

Investigating the Role of Motion Perception in Designing Architectural Spaces for Children with Autism Spectrum Disorder: Focusing on Vestibular System Behavior to Achieve Environmental Perception

Hamid Araghi¹, Anahita Zendehtdelan², Mahbubeh Sabet Imani³

1. Master of Architecture, Department of Architecture, Science and Research branch, Khorasan Razavi, Islamic Azad University, Neyshabur, Iran. Master of Architecture, Department of Architecture, Neyshabur branch, Islamic Azad University, Neyshabur, Iran
2. Ph.D. of Architecture, Faculty Member, Department of Architecture, Ne.C., Islamic Azad University, Neyshabur, Iran.
anahita_zc@yahoo.com
3. Ph.D. of Educational Psychology, Faculty member, Technical-professional educational institution, Neyshabur, Iran.

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ABSTRACT

Objective: Vestibular dysfunction in children with autism spectrum disorder (ASD) disrupts motion perception and the visual organization of color, depth, and luminance. Lacking coherent sensory schemas and stimuli-filtering capabilities, these children exhibit hyper-reactive or hypo-reactive behaviors. This study identifies cognitive motion-perception patterns linked to vestibular profiles to inform visual sensory organization and environmental perception in architectural design.

Methods: This comparative, library-based study evaluated depth perception mechanisms relative to vestibular behavior and motion perception. Visual variations in depth were analyzed across light, color, and form. Perceptual characteristics were mapped onto fluid and dynamic environments to derive compatible architectural components for both sensory profiles.

Results: In hyper-reactive profiles, perception within fluid environments relies on similarity-based sensory integration: motion is perceived via grouping, color monochromatically, and depth through surface-based cues under luminance gradients. Conversely, hypo-reactive profiles in dynamic environments rely on distinction-based integration: motion and depth are perceived through high contrast, edge-based cues, and perspective under uniform luminance.

Conclusions: Two distinct vestibular behavioral profiles produce divergent visual sensory organizations and motion-perception patterns. Designing supportive built environments for children with ASD requires tailoring architectural elements to these specific fluid and dynamic sensory needs.

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1. Introduction

Autism is a neurodevelopmental disorder that emerges in childhood and persists into adulthood (Liu et al., 2017). In 1943, the Austrian psychiatrist Leo Kanner conducted a study on a group of eleven children and observed characteristics such as unusual physical postures, monotonic speech patterns, repetitive and stereotyped behaviors, resistance to environmental changes, poor eye contact, atypical relationships with people, images, and objects, echolalia, high rote memory, and developmental delays. Kanner referred to these children as 'autistic' or 'self-absorbed' (Muratori et al., 2019), a condition currently identified by deficits in social communication and interaction, as well as restricted and repetitive patterns of behavior, interests, or activities (Sipes et al., 2014). The Individuals with Disabilities Education Act (IDEA) defines autism as a developmental disability that affects social interaction, typically appearing before the age of three, and encompassing features such as repetitive and stereotyped movements, resistance to environmental changes or daily routines, and atypical sensory experiences (Joon et al., 2021). One of the most significant clinical features of autism is Sensory Processing Disorder (SPD). Estimates report a high prevalence of sensory symptoms in Autism Spectrum Disorders (ASD), ranging from 60 to 96 percent (Schauder et al., 2016). This study focuses on the role of motion perception and the vestibular system to explore the design of architectural spaces for children with autism. According to the DSM-5, hypersensitivity and hyposensitivity are identified as key sensory symptoms of autism (Kuno et al., 2020). Research on sensory modulation in autism suggests that deficits in self-regulation (Silva & Schalock, 2012) reflect an inability to adapt sensory stimuli to effective sensory organization. SPD signifies a maladaptation to the environment regarding sensory input; specifically, it involves challenges in regulating and organizing the type and intensity of responses to sensory stimuli (Kaliukhovich et al., 2016). Most children with autism exhibit deficits and sensory system dysfunction, where the various senses fail to acquire the necessary information for coherent processing and cognition, thereby hindering the understanding of environmental events (Monti et al., 2023). Due to a neurodevelopmental disorder, children with autism often struggle to progress through standard stages of cognitive development. They primarily face sensory deficits in receiving, filtering, and organizing environmental stimuli (Bennetto et al., 1996). Sensory dysfunction leads to atypical processing, resulting in Hyper-responding or diminished sensitivity to stimuli (Behrman et al., 2015; Missiuna et al., 2011; Hilton et al., 2007). These behaviors,

stemming from impaired sensory processing, prevent the formation of adequate sensory organization, as ‘managing, separating, and categorizing sensory stimuli is challenging for individuals with autism’ (Samadi & McConkey, 2011: 256). This deficit in discrimination indicates an inability to differentiate sensory information, ultimately leading to impaired Gestalt perception and a failure in forming cognitive schemas. Lack of Gestalt perception reflects a detail focused bias in the absorption of environmental information. This bias toward details, and the resulting failure to perceive environmental wholes, leads individuals to attend to the stimulus itself rather than to its features (Bayrami et al., 2013; Bayrami et al., 2014). The sensory dysfunctions associated with autism and deficits in sensory processing indicate a failure in the formation of a coherent cognitive pattern, which manifests as deficits in self regulation (Silva & Schalock, 2012) and an abnormal pattern of attention (Kakavand, 2009: 27–28), and results in an inability to filter information. Consequently, attentional problems and the lack of perception of stimulus features under mine the ability to understand sensory information related to sensory organization, and the relationships among environmental sensory inputs are not integrated within a single sensory experience. As a result, information is experienced in a categorical, rote, and meaningless manner, which is ineffective in supporting the absorption of sensory information relevant to sensory organization. The central focus of this study is on patterns dependent on sensory information; this focus aims to elucidate sensory organization as a basis for structuring the processing style of children with autism. The two distinct types of autism exhibit different sensory behaviors, with each type requiring specific information within the spatial environment. This phenomenon has posed challenges for environmental designers and architects in organizing the physical components of space, often leading to sensory interference for children with autism. It appears that due to deficits in self-regulation, these children lack the ability to integrate sensory information into their sensory organization, and consequently, are unable to reorganize their mental organization in response to changing sensory inputs. Therefore, this study aims to differentiate sensory organization from sensory information. By analyzing sensory behaviors, a specific framework for the physical elements of space has been proposed for each type of autism, facilitating cognitive development through the formation of robust cognitive schemas. Hyposensitive and hypersensitive behaviors within the visual system reflect two distinct levels of sensory perception in relation to the vestibular system. Focusing on the concept of motion

perception in architecture, this study adapts the sensory behavior of the vestibular system to the visual system to extract environmental features (motion) in relation to architectural components. This approach identifies specific sensory information aligned with the sensory organization of autism. Ultimately, by adjusting the fluidity and dynamism of space to align with visual system behaviors, this study offers an adaptive approach to designing environments for the two distinct types of autism.

2. Research Literature

2.1. Research Background

Tola et al. (2021), in their review study, investigated individuals with autism and the built environment, evaluating both spatial organization and the physical elements of space. They identified three core factors within the environment: sensory quality, comprehensibility, and environmental predictability. Consequently, spatial requirements for individuals with autism were derived, which form the basis for autism-adaptive architecture. The paradigm of flexible, autism-adaptive architecture has been explored in various studies, focusing on parameters such as light quality, sound, and environmental temperature.

Baumers and Heylighen (2010) examined the experiences of individuals with autism within the built environment, emphasizing the significance of understanding their unique interaction with architectural spaces. They observed that individuals with autism employ a distinctive method of information processing that significantly influences their perception of the environment. The authors framed the impact of the physical environment on individuals with autism as a perceptual difference. Crucially, this variance does not lie in the raw reception of information, but rather in its absorption. Nevertheless, establishing the foundations for perception necessitates an appropriate level of cognitive preparedness.

McAllister (2010), in defining the autism-friendly environment, highlights the complexities, challenges, and design features involved, noting that the human-made environment may be perceived as a daunting or incomprehensible place for individuals with autism. Indeed, the modification of the built environment should commence within the classroom setting. In this context, maximizing a student's ability level is inherently challenging due to dynamic external/environmental factors that vary significantly among individuals, posing a fundamental

issue for educators. The most significant challenge for designers is ensuring that the environment remains adaptable in response to these individual differences.

Ahrentzen and Steele (2010, as cited in Mostafa, 2020) examined living spaces of individuals with autism and derived essential requirements for environmental design. These include: the need for safety and security; maximizing familiarity; stability and transparency; reducing sensory sensitivity; facilities for controlling social interaction and ensuring privacy; choice and independence; health promotion; self-esteem enhancement; ensuring durability; affordability; and neighborhood accessibility and support.

Scott (2009) analyzed four built schools based on the design guidelines published by the Department for Education and Employment (DfEE) in 2005. These standards encompass legibility, spatial scale, color and decorations, lighting, personal spaces, security, material durability and hygiene, the placement of door handles, detail reduction, and plan modifications.

Kinnaer et al. (2016), by examining the autobiographies of individuals with autism, highlighted that architectural concepts should be interpreted through various lenses. Some individuals with autism prefer open spaces, as they allow for a comprehensive overview—enhancing predictability without the need for partitioning—while facilitating a comfortable distance from others. Conversely, others prefer spaces to be subdivided to make the spatial structure more tangible and to minimize sensory inputs. Ultimately, they identified significant variations in spatial perception. In educational settings, large volumes can induce fear and anxiety, thereby reducing concentration; however, high ceilings are suitable for active and energetic tasks. In contrast, low ceilings are preferred for fostering calm and comfort. While a flexible, combined use of open and confined spaces is suggested to meet the needs of individuals with autism, some studies advise against the use of multipurpose spaces. Nevertheless, the inclusion of intermediary spaces (or transition zones) is effective in promoting cognitive preparedness for new environments, as they help prevent abrupt sensory transitions and mitigate anxious behaviors (Tola et al., 2021).

Ghazali et al. (2021) argued that children with autism, due to their perceptual differences, experience challenges in interacting with the built environment, highlighting the necessity of creating a supportive environment. Within physical learning environments, spaces must be meticulously designed considering sensory sensitivity and sensory stimulation. By exploring four fundamental principles of environmental design—sensory sensitivity, sensory stimulation, sensory

design, and the physical learning environment—the authors elaborated on criteria to improve educational settings for children with autism. Sensory design is applied across seven domains, necessitating design interventions for one or more sensory modalities, with a primary focus on sensory-aware design.

Mostafa's ASPECTSS Design Index is grounded in sensory theory and comprises seven criteria: Acoustics, Spatial Sequencing, Escape Space, Compartmentalization, Transition Zones, Sensory Zoning, and Safety. Research indicates that the ASPECTSS index demonstrates a high alignment with design requirements, serving as a robust tool for evaluating environments tailored to individuals with autism (Mostafa, 2014, 2018).

Furthermore, Mostafa (2020) examined sensory elements—such as texture, color, patterns, and acoustics—emphasizing their role in supporting cognition and integration within the sensory profile of autism. These principles are categorized into five main domains: spatial quality, spatial organization, spatial orientation, spatial integration, and safety.

Wang et al. (2021) conceptualized design strategies for children with autism through the lens of Sensory Integration Therapy. They delineated the essential professional facilities for a therapeutic space, addressing specific sensory disorders. Furthermore, they emphasized the importance of spatial categorization during the design process, employing strategies for neighborhood open spaces based on sensory integration principles. By incorporating play and specialized facilities, these neighborhood spaces facilitate a comprehensive cognitive understanding of the environment, fostering stable interactions between children with autism and their families. These environments not only address the functional needs of children but also support preventive care and sensory therapy.

Clouse et al. (2020) proposed design interventions that extend beyond the ADA (Americans with Disabilities Act) standards to address the needs of individuals with autism. They highlighted the design complexities inherent in balancing hyposensitivity and hypersensitivity, noting that such needs are often obscured by the nature of neurological disorders. They outlined specific responsibilities for architects, which can enhance the independent functioning of individuals with autism within the built environment. Importantly, they argued that the designer's goal should transcend the mere elimination of sensory stimuli to suppress behavioral reactions; instead, they advocated for creating flexible environments that encourage active interaction.

Black et al. (2022) examined the interior environment, suggesting that understanding the positive and negative design impacts is critical for optimizing environmental conditions. Design ambiguity, stemming from idiosyncratic sensory processing, can render the built environment overwhelming or confusing. Therefore, the architects' awareness of these sensory nuances is fundamental. Ultimately, enhancing spatial comfort is positively correlated with increased social interactions for individuals with autism.

Mostafa (2008) proposed a sensory-based approach in architecture for individuals with autism, delineating the core concepts of sensory design theory to inform design interventions. This theory serves as a foundational framework in environmental design for the autism spectrum, positing that by modifying the sensory environment through targeted interventions—as manifested via input from the built environment—positive changes in behavioral outcomes can be achieved (Mostafa, 2020).

Numerous studies have advocated for the implementation of sensory rooms, which utilize spatial separation to regulate sensory behaviors and mitigate fatigue resulting from sensory-behavioral tensions (Tola et al., 2021). Mostafa (2015) introduced the concept of an 'escape space'—a stimuli-free environment designed to restore sensory balance and effectively manage anxiety-driven behaviors.

Furthermore, research emphasizes the regulation of sensory stimuli to prevent overstimulation. Since hypersensitivity to light and luminance is frequently correlated with anxiety in children with autism, reducing light intensity is a recommended strategy to manage sensory responses. Conversely, for individuals exhibiting hyposensitivity, sensory processing thresholds may be impaired. Nevertheless, low-level lighting is generally recommended in educational settings. Additionally, studies highlight the use of color contrast in environmental design to facilitate shape perception. Conversely, color complexity is discouraged, and evidence suggests that the use of vivid or bright colors may have detrimental effects on individuals with autism who have comorbid intellectual disabilities (Tola et al., 2021).

Another study, utilizing interviews with parents, teachers, therapists, and students with autism, identified specific environmental design techniques. These strategies include flexibility and adaptability, ensuring the space is non-threatening and distraction-free, enhancing predictability

and controllability, and providing a sense of agreeable motion and security (Mostafa, 2020, citing Vogel).

Regarding circulation, studies indicate that complex layouts, consecutive changes in floor levels, and long corridors exacerbate sensitivity and complexity for individuals on the autism spectrum. Consequently, legibility and predictability are critical design requirements. Circulation spaces should be designed to support movement predictability, avoiding sudden turns or sharp right-angle corners. Furthermore, the implementation of one-way circulation paths has been suggested to meet the child's needs and better manage movement predictability (Tola et al., 2021).

Owen and McCann (2013) examined the relationship between home environments and daily care experiences, focusing on the dimensions of physical space, spatial organization, and sensory perception. Their findings emphasize the importance of dedicated physical space for personal belongings and the inclusion of a 'movement room' to support children's territorial needs. In a subsequent study, Owen and McCann (2018) highlighted the complex, evolving needs of children with autism, underscoring the necessity for environmental adjustments at home. Given that these adjustments must account for individual and developmental trajectories, the authors emphasized the importance of housing flexibility to accommodate a wide range of behaviors, sensitivities, and individual preferences. Such home-based modifications necessitate public awareness, which may vary depending on the specific environmental context. Ultimately, across these studies, sensory interference emerges as a primary design challenge, manifesting as dualities in spatial perception due to underlying deficits in sensory processing.

Consequently, these diverse findings underscore the imperative of bridging the gap between clinical sensory-vestibular profiles and architectural spatial configurations—the primary objective of the current study.

2.2. Sensory Processing Deficits in Autism

Various studies have reported atypical responses to sensory stimuli in autistic individuals. These responses include Hyper-responsivity, Hypo-responsivity, and sensory-seeking behaviors, which may occur across the sensory domains, including the most prominent ones: auditory, visual, vestibular, tactile, and proprioceptive (Gal et al., 2002; Kern et al., 2007; Tomchek, 2007). Sensory abnormalities have been identified as a form of sensory modulation disorder associated with self-awareness (Kientz et al., 1997; Baranek et al., 2005).

Accordingly, sensory processing difficulties may hinder the formation of a coherent processing pattern that would otherwise enable individuals to consciously attend to relevant features of environmental information in a manner consistent with their sensory experience. Consequently, individuals with autism may experience difficulties filtering incoming information due to deficits in attentional processes, which are influenced by abnormal and atypical sensory processing patterns (Roger et al., 2003; Kern et al., 2006; Cheung et al., 2009; Hochhauser et al., 2010).

Dunn's model identifies four sensory processing patterns (Dunn, 1997, as cited in Perez Repetto et al., 2017; Schaaf et al., 2014; Miller et al., 2007):

Low Registration: Characterized by reduced sensory registration, a high neurological threshold, Hypo-responsivity to sensory input, and a need for stronger stimuli.

Sensory Seeking: Characterized by a high neurological threshold, Hypo-responsivity to sensory input, and active pursuit of more intense sensory experiences.

Sensory Sensitivity: Characterized by a low neurological threshold and heightened responsivity; individuals may become distressed, yet they tend to manage input in a relatively passive manner.

Sensory Avoiding: Characterized by a low neurological threshold and heightened responsivity; individuals actively attempt to reduce or avoid distressing sensory input.

Numerous studies have examined sensory evaluation in autism with reference to Dunn's model, indicating the presence of sensory processing disorders/difficulties in this population (Schaaf et al., 2014; Ahmadi et al., 2012; Kern et al., 2006; Hochhauser et al., 2010; Roger et al., 2003). Anxiety resulting from hypersensitivity arises from hyper-responsivity in the sensory system, which requires the removal of anxiety-inducing factors. Conversely, hyposensitivity is due to Hypo-responsivity of the sensory system and requires additional sensory stimulation (Dunn, 1997).

In sensory therapy for individuals with autism, for an Hypo-responsive sensory system, stimulus intensity is gradually reduced from high to low, whereas for an Hyper-responsive sensory system, stimulus intensity is gradually increased from low to high (Rafei, 2008: 90–102). Thus, behavior is regulated through adjustments in stimulus intensity. This pattern is applied to the perception of color and light within the visual system to help control sensory behaviors.

Various studies have focused on the lack of cognitive pattern formation in individuals with autism, which leads to abnormal attention to only part of the information and results in a preference for

detail-focused processing rather than holistic processing (Bayrami et al., 2013; Bayrami et al., 2014). Unusual sensory experiences (Hus et al., 2014) and a detail-focused approach, which manifests through an inappropriate attention pattern (Kakavand, 2009: 27–28), have contributed to a loss of the ability to filter information.

Attention is defined as “a type of focusing of mental effort on sensory or mental events” in the surrounding environment. Given the limited capacity of the mind for receiving, processing, and storing information, attention is directed only to stimulus features so that the processing system does not become overloaded (Pakzad & Bozorg, 201[^]: 161–162). These features include stimulus intensity, contrast, movement, repetition, and so on, which cause a specific element to stand out from the background and receive more attention than other components (Pakzad & Bozorg, 201[^]: 165).

Environmental stimuli contain sensory information; however, in autism, individuals tend to attend to the stimulus itself rather than to its features (Bayrami et al., 2013; Bayrami et al., 2014). This leads them to ignore essential environmental information, a phenomenon known as overselectivity. On the one hand, they may have difficulty dividing attention between two stimuli, and on the other hand, they may struggle to shift attention from one stimulus to another (Kakavand, 2009: 27–28). In overselectivity, attention is focused on the stimulus, and therefore information related to stimulus features is not adequately perceived.

This directly affects their cognitive performance and causes problems in their attention pattern for environmental recognition. The abnormal pattern of sensory experience has had a distinct impact on their attention mechanisms, leading to enhanced rote memory in autism. Although this is sometimes considered an ability, such behavior is due to the absence of a spontaneous pattern or schema, which in turn impairs the ability to organize information (Williams et al., 2006; Minshew et al., 2001). In other words, it reflects a deficit in filtering information (lack of schema formation) and a failure to attend to stimulus features (related to sensory information), indicating a disorder in cognitive processing that is directly associated with impaired sensory perception.

Accordingly, considering the visual system and its connection to the vestibular system, stimulus features (movement, contrast, stimulus intensity, repetition, etc.) have been examined as variables for schema formation within architectural spaces specifically designed for children with autism. In this study, these stimulus features that underlie schema formation are regulated through motion

perception, so that the visual system is aligned with the vestibular system, thereby facilitating environmental perception.

2.2. Perception of Movement

According to Piaget's developmental perspective, developmental stages in children form sequentially, consistently, regularly, and in an interconnected manner from birth to 16 years of age; these stages are mutable yet possess a unified organization. Given the continuity of development from Piaget's viewpoint, a disruption at one stage can influence subsequent stages of development. Piaget's sensorimotor stage emerges from birth to two years of age, during which the environment is perceived through the use of the senses and motor actions (Crain, 2016, pp. 157–158; Wadsworth, 1999, p. 41). Hence, understanding the sensorimotor stage in relation to environmental perception has a significant impact on the cognitive process.

Numerous studies have investigated the effect of motor activity on the mental development of typically developing children, in which cognitive criteria include language, attention, working memory, and executive function; these studies indicate the important role of motor activity in cognitive performance (Barnett et al., 2008). Within the domains of psychomotor, cognitive, and affective learning, motor abilities can substantially contribute to efficient human performance (World Health Organization, 2017; U.S. Department of Health and Human Services, 2008; Nourbakhsh, 2006). Given that motor and cognitive skills share several fundamental processes, including sequencing, monitoring, and planning, an individual's motor skills may influence their cognitive development (Mahar et al., 2006; Hillman et al., 2008; Roebbers et al., 2009; Donnelly et al., 2009; Kamijo et al., 2011; Booth et al., 2013; Zeng et al., 2017).

Furthermore, executive functions encompass cognitive processes such as working memory, attention, problem-solving, verbal reasoning, initiation and monitoring of activities, planning, response inhibition, and cognitive flexibility (Bennetto et al., 1996). Executive function deficits in children with autism indicate disturbances in sensory outputs and sensory processing, and motor skills may play a role in supporting or enhancing executive functioning (Ozonoff et al., 1996). Among the executive function deficits observed in children with autism are lack of cognitive flexibility, perseveration (insistence on sameness and resistance to change), and inappropriate responses to social situations (Kenworthy, 2010).

Given the executive function deficits in children with autism, as well as their difficulties in motor planning, the necessity of movement perception (motion perception) in this population becomes particularly important, as it can positively affect both cognitive development and environmental perception. Accordingly, the factors contributing to movement perception have been examined from two perspectives—fluid environment and dynamic environment—within architectural spaces for children with autism.

Movement serves as the core of the entire spatial experience, and spatial perception is inherently dependent upon movement. Existing evidence suggests that the surrounding world is continuously undergoing both external and internal evolution and dynamism (Rahimian, 2004, p. 146). Movement is conceptualized as a time-dependent factor; with the contemporary expansion of scientific disciplines, space and time have been articulated in novel ways, intensifying and integrating into the visual arts. In pre-Renaissance paintings, representation was characterized by a two-dimensional perspective. However, the discovery of perspective during the Renaissance fundamentally altered spatial conception, as changing one's viewpoint through movement modifies the perceived characteristics of objects, rendering a complete description from a fixed viewpoint impossible (Giedion, 2007, pp. 362–363).

Giedion and Zevi position the human being as the axis of movement in space and the observer of the environment, through which individuals construct a unique form of experience (Memarian, 2007, p. 336). Spatial perception is thus analyzed from two distinct perspectives: (1) physical movement coupled with motor activity, and (2) observation of the environment in the absence of motor activity; both can fundamentally alter the nature of sensory experience in space. From the first perspective, sensory experience within a dynamic environment induces a sense of movement, whereas from the second, a fluid environment establishes a sense of stasis or spatial stillness. Consequently, movement (motor activity) and stillness (motor inactivity) constitute essential prerequisites for spatial perception and must be calibrated in accordance with the vestibular behavior of individuals with autism.

Finally, depth perception functions as a prerequisite for movement, enabling individuals to comprehend themselves and their surroundings through the sensory experience of the environment. This underscores the significance of the proprioceptive and vestibular senses, which

Samadi and McConkey (2011) identify as the primary focal points and fundamental origins of sensory integration (p. 299).

2.2.1. Vestibular System Behavior in Children with Autism Spectrum Disorder

The three senses of touch (tactile), proprioception, and the vestibular (movement) system are the primary focus of sensory integration therapy, as they establish sensory balance within the environment and coordinate with other senses (McPartland, 2012; Clark, 2008). Vestibular dysfunction in children with autism may manifest in two primary forms. Some individuals are hypersensitive to vestibular input, displaying anxious behaviors toward motor activities and struggling to navigate unstable surfaces, such as stairs. Conversely, others may actively seek intense sensory experiences—such as excessive spinning, jumping, or whirling—which indicates behavioral disorganization and a physiological need for motor stimulation (Hatch, 1995).

Behaviors such as an exaggerated reaction to motor activity (a preference for stillness) and a stiff body posture—where the head is maintained at a fixed angle, leading to two-dimensional vision and impaired depth perception—are characteristic of vestibular hypersensitivity. These individuals encounter difficulties navigating various levels due to an inability to perceive elevation changes and often rely on walls or railings for support during movement (Kakavand, 2009, p. 103). On the other hand, behaviors including a need for constant motion, circular movement, slow navigation, and prolonged response times to motor instructions (due to poor depth perception) are associated with vestibular hyposensitivity (Kakavand, 2009, p. 103). Thus, two facets of the vestibular system—Hyper -responsivity and Hypo-responsivity—are evident in motion perception. These responses drive two distinct behavioral patterns: a “desire for stillness” and a “desire for movement,” both of which are deeply linked to deficits in depth perception.

The manifestation of hypersensitivity or hyposensitivity in the vestibular activities of children with autism does not imply that environmental perception can be achieved solely by adapting the environment to control sensory behaviors. A model that merely eliminates motor activity to manage anxiety in Hyper -responsive systems or adds it for Hypo-responsive ones is ineffective. Instead, sensory organization must be sought within the context of movement perception.

Both hypersensitivity in Hyper-responsive profiles and hyposensitivity in hypo-responsive profiles are linked to a lack of schema formation. In these cases, individuals tend to focus on the stimulus itself rather than its intrinsic features. This abnormal pattern in the attention mechanism prevents

them from processing vital information, leading to an overwhelming “flood of information”; consequently, sensory data is recorded categorically but lacks a coherent schema. Therefore, to facilitate schema development, it is essential to identify the sensory organization related to information processing. By creating distinct spaces, designers can provide information that is congruent with the user’s sensory organization. Movement circulation in fluid versus dynamic environments reveals different aspects of formal characteristics. Consequently, to support environmental perception, movement circulation must be defined separately from the perspectives of both dynamic and fluid environments, based on the specific vestibular behaviors of individuals with autism.

2.2.2. Sensory Organization in Movement Perception

Deficits in schema formation reflect a failure to integrate environmental patterns within cognitive processes, leading to a recognized bias toward details or detail-focused processing (Beyrami et al., 2013; 2014). In fact, an abnormal attentional pattern directs focus toward the stimulus itself rather than its intrinsic characteristics within the attention mechanism. Given the individual’s limited processing capacity, this information fails to enter the processing system, indicating a core deficit in environmental cognition as manifested in behavior.

Effective environmental cognition necessitates environmental sensation to facilitate the perception of spatial patterns. Sensation transmits patterns of sensory processing related to sensory information to the brain; however, sensory processing deficits—linked to an impairment in movement perception—disrupt this process. Deficits in movement perception within the vestibular system of this population are manifested through distinct motor activity patterns. Specifically, hyper-responsive vestibular behavior is associated with a preference for stillness, whereas hypo-responsive behavior is linked to a seeking of movement (Hatch, 1995). Consequently, behavioral patterns in fluid environments (for Hyper-responsive autism) and dynamic environments (for hypo-responsive autism) are examined to organize the sensory processing system and establish the necessary conditions for environmental perception through the lens of movement perception.

In spatial perception, movement and stillness are inseparable elements; an impairment in perceiving either dimension can compromise overall movement perception. Based on vestibular behavior, movement perception is analyzed using Gibson’s Differentiation Theory for dynamic environments and Gestalt Theory for fluid environments. This signifies a specific sensory pattern

and information-absorption mechanism, representing a schema-based representation of specific environmental sensory data.

Wertheimer's insights into Gestalt Theory originated from observations made during a train journey, where he realized changes in spatial perception. However, because Wertheimer was seated—and it was the train that was in motion—he pursued his subsequent perceptual experiments in a laboratory as a stationary observer in the environment (Shapourian, 2008, p. 5). Gestalt Theory emphasizes the role of grouping forms in human perceptual organization. It focuses on principles inherent in the experience itself and defines human sensory organization by assuming the observer is fixed in space (Shapourian, 2008, p. 99; Shahcheraghi & Bandarabad, 2016, p. 162).

This perspective posits that the perceived whole is distinct from the sum of its parts; the controller of environmental information is the organization (Gestalt) rather than individual components (Grütter, 2009, p. 569). In fact, the perceived whole constitutes the stimulus characteristics, which are perceived differently by a stationary observer at a fixed point compared to an observer moving through space. These characteristics organize environmental elements, allowing the surroundings to be perceived as an integrated whole.

Gestalt theorists identified the perceived whole or stimulus characteristics through the laws of grouping. These laws include principles such as continuity, proximity, similarity, Prägnanz (good form), and symmetry. They assert that the perceived whole is fundamentally different from the sum of its parts (Shapourian, 2007, p. 96; Wagemans et al., 2012). Thus, disregarding the relationships between individual parts paradoxically strengthens a holistic view.

In this view, it is crucial that the stimulus characteristics (the perceived whole) do not follow the relationships between parts; instead, they are coded in the mind as an integrated whole across multiple separate layers according to grouping rules. The commonality between Gestalt ideas and Hyper-responsive autistic vestibular behavior is the tendency toward motor inactivity, often driven by anxiety-based responses. Therefore, Gestalt theory, through its grouping laws, can enhance the perceptual organization of individuals with Hyper-responsive autism.

In contrast to Gestalt theory, James and Eleanor Gibson proposed the Ecological Theory of Perception, introducing a different model of perceptual organization. They viewed perception as information-based; James Gibson introduced the reality of sensory experience not as the “building blocks” of perception, but as its product (Lang, 2009, p. 97). They argue that sensory perception

depends on information picked up from the environment; under certain environmental conditions, these characteristics may vanish, thereby reducing the sensory experience. For instance, a decrease in light quality prevents the relationship between parts from being seen; perceiving these relationships requires high-quality lighting conditions.

The Gibsons linked the relationship between parts to motor activity in space, which reveals distinct stimulus characteristics within the perceptual organization. By moving through space and forming experiences, individuals can attend to more comprehensive environmental details (Lang, 1987, p. 104). Gibson identified a visual order called “texture gradients” or depth-representing textures (Grütter, 2009). These rules are closely related to the perception of linear perspective. The Gibsonian approach to sensory perception emphasizes the absorption of sensory information (stimuli) based on differences and highlights the relationship between sensory data within depth-representing textures. The Gibsons defined the axis of perception as movement in space.

The commonality between the Gibsons’ ideas and the vestibular behavior of individuals with hypo-responsive autism is the tendency toward motor activity. This suggests that the Ecological Theory of Perception can improve the sensory organization of those with hypo-responsive autism. Gibson’s Differentiation Theory posits that sensory development results from attaining stabilities related to objects and identifying differences among similar stimuli (Mohseni, 2004, p. 219). According to the Differentiation Theory, the Gibsonian perspective in ecological theory becomes clear: stimulus characteristics constitute the stabilities that play a role in schema formation in both ecological and Gestalt theories. Consequently, depending on the type of movement perception—spatial fluidity or spatial dynamism—the nature of sensory information changes.

Thus, based on autistic vestibular behavior, sensory organization is categorized into dynamic environments (movement-seeking) via the Ecological Theory of Perception and fluid environments (stillness-seeking) via Gestalt Theory. These two theories differ in their methods of absorbing sensory information and the relationships between that information; hence, the way stabilities are achieved differs, and Gibson’s approach in Differentiation Theory diverges from Gestalt.

In Gestalt theory, information absorption occurs through the principle of similarity, based on similarities among similar stimuli, to reach an integrated whole through grouping. In Ecological theory, however, this process is based on differences among similar stimuli during active

movement. In fact, stabilities represent stimulus characteristics and relate to past experiences. During motor activity, what is perceived is subject to change, and multiple layers of information are understood through stabilities in the differences among similar stimuli (high-intensity changes) in relation to environmental elements.

Conversely, in the absence of motor activity, the environment is perceived through a two-dimensional view from a single observer point. In this state, stabilities are grouped by the similarity of stimuli (low-intensity changes) and understood within a single layer of information. Since sensory experiences in autism are often atypically formed, these stabilities must be designed according to the type of movement perception. This allows individuals with autism to encode environmental information as schemata in their minds and represent them through the attention process despite their processing limitations.

The perception of stabilities through the lenses of Gestalt and Ecological theories reveals distinct types of sensory organization in movement perception, which function differently in terms of depth, color, and shape perception. Therefore, these factors related to movement perception must be designed for both fluid and dynamic environments, tailored to the type of sensory information, to be effectively implemented in architectural spaces for children with autism.

2.2.3. Sensory Information in Movement Perception

The movement effect of objects (space of movement) has been examined within both dynamic and fluid environments to organize spatial stimuli tailored to the vestibular behavior of individuals on the autism spectrum. This approach, adapted from Fabio Metelli's perspective on motion perception as presented in Jörg Grütter's *Aesthetics in Architecture* (2009), is employed to explain the visual-motor behaviors of children with Autism Spectrum Disorder (ASD).

According to this framework, the experience of movement is fundamentally contingent upon form. These objects either possess or lack a discernible movement effect; thus, they provide critical sensory information within the visual domain that interacts with the autistic vestibular system. Metelli suggests that the movement effect is suppressed across all stationary and moving components in a monochromatic environment; consequently, an individual moving through a space with monochromatic elements fails to perceive a movement effect, whereas non-monochromatic environments facilitate this perception. Metelli emphasized the properties of moving versus stationary planes, noting that geometric configuration is pivotal: for instance, a

rotating square yields a perceptible movement effect, while a rotating circle does not (Grütter, 2009, p. 401). Rudolf Arnheim further posits that dynamism, through weakened proportions, reinforces stasis (Grütter, 2009, p. 411). Thus, objects lacking edges (e.g., circles) lack a movement effect, while objects with edges exhibit a discernible one.

Given the inclination toward stillness (stasis) in the vestibular behavior of hyper-responsive autism, edge-less shapes such as circles, or elongated rectangles, are appropriate for mitigating anxiety-related responses to movement. In these cases, monochromatism (within a brightness spectrum) renders motion perceivable at a manageable intensity. Conversely, for hypo-responsive autism, characterized by movement-seeking behavior, the movement effect can be amplified by utilizing polygonal shapes (e.g., hexagons, octagons) or by explicitly creating edges on surfaces, further reinforced by non-monochromatic characteristics.

Furthermore, Gibson's approach to sensory information absorption—based on differentiation—aligns with Metelli's non-monochromatic strategy, reflecting a detail-oriented perception of the environment. Conversely, the role of monochromatism in the absence of a movement effect facilitates the formation of a 'fluid environment.' In terms of sensory absorption, this aligns with Gestalt Theory's principle of similarity, fostering a holistic perception of the environment.

2.3. Sensory Information Related to Sensory Organization

The sensory organization within the autistic visual system can be examined through three primary aspects: color, light/brightness, and shape. These elements facilitate distinct modes of perception that correlate with specific visual-sensory behaviors.

2.3.1. Depth Perception in Children with Autism Spectrum Disorder

Depth perception is conceptualized differently by Gibson's ecological theory and the Gestalt approach, although their although Gibson's affordances and the Gestalt approach exhibit significant overlap (Shahcheraghi & Bandarabad, 2016: 162). Consequently, the disparity in depth perception is elucidated by examining movement perception, where depth acquisition is contingent upon either motion or stasis. The divergence between Gibson's ecological theory and Gestalt theory reveals two distinct levels of depth perception—holistic and detail-oriented—which are essential for tailoring stimuli to autistic visual processing. Accordingly, depth perception factors within these two theories are analyzed across two environments: the fluid environment

(characterized by the absence of movement) and the dynamic environment (characterized by active movement).

In individuals with vestibular hypo-responsivity, movement-seeking behavior is prevalent; however, it appears that self-stimulatory rotational movements often serve as a compensatory mechanism for deficits in depth perception. Therefore, understanding depth perception within a dynamic environment is critical for these individuals. Gibson's ecological theory provides the theoretical foundation for this; he identified distinct visual rules termed depth-representing textures (texture gradients) (Grütter, 2016: 30). These rules govern the linear perspective and visual order, facilitating a unique mode of depth perception. According to Gibson, the visual field expands as one moves toward objects and contracts as one moves away (Shahcheraghi & Bandarabad, 2016: 145). At this level, as objects recede, they appear smaller, and depth perception is mediated by differences in size, color, and height (Grütter, 2016: 30-32). When depth remains unperceived, hypo-responsive autistic individuals often utilize rotational movements as a compensatory visual stimulation mechanism. Gibson's Differentiation Theory posits that stabilities (stimulus features) are absorbed through differences in similar stimuli (Mohseni, 2004: 219). In this context, the perception of stimulus features during movement depends on variations in shape, size, and color, which, as discussed in this study, align with Fabio Metelli's theory regarding the movement effect of objects. To enhance surface perception and facilitate a three-dimensional view for hypo-responsive individuals, visual order and depth-representing textures—achieved through surface variations or positive/negative space—can be effectively employed.

Conversely, individuals with a Hyper-responsive autistic vestibular system favor stillness, perceiving their surroundings through a fluid environment. Gestalt theory's principles, which define visual rules within static space, are particularly effective for this group. Depth perception in Gestalt theory is defined via figure-ground relationships. The principles of Gestalt grouping—such as good continuation, similarity, proximity, and closure—organize information into layers, resulting in a two-dimensional depth perception (Atkinson & Hilgard, 2017: 211). In figure-ground dynamics, the figure (the smaller, component-rich element) is perceived as being in front of the ground (the larger, component-free surface) (Shapourian, 2007: 96-97). Through these grouping laws, the figure integrates components onto the ground, establishing the connections necessary for the appearance of an integrated whole. Thus, background perception in a fluid environment is vital,

as depth perception emerges as “surface perception,” grouping common characteristics within a unified ground. In such environments, information is processed in layers; layers occupying larger surface areas are perceived as being positioned in the foreground, culminating in a layered, surface-based depth perception that constitutes a two-dimensional view.

2.3.2. Color and Brightness Perception in Children on the Autism Spectrum

Light and color are interdependent factors that play a crucial role in color perception. Variations in stimulus intensity, driven by light and color, fluctuate depending on whether the observer is in motion or at rest. According to Fabio Metelli’s theory of visual perception, during observer motion, non-isochromatic (differently colored) elements produce a perceptible movement effect, whereas isochromatic (monochromatic) elements render this effect imperceptible. In a stationary state, for monochromatic elements, stimulus intensity is primarily dependent on brightness, where colors are perceived along a spectrum of shade and half-shade. However, in non-isochromatic configurations under high-intensity uniform light, a reduction in light leads to a diminished movement effect (blurring of object edges) and a loss of spatial detail. Consequently, due to the dual impact of light and color intensity variations on autistic children’s perception, their visual-sensory behavior must be regulated.

In visual-sensory therapy, two distinct stimulation protocols are employed: for hyper-responsive autism, stimulus intensity progresses from low to high, while for hypo-responsive autism, it transitions from high to low (Rafei, 2008: 90-101). Hyper-responsive individuals, characterized by hypersensitivity, often exhibit behaviors such as avoiding sunlight and glare, hypersensitivity to any spatial movement, staring, or retreating from light stimuli like fluorescent lamps (Kakavand, 2009: 102). They may respond physically to specific objects or colors; other behaviors include avoidance of or fixation on rotational movements, fear of darkness, and reactions to mirrors reflecting sunlight (Rafei, 2008: 91-92). To mitigate these reactions in interior spaces, architects should employ lower light intensities with low color tonality and structured, progressive stimulus sequences to encourage regulated movement. In intense exterior environments, high tonality and matte colors should be used to minimize glare and reduce anxiety. Additionally, direct sunlight should be avoided in interiors, and fluorescent lighting should be designed as concealed (hidden) light sources. In exterior spaces, architectural projections (overhangs) and shading strategies can effectively reduce light sensitivity.

Conversely, the hypo-responsive visual system, marked by hyposensitivity, is characterized by a lack of awareness of people's presence, an inability to locate objects or individuals, and a failure to perceive figure-ground relationships (Kakavand, 2009: 102). Behaviors such as staring directly at intense light sources or vibrant colors, inability to track moving objects, spinning around objects, or throwing them due to visual deficits, and 'touching dark edges of objects' are observed in these individuals (Rafei, 2008: 93, 106), indicating a lack of ambient movement perception. Movement perception can be facilitated through stimuli with a strong movement effect, such as color contrasts and edged surfaces. While holistic perception in a fluid environment relies on surface perception, detail-oriented perception is formed through edges; thus, surfaces must be perceived via their boundaries. Regarding the behavior of 'touching dark edges,' darkening the boundaries of surfaces can create a spatial pattern for surface differentiation. Effectively, color contrast delineates boundaries more clearly and expands edge perception. For hypo-responsive individuals, color is reinforced through contrast and stimulus intensity: in low-light interior spaces, low tonality with high brightness (for maximum reflection) is utilized, whereas in high-light exterior spaces, high color tonality is positioned to maintain visual stability.

2.4. Environmental Perception

The relationship between sensory organization and sensory information, viewed through the lens of movement perception in autistic children, is intended to explain environmental perception. Patterns of behavior in the autistic vestibular system reflect the individual's mode of motor activity: a desire for movement is typically facilitated in response to environmental dynamism, whereas a desire for stillness tends to emerge within a fluid environment. Nevertheless, movement and pause within space remain inseparable components of environmental perception. In autistic children, it is primarily the *type and weighting of sensory information* that differs.

Drawing on the perception of color, brightness, and depth within dynamic and fluid environments, this study outlines design foundations aligned with vestibular-behavioral profiles in autism. These two vestibular patterns—through differences in sensory information uptake—correspond to different sensory thresholds within the visual system. Accordingly, vestibular–visual interactions, framed by dynamic and fluid environments, yield distinct informational conditions for movement perception.

In hyper-responsive autism, the movement effect of objects can directly intensify sensory sensitivity, contributing to movement-related anxiety. Therefore, movement perception is regulated through reduced or absent motor activity, reinforcing a preference for stillness. Consequently, to support a desire for movement, the movement effect of objects should be moderated—an approach associated with the characteristics of a fluid environment.

By contrast, in hypo-responsive autism, children often display rotational and poorly organized movements, indicative of hyposensitivity in the vestibular system, and a strong tendency toward movement is frequently observed. For movement perception to develop under this profile, sensory information should be structured in the form of objects that produce a salient movement effect within a dynamic space. This framework is developed with reference to Fabio Metelli's theory of visual perception of objects.

2.4.1. Designing a Fluid Environment for Hyper-Responsive Autism

In movement spaces, adhering to Fabio Metelli's theory of visual perception—which posits that homogeneous elements lack a discernible movement effect—can effectively mitigate movement-related anxiety in autistic individuals. This homogeneity is perceived as depth through a luminance gradient (from shade to light). Within a fluid environment, utilizing Gestalt grouping laws—which assume a stationary observer—the absorption of sensory information is anchored in the principle of similarity, where similar stimuli achieve coherence through grouping. Sensory information (e.g., similarity in color, form, and size) is thus perceived as layered depth. Consequently, to optimize environmental perception for the hyper-responsive autistic visual system, the design of fluid environments is structured across form, space, movement paths, orientation, and organizational strategies. Dynamic visual stimulation is moderated through proportions to reinforce the fluid nature of the space (Grütter, 2009: 411).

Form: Circular planes, which lack a movement effect, reinforce a desire for stillness through color homogeneity (Grütter, 2009: 401). For rectangular planes, surface focus serves as a suitable stimulus, interpreted through figure-ground relationships; by incorporating solid and void elements, designers can effectively delineate distinct layers of information.

Space: Spatial openness facilitates a unified perception where, according to the principle of continuity, similar objects are cognitively grouped. Models positioned on a single surface are

grouped as a single informational layer, further reinforced by the principle of similarity. In interior design, high ceilings and expansive spatial volumes foster this unified spatial perception.

Movement Paths: Configuring paths with homogeneous surfaces minimizes the movement effect, thereby preventing anxiety in the hyper-responsive visual system. The use of ramps helps regulate reactions triggered by the fear of elevation changes. Furthermore, using uniform, monochromatic materials for flooring mitigates anxiety during locomotion.

Orientation: To encourage stillness, directional cues in static spaces are intentionally minimized. Utilizing the principle of symmetry alongside the principle of similarity can effectively reduce the propensity for excessive movement.

Organization of Activities: In accordance with the principle of similarity, activities with analogous requirements are clustered within the same spatial zone.

2.4.2. Designing a Dynamic Environment for Hypo-Responsive Autism

In motion spaces, based on Fabio Metelli's theory of visual perception, non-isochromatic (contrasting) elements generate a "movement effect," stimulating the impulse for movement. Furthermore, according to Gibson's ecological theory, which posits movement as the foundation of sensory perception, sensory information is processed through differences in stimuli—specifically variations in color, size, and elevation—to perceive depth. This depth is perceived within a visual order (Gibson's texture gradients), which evokes linear perspective. These factors are applied to dynamic design across form, spatial function, movement paths, and spatial organization to facilitate environmental perception in the visual system of hypo-responsive individuals.

Form: Non-isochromatism creates a movement effect (Grütter, 2009), which is enhanced by color contrast. Edged surfaces generate a movement effect, further reinforced by non-isochromatic treatments. Regarding depth perception, shapes such as hexagons and octagons exhibit superior depth cues (Grütter, 2009). In rectangular modules, depth perception is enhanced by introducing elevation changes on building facades. Order increases predictability (Grütter, 2009), facilitating environmental navigation and perception.

Spatial Function: Order enhances spatial predictability (Grütter, 2009). Following Gibson's texture gradients, formal proportions can define distinct functions, where modulating spatial dimensions can induce the perception of "new" space.

Movement Paths: Elevation changes in non-planar movement spaces (e.g., stairs) should be reinforced by non-isochromatic elements to enhance the movement effect. Flooring should incorporate varied colors and textures to improve sensory perception of movement. Direction: Establishing axial environments simplifies orientation. Floor-integrated guidelines serve as navigation aids. Depth: Intensifying perspective through solid and void volumes provides a sufficient stimulus for triggering depth perception.

Spatial Organization: Radial organization can cause confusion and disorientation in autistic children due to the convergence of multiple paths. Conversely, linear organization enhances predictability and legibility. Legibility at this perceptual level is formed through categorical, part-oriented information processing, where proportions increase predictability. Thus, through the relationship between parts, the “whole” is perceived as an integrated entity. These proportions, when applied to discrete elements within a sequence, induce a rhythmic cadence, fostering spatial continuity (Grütter, 2009).

3. Material and Methods

A comparative method was adopted as the research strategy. The study was based on library research and a review of books and reputable scholarly articles. In the present study, the classification of sensory behavioral subcategories was derived from Rafiei (2008) and Kakavand (2009), which served as the main references for identifying and categorizing sensory behavioral patterns in children with autism. The analysis was conducted through a comparative approach from two distinct analytical perspectives.

In the first approach, by differentiating movement perception in the autistic vestibular system and examining its connection with the visual system, environmental characteristics for each group were identified and separated. In the second approach, by distinguishing the movement effect within the visual system and its relationship with the autistic vestibular system, the characteristics of environmental components involved in movement perception were systematically differentiated. Finally, the findings from both approaches were integrated.

The resulting model is constructed through two stages. First, from the perspective of a neurotypical observer, the main environmental components and sensory organization are delineated. In the

second stage, these extracted components are adapted to autism-specific environments by matching them with autistic sensory information, defined across two distinct environmental types. In the first approach, to generate movement perception, it was necessary to examine vestibular behavior in autism and identify the environmental conditions under which different behavioral patterns emerge in each autistic group. Accordingly, on one hand, the environment was classified based on vestibular sensory behavior, and on the other hand, in connection with the visual system and drawing on environmental perception theories (Gestalt theory and Gibson's Differentiation Theory), the environment was divided into fluid and dynamic types. Aligning these environmental types with visual sensory behaviors in autistic children led to two distinct modes of environmental design.

In the second approach, with the primary aim of examining sensory information in relation to sensory organization, and based on Fabio Metelli's theory of visual perception of objects, object characteristics were analyzed at two levels of visual perception—with and without a movement effect—in relation to movement perception. This analysis provided appropriate sensory stimuli within the visual system that correspond to behavioral patterns in the autistic vestibular system. Overall, the study pursued these two approaches from the perspective of movement perception in the visual system. By integrating them, a connection between sensory information and sensory organization was established, with the aim of regulating and modulating the visual sensory behaviors of autistic children. The consensus diagram in Figure (1) represents the convergence of these two approaches, illustrating two distinct perceptual levels that depend on vestibular behavior in autistic children and, consequently, reveal a specific type of visual perception.

4. Discussion

In autism-related spaces, due to difficulties in self-regulation, it is necessary to establish a form of adaptability between autistic behaviors and the environment; in other words, the environment should be adjusted to behavioral patterns associated with autism. From this perspective, studies conducted in the field of architecture have been examined. In the studies by Owen and McCann (2013, 2018), spatial organization has been explained in relation to the complexity of physical spaces alongside the element of movement; an approach that may lead to the formation of a dynamic environment. However, this approach primarily reflects the sensory organization of hypo-responsive autism, whereas another dimension of movement perception in hyper-responsive

autism has received less attention; in this condition, sensory information is controlled through the physical separation of spaces. Baumers and Heylighen (2010) introduced the concept of cognitive readiness for the perception of space and argued that the difference lies not in receiving information, but in absorbing it. Cognitive readiness indicates the necessity of understanding spatial organization; a process that may be realized through sensory information appropriate to that mode of perception.

McAllister (2010) emphasized the importance of adapting the environment to sensory behavior. However, due to interference among stimuli in the two autism groups—namely, hyper-responsive autism and hypo-responsive autism—sensory organization should be designed separately. Mostafa (2020), through sensory design theory, also addressed this issue in the design of autism-related spaces. Nevertheless, in autism, due to deficits in self-regulation, acceptance of change in environmental organization does not occur easily, and the individual responds through insistence on sameness. This issue results from deficits in sensory processing; that is, due to a failure to perceive sensory organization and an inability to adapt to spatial organization, a relationship with the environment may not be formed, and this condition may manifest itself in the form of atypical behaviors. Therefore, conditions should be provided in accordance with their perception. To address this issue and improve environmental conditions, a space referred to as an “escape space” has been designed so that a stimulus-free setting may be created to achieve sensory balance and control anxiety-related behaviors (Mostafa, 2015). In practice, this space is applicable to hyper-responsive autism; however, for hypo-responsive autism, which requires high-intensity stimuli, such spaces are unlikely to be effective. Even so, it is necessary to pursue an organization related to sensory information so that autistic processing may be organized in relation to the stimulus itself and develop toward understanding the characteristics of the stimulus.

In various studies, autism-adapted architectural patterns and flexible environmental design in terms of lighting quality, sound, and ambient temperature have been proposed in order to provide suitable environmental conditions for children with autism (Tola et al., 2021). In relation to sensory information, this can be achieved through the separation of stimuli; however, sensory interference among the senses must also be taken into account. In the present study, due to the breadth of the disorders and with reference to the sensory integration approach—which focuses on the three senses of touch, vestibular sense, and proprioception—only the visual system has been examined

in relation to the vestibular system. Nevertheless, a deeper gap identified in this study is sensory interference among the senses, although this issue is not the main focus of the present study.

In the studies of Clouse et al. (2020), sensory design was discussed with attention to hyposensitivity and hypersensitivity in individuals with autism, and flexible environments were proposed on the grounds that the needs of these children are not directly observable. However, lack of flexibility and insistence on remaining in one position in social relations (Kenworthy, 2010) constitute a pattern that makes the achievement of a flexible environment for children with autism very difficult. Likewise, the sensory interference discussed in architectural studies cannot lead to a single space with identical stimuli, and different environments must therefore be designed (Ghazali et al., 2021). On the other hand, Kinnaer and colleagues referred in their studies to two different levels of spatial perception, indicating a different sensory organization in these children. Therefore, in practice, flexibility in space acquires a different meaning, and for this reason a uniform spatial organization cannot be envisioned for these children; rather, only specific activities under the guidance of a therapist are possible. Given the behavioral characteristics of children with autism, two patterns—hypersensitivity and hyposensitivity—are observed across their seven sensory domains, and these must be taken into account in design (Ghazali et al., 2021). This issue indicates differences in the sensory information present in the physical structure of space, which must be regulated separately for these two types. Despite all these complexities in the creation of stimuli, whether in terms of environmental organization or environmental information, compatibility with the environment rather than flexibility should be pursued.

Kinnaer et al. (2015), in autism-adapted architecture, drew attention to two distinct perceptual organizations in the organization of space. However, since perception in autism begins with sensory information and their cognitive patterns are formed differently from those of neurotypical individuals, sensory information should be designed in accordance with sensory organization.

Various studies have identified deficits in schema formation (Minshew et al., 2001; Williams et al., 2006), and this issue may be the source of non-Gestalt perception (Bayrami et al., 2013, 2014). The cognitive pattern in the autistic child is formed on the basis of received sensory information, and differences in schema formation in these children indicate that the cognitive patterns of neurotypical individuals are not directly generalizable to autism; rather, such generalization is possible only in relation to sensory information. Some studies have also raised deficits in schema

formation, and since this process constitutes a form of sensory processing and operates entirely at an unconscious level, the cognitive pattern of the neurotypical individual is generalizable only when considered in relation to environmental sensory information. From this perspective, it becomes possible to design a flexible environment compatible with autism.

Children on the autism spectrum, due to deficits in the sensory processing system and in view of the two behavioral patterns of hyposensitivity and hypersensitivity in their sensory system, have been carefully studied from the perspective of perceptual levels of movement. Dunn's sensory processing model explains sensory dysfunctions within the framework of sensory thresholds and, on this basis, identifies the types of stimuli across the two autism spectra of hyper-responsiveness and hypo-responsiveness. Accordingly, with reference to sensory behaviors, this model demonstrates the formation of stimuli in the visual and vestibular systems in terms of brightness, color, and depth. This model also identifies stimulus intensity—which is a type of environmental characteristic and influential in schema formation—and can organize autistic processing in relation to the stimulus itself.

Movement perception in the functioning of the vestibular system in autism has been examined with reference to Gestalt theory and Gibson's ecological theory of perception; this examination has revealed the tendencies toward stillness and toward movement in the perception of space. Since only cognitive aspects have been examined in the perception–cognition model, theories of perception–cognition were therefore studied in relation to sensory perception in light of the sensory difficulties associated with autism. The study of these two theories has shown a pattern of two separate sensory perceptions in cognitive processes that depend on movement perception and can reveal the sensory organization of autism. Therefore, by analyzing Gibson's perspective in the theory of differentiation, the view of ecological perception theory was clarified so that, in comparison with Gestalt theory, different aspects of spatial perception could be revealed. The differences between these two theories in movement perception have been defined in accordance with the functioning of the vestibular system in autism so that, in relation to the visual system, the basis for sensory perception in space may be provided.

The study of these two theories has revealed differences in their sensory perception from two aspects of motor activity, namely movement and stillness in space; this is an aspect that constitutes a point of commonality between the vestibular system in autism and movement perception from

the perspective of these two theories. This point of commonality reveals different stimuli of color, brightness, and depth in space. Accordingly, with reference to Fabio Metelli's theory of the visual perception of objects, the effect of movement has been adapted in terms of the color and form of these features so that the stimuli may be regulated in harmony with their own characteristics. This has made it possible to provide the basis for sensory perception in the perception of depth, movement, color, brightness, and spatial dimension, at two different perceptual levels for hyper-responsive and hypo-responsive autism, within the framework of spatial fluidity and dynamism.

5. Conclusion

In this study, two levels of motion perception within the vestibular system of individuals with autism were identified in relation to the visual system. These two perceptual levels for autistic children are explained through Gestalt theory and Gibson's ecological theory of perception, clarifying how sensory organization (stimulus properties) is formed in the perception of movement. Although both theories describe a common concept regarding sensory information absorption, they generate different types of perception due to the nature of sensory input. This highlights the importance of sensory information that is congruent with the sensory organization for autistic children, because instead of attending to environmental properties as a whole, they primarily focus on the stimulus itself. Consequently, their cognitive patterns are organized around the properties of the stimulus, and the environment must be structured according to these stimuli. The following diagram illustrates the research process leading to the study's objective. Figure (1) provides a schematic representation of the relationships discussed above between motion perception, sensory organization, and the visual–vestibular system within the research framework.

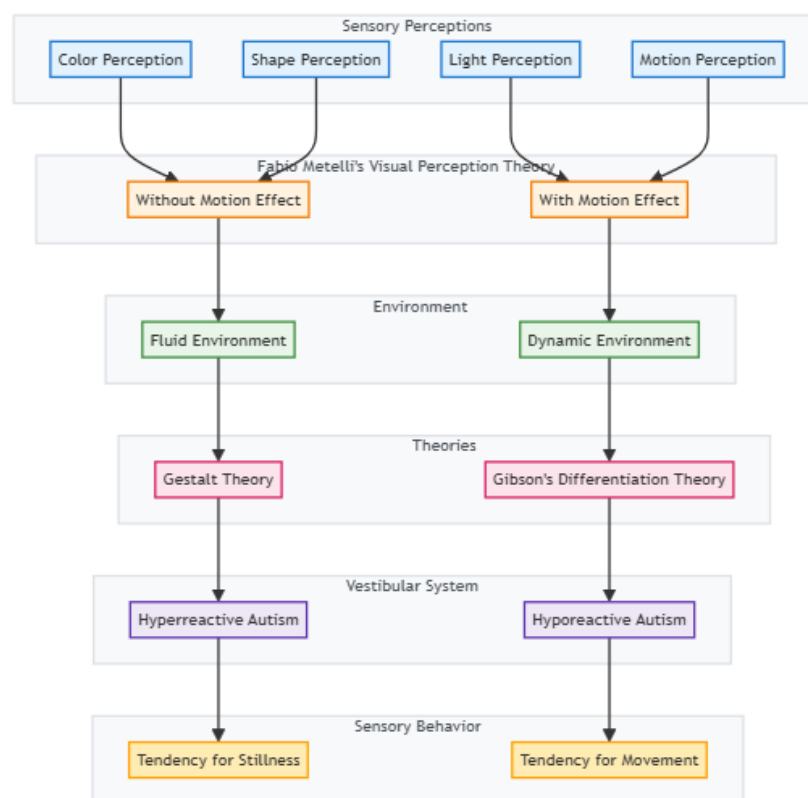


Figure 1. Motion perception diagram with a focus on the vestibular system

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving human participants were reviewed and approved by the ethics committee of Islamic Azad University. The patients/participants provided their written informed consent to participate in this study.

Author contributions

All authors contributed to the study conception and design, material preparation, data collection, and analysis. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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