foster a sense of ownership among the users of these spaces. -(Victoria Derr et al., 2018).

-As the children became more familiar with the environment, they gathered under mature apple trees for relaxation and socialising. -(Laaksoharju & Rappe (2017).

-Affordances for skating and running. -(Kytta, 2004).

-Flat, relatively smooth surfaces for walking, cycling, skating, and skateboarding.

-Climbable features for exercise/mastery, lookout points, and passage. -(Heft, 1988).

- In urban planning, incorporating vibrant colours, expressive designs, strategically located playgrounds, and green areas with diverse vegetation can support wayfinding and mobility. -(Johansson et al., 2020, p.226)

-Children develop their support system for outdoor life, helping them adapt independently. - (Wales et al.,2021)

All are related to children's needs, with a focus on children's health and well-being benefits.

5.- Children and Aesthetic Qualities: Insights from a PSD Colour Wheel

The PSD Model and Environmental Design

Subtheme. The concept of adjacent qualities in the PSD model and their potential for creating strong, synergistic environments with minimal conflict.

-Emphasises the value of combining three closely related PSDs for optimal environmental quality. related to the impact on the Synergistic between the four axes.