Interior Yacht Design for People with Autism Spectrum Disorder (ASD)

Massimiliano DI LECCE [a,1]
[a] *Università degli Studi di Genova*

Abstract. This paper explores the impact of design features on people with Autism Spectrum Disorder(ASD) and aims to give guidelines regarding yacht interior design in creating an autism-friendly environment. Design features can create an autism-friendly environment, with general best practices including, for example, avoiding vibrant, highly saturated colors and minimizing colours contrast, spatial sequencing should aim to create routine and predictability in spaces for autistic individuals and involves organizing spaces logically based on their scheduled use and sensory flow, ensuring seamless flow from one activity to the next. In recent years, there has been a significant increase in diagnoses, especially in adulthood, due to a number of factors, including increased awareness of the condition of autism, better access to early diagnosis services, greater training of specialists in this field and, consequently, a continuous evolution of diagnostic criteria that leads to a broadening of the spectrum. For this reason, there is an increasing need to be aware of the ways in which an autistic person perceives the surrounding environment and, therefore, to investigate the impact that sensoriality could have on the design for the environment. The approach used in designing for autism benefits not only people on the autism spectrum, but enriches the lives of everyone, promoting more caring, intuitive and accessible environments.

"Universal design, designing for everyone, is a challenge, but one well worth the effort. Indeed, the Universal Design philosophy argues persuasively that designing for persons with disabilities, the hard of hearing or seeing, or those less agile than average invariably makes an object better for everyone. There is no excuse not to design usable products that everyone can use."
Don Norman, Emotional Design.

"There is real progress only when the advantages of a new technology become for everyone."
Henry Ford.

Keywords. Autism Spectrum Disorder (ASD), universal design, therapeutic navigation, marine accessibility, sensory sensitivity, stability and comfort, smart materials

1. Introduction

The intersection of design and neurodiversity has gained significant attention in recent years, with an increasing emphasis on creating environments that cater to the specific needs of individuals with autism spectrum disorder. ASD affects sensory processing, communication, and social interaction, making it essential to design spaces that are predictable, calming, and adaptable. The design of environments for autistic people is based on a fundamental principle: the creation of spaces that respect and

[1] Massimiliano Di Lecce, Dipartimento Architettura e Design, Stradone di Sant'Agostino, 37 - 16123 Genova, Italia; E-mail: massimiliano.dilecce@edu.unige.it

support the specific needs of those living with autism. This may involve architectural modifications, design choices, and the use of materials that take into consideration sensory sensitivities and individual preferences. For proper design, we should start with the concepts of hypersensitivity and hyposensitivity in order to analyse the spatial and architectural aspects that can cause stress, reactions and problem behaviour. When we speak of hypersensitivity, we refer to a sensory system that picks up too much information from the surrounding environment and is unable to analyse it, while in cases of hyposensitivity, the sensory system picks up too little information and the subject will appear as indifferent to his or her surroundings. Our sensory systems enable us to acquire the information we need to act, interact and understand the outside world and are the basis of learning. Autistic people's difficulties in fitting into the world could therefore be ascribed to over- and under-stimulation of the various sensory systems (e.g. a faint sound felt with particular intensity or a touch, a caress experienced as the pressure exerted by sandpaper). Hence the statement by Temple Grandin, an American academic and ethologist, In 2010, Time named her in the "Heroes" category, ‘people with severe sensory impairments have enormous difficulty in understanding what reality is like.” They may affect one or more senses, such as sight, hearing, touch, taste, smell, proprioceptive sense (perception of the body in space) and vestibular system (balance and movement). These phenomena are extremely common among people on the autism spectrum, although they vary widely in nature and intensity and hypo- and hypersensitivity to environmental stimuli often fluctuates between the two poles. The impairment is often accompanied by difficulties in sensory integration, i.e. problems in combining information with different senses, causing confusion or discomfort. An autistic person can be both hyposensory and hypersensory, or hypo for some senses, hyper for others. This sensory alteration may also change over time from one to another form. "If you've met one person with autism, you've met one person with autism.” (Dr. Stephen Shore - Professor of Special Education, Adelphi University). While much research has focused on autism-friendly architecture in residential and educational settings, little has been explored regarding yacht interior design. Given the controlled yet dynamic nature of yachts, optimizing interior spaces for autistic individuals can profoundly impact their well-being and overall experience. This paper explores the fundamental principles of autism-friendly design in the context of yacht interiors, providing guidelines that enhance accessibility, predictability, and sensory comfort.

2. Pioneering Inclusive Nautical Design: an autism-friendly approach

In the extant academic landscape, a conspicuous absence of in-depth studies or substantial contributions focused on the design of inclusive vessels for individuals with Autism Spectrum Disorder (ASD) is evident. While various initiatives have been promoted by entities and associations to facilitate the participation of autistic individuals in nautical activities, these tend to concentrate on recreational experiences rather than a comprehensive design analysis. Confronted with this dearth of specific research, my attention is increasingly drawn towards the concept of "autism-friendly architecture," a discipline that has solidified within the architectural domain to ensure the creation of sensory and psychologically conducive spaces for individuals with ASD. These environments are meticulously designed to mitigate sensory overload, foster autonomy,

and stimulate socialization in a controlled and secure manner. Although such principles have been primarily developed for land-based architectural contexts, I suppose that their applicability to the nautical realm is not only feasible but profoundly pertinent, considering the vessel as a veritable "floating edifice."

3. Autism-Friendly Design Principles

Architecture, as a science, deals with the manipulation of the physical environment to facilitate certain functions and elicit intended behavior [1]. This autism friendly environment is comprised primarily of sensory elements- textures, colors, patterns, acoustics etc. In accordance to the sensory definition of autism, these elements play an important role in autistic behavior and their cognition and integration are at the core of the disorder. Despite the apparent possibilities of designing favorable architectural environments for autistic users, autism has generally been excluded from architectural design codes and guidelines [2]. According to more recent literature, the key to designing for autism seems to revolve around the issue of the sensory environment and its relationship to autistic behavior. This role of the sensory environment in autistic behavior has been an issue of debate since Leo Kanner first defined the disorder in 1943. Magda Mostafa, an Associate Professor in the Architecture Department at the American University in Cairo (AUC), is internationally recognised for her work and is the author of autism ASPECTSS™ design index guidelines. The index is based on the Sensory Design Theory, which hypothesizes that by altering the sensory environment using specific design interventions, as manifested through input from the built environment, autistic behavior can be altered positively [3]. The index summarizes the seven design criteria conclusively recommended to facilitate and improve the user-built environment relationship for autistic individuals. These criteria deal with acoustics, spatial sequencing, escape space, compartmentalization, transition spaces, sensory zoning and safety. Drawing from the extensive body of scientific literature analyzed, I have sought to synthesize the fundamental principles of Autism-Friendly Design:

Sensory Considerations

Individuals with ASD often experience sensory sensitivities that can significantly impact their perception of space [4]. Yacht interiors should minimize overstimulation by incorporating neutral color palettes, soft lighting, and acoustic dampening materials. Vibrant and highly saturated colors should be avoided, as they can lead to sensory overload. Instead, a muted and harmonious color scheme, inspired by natural tones, can promote relaxation and emotional stability.

Spatial Sequencing and Predictability

Predictability and routine are crucial for individuals with ASD, as unexpected changes can cause distress [5]. Yacht interiors should be designed with clear spatial sequencing, ensuring a logical flow between different areas based on function and sensory input. For instance, transitioning from high-stimulation areas (e.g., social lounges) to low-stimulation spaces (e.g., quiet cabins) should be intuitive and seamless.

Tactile and Material Considerations

Materials play a significant role in sensory experiences. Soft, natural textures, such as organic fabrics and wood finishes, can create a sense of warmth and familiarity. Avoiding glossy or highly reflective surfaces reduces glare, which can be distressing to individuals with ASD. Moreover, non-slip flooring and cushioned furniture enhance both safety and comfort.

Lighting and Acoustics

Lighting should be adaptable, allowing users to control brightness and temperature to match their sensory preferences [6]. Dimmable LED lighting with a focus on warm, natural hues is preferable to harsh fluorescents. Similarly, acoustic considerations should include sound-absorbing panels and noise-canceling design strategies to minimize disruptive background noise, ensuring a tranquil environment.

Augmentative and Alternative Communication

The implementation of clear and effective signage incorporating universally recognizable pictograms is essential in designing inclusive environments. To enhance usability, the Picture Exchange Communication System (PECS), has demonstrated significant efficacy in facilitating comprehension and navigation. Moreover, its advantages extend beyond autistic individuals, offering cognitive and navigational support to neurotypical users as well.

4. The Broader Impact of Autism-Inclusive Yacht Design

Among the documents I have examined, there remains a notable lack of clarity regarding architectural and interior design strategies for creating autism-friendly environments. This ambiguity largely stems from the frequent omission of a critical distinction between hyposensitive and hypersensitive individuals. Consequently, my research has been dedicated to advancing design methodologies by systematically documenting these two forms of sensory alterations and exploring how spatial configurations can mitigate their impact. It is essential to recognize that an autistic individual may exhibit both hyposensitivity and hypersensitivity, sometimes experiencing one condition for certain senses while displaying the opposite for others. Moreover, these sensory responses are not static; they can fluctuate over time, shifting from one form to another. This dynamic nature underscores the need for a more nuanced, adaptable approach to design that accommodates the evolving sensory needs of autistic individuals. By prioritizing sensory-friendly design, yacht interiors can become more welcoming to individuals with different cognitive and sensory needs, fostering a more inclusive and enjoyable experience for all. As awareness of neurodiversity continues to grow, there is an increasing responsibility for designers to create environments that cater to the needs of individuals with ASD. Yacht interiors, with their confined and often unpredictable nature, pose unique challenges but also offer opportunities for innovation in sensory-friendly design. By incorporating principles of predictability, sensory modulation, and material consideration, yacht interiors can be transformed into safe, comfortable, and enriching spaces.

5. Architectural design for individuals with autism experiencing hyposensitivity and hypersensitivity.

While hypersensory users benefit from spaces that reduce excessive stimulation, hyposensory users benefit from environments that amplify and diversify sensory experiences. A careful and personalised design approach can significantly improve the quality of life of these people, promoting their well-being and social integration. These differences significantly influence how spaces must be designed to ensure the comfort, safety and well-being. People with hypersensoriality perceive sensory stimuli in an amplified way, making them particularly sensitive to bright lights, loud noises and specific textures: lighting control using soft, adjustable lighting to avoid glare and excessive contrasts. The use of diffuse natural lighting can help create a more comfortable environment. Sound insulation: incorporate sound-absorbing materials, such as acoustic panels, carpeting and heavy curtains, to reduce ambient noise and prevent disturbing echoes or reverberations. Choice of materials: prefer smooth surfaces and non-reflective materials to minimise visual and tactile distractions. Avoid complex patterns or overly bright colours that may overstimulate the user. Organisation of spaces: design orderly and predictable environments, with a clear distinction of functional areas, to reduce anxiety and facilitate orientation. Conversely, people with hyposensory impairment may have a reduced perception of sensory stimuli, requiring greater intensity to achieve an appropriate response. Design for these users should include: an augmented sensory stimulation: integrate elements that provide stronger sensory stimuli, such as bright colours, different textures and moderate sounds, to facilitate interaction with the environment, interactive spaces creating environments that encourage exploration and interaction, using materials and surfaces that provide distinct sensory feedback, immersive technologies: implement devices that offer multi-sensory stimuli, such as dynamic lights, sounds and vibrations, to further engage the user, consider setting up multisensory rooms, known as Snoezelen, that offer a variety of controlled stimuli to promote relaxation and sensory interaction.

6. Interior design guidelines

Designing a vessel for individuals on the autism spectrum with contrasting sensory needs—both hypersensitive and hyposensitive—requires a highly flexible and adaptive architectural approach, allowing for dynamic environmental customization based on each user's specific requirements. Through my research and insights, I have developed the following design strategies to effectively balance these divergent sensory conditions. The key is design flexibility: through the use of adaptable technologies, space division and adjustable solutions, a boat can be inclusive for people with opposing sensory needs. The design must allow for customisation and autonomous adjustment, creating a tailor-made experience for each individual. I propose a summary of the information in tabular form, an interior design for a boat that can accommodate both hypersensory users (who need a calm environment without excessive stimulation) and hyposensory users (who need more sensory stimulation). The key to the project will the possibility of adapting spaces according to the needs of users, interior design allows people with opposing

sensory needs to co-exist in the same space, thanks to the modularity and customisation of the environment:

Table 1. Interior design strategies for hypersensory and hyposensory needs

Design Element	Hypersensory Profile	Hyposensory Profile
Differentiated Zones(The subdivision of spaces is essential in order to provide suitable environments for both needs)	Calm spaces with neutral colours, adjustable lighting and soundproofing.	Areas with varied tactile surfaces, interactive lighting, bright colours, and movement opportunities.
Lighting	Soft, indirect, dimmable LED lighting with warm tones.	Dynamic or chromotherapy lights; RGB LEDs to stimulate sensory interaction.
Acoustics and Sound	Sound-absorbing materials (carpets, padded walls, acoustic panels); quiet rooms.	Controlled diffusion of ambient music or sounds; stimulation through moderate acoustic input.
Modularity and Adaptability	Movable panels and furniture to control spatial stimuli; enveloping seating for tactile comfort.	Adjustable spaces with structured seating to encourage proprioceptive and tactile engagement.
Materials and Textures	Smooth, matte surfaces; natural materials (wood, soft fabrics).	Structured and textured surfaces (rubber, textiles with relief) to enhance tactile experience.
Technology and Automation	Smart controls for temperature, lighting, and sound to reduce overload.	Interactive walls/screens; movement zones with physical engagement tools.
Outdoor Sensory Areas	Shaded, quiet spaces protected from wind, with natural sounds for calming regulation.	Open areas with access to water, tactile pathways, and interaction with the marine environment.
Entrance & Common Area	Transitional space with soft surfaces and warm lighting for calm orientation.	Dynamic coloured LEDs, adjustable walls, structured furniture to stimulate interaction.
Private Cabins	Soundproof, with neutral colours, soft textures, and dimmable lighting.	Stimulating walls, RGB lighting, sound systems, vibrating mattresses for sensory engagement.
Relaxation & Sensory Room	Quiet corners with ergonomic seating and upholstered walls; calm colours.	Colour-therapy, tactile panels, water elements, and scent diffusion for immersive stimulation.
Kitchen & Dining Area	Low-reflective surfaces, sound-controlled environments for minimal sensory interference.	Movable seating, natural tactile materials, freedom of movement for enhanced sensory interaction.
Smart Solutions	Touch control for sound, light, temperature; movable walls and sound insulation for flexibility.	Adaptive panels and interactive controls to enable tailored sensory stimulation.

A brief mention of the Outdoor Deck and Open Zones: For hypersensory: shaded areas sheltered from the wind, with spaces for individual relaxation. For hyposensory: direct access to the water with tactile pathways and interaction with the marine environment. Natural materials (wood, stone) for authentic sensory contact.

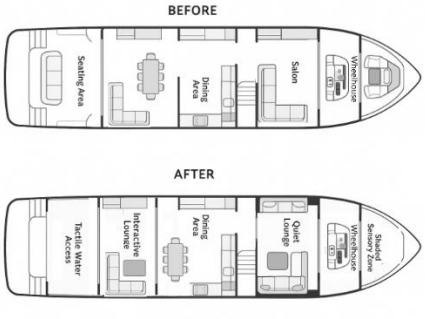

Figure 1. Here a short sample of a typical main deck GA showing wich areas could be modified, with a "before - after" approach.

Conclusions

The design of a vessel specifically tailored to individuals with autism, with an emphasis on hypersensory and hyposensory experiences, requires a profound consideration of how these individuals engage with and interpret the world around them—particularly in unique and complex environments such as the maritime context. Drawing from both empirical research and innovative design principles, I propose that the strategic use of intelligent materials and adaptive fabrics can offer a dynamic and responsive solution to these sensory needs. By employing such materials, we can create a distinctive sensory experience that honors the specific needs of individuals on the autism spectrum, ensuring their comfort and well-being while engaging with the maritime environment. This approach to boat design must transcend simple functionality, embracing a multifaceted integration of comfort, safety, and stimulation. The aim is to craft an environment that is highly customizable, allowing each individual to interact with their surroundings in a manner best suited to their sensory profile. In this context, the use of intelligent materials becomes not merely a technical consideration but a central feature of a broader design philosophy focused on sensory diversity and inclusivity. Through such innovative solutions, we can begin to unlock new possibilities in the realm of maritime design, making it more accessible and supportive for a wider range of individuals. These variations demand thoughtful attention when designing spaces, particularly in environments where sensory inputs are heightened, such as aboard a boat. Creating a space that balances security with stimulation is paramount—providing both a refuge for individuals overwhelmed by sensory inputs and an environment that engages those who require additional sensory stimuli. Smart materials offer a promising solution within this design framework. By incorporating fabrics and surfaces that can adapt dynamically to environmental stimuli, we can cater to the varying needs of users. For individuals with hyposensitivity, tactile feedback through materials that alter their texture or temperature upon contact can provide much-needed stimulation. For instance, a fabric that generates warmth when touched could gently encourage a tactile response from individuals who do not normally register such sensations. Conversely, cooling materials can offer relief to individuals with hypersensitivity, helping to regulate the sensory load

by introducing a more controlled, calming effect. Sound is another critical sensory element that can be effectively managed using intelligent materials. Individuals with hypersensitivity to sound may find environments such as a boat's cabin overwhelming. Materials that absorb or modulate sound can significantly reduce auditory stress, ensuring a more comfortable experience. Additionally, fabrics that respond to varying acoustic needs could be particularly valuable, creating environments where noise levels are tailored to the specific sensory thresholds of the user. Lighting, too, plays a vital role in accommodating sensory sensitivities. The integration of fabrics or surfaces embedded with adjustable LEDs, capable of changing light intensity, would allow for a more customized visual experience. For those sensitive to bright lights, the ability to dim or soften illumination would foster a more comfortable atmosphere, while those with hyposensitivity could benefit from heightened light levels to encourage engagement with their surroundings. The design of customizable spaces is crucial to ensuring that individuals have the autonomy to adjust their environment according to their preferences. Cabins equipped with adjustable lighting and temperature controls are just one example of how a boat could cater to sensory needs. Furthermore, implementing feedback systems that monitor and respond to an individual's physiological responses—such as sensors that adjust temperature, humidity, or lighting based on stress levels—would ensure a highly personalized experience. The integration of wearable or embedded sensors could continuously monitor stress indicators, automatically adjusting variables such as sound levels or airflow to maximize comfort. In conclusion, the design of a boat tailored for individuals with autism, incorporating intelligent materials and sensory-responsive fabrics, represents a transformative opportunity to foster inclusivity and accessibility within maritime design. This approach not only addresses the specific sensory needs of individuals on the autism spectrum but also offers broader insights into how we can design environments that support diverse sensory profiles. By embracing the complexities of sensory diversity, we can create spaces that are truly adaptable, ensuring that all individuals, regardless of their sensory experiences, are able to engage meaningfully with their surroundings. Through such innovative design, we move closer to a future where inclusivity is not merely an aspiration but a reality in every aspect of the built environment.

References

[1] Mostafa M. Fine-tuning the sensory environment: The impact of design on individuals with autism spectrum disorder. Journal of Autism and Developmental Disorders. 2014;44(11):2784-2794.

[2] Magda M. Archnet-IJAR, Volume 8 - Issue 1 - March 2014 - (143-158).

[3] Magda M. Chapter 23 - Architecture for autism: Built environment performance in accordance to the autism ASPECTSS design index - 2020 - (479-500).

[4] How does autism affect spatial awareness? [Internet]. Rainbow Therapy. [cited 2025 Mar 01]. Available from: https://rainbowtherapy.org/blogs-how-does-autism-affect-spatial-awareness

[5] Bahrami B, Nejad NMH. Designing autism-friendly schools: bridging the perspectives of children with ASD and the perspectives of adult stakeholders. Int J Archit Eng Urban Plan. 2024;34(1).

[6] Autism and energy-efficient smart lighting [Internet]. Apex ABA. 2023 [cited 2025 Mar 10]. Available from: https://www.apexaba.com/blog/autism-and-energy-efficient-smart-lighting.