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Designing Therapeutic Interior Environments for Children with Autism Spectrum Disorder in Pakistan: An Evidence-Based Approach

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ABSTRACT

Autism Spectrum Disorder is a complex neurodevelopmental condition characterized by challenges in communication, social interaction, and sensory processing (Bashir et al., 2024; Nair et al., 2022). The rising prevalence of autism spectrum disorder in Pakistan presents significant societal and infrastructural challenges, yet the development of therapeutic, sensory-supportive interior environments remains largely unaddressed in the national architectural discourse. Given the recent estimates from the Pakistan Autism Society indicating that approximately 350,000 children are currently affected, the urgent need for specialized infrastructure is becoming a critical public health priority (Sareer et al., 2025). Despite this pressing demand, the architectural landscape in Pakistan lacks standardized, sensory-responsive design frameworks, leaving many therapeutic and educational facilities unable to adequately support the specific physiological needs of these children (Mohamed & Almaz, 2024). This research gap is exacerbated by the absence of empirical data on how localized environmental stressors, such as acoustic fluctuations and lighting, impact sensory integration within While international research underscores the critical impact of architectural design on mitigating sensory overload and improving behavioral outcomes for children with ASD (Nair et al., 2022), there is a notable research gap regarding evidence-based design guidelines tailored to the specific socio-cultural and environmental context of Pakistan (Bashir et al., 2024).. Consequently, current rehabilitation centers often rely on improvised spatial configurations that fail to address the atypical sensory processing inherent to the spectrum, potentially hindering rather than facilitating developmental progress (Mehboob, 2025; Zhou et al., 2025). This critical deficiency underscores a broader challenge where intuitive, non-quantified spatial planning often overlooks the nuance required to balance individual sensory profiles with functional design (Al-Harasis et al., 2025). To address this, there is an urgent need to transition from generalized construction practices toward a refined, evidence-based architectural paradigm that systematically mitigates visual and auditory distractions (Kalantari et al., 2025). By integrating environmental psychology with localized construction standards, such an approach must move beyond aesthetics to address the fundamental spatial zoning and ergonomic requirements essential for sensory regulation (Niknejad & Mesbah, 2025; Sarwar et al., 2025). Furthermore, the current lack of empirical, context-specific guidelines leaves architects without a standardized framework to optimize therapeutic outcomes through spatial manipulation (Jalalian, 2021). This study proposes to bridge this critical void by synthesizing interdisciplinary insights into a replicable model that accommodates the unique sensory and cognitive requirements of children on the spectrum (Ghazali et al., 2019; Niknejad & Mesbah, 2025). By shifting the focus toward sensory-responsive architectural standards, this research seeks to mitigate the environmental triggers that contribute to behavioral distress (Mostafa, 2015). By adopting

frameworks such as the ASPECTSS model—which emphasizes acoustics, spatial sequencing, and sensory zoning—designers can move beyond voluntary, fragmented practices toward a systematic, evidence-based mandate for inclusive infrastructure (Ho, 2025)

Keywords: *Autism Spectrum Disorder, Therapeutic Interior Design, Pakistan, Sensory Sensitivity, Evidence-Based Design*

INTRODUCTION

Individuals with Autism Spectrum Disorders are part of a growing population that is usually ignored in design. The needs of those with ASD are excluded entirely from all building codes and design guidelines. This is a serious concern, since these individuals are more sensitive to their physical surroundings than the average person. When an individual is unable to understand or adapt to their environment, negative behaviors typically ensue. Although the surrounding environment has such a strong influence over people with ASD, there is very little information on how to design spaces for these individuals.

Another prominent challenge involved in designing spaces for individuals with ASD is that no two cases are alike. ASD is referred to as a spectrum disorder because each individual has different symptoms, different sensitivities, and a different level of functioning. [1] Symptoms vary from mild to severe; some children on the spectrum have intellectual disabilities or impaired speech, while others do not. Ideally, spaces would be designed for each individual case and the space would accommodate each unique symptom, but also help individuals with ASD build a tolerance to environmental stimuli. McCallister states that environments for individuals on the spectrum should prepare them for the challenges and problems they will face in everyday life: "Cocooning the ASD pupil from all external factors will not necessarily help them reach their full potential in life. Therefore, designers should not overly cater to users with ASD and create unrealistic environments that will leave them unprepared to face other environments.

Individuals with Autism Spectrum Disorders (ASD) are particularly sensitive to the surrounding environment, primarily because of sensory processing deficits. For many, sensory processing deficits, such as sensitive eyesight or hearing, can make the built environment a distracting and even frightening place. In her autobiography, Temple Grandin described autism as "seeing the world through a kaleidoscope and trying to listen to a radio station that is jammed with static at the same time. Add to that a broken volume control, which causes the volume to jump erratically from a loud boom to inaudible." Many individuals on the spectrum employ coping mechanisms in the form of rigid and repetitive behaviors to deal with incoming sensory stimuli. To an outsider, these behaviors appear like an inappropriate tantrum when in actuality, they are the result of an "imbalance between the environment and an individual's ability to adapt to it." Architecture and interior spaces can be modified to positively influence the individual's behavior.

Contemporary autism research increasingly recognizes that many behaviors traditionally described as "challenging" represent meaningful communication rather than deliberate non-compliance. Emotional distress, withdrawal, repetitive behaviors, or refusal to participate frequently emerge when environmental demands exceed an individual's capacity to regulate sensory, emotional, or cognitive experiences. Consequently, therapeutic environments should not merely minimize behavioral disruption but actively support regulation, communication, autonomy, and participation.

[1] *Designing for*
Autism spectrum Disorders
Kristi Gaines, Angela Bourne, Michelle Pearson, and Mesha Kleibrink

This perspective shifts architectural design away from creating spaces intended to control behavior and towards environments that accommodate neurological diversity. Rather than asking autistic children to adapt to environments designed for neurotypical users, neuro affirming design asks how environments can become sufficiently flexible to respond to individual sensory profiles, developmental readiness, and emotional needs.

Background/History

Autism is a developmental disorder that affects the functioning of the brain. Individuals with ASD are identified as having difficulty with social interaction, communication skills, and as having a small range of interests. IQ levels of individuals on the spectrum can vary in range from gifted to severe mental disabilities. At the mild end of the spectrum, ASD may be nearly indistinguishable from the general public. These individuals are commonly referred to as high functioning. Others with ASD exhibit severe or life-threatening behaviors. Self-injurious behavior is not uncommon in individuals with ASD, but may include head banging or biting oneself.[2]

Sensory Processing

Individuals with ASD often have abnormal responses to incoming sensory information from the surrounding environment. Typically, people receive information about a space based on all of their senses collectively: smell, sight, taste, sound, and touch. This ability is known as sensory integration and is essential to achieve a coherent perception of a situation and to decide how to act. However, people with ASD have deficits in sensory integration due to the inability to process information from several senses at once. This may be manifested through being hyper-sensitive to stimuli or being hypo-sensitive (under-reactive) to stimuli. Rapid shifting of attention between two different stimuli is difficult, and abnormal sensory processing can cause individuals with ASD to demonstrate unusual behaviors. Additionally, a dysfunction in this sensory integration may result in language delays and academic under-achievement. There are some reports of sensory perception deficits in which sounds are perceived as smells or colors.

Hypo- And Hyper-Sensitivity

Generally, individuals with ASD are either hypo-sensitive or hypersensitive or sometimes both to certain information pertaining to smell, sight, taste, sound, or touch. There are also instances of hyper- or hypo sensitivities in vestibular movement and proprioception, or the ability to sense the position of the body in space. Hypo-sensitive cases appear to be under-responsive, as if certain sensory information goes unnoticed or certain senses are impaired. Young children who were later diagnosed with ASD and had hypo-sensitive auditory tendencies were often thought to be deaf as infants. Hyposensitive cases are often qualified as "sensory-seeking," meaning they often create or generate their own sensory experiences either for pleasure or to block out other unpleasant stimuli. Conversely, hyper-sensitive cases are over-responsive to sensory stimuli. Children with hyper-sensitivity can be easily overwhelmed by incoming sensory information. The

[2] *Designing for*
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environment can be terrifying at times because loud or sudden noises feel physically painful to hypersensitive individuals.[34]

Repetitive And Restricted Behaviors

Individuals with ASD also exhibit repetitive, rigid behaviors. These kinds of behaviors are defined as repetitive, sometimes self-injurious body movements, compulsive behaviors, and limited, almost obsessive interests. Self-injurious behaviors, like head banging, are also called "stimming." These can be dangerous both to the individual and to other individuals nearby. [5]

For most people, adapting to changes in the physical environment requires relatively little conscious effort. Children with ASD, however, frequently depend on routine, predictability, and environmental consistency to understand and navigate daily life. Sudden changes in lighting, unfamiliar spatial layouts, excessive visual information, unexpected sounds, or overcrowded environments can increase anxiety and behavioral challenges. Consequently, the design of interior spaces should not be regarded as merely an aesthetic consideration, but as an essential component of therapeutic and educational support.

Growing evidence from environmental psychology suggests that physical environments influence behavior through continuous interactions between sensory perception and cognitive processing. Unlike conventional design approaches that primarily focus on visual appearance, autism-supportive design considers how multiple sensory systems simultaneously interact with the environment. Vision, hearing, touch, smell, temperature, movement, and spatial orientation collectively determine whether an environment promotes comfort or creates sensory overload. Because autistic children often process sensory information differently from neurotypical individuals, design decisions that appear insignificant to designers may substantially affect users' daily experiences.

Recognition of the importance of sensory-responsive environments has contributed to the emergence of evidence-based design within healthcare architecture and interior design. Evidence-Based Design (EBD) applies findings from scientific research to improve user outcomes by informing design decisions with empirical evidence rather than personal preference. Initially developed within healthcare environments to improve patient safety and recovery, EBD has increasingly been applied to educational settings and therapeutic facilities supporting individuals with developmental disabilities. The objective is not simply to produce visually attractive spaces but to create environments that demonstrably enhance health, learning, emotional well-being, and functional independence.

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[5] *Designing for*
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Within autism research, environmental design has gradually shifted from concentrating primarily on accessibility towards understanding how spatial qualities influence sensory experiences. One of the most influential contributions to this field was made by Magda Mostafa, whose Autism ASPECTSS™ Design Index introduced evidence-based principles including acoustics, spatial sequencing, escape spaces, compartmentalization, transition zones, sensory zoning, and safety. These principles demonstrated that thoughtful architectural and interior design could reduce environmental stress while improving concentration, independence, and behavioral outcomes.

Similarly, autobiographical accounts by Temple Grandin have highlighted how autistic individuals often experience environmental stimuli with exceptional intensity. Grandin describes ordinary sounds, lights, and textures as potentially overwhelming, emphasizing the importance of environments that minimize unnecessary sensory stimulation while maintaining opportunities for positive sensory engagement. These first-person perspectives have significantly influenced contemporary autism-supportive design by encouraging designers to understand environments from the user's perspective rather than solely from professional assumptions.

Interior design plays a particularly significant role because children spend most of their daily lives inside buildings, including homes, schools, therapy centres, clinics, and hospitals. Each of these settings presents distinct environmental challenges. Classrooms frequently contain high noise levels, visual clutter, and crowded layouts that compete for attention. Healthcare environments often introduce unfamiliar equipment, bright artificial lighting, and complex circulation patterns that increase stress during clinical visits. Therapy centres must balance sensory stimulation with opportunities for regulation, while residential environments require flexibility to accommodate changing developmental needs. Designing these spaces without considering sensory processing differences may unintentionally increase anxiety, reduce participation, and limit therapeutic outcomes. Conversely, sensory-supportive interiors can enhance engagement, encourage independence, facilitate learning, and improve emotional regulation.

Despite increasing awareness of autism-friendly design, several important challenges remain. Existing studies often examine individual environmental factors—such as lighting, acoustics, or color—in isolation rather than considering the combined influence of multiple interior design elements. Moreover, many published guidelines focus primarily on architectural planning and building layout while providing comparatively limited discussion of interior spatial experience, furniture selection, materiality, environmental psychology, and multisensory interaction. The absence of an integrated evidence-based framework limits designers' ability to translate research findings into practical design decisions, particularly within developing countries where autism-supportive design guidelines remain scarce.

Therefore, this study aims to synthesize current evidence from interior design, architecture, environmental psychology, occupational therapy, and neuroscience to develop a comprehensive interior design framework for children with autism spectrum disorder. Rather than presenting isolated recommendations, the research integrates sensory processing theory with evidence-based interior design principles to propose practical strategies applicable to educational, healthcare, therapeutic, and residential environments. By combining scientific evidence with design practice, the study seeks to demonstrate that thoughtfully designed interior environments can become active therapeutic tools that support sensory regulation, emotional well-being, learning, and participation for children with ASD.

LITERATURE REVIEW

Understanding Autism Spectrum Disorder

Autism Spectrum Disorder (ASD) is a lifelong neurodevelopmental condition that affects how individuals perceive, process, and respond to both social and physical environments. The term *spectrum* reflects the considerable variation in the presentation and severity of symptoms among individuals. While some children require substantial support in daily functioning, others demonstrate high levels of independence, but continue to experience challenges in communication, social interaction, executive functioning, and sensory processing. According to the *Diagnostic and Statistical Manual of Mental Disorders (DSM-5-TR)*, ASD is characterized by persistent deficits in social communication and social interaction, together with restricted or repetitive patterns of behavior, interests, or activities. These symptoms are present from early childhood and significantly influence daily functioning across educational, therapeutic, and residential settings.

Recent epidemiological studies indicate that the prevalence of ASD has increased worldwide over the past two decades. Although this increase is partly attributed to improved diagnostic practices and greater public awareness, it also highlights the growing need for inclusive educational, healthcare, and community environments. The Centers for Disease Control and Prevention estimates that approximately one in every thirty-six children is diagnosed with ASD, emphasizing the importance of developing environments that accommodate diverse sensory and cognitive needs.

Unlike many developmental conditions, ASD is not solely defined by behavioral characteristics. Increasing evidence suggests that differences in sensory perception constitute one of the core components influencing daily experiences. Many autistic individuals perceive environmental stimuli with greater or lesser intensity than neurotypical individuals. Sounds that appear ordinary to others may become painful, fluorescent lighting may appear excessively bright or flickering, and crowded interiors may generate overwhelming amounts of visual information. Conversely, some individuals actively seek sensory stimulation through repetitive movement, tactile exploration, or deep pressure activities.

Temple Grandin has described autism as experiencing the world through an intensified sensory lens, where ordinary environmental conditions can become physically exhausting or emotionally distressing. These autobiographical insights have substantially influenced contemporary environmental design, because they provide direct evidence that sensory experiences should be considered fundamental design parameters rather than secondary concerns.

Sensory processing differences also affect learning performance, emotional regulation, communication, and behavioral adaptation. Research by Dunn (1997; 2007) demonstrated that children with autism frequently exhibit atypical responses across multiple sensory systems, including auditory, visual, tactile, vestibular, and proprioceptive processing. These differences influence attention, participation in classroom activities, and responses to environmental change. Consequently, interior environments become active participants in children's daily experiences rather than passive physical settings.

Sensory Processing Theory

Understanding sensory processing is fundamental to designing environments for autistic children. Sensory Processing Theory, originally developed by occupational therapist A. Jean Ayres (1972), proposes that the human brain continuously receives information from multiple sensory systems and organizes this information to produce appropriate behavioral responses. When sensory information is processed

efficiently, individuals are able to interact comfortably with their environment. However, disruptions in sensory integration may produce either exaggerated or diminished responses to environmental stimuli.

For children with ASD, sensory processing differences frequently influence everyday activities including learning, communication, self-regulation, and social interaction. These differences extend beyond the traditional five senses and include vestibular perception (balance and movement), proprioception (body awareness), and interoception (internal body awareness). Consequently, autistic children may experience discomfort in environments that neurotypical users consider ordinary.

Research consistently demonstrates that sensory processing influences educational outcomes, emotional regulation, and behavioral functioning. Dunn's Sensory Processing Framework categorizes sensory responses according to neurological thresholds and behavioral self-regulation strategies. Individuals may exhibit sensory sensitivity, sensory avoidance, sensory seeking, or low registration, each requiring different environmental responses.

From an interior design perspective, these findings suggest that no single environment can accommodate every autistic individual. Instead, environments should provide flexibility through adjustable lighting, acoustic control, transition spaces, quiet zones, and opportunities for sensory choice. Such strategies allow occupants to regulate their own sensory experiences according to individual needs.

Sensory integration theory therefore provides the scientific basis for many contemporary autism-supportive interior design principles, including sensory zoning, escape spaces, predictable circulation, and environmental modulation.

In addition to Sensory Integration, many interventions may fail if the practitioners overlook readiness. For example: Before expecting participation within therapeutic or educational environments, designers and practitioners must recognize that behavior is influenced by multiple interacting variables including hunger, fatigue, illness, anxiety, communication barriers, executive functioning demands, and sensory overload. Environmental design should therefore be viewed as one component of a broader system that supports readiness for participation rather than assuming behavioral compliance as the starting point.

Individual Sensory Profiles and Environmental Accommodation

One of the greatest challenges in designing therapeutic environments for autistic children is recognizing that autism does not represent a single sensory experience. Although atypical sensory processing is now recognized as a core characteristic of Autism Spectrum Disorder (American Psychiatric Association, 2022), the way individuals perceive, interpret, and respond to sensory information varies considerably. Consequently, environmental features that promote regulation for one child may become overwhelming, distracting, or even distressing for another.

Research has demonstrated that autistic individuals may exhibit **hyper-responsivity**, **hypo-responsivity**, or **sensory-seeking** behaviors across different sensory systems, including vision, hearing, touch, smell, taste, proprioception, vestibular processing, and interoception (Dunn, 1997; Schaaf & Lane, 2015). Importantly, these sensory patterns rarely occur uniformly. A child may be highly sensitive to auditory stimuli while simultaneously seeking vestibular movement, or may avoid tactile input while actively pursuing deep-pressure sensations. Such diversity illustrates that sensory processing exists along multiple continua rather than within a single profile.

This variability has significant implications for architectural design. Traditional approaches frequently recommend generic autism-friendly design strategies, such as reducing visual complexity, minimizing

noise, or using muted color palettes. While these interventions may benefit many autistic individuals, they cannot be assumed to meet the needs of every child. For some, carefully controlled sensory stimulation may support engagement, learning, and emotional regulation more effectively than environments characterized by minimal sensory input. Conversely, children experiencing sensory overload may require immediate access to quieter, lower-stimulation spaces that facilitate recovery and self-regulation.

Moreover, sensory processing is not static. A child's sensory needs fluctuate throughout the day in response to fatigue, stress, illness, emotional state, task demands, social interactions, and cumulative sensory experiences. An environment that feels comfortable during one activity may become overwhelming later in the day following prolonged cognitive effort or repeated sensory exposure. Similarly, developmental changes, familiarity with routines, and increasing self-regulation skills may alter environmental preferences over time. This dynamic nature of sensory processing suggests that environmental suitability cannot be understood as a fixed characteristic of a building but rather as an ongoing interaction between the individual and the environment.

From a neuroaffirming perspective, these observations challenge the assumption that a universally "autism-friendly" environment can be designed. Instead, therapeutic environments should prioritize **flexibility**, **adaptability**, and **individualization** over standardized sensory prescriptions. Rather than attempting to create a single optimal sensory setting, designers should provide a range of environmental conditions that enable children to regulate their own sensory experiences according to their individual needs. Such environments may include graduated sensory zones, adjustable lighting systems, acoustic controls, flexible furnishings, opportunities for movement, access to quiet retreat spaces, and choices between high- and low-stimulation settings. These features acknowledge that successful participation often depends less on achieving a universally ideal environment than on enabling individuals to select environments that best support their current sensory state.

This perspective also has implications for therapeutic practice. Many intervention settings continue to expose children to standardized sensory experiences without first developing comprehensive sensory profiles that identify individual patterns of hyper-responsivity, hypo-responsivity, sensory-seeking behaviors, emotional regulation needs, and environmental triggers. When environmental demands exceed a child's current capacity for regulation, distress may be interpreted as behavioral non-compliance rather than as evidence of an inadequate person–environment fit. A neuroaffirming design philosophy instead views such responses as valuable feedback, indicating that the environment requires modification rather than expecting the child to adapt unconditionally.

Accordingly, this paper argues that **the concept of a universally autism-friendly therapeutic environment is inherently limited**. Therapeutic architecture should instead be understood as a responsive environmental system capable of accommodating diverse and changing sensory profiles. The primary design objective is therefore not to produce one ideal environment for all autistic children, but to create flexible environments that support autonomy, self-regulation, participation, and wellbeing across a wide spectrum of individual sensory experiences.

Environmental Psychology and Human Behavior

Environmental psychology examines the reciprocal relationship between people and their physical surroundings. Unlike traditional architectural approaches that primarily emphasize aesthetics and function, environmental psychology investigates how spatial characteristics influence cognition, behavior, emotional well-being, and social interaction.

The theoretical foundation of environmental psychology was established through the work of Roger Barker, Irwin Altman, Harold Proshansky, and Robert Gifford, who demonstrated that behavior cannot be separated from environmental context. Individuals continuously interpret environmental information through perception, memory, attention, and previous experiences. Consequently, interior environments influence not only physical comfort but also psychological functioning.

For autistic children, this relationship becomes particularly significant because sensory information directly affects cognitive processing. Excessive environmental stimulation may increase physiological stress, reduce concentration, and contribute to behavioral dysregulation. Conversely, environments characterized by predictability, clarity, and sensory balance can reduce anxiety while encouraging learning and social participation.

Ulrich's Theory of Supportive Design further proposes that environments promoting perceived control, positive distraction, and social support contribute to improved health outcomes. Although originally developed for healthcare facilities, these principles are highly applicable to autism-supportive interiors. Providing opportunities for environmental choice, reducing unnecessary sensory stimuli, and incorporating restorative natural elements may significantly improve user experience.

Research also indicates that predictable environments reduce uncertainty, an important consideration, because many autistic children rely heavily on routine and environmental consistency. Interior spaces that clearly communicate function through organization, visual hierarchy, and intuitive circulation reduce cognitive effort required for navigation and increase feelings of security.

Environmental psychology therefore provides a conceptual bridge connecting neuroscience, sensory processing, and interior design by explaining how physical settings shape emotional and behavioral responses.

Evidence-Based Design

Evidence-Based Design (EBD) has become one of the most influential approaches in contemporary healthcare and educational design. The concept emerged from Evidence-Based Medicine, where clinical decisions are informed by empirical research rather than tradition or personal preference. Roger Ulrich subsequently adapted these principles to architecture, arguing that design decisions should similarly be supported by scientific evidence demonstrating measurable improvements in user outcomes.

Evidence-Based Design differs from conventional design approaches by asking a fundamental question:

"What environmental characteristics produce measurable improvements in health, behavior, learning, and well-being?"

Within autism-supportive environments, EBD emphasizes objective research regarding lighting quality, acoustic performance, spatial organization, color psychology, furniture design, material selection, and environmental control.

Numerous studies have demonstrated that design interventions influence stress levels, concentration, behavioral regulation, communication, and learning performance among children with ASD. Rather than viewing architecture as merely providing shelter, EBD recognizes interior environments as therapeutic interventions capable of improving developmental outcomes.

The principles of EBD are particularly valuable because they encourage interdisciplinary collaboration among architects, interior designers, occupational therapists, psychologists, educators, and healthcare professionals. This collaborative approach ensures that design decisions respond directly to users' physical, cognitive, and emotional needs rather than aesthetic preferences alone.

Towards a Neuro affirming Design Philosophy

Contemporary autism research increasingly recognizes that many behaviors traditionally described as "challenging" represent meaningful communication rather than deliberate non-compliance. [6] Emotional distress, withdrawal, repetitive behaviors, or refusal to participate frequently emerge when environmental demands exceed an individual's capacity to regulate sensory, emotional, or cognitive experiences. [7] Consequently, therapeutic environments should not merely minimize behavioral disruption but actively support regulation, communication, autonomy, and participation. [8]

This perspective shifts architectural design away from creating spaces intended to control behavior and towards environments that accommodate neurological diversity. Rather than asking autistic children to adapt to environments designed for neurotypical users, neuroaffirming design asks how environments can become sufficiently flexible to respond to individual sensory profiles, developmental readiness, and emotional needs.

Neuroarchitecture: Linking the Brain and the Built Environment

Neuroarchitecture is an emerging interdisciplinary field that combines architecture, neuroscience, psychology, and cognitive science to investigate how built environments influence brain function and human behavior. Rather than treating buildings as static physical structures, neuroarchitecture considers environments as dynamic systems capable of affecting neural activity, stress responses, attention, emotional regulation, and cognitive performance.

For children with ASD, neuroarchitecture provides valuable insights into how environmental stimuli influence sensory processing. Excessive visual complexity, glare, unpredictable lighting, reverberant acoustics, or spatial ambiguity may increase cognitive load and activate stress responses. Conversely, environments characterized by balanced sensory stimulation, natural materials, daylight, and coherent spatial organization may reduce physiological arousal while improving concentration and emotional regulation.

Contemporary neuroscience further suggests that exposure to natural environments reduces cortisol levels and promotes restorative cognitive processes. Consequently, integrating biophilic design principles into autism-supportive interiors may provide measurable psychological benefits.

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[6] **National Institute for Health and Care Excellence (NICE). (2015).** *Challenging behaviour and learning disabilities (NG11).*
Emerson (2001). *Challenging Behaviour: Analysis and Intervention in People with Severe Intellectual Disabilities.*
Kurth & Mastergeorge (2010) *Discuss behavioural challenges in autism from a communication perspective.*
Prizant et al. (2006). *The SCERTS Model.*
[7] Dunn (1997) — Sensory Processing Framework; Schaaf & Lane (2015) ; Ashburner, Ziviani & Rodger (2008)
[8] Prizant, Wetherby, Rubin & Laurent (2006) *The SCERTS Model.*

Neuroarchitecture therefore reinforces the importance of designing environments that support neurological functioning rather than merely satisfying functional requirements.

Existing Autism Design Frameworks

One of the most significant developments in autism-supportive architecture is the **Autism ASPECTSS™ Design Index**, developed by Magda Mostafa. Based on extensive empirical research, the framework identifies seven core design principles:

- **Acoustics**
- **Spatial Sequencing**
- **Escape Spaces**
- **Compartmentalization**
- **Transition Spaces**
- **Sensory Zoning**
- **Safety**

These principles remain among the most widely cited evidence-based guidelines for autism-supportive environments. Rather than prescribing stylistic solutions, the framework encourages designers to organize environments according to sensory predictability and behavioral needs.

It expands on these ideas by emphasizing that environments designed for individuals with ASD should prioritize organization, safety, sensory comfort, and independence. The authors argue that architects and interior designers have a responsibility to accommodate sensory differences through evidence-based environmental planning rather than relying solely on conventional accessibility standards.

Despite the value of existing frameworks, most focus predominantly on architectural planning. Comparatively little attention has been given to interior-specific variables such as furniture configuration, material selection, color psychology, tactile experiences, biophilic interiors, and adaptive lighting systems. Addressing this gap forms one of the principal objectives of the present research.

Research Gap

The growing recognition of autism spectrum disorder (ASD) has resulted in increased attention towards creating supportive educational, healthcare, and residential environments. Numerous studies have investigated the relationship between the built environment and autistic behavior, demonstrating that sensory-responsive spaces can positively influence emotional regulation, learning performance, communication, and overall well-being. Research by Mostafa (2008), Gaines et al. (2016), Khare and Mullick (2009), Sánchez et al. (2011), and others has established that architectural design can significantly reduce sensory overload through careful environmental planning. However, despite these advances, several important research gaps remain.

First, existing literature predominantly focuses on architectural planning and building configuration rather than the quality of interior environments. Many studies discuss site planning, classroom dimensions,

circulation, or building layout but provide comparatively limited guidance regarding interior elements such as furniture design, material selection, lighting characteristics, acoustic treatment, tactile experiences, spatial flexibility, and environmental personalization. Since children spend most of their daily lives interacting directly with interior spaces rather than exterior architecture, this represents a significant limitation within current research.

Second, much of the existing evidence examines individual environmental variables in isolation. For example, one study may investigate lighting while another focuses exclusively on acoustics or color psychology. Although these investigations provide valuable insights, they rarely explain how multiple environmental factors interact simultaneously within real-life interior environments. Autism is characterized by multisensory processing differences; therefore, environmental design should similarly adopt an integrated rather than fragmented approach.

Third, most available autism design guidelines have been developed within Western educational and healthcare contexts. There remains limited research addressing the application of evidence-based interior design strategies in developing countries where economic resources, cultural expectations, climatic conditions, and healthcare infrastructure differ considerably. Countries such as Pakistan, India, Bangladesh, and many regions of the Middle East often rely on conventional educational and healthcare facilities that were not originally designed to accommodate sensory processing differences. Consequently, interior designers working within these contexts lack locally adaptable evidence-based guidelines.

Another limitation concerns the limited integration of emerging interdisciplinary knowledge. Recent developments in neuroscience, environmental psychology, biophilic design, circadian lighting research, and neuroarchitecture have generated important insights into how physical environments influence brain function, stress regulation, attention, and emotional well-being. However, these findings remain insufficiently integrated into autism-supportive interior design literature.

Furthermore, current frameworks, including the Autism ASPECTSS™ Design Index, provide valuable architectural guidance but do not comprehensively address detailed interior design decisions such as adaptive furniture systems, multisensory materials, environmental technologies, flexible learning environments, or therapeutic spatial experiences. There is therefore an opportunity to expand existing frameworks by incorporating contemporary evidence from healthcare interior design, occupational therapy, environmental neuroscience, and sensory integration research.

This study addresses these limitations by developing a comprehensive evidence-based interior design framework specifically focused on interior spatial quality rather than architectural planning alone. The proposed framework integrates sensory processing theory, environmental psychology, neuroarchitecture, evidence-based design, and universal design principles into a practical model for architects, interior designers, educators, therapists, and healthcare professionals.

Aim of the Study

The primary aim of this research is to develop an evidence-based interior design framework that enhances sensory regulation, emotional well-being, learning performance, and functional independence among children with Autism Spectrum Disorder through carefully designed interior environments.

Research Objectives

The study seeks to achieve the following objectives:

1. To examine the relationship between sensory processing characteristics of children with Autism Spectrum Disorder and interior environmental conditions.

2. To critically review evidence-based interior design strategies that improve behavioral, emotional, and cognitive outcomes among autistic children.

3. To analyze existing autism-supportive architectural and interior design frameworks.

4. To identify the interior environmental factors that most effectively reduce sensory overload and environmental stress.

5. To develop a comprehensive evidence-based interior design framework applicable to educational, therapeutic, healthcare, and residential environments.

Research Questions

The study is guided by the following research questions:

1. How do interior environments influence the behavior and sensory experiences of children with Autism Spectrum Disorder?

2. Which interior design elements most effectively reduce sensory overload and improve environmental comfort?

3. How can evidence-based design principles be integrated into autism-supportive interior environments?

4. What role do environmental psychology and neuroarchitecture play in designing therapeutic interior spaces?

5. How can an integrated evidence-based framework assist architects and interior designers in creating more inclusive environments for children with ASD?

RESEARCH METHODOLOGY

a. Research Approach

This study adopts a qualitative research approach because it seeks to develop a conceptual understanding of how interior design influences sensory experiences and behavioral outcomes among children with autism spectrum disorder. Qualitative research is particularly appropriate for investigating complex interactions between people and environments where multiple physical, psychological, and behavioral variables operate simultaneously.

Rather than collecting primary experimental data, the study synthesizes existing scientific evidence to establish design recommendations supported by empirical research.

b. Research Design

A systematic literature review forms the primary research strategy. This method enables the identification, evaluation, comparison, and synthesis of published evidence from multiple disciplines including

architecture, interior design, environmental psychology, occupational therapy, neuroscience, healthcare design, and autism research.

Unlike traditional narrative reviews, systematic literature reviews employ transparent selection criteria, allowing findings to be critically evaluated while minimizing researcher bias.

c. Data Sources

The literature reviewed in this study is obtained from peer-reviewed academic databases including:

- Scopus
- Web of Science
- ScienceDirect
- SpringerLink
- Taylor & Francis Online
- Wiley Online Library
- PubMed
- SAGE Journals
- MDPI
- Google Scholar

Additional information is obtained from internationally recognized organizations including the World Health Organization (WHO), the Centers for Disease Control and Prevention (CDC), and the American Psychiatric Association (APA).

Books focusing on autism-supportive environments, environmental psychology, and evidence-based healthcare design are also included to provide theoretical foundations.

d. Inclusion Criteria

The literature included in this review satisfies the following criteria:

- Published in peer-reviewed journals.
- Written in English.
- Focuses on Autism Spectrum Disorder.
- Discusses architecture, interior design, healthcare environments, educational environments, environmental psychology, or sensory processing.
- Published between 2000 and 2025, with greater emphasis placed on recent studies.

Seminal publications published before 2000 are included where necessary because of their continuing theoretical significance.

e. Data Analysis

The collected literature is analysed using thematic analysis.

Major themes identified include:

- Sensory Processing
- Lighting
- Acoustic Environment
- Colour Psychology
- Spatial Organization
- Wayfinding
- Furniture Design
- Material Selection
- Biophilic Design
- Transition Spaces
- Safety
- Flexibility
- Therapeutic Environments

Thematic analysis allows recurring design principles to emerge from multiple independent studies, thereby increasing the reliability of the proposed framework. The proposed framework is based on the argument that ***a neuroaffirming therapeutic environment is not one that removes every challenge, nor one that requires autistic children to tolerate environments designed around neurotypical expectations. It is an adaptive environment that recognizes individual sensory profiles, supports regulation, provides meaningful choice, interprets distress as potential environmental feedback, and enables children to encounter increasing levels of participation and environmental complexity according to their readiness.***

This proposed framework includes the following eight principles listed below and detailed in the following section:

1. **INDIVIDUALISE** → understand the child's sensory profile
2. **REGULATE** → establish environmental and emotional readiness
3. **EMPOWER** → provide choice and environmental control

4. **LISTEN** → interpret behavior as possible environmental feedback
5. **ORIENT** → provide predictability and spatial legibility
6. **GRADUATE** → introduce manageable challenge without forced exposure
7. **PARTICIPATE** → allow multiple forms of meaningful engagement
8. **ADAPT** → enable the environment to change over time

RESULTS AND DISCUSSION

Proposed Design Principles:

Individualized Sensory Accommodation: ***Design for sensory profiles, not for a generic autistic user.***

Therapeutic environments for autistic children should not be designed around a generic concept of "autism-friendly" architecture. Instead, they should be conceived as adaptive environments that respond to each child's unique and changing sensory profile. The success of an environment therefore depends not on achieving a fixed sensory standard but on its capacity to accommodate sensory diversity through flexibility, choice, and ongoing environmental adjustment.[9]

Regulation Before Participation: ***Support regulation before expecting engagement or task performance.***

Therapeutic environments should support regulation before requiring participation. Spatial planning should provide opportunities for arrival, decompression, sensory regulation, predictable transition, visual understanding, and meaningful choice before children are expected to engage in structured therapeutic tasks. Participation should emerge from an environment that supports readiness rather than one that demands immediate compliance.

This principle has important implications for the organization of therapeutic environments. The journey from entrance to therapy room should be considered a regulatory sequence, with spaces that progressively support the child's readiness for participation.

Choice, Autonomy and Environmental Control: ***Enable the child to exercise meaningful control over their environment***

Neuroaffirming environments should move beyond passive accommodation towards environmental agency. Wherever developmentally appropriate, children should be able to influence aspects of their surroundings—where they sit, whether they participate immediately or observe first, whether they require movement, and when they need temporary retreat.

Providing choices can reduce uncertainty and dependence on adult-directed regulation while supporting the gradual development of self-advocacy.

[9] Author's proposition

Environmental Behavior as Communication: Interpret distress as *information about person–environment fit.*

Behavior should be considered potential environmental feedback rather than automatically treated as a problem located within the child. The design should include accessible escape and retreat routes; opportunities to modify environmental conditions; spaces allowing observation without compulsory participation; post-occupancy evaluation incorporating children's behavioral and communicative responses.

Predictability Without Rigidity: ***Make environments understandable while retaining flexibility.***

Neuroaffirming environments should reduce unnecessary uncertainty without eliminating all opportunities for flexible adaptation.

Predictability can reduce cognitive and emotional demands for many autistic children. However, predictability should not mean creating environments so rigid that children become dependent upon an exact sequence or configuration.

Architecture can provide legibility—allowing children to understand where they are, what happens there, and where they are going next—while still permitting manageable variation. Architectural design to include clear spatial sequencing; intuitive circulation; visual schedules; identifiable activity zones; transition cues; consistent landmarks; clear entrances and exits; advance indication of changes where possible.

This principle also provides a useful response to McCallister's concern about **"cocooning"** autistic children. The alternative is neither complete environmental protection nor forced exposure: it is **supported and manageable engagement with environmental variation**.

Graduated Challenge Rather Than Forced Exposure: ***Support development without deliberately creating distress.***

Environmental challenge should be graded, purposeful, and responsive to readiness—not imposed as a test of compliance or tolerance.

Therapeutic environments should prepare children to participate in wider society, but preparation should not require exposing them to overwhelming sensory conditions simply because such conditions exist outside the therapeutic setting.

Instead, environments can provide a **continuum of sensory and social demand**, allowing children to encounter greater complexity progressively, with opportunities to retreat, recover, and try again.

For example, rather than choosing between a completely silent therapy room and a noisy common area, the building might provide quiet, moderately stimulating, and socially active environments.

Multiple Pathways to Participation: ***Participation should not require one prescribed form of behavior***

Successful participation should be defined by meaningful engagement rather than conformity to a single behavioral norm.

Traditional therapeutic and educational environments can implicitly define successful participation as sitting still, maintaining attention in a particular manner, remaining within a group, or completing an activity according to a predetermined sequence.

A neuroaffirming environment recognizes that meaningful participation may look different for different children. One child may participate while moving; another may observe before joining; another may require reduced social proximity; and another may communicate without conventional speech.

Architecture should therefore facilitate **different ways of being present and engaged**.

Adaptability Across Time, Context and Development: ***Design environments as systems capable of changing with the child.***

Neuroaffirming architecture should accommodate change rather than permanently designing around a child's present difficulties. Autistic children's needs are neither uniform nor static. Sensory preferences, communication abilities, interests, regulation strategies, independence, and tolerance for environmental complexity may change with development and experience.

Therapeutic environments should therefore avoid highly specialized fixed solutions that accommodate only one assumed developmental stage or sensory profile.

Interior Design Strategies for Children with Autism Spectrum Disorder

The literature consistently demonstrates that well-designed interior environments can significantly reduce anxiety, improve attention, support learning, and enhance behavioral regulation among children with ASD. Rather than functioning as passive backgrounds, interior environments actively shape children's sensory experiences and daily interactions.

The following evidence-based strategies represent the principal design interventions identified through the literature review.

Sensory Zoning

Sensory zoning refers to organizing interior environments according to different levels of sensory stimulation. Instead of exposing children to uniformly stimulating spaces, environments are divided into zones that accommodate varying sensory needs.

Mostafa (2008) identifies sensory zoning as one of the most important design principles because it minimizes abrupt sensory transitions while allowing children to regulate their own environmental exposure. Highly active functions such as group learning areas should be separated from quiet therapeutic spaces through intermediate transition zones.

A typical autism-supportive facility may include:

- High-stimulation zones (play areas, activity rooms)
- Moderate-stimulation zones (classrooms)
- Low-stimulation zones (therapy rooms)
- Minimal-stimulation zones (quiet rooms and sensory retreat spaces)

Such zoning reduces environmental unpredictability and allows children to move gradually between different sensory experiences, reducing stress and behavioral dysregulation.

Lighting Design

Lighting is among the most influential environmental variables affecting children with ASD. Many autistic individuals demonstrate heightened sensitivity to brightness, glare, shadows, and flickering artificial lighting. Conventional fluorescent lighting can produce imperceptible flicker frequencies that may nevertheless trigger discomfort, distraction, or anxiety.

Evidence indicates that access to natural daylight improves mood, attention, and circadian rhythm regulation. However, daylight should be carefully controlled through blinds, diffused glazing, and shading systems to prevent excessive glare and visual discomfort.

Artificial lighting should incorporate:

- Flicker-free LED technology
- Adjustable illumination levels
- Indirect lighting systems
- Warm color temperatures (approximately 2700–3500 K in calming areas)
- Dimmable luminaires

Circadian lighting systems that mimic natural daylight patterns have also demonstrated promising therapeutic benefits by supporting healthy sleep–wake cycles and improving emotional regulation.

Acoustic Environment

Auditory hypersensitivity is one of the most frequently reported sensory challenges among autistic children. Environmental sounds that neurotypical individuals easily ignore—including HVAC systems, fluorescent light ballasts, footsteps, echoes, and conversations—may become overwhelming sources of stress.

Research indicates that excessive reverberation negatively affects speech intelligibility, concentration, and classroom performance. Consequently, acoustic control should be considered a primary design priority rather than an optional enhancement.

Evidence-based acoustic strategies include:

- Sound-absorbing ceiling systems
- Acoustic wall panels
- Carpet tiles
- Cork flooring
- Upholstered furniture
- Acoustic partitions

- Quiet mechanical ventilation systems
- Double-glazed windows where external noise is significant

Reducing background noise improves communication, minimizes sensory overload, and enhances learning performance.

Color Psychology

Color strongly influences emotional responses and visual stimulation. Bright, saturated colors commonly used in children's environments may unintentionally contribute to sensory overload among autistic users.

Research recommends soft, neutral, and desaturated color palettes that create visually calming environments. Earth tones, muted greens, light blues, warm greys, and natural timber finishes are generally associated with reduced visual stress.

Color may also function as an organizational tool through color-coded wayfinding systems, allowing children to identify classrooms, therapy spaces, and activity zones more easily without introducing unnecessary visual complexity.

Spatial Planning and Environmental Organization

Spatial planning is one of the most influential aspects of autism-supportive interior design because it determines how users understand, navigate, and interact with their surroundings. Children with ASD often experience anxiety when environments are visually complex or functionally ambiguous. Spaces that lack clear organization can increase cognitive effort, reduce independence, and contribute to behavioral challenges.

Evidence suggests that interior layouts should follow a logical and predictable sequence, enabling children to anticipate activities and move confidently between spaces (Mostafa, 2008). Open-plan environments should be carefully managed, as excessive openness may create sensory distractions, while overly enclosed spaces may limit supervision and social interaction. A balanced approach is therefore recommended, where classrooms, therapy rooms, activity zones, and quiet areas are clearly defined but remain visually connected when appropriate.

Compartmentalization is another important strategy. Separating activities according to their sensory characteristics reduces environmental conflict. For example, active play spaces should not be directly adjacent to quiet therapy rooms, and circulation routes should avoid passing through learning areas. Clearly defined boundaries, achieved through changes in flooring, ceiling height, furniture arrangement, or lighting, help children recognize different functional zones without relying solely on written signage.

Based on the Principle of Regulation before Participation, the journey from entrance to therapy room should be considered a **regulatory sequence**, with spaces that progressively support the child's readiness for participation.

For example:

- **Waiting spaces** should offer alternatives to conventional communal waiting rooms. Children may need quieter seating, reduced visual stimulation, opportunities for movement, or the choice to wait away from crowded areas.

- **Decompression rooms or arrival spaces** can provide a low-demand environment where a child may recover from the sensory and emotional demands of travelling, entering an unfamiliar building, or transitioning from another activity before therapy begins.

- **Sensory retreats** should be accessible as voluntary spaces for regulation rather than being used only after distress has escalated. Their design should recognise different sensory profiles: some children may seek enclosure and reduced stimulation, while others may need movement, proprioceptive input, or greater spatial openness.

- **Predictable transitions** can be supported architecturally through clear circulation routes, visual zoning, consistent spatial sequencing, identifiable landmarks, and gradual transitions between high- and low-stimulation areas. Children should be able to anticipate where they are going and what is likely to happen next.

- **Visual supports** can be integrated into the built environment through pictorial signage, colour or symbol coding, visual schedules, destination markers, and clearly identifiable activity zones. These supports reduce dependence on repeated verbal instructions and make the environment more independently understandable.

- **Choice-making opportunities** can be embedded into spatial planning. A child might choose between a quiet or active waiting area, sitting or standing, an open or more enclosed regulatory space, or different routes and positions within an activity area where feasible. Such choices provide agency without removing therapeutic structure.

Wayfinding and Environmental Legibility

Many autistic children rely on visual rather than verbal information to understand their environment. Consequently, intuitive wayfinding systems play an essential role in reducing anxiety and promoting independence.

Effective wayfinding extends beyond directional signage. Color coding, pictograms, floor graphics, symbols, and consistent spatial organization provide environmental cues that support navigation. Visual schedules positioned at entrances to classrooms or therapy spaces help children anticipate activities, reducing uncertainty during daily routines.

Kevin Lynch's concept of environmental legibility is particularly relevant. Environments that are easy to understand require less cognitive effort and create a greater sense of security. Interior designers should therefore minimize unnecessary complexity while reinforcing recognizable landmarks, consistent circulation patterns, and sequential spatial organization.

Furniture Design

Furniture directly influences comfort, safety, posture, and sensory regulation. Conventional educational furniture often emphasizes durability and standardization but may overlook the behavioral and sensory needs of autistic children.

Evidence-based furniture design should prioritize:

- Rounded corners to reduce injury risk.

- Adjustable heights to accommodate different ages and physical abilities.
- Stable construction that minimizes unexpected movement.
- Soft tactile finishes that provide comfort without causing sensory discomfort.
- Flexible seating options, including beanbags, rocking chairs, balance stools, and sensory seating where clinically appropriate.

Some children benefit from deep-pressure seating or enclosed seating pods that provide a greater sense of security. Flexible furniture arrangements also allow educators and therapists to adapt spaces according to individual learning styles and therapeutic objectives.

Materials and Surface Finishes

Material selection contributes significantly to multisensory perception. Surface texture, reflectivity, thermal properties, and acoustic performance all influence user experience.

Natural materials such as timber, cork, bamboo, and cotton are generally associated with warmer sensory experiences than highly reflective synthetic finishes. Matte surfaces reduce glare and visual overstimulation, while acoustic materials minimize sound reflection and improve speech intelligibility.

Flooring should provide both safety and acoustic comfort. Cork, rubber, or carpet tiles reduce impact noise while improving underfoot comfort. However, maintenance, hygiene, and infection control requirements should also be considered, particularly within healthcare environments.

Tactile diversity should be introduced thoughtfully. Rather than overwhelming users with excessive material variation, designers should provide controlled opportunities for sensory exploration within designated sensory spaces.

Biophilic Interior Design

Biophilic design recognizes the innate human preference for connections with nature. Although originally developed to improve workplace and healthcare environments, its principles have demonstrated considerable potential for supporting autistic children.

Natural daylight, indoor vegetation, timber finishes, water features, natural ventilation, and views towards outdoor landscapes contribute to restorative environments by reducing physiological stress and improving emotional well-being. Research in environmental psychology indicates that exposure to nature lowers cortisol levels, improves attention, and supports cognitive restoration.

Within autism-supportive environments, biophilic elements should be introduced carefully to avoid unnecessary sensory complexity. Indoor planting, natural textures, fractal-inspired patterns, and calming nature imagery may provide positive sensory stimulation without becoming visually overwhelming.

The use of fractal geometry, which occurs naturally in trees, leaves, clouds, and coastlines, has gained increasing attention within neuroarchitecture. Moderate fractal complexity has been associated with stress reduction and visual comfort, suggesting potential applications within therapeutic interiors.

Sensory Rooms

Sensory rooms have become increasingly common within schools and therapy centers serving autistic children. Unlike conventional classrooms, sensory rooms are intentionally designed to provide carefully controlled sensory experiences that promote self-regulation and therapeutic engagement.

A well-designed sensory room may include:

- Adjustable lighting systems.
- Fibre optic lighting.
- Bubble tubes.
- Soft floor surfaces.
- Weighted blankets.
- Tactile walls.
- Interactive projections.
- Vestibular equipment.
- Proprioceptive activities.
- Calming auditory environments.

Importantly, sensory rooms should not function as recreational spaces alone. Their design should support individualized therapeutic goals developed collaboratively by occupational therapists, educators, psychologists, and interior designers.

Transition Spaces

Transition spaces are among the least discussed yet most valuable interior design strategies for autism-supportive environments.

Children with ASD often experience difficulty adapting to sudden environmental changes. Transition spaces provide intermediate zones between environments with different sensory characteristics, allowing gradual adjustment rather than abrupt sensory shifts.

Examples include:

- Entrance vestibules.
- Quiet waiting areas.
- Transitional corridors.
- Buffer zones between classrooms.

- Small decompression spaces.
- Covered outdoor terraces.

These spaces reduce sensory shock while improving emotional regulation during movement between activities.

Safety and Risk Reduction

Safety extends beyond compliance with building regulations. Many autistic children display behaviors such as wandering, climbing, impulsivity, or limited awareness of environmental hazards.

Evidence-based safety strategies include:

- Anti-ligature hardware where appropriate.
- Secure access control.
- Soft corners.
- Impact-resistant materials.
- Shatter-resistant glazing.
- Protected electrical outlets.
- Controlled visibility for supervision.
- Non-slip flooring.
- Safe outdoor access.

Design should balance security with independence, avoiding institutional environments that may increase stress or stigma.

Technology Integration

Advances in smart building technologies provide new opportunities for adaptive interior environments.

Emerging technologies include:

- Smart circadian lighting.
- Automated daylight control.
- Occupancy sensors.
- Noise monitoring systems.
- Interactive educational walls.

- Digital visual schedules.
- Environmental monitoring for air quality and temperature.
- Adaptive HVAC systems.

Technology should remain supportive rather than dominant, ensuring that digital interventions reduce rather than increase sensory complexity.

AUTISM SENSORY INTERIOR DESIGN FRAMEWORK (ASIDF)

Based on the synthesis of literature, this study proposes the Autism Sensory Interior Design Framework (ASIDF) as an evidence-based approach for translating knowledge about sensory processing into practical interior design decisions. The framework integrates principles derived from Sensory Processing Theory, Evidence-Based Design, Environmental Psychology, Neuroarchitecture, Universal Design, and autism-supportive design. However, rather than treating autism as a single set of environmental requirements, the ASIDF recognizes considerable variation in how individual autistic children perceive, process, and respond to their surroundings.

From Autism-Friendly Design to Individual Sensory Accommodation

A central proposition of the ASIDF is that there is no single universally "autism-friendly" environment. Autism encompasses diverse and sometimes contrasting sensory experiences. A child who is hypersensitive to sound may require substantial acoustic protection, while another child with low auditory registration may actively seek stronger auditory input. Similarly, one child may find movement regulating while another may experience vestibular stimulation as distressing. Sensory responses may also vary according to fatigue, emotional state, familiarity, physical well-being, activity demands, and time of day.

Consequently, therapeutic environments should not be designed around a generic concept of autism. Instead, they should function as adaptive environments capable of responding to individual and changing sensory profiles. Within the ASIDF, environmental flexibility therefore becomes as important as sensory reduction. Adjustable lighting, alternative seating, variable levels of enclosure, acoustic differentiation, sensory retreats, flexible furniture arrangements, and opportunities to move between different sensory conditions enable children to select environments that better correspond with their immediate regulatory needs.

This represents an important distinction between sensory-responsive and sensory-restrictive design. An autism-supportive environment should not necessarily eliminate stimulation or create uniformly quiet, muted, low-arousal interiors. Such an environment may benefit some children while being insufficiently stimulating for sensory-seeking children. The objective should instead be to provide a range of controlled sensory opportunities, allowing stimulation to be increased, decreased, avoided, or sought according to individual requirements.

Behavior as Environmental Communication

The ASIDF further proposes that children's behavioral responses should be considered potential indicators of the relationship between the individual and the environment. Crying, withdrawal, covering the ears, repetitive movement, attempts to leave a space, refusal to participate, increased movement, or other expressions of distress may indicate sensory overload, anxiety, uncertainty, communication difficulty, fatigue, or a mismatch between environmental demands and the child's current capacity for regulation.

This interpretation has important implications for interior design. Rather than asking only how an environment can reduce "challenging behavior," designers should investigate what environmental conditions may be contributing to distress. Excessive reverberation, visual clutter, glare, uncomfortable textures, crowding, unpredictable circulation, lack of personal space, difficult transitions, excessive enclosure, or insufficient opportunities for movement may all affect participation.

The environmental response should therefore precede assumptions about behavioral non-compliance. When distress repeatedly occurs within a particular space or activity, the physical environment itself should become part of the assessment. In this sense, behavior can provide valuable post-occupancy information about whether an environment is successfully supporting its users.

Regulation Before Participation

An important principle incorporated within the ASIDF is Regulation Before Participation. Educational and therapeutic environments frequently expect children to enter a space and immediately participate in predetermined activities. For autistic children, however, successful participation may depend upon first achieving sufficient sensory and emotional regulation.

The built environment can facilitate this process by providing transitional and regulatory opportunities before demanding focused engagement. Quiet waiting areas, decompression spaces, sensory retreats, predictable entrance sequences, visual information, reduced-stimulation circulation routes, and opportunities for movement can allow children to regulate before entering classrooms or therapy spaces.

Regulation should therefore not be considered a reward provided after successful participation or a response offered only after dysregulation has occurred. It should be embedded proactively within spatial planning. A child who can access an appropriate regulatory environment before becoming overwhelmed may be better able to communicate, learn, interact, and participate.

This principle also changes the role of sensory spaces. Rather than concentrating sensory support within a single designated "sensory room," the ASIDF proposes that regulation should be distributed throughout the environment. Classrooms, corridors, waiting areas, therapy spaces, entrances, outdoor areas, and circulation zones can each provide different levels of sensory support. Dedicated sensory rooms may remain valuable, but they should form part of a broader sensory-supportive spatial system rather than becoming the only place where regulation is expected to occur.

Choice, Autonomy and Environmental Control

Perceived control is an important component of environmental comfort. For autistic children, environments in which sensory experiences are imposed without opportunities for withdrawal or adjustment may increase stress. The ASIDF therefore identifies choice and environmental control as essential design considerations.

Choice can be incorporated at multiple scales. A child may choose between an open or enclosed seat, brighter or dimmer areas, individual or group workspaces, active or quiet zones, indoor or outdoor settings, or different tactile and movement opportunities. Even relatively small environmental choices can increase predictability and provide children with greater agency over their sensory experiences.

Importantly, environmental choice does not mean that every space must accommodate every possible sensory preference simultaneously. Instead, facilities can provide a gradient of environmental conditions connected through predictable circulation. Children can then move between higher- and lower-stimulation environments according to their needs.

Predictability Without Rigidity

Predictability represents another fundamental component of the ASIDF. Clearly organized environments can reduce cognitive load by helping children understand where activities occur, what is expected within different spaces, and how they can move between them. Spatial sequencing, visual schedules, pictograms, identifiable landmarks, consistent storage systems, transition cues, and clearly differentiated functional zones can therefore support environmental comprehension.

However, predictability should not result in environmental rigidity. Autistic children develop, learn new skills, encounter different activities, and experience changing sensory needs. The framework therefore proposes predictable structure combined with adaptive flexibility. The underlying spatial organization should remain understandable while furniture, sensory conditions, activity arrangements, and levels of environmental stimulation remain adjustable.

Family and Child Knowledge as Design Evidence

The ASIDF also expands the conventional understanding of evidence-based design by recognizing experiential knowledge as an important component of environmental assessment. Parents and caregivers frequently possess detailed knowledge regarding children's sensory preferences, environmental triggers, communication patterns, calming strategies, movement needs, and responses to unfamiliar situations. Where possible, autistic children themselves should also be included in environmental decision-making through developmentally and communicatively appropriate participatory methods.

Professional expertise remains essential, but architects and interior designers should not assume that a diagnostic label alone provides sufficient information for design. Collaboration among children, families, educators, occupational therapists, psychologists, architects, and interior designers can provide a more complete understanding of how environments are actually experienced.

The initial User Characteristics stage of the ASIDF should therefore be understood as an individual environmental profile rather than a diagnostic checklist. In addition to age, communication and cognitive requirements, this profile should document sensory preferences, known environmental stressors, preferred methods of regulation, movement requirements, tolerance of transitions, need for personal space, and environmental conditions associated with successful participation.

Family-Centered Design

Family-centered design recognizes that parents and caregivers frequently possess the most detailed and continuous knowledge of an autistic child's sensory preferences, communication patterns, environmental triggers, routines, coping strategies, and responses to unfamiliar situations. While architects, therapists, educators, and psychologists contribute important professional expertise, their observations are often limited to particular settings or periods of time. Families, by contrast, observe the child across multiple environments and are often able to identify subtle patterns that may not become apparent during formal assessment.

Within the Autism Sensory Interior Design Framework (ASIDF), family knowledge should therefore be considered an important source of evidence during environmental assessment. Parents may be able to identify, for example, whether a child becomes distressed by enclosed spaces, sudden sounds, bright lighting, particular textures, crowding, waiting, or unexpected transitions. They may also know which conditions support regulation, such as movement, quiet spaces, access to daylight, deep-pressure activities, familiar visual cues, or opportunities to withdraw temporarily from demanding environments.

This information is particularly important because children with the same diagnosis may respond very differently to identical spaces. A design solution considered calming for one child may be uncomfortable for another. Consequently, consultation should move beyond asking families whether they prefer particular colors, furniture, or decorative treatments. Instead, designers should seek to understand the child's everyday environmental experiences: Where does the child feel comfortable? Which spaces are avoided? What happens before distress occurs? What environmental conditions help the child recover? What sensory experiences does the child actively seek?

Family-centered design also requires recognizing behavior as potential environmental communication. When parents report that a child consistently cries, withdraws, attempts to leave, covers their ears, refuses to enter a particular space, or becomes highly dysregulated during a specific activity, these responses should not automatically be interpreted as unwillingness to participate. They may indicate that the sensory, spatial, emotional, or cognitive demands of the environment exceed the child's current capacity. Such observations can provide valuable information for designers and practitioners when reviewing lighting, acoustics, enclosure, transitions, spatial density, activity demands, or access to regulation.

Where developmentally and communicatively possible, the autistic child should also participate directly in the design process. Participation does not necessarily require conventional verbal consultation. Children may communicate preferences through pictures, visual choice boards, photographs, drawings, observation, environmental trials, or simply through patterns of approaching, avoiding, selecting, or remaining within particular spaces. A neuroaffirming approach therefore recognizes both verbal and non-verbal forms of environmental preference as meaningful design information.

Family involvement should continue after a facility has been occupied. Sensory requirements may change with age, development, familiarity, fatigue, emotional state, and changing educational or therapeutic demands. Post-occupancy feedback from families can therefore help identify environmental conditions that are working effectively and those requiring modification. This transforms family participation from a one-time consultation exercise into an ongoing process of observation, feedback, adaptation, and reassessment.

Importantly, family-centered design does not mean that parents alone determine therapeutic or architectural decisions. Rather, it establishes a collaborative model in which experiential knowledge is considered alongside professional and research evidence. Architects and interior designers can interpret environmental information spatially, occupational therapists may contribute understanding of sensory processing, educators can describe participation within learning environments, psychologists can contribute behavioral and emotional perspectives, and families can provide knowledge of the child's lived experience across settings.

The ASIDF therefore proposes a collaborative relationship:

Child + Family + Educators/Therapists + Design Professionals → Environmental Understanding → Design Response → Observation → Adjustment

Such collaboration is especially important when developing autism-supportive environments in contexts where formal sensory assessments, specialist facilities, or extensive technical resources may not always be available. Careful listening to children and families can identify relatively simple but meaningful environmental accommodations, such as changing seating position, reducing visual clutter, controlling noise, adjusting lighting, providing a retreat space, improving transition cues, or allowing greater flexibility in how a child uses a space.

Family-centered design ultimately reinforces a fundamental principle of neuroaffirming practice: the environment should be shaped around an understanding of the individual child rather than assumptions derived from the diagnostic label alone. By incorporating children's and families lived experiences into design decision-making, therapeutic interiors can become more responsive, adaptable, and respectful of sensory diversity while supporting regulation, autonomy, participation, and emotional well-being.

The ASIDF as a Dynamic Feedback System

Rather than functioning as a linear process that ends once an interior has been constructed, the ASIDF should operate as a continuous feedback system:

Individual Sensory Profile → Environmental Assessment → Design Response → Child's Experience → Observation and Feedback → Environmental Adjustment

This feedback loop recognizes that children's requirements change over time and that designers cannot anticipate every sensory response during the design stage. Post-occupancy observation therefore becomes particularly important. If children repeatedly avoid a particular room, become distressed during specific transitions, seek particular spaces, or demonstrate improved regulation within certain environmental conditions, these behavioral patterns provide information that can guide subsequent environmental modifications.

The success of an autism-supportive environment should consequently not be evaluated solely according to whether children demonstrate fewer observable behaviors. Evaluation should consider whether children experience greater comfort, autonomy, communication, participation, environmental choice, emotional regulation, independence, and opportunities for meaningful engagement.

Revised ASIDF Structure

The proposed framework can therefore be expanded as follows:

1. Individual Sensory and Participation Profile

Sensory responsiveness • sensory seeking • sensory avoidance • communication preferences • movement needs • environmental triggers • preferred regulation strategies • transition needs • individual strengths and preferences

↓

2. Environmental Assessment

Lighting • acoustics • visual complexity • spatial organization • enclosure • crowding • materiality • thermal comfort • movement opportunities • predictability • transition demands • environmental control

↓

3. Neuroaffirming Design Response

Sensory zoning • adjustable lighting • acoustic modulation • regulation spaces • predictable transitions • visual supports • environmental choice • flexible furniture • movement opportunities • differentiated levels of stimulation • accessible retreat spaces • safe circulation • adaptive technologies

↓

4. Child Experience and Participation

Sensory regulation • emotional comfort • perceived safety • autonomy • communication • participation • learning • social engagement • independence

↓

5. Observation and Environmental Feedback

Child response • family feedback • educator and therapist observations • patterns of environmental avoidance or preference • post-occupancy evaluation

↓

6. Environmental Adaptation

Modify • personalise • reassess • monitor

The process then returns to the child's sensory and participation profile, creating a continuous cycle rather than a fixed design prescription.

Central Design Proposition of the ASIDF

The central proposition emerging from the framework is therefore:

Therapeutic environments for autistic children should not be designed around a generic concept of "autism-friendly" architecture. Instead, they should be conceived as adaptive environments that respond to each child's unique and changing sensory profile. The success of an environment therefore depends not on achieving a fixed sensory standard but on its capacity to accommodate sensory diversity through flexibility, choice, predictability, regulation, and ongoing environmental adjustment.

Through this approach, the ASIDF moves beyond the objective of simply reducing sensory overload. It positions the interior environment as an active but adaptable participant in supporting regulation, autonomy, learning, communication, and meaningful participation. The therapeutic value of the environment consequently lies not in requiring autistic children to tolerate predetermined environmental conditions, but in providing sufficient diversity and flexibility for different children to engage with their surroundings in ways compatible with their neurological and sensory needs.

PRACTICAL DESIGN GUIDELINES

The Autism Sensory Interior Design Framework (ASIDF) translates into a set of practical guidelines for educational, therapeutic, healthcare, and residential settings. Rather than prescribing a single "autism-friendly" environment, these guidelines emphasize flexibility, predictability, sensory choice, and adaptation according to individual needs.

Environmental planning should begin with an understanding of each child's sensory profile, including sensory sensitivities, sensory-seeking behaviors, communication preferences, movement needs, environmental triggers, and preferred methods of regulation. These profiles should guide design decisions

but should not be treated as fixed classifications, since sensory responses may change according to activity, fatigue, familiarity, emotional state, and time of day.

Sensory Diversity and Environmental Choice

Facilities should provide a range of sensory conditions rather than a uniformly low-stimulation environment. Quiet areas, active spaces, enclosed retreats, open areas, movement opportunities, and different levels of lighting and acoustic stimulation allow children to select environments that better correspond with their immediate needs.

This approach accommodates both hyper-responsive and hypo-responsive sensory profiles and recognizes that some children may require reduced stimulation while others actively seek movement, tactile input, pressure, or other forms of sensory engagement.

Regulation Before Participation

Opportunities for regulation should be incorporated throughout the environment rather than confined to dedicated sensory rooms. Quiet waiting spaces, transition zones, small retreats, movement opportunities, and reduced-stimulation areas can help children regulate before or during learning and therapeutic activities.

The objective is to support participation by first creating conditions in which the child feels sufficiently regulated and secure.

Lighting, Acoustics and Visual Environment

Lighting should minimize glare, flicker, and excessive contrast while providing adjustable illumination wherever possible. Natural daylight should be controlled through shading or diffusion rather than assumed to be universally beneficial.

Acoustic design should reduce unpredictable and unnecessary noise through sound-absorbing materials, spatial separation, quiet mechanical systems, and access to quieter zones.

Similarly, color and visual information should be managed carefully. Highly saturated colors, excessive patterns, signage, and clutter may create additional sensory demand for some children. A visually calm background can be combined with purposeful color for wayfinding, identification, and personalization.

Spatial Planning, Furniture and Movement

Spatial layouts should be understandable, predictable, and clearly zoned while allowing different degrees of openness and enclosure. Some children may seek enclosed spaces for comfort, whereas others may find confined areas distressing.

Furniture should therefore support different postures and sensory needs rather than requiring all children to sit in the same way. Conventional seating can be supplemented with standing options, movement-compatible seating, floor activities, or protected retreat spaces where appropriate.

Materials and Sensory Experience

Materials should be selected according to tactile, visual, acoustic, thermal, maintenance, and safety characteristics. Highly reflective or noisy finishes should be limited where they create unnecessary sensory stress.

At the same time, controlled tactile opportunities can be incorporated for children who seek sensory input. The aim is not to make environments completely sensory-neutral but to provide sensory experiences intentionally and selectively.

Predictability and Transitions

Clearly defined spaces, visual schedules, pictograms, landmarks, consistent storage, and transition cues can help children understand where activities occur and what is likely to happen next.

Transition spaces should therefore be considered part of the therapeutic environment. Entrance areas, corridors, buffer zones, waiting spaces, and small decompression areas can support gradual adjustment between environments with different sensory or social demands.

Safety, Autonomy and Family Participation

Safety measures should protect children without creating unnecessarily restrictive or institutional environments. Clear sightlines, protected electrical fittings, non-slip surfaces, rounded edges, secure boundaries, and safe circulation can support both safety and independence.

Where possible, children should also be provided with meaningful environmental choices. Parents and caregivers should contribute to design decisions because they frequently possess detailed knowledge of sensory preferences, triggers, communication patterns, and successful regulation strategies.

Continuous Environmental Adjustment

The ASIDF treats the environment as adaptable rather than complete once construction has finished. Post-occupancy observation should examine patterns of preference, avoidance, sensory seeking, distress, independence, and participation.

Repeated difficulty within a particular room or transition should therefore prompt examination of environmental conditions rather than immediate assumptions of behavioral non-compliance.

The practical design process may be summarized as:

Profile → Provide Choice → Support Regulation → Observe → Adjust → Reassess

Summary of Practical Design Guidelines

Design Domain	ASIDF Recommendation	Intended Outcome
Sensory Profile	Assess individual sensory preferences, sensitivities, seeking patterns and environmental triggers	Person–environment compatibility
Sensory Zoning	Provide a gradient from low-stimulation retreats to active sensory environments	Choice of appropriate sensory intensity
Regulation	Integrate regulatory opportunities throughout the building rather than only in sensory rooms	Regulation before and during participation
Lighting	Use controllable daylight and flicker-free, dimmable artificial lighting	Individual visual comfort
Acoustics	Reduce unpredictable noise and provide acoustically differentiated areas	Auditory comfort and improved attention
Colour & Visual Environment	Control clutter and excessive visual complexity while allowing functional colour and personal preference	Reduced unnecessary visual demand
Spatial Planning	Provide clear zoning, predictable circulation and different degrees of enclosure	Orientation, security and environmental choice
Furniture	Offer stable, flexible and movement-compatible seating and working options	Postural choice and sensory regulation
Materials	Balance calm surfaces with controlled opportunities for tactile experience	Sensory comfort and appropriate sensory engagement
Wayfinding	Use consistent landmarks, pictograms and visual supports where needed	Predictability and greater independence
Transitions	Provide buffer, orientation and decompression spaces between contrasting environments	Reduced transition-related stress
Retreat Spaces	Provide easily accessible low-demand spaces without using them as punishment or exclusion	Voluntary self-regulation
Movement	Integrate safe opportunities for vestibular and proprioceptive activity where appropriate	Support for sensory-seeking and regulation
Choice & Autonomy	Allow children to select between appropriate environmental alternatives	Agency and environmental control

Safety	Use unobtrusive passive safety measures while preserving independence	Safety with dignity
Family Participation	Incorporate child and family knowledge into environmental assessment	More individualized design decisions
Flexibility	Allow spaces and sensory conditions to change with users and activities	Long-term adaptability
Post-Occupancy Evaluation	Observe environmental preferences, avoidance and participation after occupation	Evidence for subsequent adjustment

From Prescriptive Guidelines to Adaptive Design

These guidelines should not be interpreted as a universal checklist. Their purpose is to provide a structured set of considerations that can be adapted according to individual users, functional requirements, available resources, and observed outcomes.

This is particularly relevant in Pakistan, where specialist facilities and expensive sensory technologies may not always be feasible. Meaningful improvements may still be achieved through modest interventions such as reducing visual clutter, controlling glare, rearranging furniture, improving acoustic separation, creating a small retreat space, providing transition cues, and allowing greater environmental choice.

The success of an autism-supportive interior should therefore be assessed not by whether it conforms to a predetermined design formula, but by whether it can accommodate sensory diversity, support regulation, provide meaningful choice, and respond flexibly when a child's behavior indicates that environmental conditions require adjustment.

CONCLUSION

The findings of this study demonstrate that interior design is not merely a functional or aesthetic component of buildings but an active contributor to the health, development, and well-being of children with Autism Spectrum Disorder. Because many autistic children experience atypical sensory processing, environmental conditions directly influence emotional regulation, learning, communication, and behavioral responses. Carefully designed interior environments can therefore function as therapeutic tools that complement educational and clinical interventions.

The review highlights that successful autism-supportive environments require an integrated approach rather than isolated design solutions. Lighting, acoustics, color, spatial organization, furniture, material selection, wayfinding, transition spaces, sensory rooms, and biophilic design should be considered collectively, acknowledging the interaction between multiple sensory systems. Such an approach moves beyond traditional accessibility standards toward environments that actively promote comfort, independence, participation, and inclusion.

A major contribution of this research is the proposed **Autism Sensory Interior Design Framework (ASIDF)**, which synthesizes principles from Sensory Integration Theory, Evidence-Based Design, Environmental Psychology, Neuroarchitecture, and Universal Design into a practical model for interior designers. The framework provides a structured process for translating scientific evidence into design

practice and addresses an important gap in existing literature, which has largely emphasized architectural planning rather than interior spatial experience.

Although the present study is based on a systematic review of existing evidence, future research should validate the proposed framework through post-occupancy evaluations, behavioral observations, and user-centered studies conducted in schools, therapy centres, healthcare facilities, and residential environments. Longitudinal research examining the influence of adaptive technologies, smart environmental controls, and culturally responsive design solutions will further strengthen evidence-based practice.

Importantly, the findings challenge the assumption that a single "autism-friendly" environment can respond adequately to all autistic children. Sensory needs are individual, multidimensional, and may change across activities and over time; therefore, effective therapeutic interiors should be adaptable rather than prescriptive. The proposed ASIDF consequently places individual sensory profiling, regulation before participation, environmental choice, family-centered knowledge, and continuous observation and adjustment at the center of the design process. Behavioral responses should also be understood as potentially meaningful information about the person–environment relationship, prompting consideration of environmental mismatch before being interpreted as non-compliance.

Ultimately, designing for autism is not simply about reducing sensory overload; it is about creating environments that respect neurodiversity, support individual differences, and enable children to participate with greater comfort, autonomy, and dignity. The therapeutic value of an environment therefore lies not in making autistic children conform to predetermined spatial conditions, but in creating spaces sufficiently flexible and responsive to accommodate different ways of sensing, regulating, communicating, learning, and participating.

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