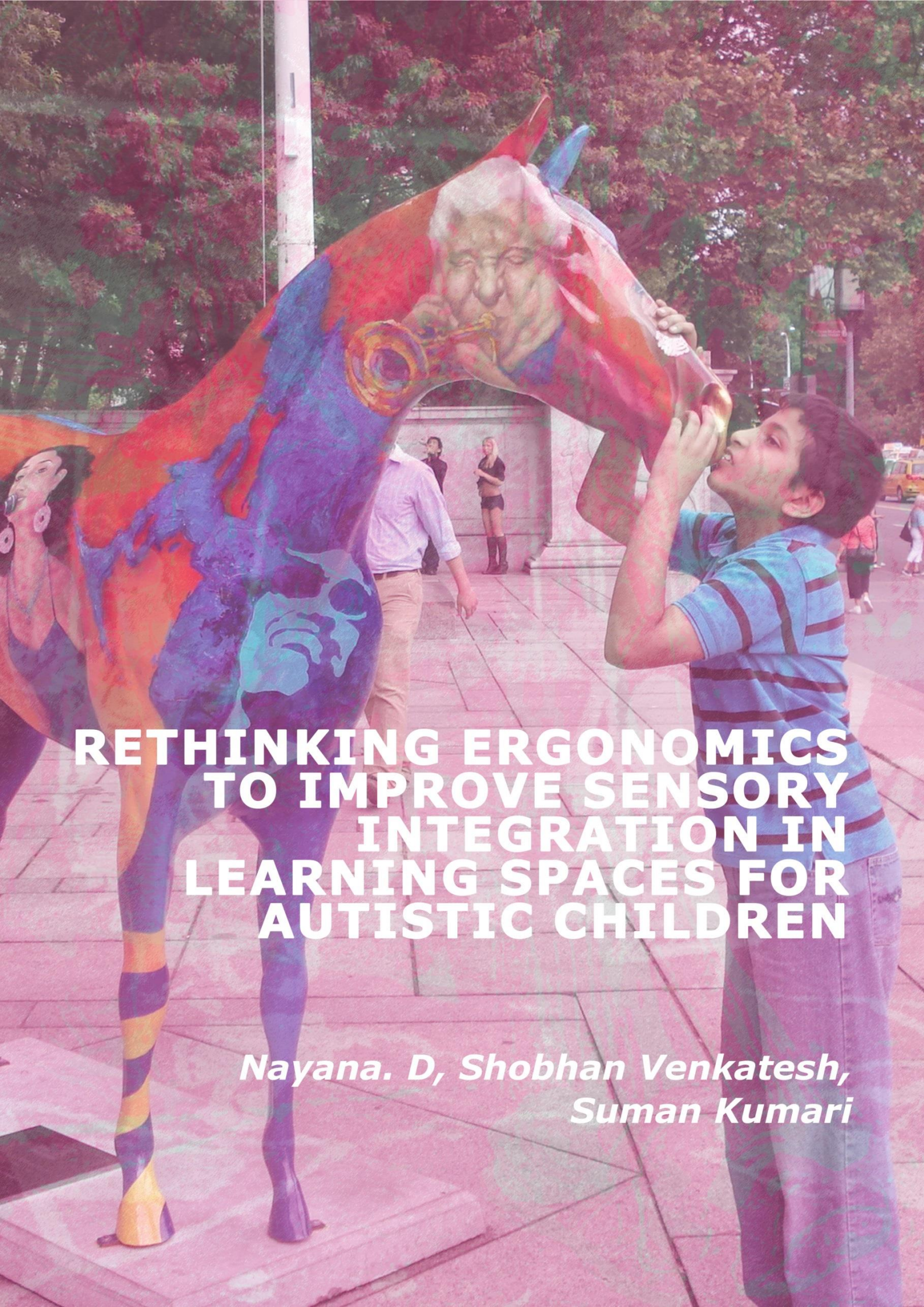


RETHINKING ERGONOMICS TO IMPROVE SENSORY INTEGRATION IN LEARNING SPACES FOR AUTISTIC CHILDREN

Nayana. D, Shobhan Venkatesh, Suman Kumari

ISSN: 2582-8304

Nayana D

She is a student pursuing B.Arch. at the School of Planning and Architecture, Bhopal, Madhya Pradesh. She comprehends her areas of interest through research and journalism. Her research interests include Social Architecture, Urbanism and Societal changes. She aspires to tap into human behaviorism and bridge the gap between Architecture and community psychology.

Suman Kumari

She is a student pursuing a B.Arch. degree at the School of Planning and Architecture, Bhopal, Madhya Pradesh. She comprehends her areas of interest through research. Her research interests include Sustainable Architecture, Human sensitive design, and Community building. She aspires to tap into human behaviorism and bridge the gap between Architecture and behavioral psychology.

ISSN: 2582-8304

Shobhan Venkatesh

He is a student pursuing a B.Arch. degree at the School of Planning and Architecture, Bhopal, Madhya Pradesh. He explores his areas of interests through inquisitive research, writing and experimental design. His research interests include Sensory design, Adaptive Architecture and Architecture for Social Harmony. He aspires to understand and contribute towards Architecture and its entanglement with human psychology.

ISSN: 2582-8304

Rethinking Ergonomics to Improve Sensory Integration in Learning Spaces for Autistic Children

Nayana. D, Shobhan Venkatesh, Suman Kumari

ABSTRACT

Sensory integration is a natural phenomenon for human beings, and it is the prime reason for our proper functioning with respect to any given task or in a social construct. For people with ASD or autism spectrum disorder, it is an attribute that must be nurtured. There are a lot of ways by which one can nurture it through tangible and intangible entities that can be responsible in integrating one's senses. This paper discusses 'Furniture design' as one of the approaches and intends to find how reconsideration of ergonomics and design elements can affect and improve the sensory integration for Children with ASD. Children belonging to the age groups 4-14 years were considered as the target user group and their learning spaces were taken as the context. Parents and caretakers of children belonging to this age group were surveyed by the means of forms and interviews, to collect, analyze and synthesize data that clarified what triggers them and what affects them positively, to find a solution for better sensory integration.

KEYWORDS:

Autism Spectrum Disorder, Furniture Design, Learning Spaces, Sensory Integration, Cognition skills.

1.INTRODUCTION

Autism is a brain-functioning disorder that affects development. Despite being a significant part of society and contributing to the

world's expanding population, people with autism spectrum disorders are frequently overlooked in design processes. The physical and mental needs of this section of the society is barely acknowledged by the building codes and various design guidelines that concern objects that play an important role in our daily lives such as furniture. The environments that people with the condition of ASD are subjected to play a very important role in their well-being. Negative behavior frequently begins to develop when a person is unable to comprehend or adjust to their environment. Approximately 1 in 68 children have autism spectrum disorder (ASD), according to estimates from the CDC's Autism and Developmental Disabilities Monitoring (ADDM) Network (Gaines, Bourne, Peaarson, & Kleib, 2016). The childhood experiences of a person largely impact their way of thinking, acting, and feeling, that tends to be carried on into adulthood, which impacts their entire life. Obsessive behaviors are extremely common in children with ASD, and it is important to take into consideration the environment they are subjected to, and the ergonomics of the objects they handle daily.

Learning spaces and the objects used in these spaces, meant for children with ASD plays a vital role in helping the children overcome the difficulties caused by their condition. To positively influence these kids' behavior, interior space modifications can be used. By taking to consideration, the factors like texture, color, acoustics, sense of closure, proximity of objects, light and ventilation, brightness etc.

In this paper, we have recognized the problems faced by children with ASD with respect to their use of furniture in learning spaces. The children are constantly in contact with the furniture, through the entire learning process. Hence it is important to understand the necessity of personalized furniture for its user that does not cause irritation or hindrance to the learning process.

2. AIM AND OBJECTIVE

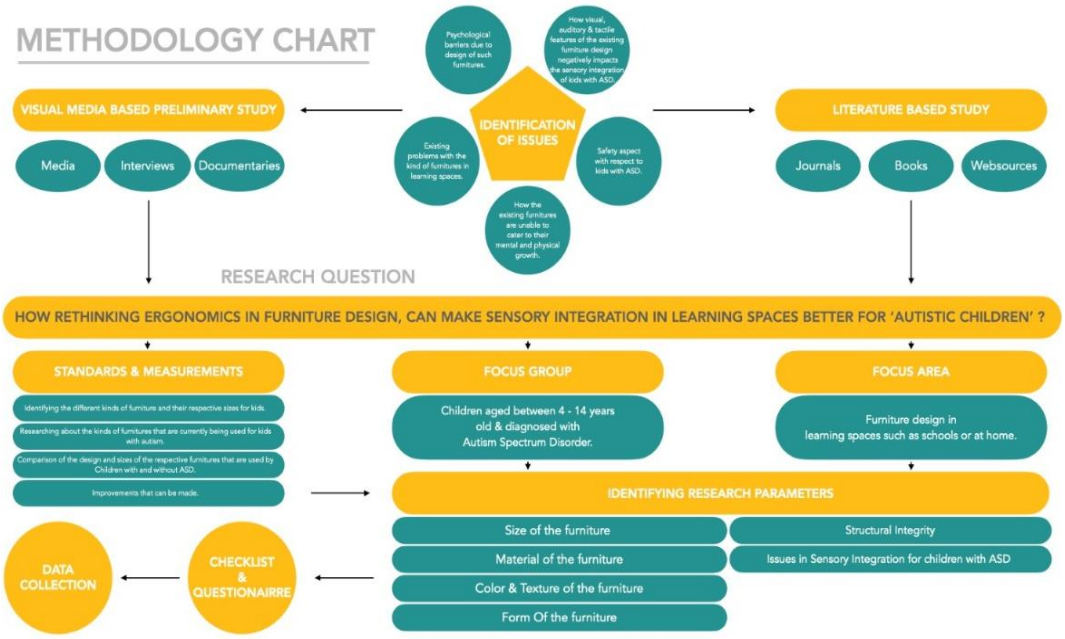
The data analyzed in the paper shows that rethinking the ergonomics of the furniture meant for learning's spaces of children with an ASD condition is important. The problems faced by these children with respect to furniture and ways to overcome them by modifying the ergonomics have been discussed. Although there are multiple papers, studies, debates, and discussions regarding the topic, we see that they are practically applied in very limited places. The aim of the research is to identify whether characteristics or elements of furniture design that trigger or improve the behavioral comfort of the user group and can bring about a better sensory integration and cognition in a learning atmosphere with themselves and their surroundings. An attempt is made to solve the issue of exclusion with an all-inclusive furniture design by evaluating the properties of existing furniture.

The objectives of the paper are as follows:

1. **To understand the user group and their requirements in the context of furniture design in their learning spaces.**
2. **To come up with a criterion of reconsidered factors and design aspects that would be referable for designing furniture for children with ASD in learning spaces.**

3. METHODOLOGY

This study employs quantitative as well as qualitative methods and a case study research design. In contrast to quantitative research, which primarily uses questionnaire results and pre-existing behavioral charts as its primary sources of data, qualitative research places more emphasis on words, or explanation, than on quantification.



The statistical data is retrieved by quantitative methods. The percentage or the chances of occurrence of ASD in a child was taken from ADDM Network 2000-Combining Data from All Sites. This data includes the surveillance year, birth year and the combined prevalence per 1000 children.

A case study is also included in the paper, which is based on an online survey which was targeted towards individuals that were in direct contact with children with ASD. We have compared and analyzed this data to that of the literature study. Previously conducted surveys by various organizations and individuals have also been taken into consideration.

4. ASD: A BROAD SPECTRUM

The fact is that no two cases of ASD can ever be the same, hence the requirements of any two individuals with ASD can never be the same. Each child has their own level of functioning, different symptoms, and different sensitivities. These symptoms range from mild to high.The sensory processing deficits in these individuals is what causes the sensitivity they have to their surrounding environment, be

it sensitive eyesight, or hearing (Gaines, Bourne, Peaarson, & Kleib, 2016). Repetitive rigid behavior is observed while trying to deal with overwhelming surroundings, which turns into a coping mechanism for many individuals on the spectrum. These behaviors might appear as irritating or might look like the person is throwing a tantrum to a third person while it is mostly due to an imbalance between an individual's capacity for adaptation and their environment. (Sánchez, Arnaiz, Vázquez, & Laureano, 2011). While in mild cases of ASD one might not even be able to tell the difference in between a person with ASD to the public, in severe cases the person might indulge in self injurious activities such as head banging or biting oneself.

Autism in children can be classified as either hypo or hypersensitive. Hypo sensitive kids can appear to be under responsive to stimuli while kids that are hypersensitive are very easily overwhelmed by the stimuli they are subjected to.

Sense	Hyposensitive	Hypersensitive
Auditory	Does not respond when called; Enjoys strange noises; makes excessive noises	Overly sensitive to noises; Likely to hear noises before the others in proximity; Cannot function with noise in the background
Tactile	Touches surfaces unnecessarily; Has abnormally high pain threshold; Isn't bothered by high temperatures	Avoids wearing certain fabric; Grooming is found to be distressing; Does not like being wet or going barefoot; Reacts negatively to being touched
Visual	Disregards people or objects in environment; Can see only outlines of certain objects; Likes bright colors and bright sunlight	Bothered by bright Lights (covers eyes or squints); Easily distracted by movement; Stares at certain people or objects
Vestibular	Disregards people or objects in environment; Can see only outlines of certain objects; Likes bright colors and bright sunlight	Bothered by bright Lights (covers eyes or squints); Easily distracted by movement; Stares at certain people or objects
Smell/ taste	Moves around unnecessarily; Enjoys spinning in circles; Becomes excited about tasks involving movement	Seems unbalanced when upside down or when feet leave the ground
Proprioception	Some reports of Pica or eating non-food substances; "Feels" objects with mouth; Seeks out strong smells; Oblivious to some scents	Picky eater; WiII only eat foods with certain textures, with smells, or at a certain temperature

Table 1.1 Behavioral chart curated by (Gaines, Bourne, Peaarson, & Kleib, 2016) depicting the differences in hypo and hyper-sensitive children.

Having remarkable talent and mastery in particular field, most often music, chess, or math, is a very fascinating common occurrence in children with ASD. Younger children are most likely to show more obsession in terms of hobbies or even simple daily objects. Social Interaction and difficulties in communication is not an uncommon trait in children with ASD. In most cases, they are unable to communicate their needs, and are unable to express their problems, which causes them to indulge in agitative behavior.

4.1 Relevance of Learning Spaces

Cognitive and social skills to overcome the problems faced by the kids, can only be taught step by step gradually, in the growth years, when they are most likely to learn effectively, catch up on routines with ease, which enables them to lead a normal life in their adulthood. Hence learning spaces and every object that is a part of these spaces plays a significant role in shaping a child's future since their wellbeing is highly influenced by their surroundings. The physical environment of these spaces should be all inclusive.

Autism is one of the most challenging developmental disorders, thriving in high numbers, even so is ignored by designers, and is not included in codes and standards.

Learning spaces are the best places to incorporate inclusive design, to enhance the learning experience of pupils, by subjecting them to appropriate physical environment and tools. (Khare & Mullick, 2009). Academic issues can be very well dealt with using suitable furniture and relevant articles in the learning spaces. Every object in these spaces should be designed with consideration for all aspects of sensory perception.

5. THE ROLE OF ERGONOMICS OF FURNITURE IN ASD

Ergonomics refers to the study of work, involving the interaction and the suitability between human capabilities and the requirements for

a task. (Tsneg & Cermak, 1993). The grip and pressure in terms of tactility of any object concerning children with autism should be studied evaluated and made suitable for their use. Furniture design highly influences the quality of not just learning spaces, but any space for better efficiency and usability. And considering the ergonomics in this field of design is crucial and can make a huge difference. Furniture is an important part of built spaces and is one of the important aspects that can affect architecture and sensory cognition in human beings, in terms of functioning of a space. The key to effectively modify these spaces, lies in the process of perception. Strategies to cater with individual needs of children with Autism in their growth years (4-14 years of age) can be incorporated in the modular furniture itself. The behavior can be favorably altered by changing the sensory aspects of furniture. (Brightness, texture, color, orientation, build, sense of closure etc.) The object that is being reconsidered must be divided into manageable pieces and arranged in a logical sequence that follows both sensory and temporal logic during the design process. Spatial quality, spatial organization, spatial orientation, spatial integration, and safety are the five main categories into which sensory design principles can be categorized. (Scott, 2009) Some relevant points that should be taken into consideration are as follows-

1. The building's layout should be uncomplicated, reflect calm, order, and clarity, and have clear signage and easy navigation.

2. Students may exhibit a variety of spatial sensitivities: some may be afraid of wide-open spaces and prefer smaller ones, while others may dislike enclosed spaces. When feeling anxious, having a variety of large and small spaces to retreat to can be helpful.

3. Low sensory-stimulus environments are designed to lessen anxiety, stress, and sensory overload.

4. The availability of a comfortable, well-proportioned space with neutral, gentle colors will enable teachers to gradually introduce stimuli (such as wall displays of student work or information).

5. Classrooms can be set up with areas for individual work or private workspaces so that teachers can use a variety of teaching techniques.

6. It is important to think about using indirect lighting and avoiding noise or other distractions (such as blind cords, exposed pipes, or imposing outside views).

7. Where there are students with severe disabilities, sturdy materials should be used, and safety measures for doors, windows, glass, plaster, and piped or wired services will be needed.

8. To avoid an institutional appearance while also reducing risks, it's important to strike a balance between security and independence as well as the right ratio of hard materials and specialized equipment to common, everyday items.

9. Modifications to the plan and simple or minimal detailing may lessen the potential for obsession. It is important for the users to be a part of the design process at every step.

The strategies and the brief should be developed by both, the designers and the users, which in our case are kids of age 4-14 years with an ASD condition. The furniture meant for these kids need to qualify three main criteria: Self-Regulation, Social Participation and Perceived Proficiency.

6. THE SIGNIFICANCE OF RECONSIDERATION

The flexibility of furniture, along with the stability and adjustability undoubtedly are an important aspect of furniture design. But when working with the case of autism in children, it important to ensure

that the flexibility does not mean constant change, instead it helps the furniture blend in any kind of learning setup. Lighting solutions withing furniture can play an important role as well. There should be scope for subdivision and rearrangement. Ideally, a single piece of furniture should enable the children to engage in various activities that help build their independence and self-confidence (Vogel, 2008). Just using open-ended materials, competency in physical abilities is enhanced. Features of furniture like rolling units, and other easily movable parts, sufficient well organized storage spaces, boards, and partitions and other multipurpose strategies are also proven to be beneficial. While being multipurpose, it is advisable to eliminate non-essential materials to form a clutter-free, aurally restorative space for learning.

Reconsidering the ergonomics in furniture design for kids with ASD, will not only benefit the students themselves, but it will also highly benefit the people who are closely associated to these children. It is very important for the layout to be perceived as welcoming, for the space to be non- threatening for the child, and to foster social relationships, and sensory skills.

The settings in which the furniture is placed also plays an important role in serving the cause by providing a sense of security and calmness. Playing with levels of elements of the furniture to enhance the visual skills while not being too overwhelming is also a great strategy that can be achieved. Visibly soft looking design elements in the furniture that can be achieved either by color, texture or hardness can also contribute to the sensory input. These can include unconventional furniture such as swings, bean bags, couches, and water or air beds. It is important to make sure the furniture is not very open and empty which can lead to a dead space, whereas ensuring that it is not cramped is also equally necessary. It is wise to avoid spaces than cannot be predicted easily, the entire study setup

should be easy to perceive and navigate. Safety is undoubtedly the most important aspect that needs to be taken care of. Creating a safe environment can be challenging when designing for children with autism. Both physical hazards (due to stimming and possible seizures) and, mental and emotional security need attention. While there is no perfect furniture design for autism, designers and everybody associated with the child need to educate themselves and identify attributes about the child to be supportive in order benefit the child as well as themselves by creating a safe, secure learning environment.

CASE STUDY: WHAT IS REQUIRED IN A FURNITURE

The survey was designed to retrieve data that provides us the opportunity to understand the user group in more detail to understand how various tangible and intangible aspects affect their sensory perception. Hence, the research demanded data from how intensity of light impacts their visual perception to how it triggers their emotions. Such data was required for all the other senses. It is known that children with ASD have more tactile sensitivity. Hence it was essential to see how their grip and comfort was to different surfaces.

Since the research was limited between an age group of 4–14-year-old, the above aspects had to be in relation with age as the controlling factor. The age factor also helped in getting an idea about the activities that are mainly concerned with the said age group, which in fact is more essential for the design of the furniture.

The furniture design aspect was one of the major perspectives of the survey along with user group and their age. The research demanded to document the furniture that are currently in use, problems faced by the user group, materiality, and ergonomics overall. The 3 major

aspects followed by a respective hierarchy of sub heads resulted in a checklist that helped in designing the survey form.

The above data is necessary and practical to come up with a framework of considerations in the design language and ergonomics for such children, in designing furniture for them in the future.

FINDINGS

Majority of the survey takers were teachers of the user group or siblings. Parents specially hesitated to be a part in fear of exposing their child's condition out though no names were asked. Though the target user group was from 4 to 14, majority of the survey takers have filled up the form recalling the behavior of now the grown-up user groups, i.e., above 14 years of age. Kids with ASD level 3, where they require very substantial support, were the ones talked about more in the survey. 14 out of the 23 survey takers have witnessed the child having a fidgeting behavior.

Table 2 Findings

Colors preferred.	**subtle neutral colors with no or very little contrast in the color scheme** **no vibrant or illuminating colors.** **blue color scheme is preferred but should not be monotonous**
Study table finishes.	**No strong or metal reflective surfaces, Glass should be avoided.** **Mild reflection** **Non reflective surfaces** **Glowing surface with tempered class on top, but not for studying**
Sound absorption	**Should absorb footsteps sound** **The furniture should not make noise which**

quality	**usually are or high pitch**
Furniture for one or more	**The furniture should have space for storage, groves, and slots for holding items for drawing etc., in hand reach zone, without them getting up or leaning in uncomfortable position to access the items.** **Place for holding water.** **Head support if the child requires one.** **Should have room for including minor group activities like playing with puzzle for two people.** **The furniture should be heavy and sturdy to avoid toppling or any accidents.**
Customization	**Height adjustment system with locking mechanism** **Detachable head and back support, with helps the furniture get transform into a multipurpose seat.** **Adjustable leaning back support which is study and angle can be adjusted.** **Height ratio of the table and chair can be adjusted to better suit the user**
Form of the table	**Rectangular table with round corners** **Circular table with study base and should not topple** **Sharp corners to be avoided** **Table with less than 4 supporting legs should be avoided** **Table should have enough height and leg room space**

Patterns on the table	**Organic monotonous pattern with neutral color scheme should be promoted.** **combination of strong colors, contrast and extreme geometrical pattern should be avoided at all costs.** **patterns containing too much of elements or colors should be avoided**
Others	**The material should be heating insulator.** **can include heating elements in colder climate.** **Material should be smooth and not slippery.** **Material should not develop crack or peel off easily which can lead to cuts.** **Furniture should be colorful but keeping the above aspects in check.**

CONCLUSION AND LIMITATION

The condition of autism and the needs of children with the condition can never be completely understood. As mentioned in the paper earlier, it is a very broad spectrum and no two people with ASD have the same requirements. But considering individuals and assessing their needs can surely improve the quality of their life. The strategies highlighted in the paper, are however broad and can be perceived as per the individual's need. The findings can benefit the children, irrespective of their position on the spectrum, to work on themselves in their learning spaces through the suitable furniture. Their symptoms should be accepted and catered to, instead of being challenged.

A pragmatic approach to furniture design in learning spaces, can contribute to the fostering of sensory skills, help with the management of the environment, and enhance organizational effectiveness. While catering to the needs and personalizing spaces for their growth, it is also important for these children to be subjected and should be prepared for challenges to remain immune to other environments. Subjecting them to overly ideal unrealistic environments can add to their processing deficit, and make other environments, distracting and even scary at times.

The insufficient availability of statistical data regarding the number of children proves to be a major setback. Only the data regarding the setup of furniture and the ergonomics of furniture is covered in the paper. Further studies on the learning environment and its impact can be conducted in the future, to understand the subject better.

REFERENCES

- **Bates, C., Imrie, R. and Kullman, K. eds., 2016. *Care and Design: bodies, buildings, cities*. John Wiley & Sons.**
- **Block, S.M., 2018. Classroom Design and its Influence on Students' Performance Within the Autism Spectrum Diagnosis.**
- **Gaines, K., Bourne, A., Pearson, M. and Kleibrink, M., 2016. *Designing for autism spectrum disorders*.Routledge.**
- **Gaudiot, D.M.S.F. and Martins, L.B., 2018, July. The Classroom Built Environment as an Inclusive Learning Process for the Deaf Students: Contribution of Ergonomics in Design. In *International Conference on Applied Human Factors and Ergonomics* (pp. 531-540).Springer, Cham.**
- **KAO, H.S., 1976. On educational ergonomics. *Ergonomics*, *19*(6), pp.667-681.**
- **Khare, R., &Mullick, A. (2009).INCORPORATING THE BEHAVIORAL DIMENSION IN DESIGNING INCLUSIVE LEARNING ENVIRONMENT FOR AUTISM. Archnet-ijar, 3(3).**
- **Khare, R., &Mullick, A. (2009, October).Designing inclusive educational spaces with reference to autism.In Proceedings of the Human Factors and Ergonomics Society Annual Meeting (Vol. 53, No. 8, pp. 517-520). Sage CA: Los Angeles, CA: SAGE Publications.**
- **Mostafa, M., 2008.An architecture for autism: Concepts of design intervention for the autistic user. *International Journal of Architectural Research*, *2*(1), pp.189-211.**
- **Mostafa, M., 2020. Architecture for autism: Built environment performance in accordance to the autism ASPECTSS design index. In *Autism 360°* (pp. 479-500).Academic Press.**
- **Scott, I., 2009. Designing learning spaces for children on the autism spectrum. *Good Autism Practice (GAP)*, *10*(1), pp.36-51.**

- **Stadele, N.D. and Malaney, L.A., 2001.The effects of a multisensory environment on negative behavior and functional performance on individuals with autism. *Journal of undergraduate research*, *4*, pp.211-218.**
- **Tseng, M.H. and Cermak, S.A., 1993.The influence of ergonomic factors and perceptual–motor abilities on handwriting performance. *American Journal of Occupational Therapy*, *47*(10), pp.919-926.**
- **Wilson, B.J., 2006. Sensory Gardens for Children with Autism Spectrum Disorder.**