BEHAVIORAL RESPONSES OF AUTISTIC CHILDREN TO
DESIGN INTERVENTIONS

Research funded by

Academy of Neuroscience for Architecture ANFA

And

Centre for Engineering Research and Development CERD

Final Draft Report

Submitted by

Department of Architecture

College of Engineering Trivandrum

September 2018
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1. ABSTRACT

The relation between human behavior and surrounding environment is crucial in the case of people with Autism Spectrum Disorder (ASD). Their sensory abilities function in a different manner than normal persons. The influence of environment is more in the case of children since they develop skills to cope with the situation at young ages. The research inquires the relation between interior everyday environments of the autistic child and the behavior of the child. The specific question here is how prolonged exposure to architectural interventions affect the behavior of the child.

An experimental research design is followed in this research. The research team made small changes in the interior environments of houses of selected children with ASD. A pre assessment was conducted to document the sensory patterns of the child and to decide the intervention. After three months of the intervention a post assessment was conducted. The results point to a strong likelihood of positive influence of the immediate environment of the children. Most caregivers agreed to a positive change in the effort required to manage the child. The study also brings to light the need for community level support systems for the families of the children.

KEYWORDS: Autism and architecture, sensory integration, environment behavior, experimental study in architecture.

2. INTRODUCTION

The relation between built environment and human behavior is a focus of research in many fields. Environment exerts, supports and demands specific kinds of human behavior. Autistic children are much more sensitive to the environment than normal children. The impact of environment and their behavior modifications are much more than normal people. Children can be trained to modify behavior in a more socially accepted manner so that it is helpful for them in their adult life. The study of how this impact happens and what type of behavior results from
this behavior is important for architects who design facilities for autistic people. It is important to neuroscientists to know why these behaviors happen and how they can be utilized for the benefit of autistic children.

2.1 Autism and Cognitive Sciences

Autism or Autism spectrum disorder is a condition characterized by poor social abilities, poor eye contact, poor verbal and non-verbal communication, repetitive behavior etc. At the same time many such persons possess unique abilities and strengths. When a child is detected with autism its family faces immense challenges of managing the child, growing the child into a self-sufficient adult, social acceptance and associated issues like loss of livelihood, depression and isolation faced by caregivers. Any intervention into the lives of autistic children with a view of improving their quality of life is always welcomed as a noble cause.

Applied Behavioral Analytic (ABA) model of treatment is recommended for children with autism spectrum disorders (ASD). The ABA model reveals teaching of new skills to reduce problematic behaviors in children with ASD. The core teaching strategies of traditional ABA therapy is the use of 'discrete trials' in which a target behavior is broken into smaller components and then drilled to high level of accuracy through repeated teaching presentations (Soorya, Carpenter, & Warren, 2013).

The early intensive behavioral treatment approaches for ASD are based on the ABA model. The models are,

1. UCLA/Lovaas Model (Lovaas, 1987)
2. Naturalistic Behavior Therapies
   a) Applied Verbal Behavioral Model
   b) Pivotal Response Therapy
   c) Nova Scotia Early Intensive Behavioral Intervention Model
   d) Early Start Denver Model
1. UCLA/Lovaas Model (Lovaas, 1987)
This model is based on ABA (Applied Behavioral Analytic) principle. The model is implemented in young children (under 5 years old) for a period of 1-3 years at an intensity of 25 to 40 hours per week.

2. Naturalistic Behavior Therapies
   a) Applied Verbal Behavioral Model

   The model describes the teaching of spontaneous and functional communication of children with autism. Based on this approach the communication is broken down into functions such as mands (requests) and tacts (labels) (Soorya, Carpenter, & Warren, 2013).

   b) Pivotal Response Therapy

   The therapy aims to use behavioral principles to teach critical (pivotal) skills for normal social development. The model uses to teach skills and extensive parent training. This model is applied to school aged children to improve motivation for academia and evaluated as a parent training program. Several studies have demonstrated its efficacy in improving individual skills such as play (Soorya, Carpenter, & Warren, 2013).

   c) Nova Scotia Early Intensive Behavioral Intervention Model

   This model is the modification of Pivotal Response Therapy by combining the parent training and behavioral intervention. The study, published in 2010 on the Nova Scotia model demonstrates gains in language and decreases the behavior problems after one year of intervention. The same study also revealed improvement in symptoms of autism in children with an IQ greater than 50 (Soorya, Carpenter, & Warren, 2013).

   d) Early Start Denver Model

   The Early Start Denver Model was developed by Dr. Sally Roger and Dr. Geraldine Dawson. The model focuses on social, emotional and relationship development (Soorya, Carpenter, & Warren, 2013).

2.2 Autism and Architectural Design

   Research shows that the autistic behavior is influenced by changing the sensory environment, ie, the physical architectural surroundings color, texture, ventilation, sense of closure, orientation, acoustics etc and the key architectural influence on the autistic behavior was the acoustics (Mostafa, 2008).

The changes in color intensity have made a negative impact on the behavior of autistic children. Autistic children prefer earth tone colors and avoid colors with busy patterns (Ibrahim Anous, 2015).

A research paper on “The impact of interior design in educational spaces for children with Autism” explains certain architectural intervention for children with ASD (Ibrahim Anous, 2015) and is described in the following table.

**Table 1: Architectural factors and interventions**

<table>
<thead>
<tr>
<th>Architectural factors</th>
<th>Interventions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light and color</td>
<td>Acoustic control and thermal comfort, pleasing exterior and interior colors as well as tactile surfaces and indirect lighting fixtures</td>
</tr>
<tr>
<td>Circulation and Spatial Sequencing</td>
<td>Pictorial language displayed, with written language will help develop skills. Various textured materials are also used to indicate circulation areas, changes in levels and for the creation of interesting sensory experiences.</td>
</tr>
<tr>
<td>Specialized therapy spaces</td>
<td>The art therapy area incorporates various activities including painting, printing, sculpture</td>
</tr>
<tr>
<td>Furniture Items</td>
<td>For children less than 7 years old, the objects need to be selected in accordance with their standard features. Shapes should be simple designed to provide with a calm environment.</td>
</tr>
<tr>
<td>Color</td>
<td>Pink is a good room color for children, both genders with learning disabilities, like autism. To avoid the over stimulation, color should be the lighter version of the favorite color of autistic child because the</td>
</tr>
</tbody>
</table>
Quality of life

Studies have reported that parents of children with ASD experience greater distress when compared to parents of typically developing children or children with other disabilities. This affects the quality of life of families. Making the management of children with ASD easier can reduce the stress level of parents and improve the quality of life.

3. RESEARCH QUESTIONS

Research Question

Can prolonged exposure to design interventions altering sensory experiences induce behavioral changes in autistic children?

Sub questions

i. Are architectural characteristics of the home environment associated with the management of children with ASD?

ii. Are sensory stimuli associated with architectural characteristics associated with the management of children with ASD?

iii. Are noise levels associated with the behavior of children with ASD.

iv. Are lighting levels associated with the behavior of children with ASD

v. Are tactile stimuli associated with the behavior of children with ASD

vi. Is presence of environmental props supporting learning associated with the behavior of children with ASD

vii. How are the presence of the following architectural characteristics associated with the behavior of children with ASD

a) Intimate scale

b) Symmetry
c) Sequencing

3. METHODS AND PROCEDURE

Research Design

Many researchers in architectural spaces for autistic persons have used experimental designs (Mostafa, 2008), post occupancy studies and case studies with detailed observation (Anous, 2015). These types of studies are conducted in schools and institutional care environments where researchers have greater control of the environment and greater opportunities for observations. However, how architectural interventions influence children with ASD in home environments is a new challenging area of enquiry. The researchers have limited access to the private homes and limited opportunities for observation. It is preferable to follow an experimental design with a pre assessment-intervention – and post assessment strategy.

The present research is planned to follow an experimental strategy where home environments are modified as per the sensory necessities of the child and assessment is made after three months to see the changes. Initially, research participants are identified and assessed using established tools for condition of Autism, sensory issues and stress on caregivers. Based on the assessment and the condition of their dwelling units, interventions are decided. Interventions are carried out with the help and consent of families. After three months an assessment on the effectiveness of the interventions is carried out.

4.1 Assessment tools

As per the research design the following assessment tools are used.

1. INCLEN Diagnostic Tool for Autism Spectrum Disorder (INDT-ASD) (to assess autism)
2. Sensory Profile (to assess the sensory requirements of the child and to decide on architectural interventions)
3. Parenting Stress Index to measure how the stress level of parents
Table 2: Tools to be used

<table>
<thead>
<tr>
<th>Assessment tools to be used</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. INCLEN Diagnostic tool for Autism Spectrum Disorder (INDT-ASD) recommended by Department of Empowerment of Persons with Disabilities, Ministry of Social Justice and Empowerment, Government of India</td>
<td>For assessment of severity of Autism. Assessment to be conducted before intervention</td>
</tr>
<tr>
<td>2. Sensory profile</td>
<td>To assess the sensory processing patterns of the child and to assess their needs for sensory stimuli.</td>
</tr>
<tr>
<td>3. Parental Stress Index</td>
<td>To assess stress on parents in managing the child.</td>
</tr>
</tbody>
</table>

4.1.1 INCLEN Diagnostic Tool for Autism Spectrum Disorder (INDT-ASD)

INCLEN is used for assessment of severity of Autism.

There are several diagnostic instruments available for the assessment of autism spectrum disorders and they are ICD-10, DSMIV TR Autism Diagnostic Observation Schedule (ADOS), Childhood Autism Rating Scale (CARS), Gilliam Autism Rating Scale (GARS), Modified Checklist for Autism in Toddlers (M-CHAT) etc. These tools were developed in the Western world (Wong & Singhal, 2014).

The currently available instruments for the diagnosis of ASD are not available in different Indian languages. (Juneja, et al., 2014). To overcome several of these limitations, INCLEN Diagnostic Tool for Autism Spectrum Disorder (INDT-ASD) was developed for identification and diagnosis of ASD using appropriate criteria developed for the Indian context (Juneja, et al., 2014).

The clinician/psychologist has to make behavioral observations of the child and score the item as well. For any discrepancy in parental response and interviewer’s assessment, it is indicated for each question whether parental response or assessor’s observation should take precedence.
Each symptom/item is given a score of ‘1’ for ‘Yes’ and ‘0’ for ‘No’ or ‘unsure/not applicable’. The INCLEN Diagnostic Tool for Autism Spectrum Disorder (INDT-ASD), has been developed in India. It is to be used by trained personnel and is based on both history from primary caregivers and direct observation (Wong & Singhal, 2014).

The INDT-ASD certainly has some distinct advantages. It takes into account various ethnic and religious variables present in this culturally vibrant country, especially in respect to peer interaction and play skills. Apart from English, it is also available in various Indian languages, including Hindi, Malayalam, Odia, Konkani, Urdu, Khasi, Gujarati and Telugu. The tool has been standardized and validated using the CARS (Wong & Singhal, 2014).

The INDT-ASD is suitable for the diagnosis of ASD in Indian context, due to the following reasons.

- It considers various variables with respect to peer interaction and play skills within the country.
- It is available free for all users.
- It is also available in various Indian languages.
- Other tools such as ICD-10, DSMIV TR Autism Diagnostic Observation Schedule (ADOS), Childhood Autism Rating Scale (CARS), Gilliam Autism Rating Scale (GARS), Modified Checklist for Autism in Toddlers (M-CHAT) etc. are western based.
- The INCLEN has been standardized and validated using CARS

AIIMS (All India Institute of Medical Sciences) modified the INCLEN tool (2015) based on the DSM 5 criteria. Earlier Versions of INCLEN use DSM 4 criteria. The tool has two sections: Section A has 28 symptoms/items and Section B contains 8 questions. It takes approximately 45-60 minutes to administer the instrument and score (Juneja, et al., 2014).

As per DSM-5 revision, following criteria needs to be fulfilled to label a child as having autism spectrum disorder: (AIIMS, 2015)

a. Persistent deficits in social communication and social interaction (3 out of 3 items)

b. Restricted, repetitive patterns of behavior, interests or activities (2 out of 4 items)
c. Symptoms must be present in the early developmental period (essential)
d. Symptoms cause clinically significant impairment in social, occupational, or other important areas of current functioning (essential)
e. These disturbances are not better explained by intellectual disability (intellectual developmental disorder) or global developmental delay (essential).

DSM-5 clubs the three core domains into two core domains with social communication and interaction into one domain and restrictive, repetitive behavior or interest being the other domain. Additionally, sensory symptoms were included in the latter domain (AIIMS, 2015).

Table 3: Change in DSM-5 from DSM-IV-TR

<table>
<thead>
<tr>
<th>Category</th>
<th>DSM-IV</th>
<th>DSM-5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category</td>
<td>Four subcategories: Autistic disorder, Asperger syndrome, Pervasive developmental disorder – Not otherwise specified and Disintegrative disorder.</td>
<td>All are combined into one term – Autism Spectrum Disorders</td>
</tr>
<tr>
<td>Case</td>
<td>Social reciprocity; Communicative intent; and Restricted repetitive behaviors.</td>
<td>Deficits in social communication and social interaction; and Restricted, repetitive patterns of behavior, interests, or activities</td>
</tr>
<tr>
<td>Symptoms/Areas of impairment</td>
<td>Not specified.</td>
<td>Defined for each area of diagnostic criteria</td>
</tr>
<tr>
<td>Symptom severity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensory behaviors</td>
<td>Not included in the criteria</td>
<td>Added in the criteria</td>
</tr>
<tr>
<td>Appearance of symptoms</td>
<td>Requires that symptoms begin prior to the age of 3 years; and symptoms must cause functional</td>
<td>“Symptoms may not be fully manifest until social demands exceed capacity”</td>
</tr>
</tbody>
</table>
The tool interpretation is shown in the figure.

Figure 1: Tool interpretation

Source: INCLEN

4.1.2 Sensory profile

Sensory profile is used to assess the sensory processing patterns of the child and their needs for sensory stimuli.

Sensory profile is an evaluation tool for getting information about the children's sensory processing abilities (Dunn, 2008). The sensory profile is applicable for children with all types of disabilities and severity levels (Dunn, 2008). It is administered through a group of standardized questionnaires for assessing sensory processing and is completed by the caregiver who has the daily contact with the children (Dunn, 2008).

Winnie Dunn developed a model for sensory processing and based on that model sensory profile is prepared. Dunn hypothesized that a person’s nervous system operation and
the self regulation strategies together create four basic patterns of sensory processing such as sensation seeking sensation avoiding, sensory sensitivity and low registration (Dunn, 2007).

The figure shows the Dunn’s model for sensory processing. Based on this model the sensory profile is developed.

![Figure 2: Dunn’s model for sensory processing](image)

Each of the questionnaires contains statements about how a person might respond to a sensory event in everyday life, and the respondent records how frequently that behavior occurs using a 5-point Likert-type scale.

Studies demonstrated that the Sensory Profile measures may reflect nervous system responses. Studies suggest that applying sensory processing concepts in natural environments is effective (Baranek, 2002; Schneck, 2001).

Baranek (2002) reviewed the literature regarding sensory integrative interventions for children with autism, and reported that in order to support generalization of skills, interventions needed to be part of the natural context.
The children with autism spectrum disorders have a pattern of significantly different registration combined with avoiding (Dunn, 2002; Myles et al., 2004). Understanding the 4 basic patterns of sensory processing enables providers to interpret children’s behaviors, and therefore tailor activities and interventions to support children to participate in everyday life.

The target population suggested for sensory profile are Autism Spectrum Disorders, ADHD, Developmental Delays, Anxiety and Mental Health Conditions and the Children presenting with vulnerable condition.

4.1.3 Parenting stress index

Parenting stress index is to assess stress on parents in managing the child and it is to be conducted before and after intervention.


Parenting Stress Index is a tool to identify stressful aspects of parent-child interaction. It is for evaluating the parenting system and identifying issues that may lead to problems in the child's or parent's behavior (Abidin, 2007). It focuses on three major domains of stress: child characteristics, parent characteristics and situational/demographic life stress (Abidin, 2007). It takes 20 minutes to administer the questionnaire.

5. INTERVENTION PROTOCOL AND ETHICAL CONSIDERATIONS

Interview and assessment of children and their parents are conducted at their houses. Participation in the research is purely voluntary. They have the freedom to withdraw from the research at any stage. Informed consent is obtained from all participants.
Only interior architectural modifications are carried out. Structural changes or interventions affecting the structure, addition of windows, doors etc. are not carried out. Interventions may include changes in interior color, texture, lighting, noise level, furniture etc.

Each house is allotted a maximum of Rupees 15,000/- (US$230 approximately). The design interventions are decided after the initial assessment and interview of parents/ caregiver, and after consultation with the medical professional/ therapist. The intervention is carried out under the supervision of Architect/Civil Engineer.

Each house is visited by the team of medical social worker, research assistant and PI. During intervention stage the presence of a woman (Research Assistant) would be ensured so that the families feel comfortable and the research team gains acceptance.

After initial assessment the team discusses about the intervention possibilities with the family. The proposed interventions are ratified by the neuroscientist in the team to ensure that it will have positive implication on the child with ASD. The intervention is carried out after finalizing it among the research team members and getting the consent of the family of the child.

6. PILOT STUDY

A pilot study was conducted at the residence of a male child assessed with a typical autism. The pilot study was intended to be an exploratory one to get an overview of the general condition of the children with autism, their family support systems, and possibility for design intervention, type of cooperation, the family environment, the life of a special child and the coping mechanism adopted by the family.

The family was visited on a Sunday morning. The residence is located in a suburban area approximately 20 km away from the city of Trivandrum. The family consists of father, mother and two children. Father works as a contractor of small buildings and residences and the mother is an employee of a government department. The family follows Islamic religion.

The residence is at 50 m from a main arterial road. The surrounding residences are those of relatives of the child’s parents. The child’s maternal grandmother and family stay close by and
takes care of the child while the mother is away at work. The child has a brother, two years older to him, is very accommodative and understanding.

The mother of the child is educated and has in-depth knowledge of the condition of autism and explores various possibilities to develop the abilities of the child. She explained the case history and her efforts to bring up the child.

The child earlier attended a special school, but when started imitating other children with more severe conditions the parents withdrew him. He is currently attending an ordinary Montessori school with specialist teachers.

6.1 Observation study

An unstructured observation of the child and an in-depth interview with the mother and other family members were conducted. Assessment with the three tools—INCLEN, Sensory Profile and Parenting Stress Index is also conducted. The child did not seem to be affected much by the presence of the researchers and continued with its play.

The house is recently constructed and even though the construction is complete, the walls are left with a mere primary paint wash as the children have a habit of scribbling on the walls. The parents seem to wait for the children to grow up before getting a final paint coat for the walls.

The residence has a main hall with sofas and a dining table which is the centre of activity in the house.

The autistic child has demanded a cradle (a cradle made with a piece of cloth used for infants) as seen in a relative’s house and to be set up in the hall. The cradle is put up in the centre of the hall and the child likes to swing in it most of the time.

The child was observed to be playing with an empty packet of incense sticks. The packet had small pictures of beautiful flowers and the child was interested in closely watching it, touching it and feeling it. The mother reported that the child is interested in such small pictures with a lot of details and also had drawn some pictures on papers and on the walls. However, when she pasted pictures of alphabets and cartoons on the walls the child tore them away.

The child likes the popular cartoon character “Chota Bheem” even though he is not interested in watching TV (kept in the hall). He likes to wear dresses with the character printed on it.
The child likes to cut figures with a scissors. Earlier, he liked to make compositions with building blocks.

On the second visit the team noticed a swing chair in the place of the cradle. The team decided that the family may be asked to do a painting of the room and additionally a carpet, puzzle mat, magnetic board and a rocking chair were provided. These were arranged in a corner in the room and they were asked to encourage the child to write on the magnetic board.

On a subsequent visit the family reported that the child likes the rocking chair and tries to write some letters on the board. He seemed to be enjoying the corner given to him.

Before intervention | After Intervention

Figure 3: Photos before and after intervention
Figure 4: Plan of child’s house

7. SAMPLE POPULATION

The following were the concerns of the research team in selecting the sample population.
A list of autistic children in different age groups residing in the city is not readily available to public. Subjects have to be selected in association with organizations providing support to children with ASD, such as ICCONS, Sree Chitra Institute of Medical Sciences, Sai Gramam special school, Shalom Special School etc.
Many of the formal institutions demand long procedures for getting ethical clearance for selecting subjects for the study. The research team did not want to prolong the research for clearance from other institutions. The research review committee of College of Engineering Trivandrum has already granted ethical clearance for the study procedures.
The socio economic characteristics of the subjects’ families vary and the design of their houses also varies.
The houses have to be within 15 km of CET for making interventions and surveys easier.
The cost of intervention was fixed as Rs, 15000/ per house. The research team wanted this to benefit poor families. Hence a deliberate attempt was made to select subjects from families in the BPL (Below Poverty Line) category. The families of the subjects have to wholeheartedly agree to participate in the research process. Taking all these into consideration, samples were selected from the list of children obtained from ICCONS, Saigramam special school, and other charitable institutions and from personal contacts.

8. CHARACTERISTICS OF THE SAMPLE

A sample of 25 children is identified and selected for the study. 20 were living with their families and 5 were residents of a boarding school.

![Number of Rooms in Houses](image)

**Socio economic characteristics**

80% of the sample belonged to BPL families. Many of the houses were small. 12 houses had only 2 rooms and 4 houses had 3 rooms.

**Age of children**

The majority of the children were in the 7 to 9 and 10 to 12 age groups.
Figure 6: Age of Children

Type of Delivery

52% of the sample was delivered normally and the rest were born through C section surgeries.

Age of mother at birth of child.

Out of the available data majority of the mothers had the child in the age group 20 to 29. 835 of the children had birth cry.
The children’s families were living in owned and rented houses. The majority of them owned the houses. The type of house is important because the type of intervention is dependent on the type of house also. Whenever the houses were rented the research interventions were limited to moveable items, furniture etc. When the houses were owned by the families, the interventions included plastering, painting etc. also.

**Material of Roof**

65% of the houses are constructed with RCC (Reinforced Cement Concrete) roof. 20% of the houses are with GI (Galvanized Iron) sheet and 15% are Asbestos sheet. Sheet materials increase the noise level inside the houses, especially during rain. RCC is a more permanent material and allows better insulation from heat and noise.
Material of Roof

- Asbestos sheet: 15%
- GI sheet: 20%
- RCC: 65%

Figure 8: Material of Roof

Inside a house constructed with asbestos sheet and unplastered wall with cement concrete block

A house constructed with unburnt mud bricks and GI sheet roof.

Figure 9: Type of Roof

Material of Wall

85% of the houses are constructed with burnt bricks and the rest are with cement concrete blocks or mud. All these materials offer good insulation from heat and outside noise.
Half of the houses have used ceramic tiles as a flooring material. One house had mud flooring which was plastered as part of architectural intervention. Mud flooring creates a dusty environment.
The above description gives an overview of the types of individual houses and the limitation in the range of architectural interventions. Each subject was assessed and a suitable interior intervention was decided based on the assessment and housing condition.

**Primary Caregivers**

In 55% cases the children were living with both their parents. However, in 30% of the cases the children were under the care of a single parent. Three children (15%) were under the care of grandparents.

![Care giver Details](image)

**Figure 12: Care giver Details**

**8.2 Type of Intervention**

After initial discussion with the parents/ primary caregivers informed consent was obtained (Annexure 3)

A general questionnaire was used to gather socio economic characteristics (Annexure 4). INCLEN (Annexure 5) was used for assessing if the child belongs to ASD category. Sensory profile (Annexure 6) and Parenting stress index (Annexure 7) were assessed. Based on the above information type of intervention was decided. Type of intervention is selected based also on literature related to suggested activities for autistic children.

Sensory Integration
Sensory integration therapy is done to facilitate the development of nervous system’s ability to process sensory input. Sensory integration is the process in the normal brain, which pulls together various sensory messages to form coherent information for one to act. This normal process can be missing in autistic individuals (King, 1996).

Lot of movement activities are recommended for an autistic child. They should be encouraged to climb, walk and swing. This would develop the vestibular system.

A massage or an extra long rub down after a bath may help to overcome oversensitivity.

85 to 90% autistic children have sensory integration problems (King 1996).

Scott (2009) recommends “learning environments” to be created in the place of just passive neutral environments. At the same time increased control of environmental conditions is also cited as an important design strategy. Scott also finds the following measures adopted by architects while designing spaces for autistic children helpful.

**Summary of design criteria**

A. The requirement to provide an ordered and comprehensible, spatial structure
B. The requirement to provide a mix of large and small spaces
C. The requirement to provide increased control of the environmental conditions to the user
D. The requirement to provide for different, autism specific teaching methods
E. The need to balance security and independence
F. The need to provide simple and reduced detailing
G. The requirement for the end user to be actively involved in the brief-building and design process
H. Appropriate use of technology to aid the learning experience
I. Appropriate technical specification (Scott, 2009)

After sensory integration therapy the following are expected

i. Decrease in tantruming
ii. Less panic reactions
iii. Less fear
iv. More willingness to interact with other people.
v. Increase in eye contact

The interior of a room where an autistic child spends a great amount of her time can aid in sensory integration. It can be regulated either provide more stimulation or to control stimulation (e.g. noise, tactile stimulation, heat etc.). This everyday environment can influence the activities of the inhabitants and help them to engage in desired activities.

The rooms of the houses were given simple interventions which would some way assist in sensory integration in the following manner

**Carpet:** A thick carpet acts as a noise damper and is easy to install or remove. It provides a tactile surface for the child to stimulate legs, hands or body parts.

**Curtain:** A curtain gives a control to natural light and also acts as a noise damper.

**Cushion:** A cushion can be used for soft touch/hug when the child is stressed or when in play

**Painting and/or plastering the walls:** It provides a uniform distribution of light and a better tactile surface.

**Rocking chair, wheel chair etc.:** These provide opportunities for movement

**Magnetic board/ Building blocks etc.:** They provide opportunity for learning/organizing/registration

The following table illustrates the sensory profile evaluation and related interventions.

Table 4: Sensory Profile Evaluation and Related Interventions
<table>
<thead>
<tr>
<th>Case no.</th>
<th>Sensory Profile Assessment</th>
<th>Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sensory quadrants</td>
<td>Sensory sections</td>
</tr>
<tr>
<td>1</td>
<td>Seeking/Seeker scores are more than others</td>
<td>Visual, touch and movement sensations are under the category of more than others and body position sensations are on much more than others.</td>
</tr>
<tr>
<td></td>
<td>Sensitivity/Sensor scores are more than others</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Registration/Bystander scores are much more than others</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Seeking/Seeker quadrant scores are more than others</td>
<td>Visual, touch and oral sensations are under the category of more than others.</td>
</tr>
<tr>
<td></td>
<td>Sensitivity/sensor quadrant scores are more than others</td>
<td></td>
</tr>
</tbody>
</table>
3. **Sensitivity/sensor** and quadrants scores are more than others.  

<table>
<thead>
<tr>
<th>Plastering and painting of Room</th>
<th>Carpet, Cushion</th>
</tr>
</thead>
<tbody>
<tr>
<td>The existing unplastered room is <strong>plastered and painted</strong>. <strong>Carpet</strong> and <strong>cushion</strong> is provided for the sensation of touch and to play.</td>
<td></td>
</tr>
</tbody>
</table>

4. **Sensitivity/sensor** quadrants scores are more than others.  

<table>
<thead>
<tr>
<th><strong>Touch</strong> sensation scores are much more than others</th>
<th>Carpet, Rocking chair, Magnetic Board</th>
</tr>
</thead>
</table>
| A thick **carpet** is provided to improve the deep pressure touch.  
A **rocking chair** is provided for calm down the child.  
A **magnetic board** is provided to improve the writing skill. |

5. **Sensitivity/sensor** and **Registration/Bystander** quadrants scores are more than others.  

<table>
<thead>
<tr>
<th>Painting of room</th>
<th>Carpet, Building block, Puzzle mat, Magnetic board</th>
</tr>
</thead>
</table>
| The room is **painted** with bright color and a **carpeted corner** with cup board is developed because the child misses more cues than others.  
**Building blocks** and **puzzle mat** is also provided for create a playing environment.  
Magnetic board is provided to improve the writing skill. |

6. **Sensitivity/sensor** and **Visual**  

<p>| Painting the room | |
|-------------------||
| The room is <strong>painted</strong> with bright color and a |</p>
<table>
<thead>
<tr>
<th>Quadrants</th>
<th>Scores are more than others</th>
<th>Movement sensations are under the category of more than others</th>
<th>Room</th>
<th>Carpet</th>
<th>Rocking chair</th>
<th>Carried corner is developed. Rocking chair is provided and it can regulate the rocking motor behavior.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Registration/Bystander</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensitivity/sensor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>The walls of the house is plastered and a carpeted corner is developed for the child.</td>
</tr>
<tr>
<td>Avoiding/Avoider</td>
<td></td>
<td></td>
<td>Diwan, Cupboard Building blocks Magnetic board</td>
<td></td>
<td></td>
<td>A corner is developed for the child with diwan, cup board, and building blocks. Magnetic board is provided to improve the writing skills.</td>
</tr>
<tr>
<td>Sensitivity/sensor</td>
<td></td>
<td></td>
<td>Diwan Magnetic board Building blocks Puzzle mat</td>
<td></td>
<td></td>
<td>A diwan is provided to improve the deep pressure touch. A magnetic board is provided to improve the writing skill. Building blocks and puzzle mat is also provided for create a playing environment</td>
</tr>
<tr>
<td>Sensitivity/sensor and Registration/Bystander</td>
<td></td>
<td></td>
<td>Wheel chair Toilet modification</td>
<td></td>
<td></td>
<td>The child cannot walk due to the weak muscles in the leg, so wheel chair is provided. Toilet is modified.</td>
</tr>
<tr>
<td></td>
<td>Sensitivity/sensor and Registration/Bystander quadrants scores are more than others</td>
<td>Touch and movement sensations are under the category of more than others.</td>
<td>Carpet Rocking chair Magnetic board Cupboard Building Blocks Puzzle mat</td>
<td>A thick carpet is provided to improve the deep pressure touch. A rocking chair is provided for calm down the child. A magnetic board is provided to improve the writing skill. A cup board is provided because the child misses more cues than others. Building blocks and puzzle mat is also provided for create a playing environment.</td>
<td></td>
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<td>---</td>
<td>---</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sensitivity/sensor quadrant scores are on the boundary of the category of just like the majority of others.</td>
<td>Touch sensation scores are on the boundary of the category of just like the majority of others.</td>
<td>Carpet Rocking chair Magnetic board</td>
<td>A carpeted corner with magnetic board is provided. A rocking chair is provided for calm down the child. A magnetic board is provided to improve the writing skill.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Seeking/ Seeker and scores are less than others</td>
<td>Visual and movement sensations are under the category of less than others</td>
<td>Adaptive chair Wall decoration</td>
<td>Wall decorating materials is provided to improve the visual sensation. Adaptive chair is provided.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Avoiding/Avoider quadrant scores are more than others and quadrant Sensitivity/Sensor scores being much more than others</td>
<td>Auditory and touch sensations are under the category of more than others</td>
<td>Carpet</td>
<td>Magnetic Board</td>
<td>A carpeted corner with magnetic board is provided. A rocking chair is provided for calm down the child.</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Seeking/Seeker, Avoiding/Avoider and Sensitivity/Sensor quadrants scores are more than others</td>
<td>Touch sensations are under the category of more than others</td>
<td>Musical Instrument</td>
<td>Carpet</td>
<td>Magnetic board</td>
<td>Musical instrument is provided to calm down the child. A carpeted corner with magnetic board is provided to improve the writing skills.</td>
</tr>
<tr>
<td>16</td>
<td>All the quadrants are just like the majority of others</td>
<td>Visual sensations are under the category of less than others and movement sensations fall under the category of more than others</td>
<td>Magnetic board</td>
<td>Carpet</td>
<td>Rocking chair</td>
<td>A carpeted corner with magnetic board is provided. A rocking chair is provided for calm down the child.</td>
</tr>
<tr>
<td>17</td>
<td>Sensitivity/sensor quadrant scores are fall under the category of more than others</td>
<td>All the sensory sections are just like the majority of others</td>
<td>Carpet</td>
<td>Rocking chair</td>
<td>A carpet is provided to improve the deep pressure touch. A rocking chair is provided for calm down the child.</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>All the quadrants are just like the</td>
<td>Touch sensations are under</td>
<td>Carpet</td>
<td>A carpeted corner with magnetic board is</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quadrant Type</td>
<td>Description</td>
<td>Sensory Intervention</td>
<td>Additional Interventions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>----------------------</td>
<td>--------------------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Majority of others</td>
<td>the border line of just like the majority of others</td>
<td>Magnetic Board</td>
<td>A rocking chair is provided.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rocking chair</td>
<td>Building blocks provided.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Building blocks</td>
<td>Carpet</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Puzzle mat</td>
<td>A carpeted corner with Building blocks and puzzle mat is also provided.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visual sensations</td>
<td>Visual sensations are under the category of less than others and movement sensations fall under the category of more than others</td>
<td>Carpet</td>
<td>A carpeted corner with Building blocks and puzzle mat is also provided for create a playing environment.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Touch sensations</td>
<td>Touch sensations and body position are under the category of more than others</td>
<td>Carpet</td>
<td>A carpeted corner with magnetic board is provided.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Avoiding/Avoider quadrants scores</td>
<td>Avoiding/Avoider quadrants scores are more than others</td>
<td>Carpet</td>
<td>Building blocks and puzzle mat is also provided for create a playing environment.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Magnetic Board</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Building Blocks</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Puzzle mat</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4: sensory profile evaluation and related interventions
9. RESULTS

A post intervention survey was conducted after three months of the intervention. As mentioned earlier, 20 children living with their families and 5 were under institutional care. Post assessment was done by discussions with the families and by a questionnaire (Annexure 3). Parenting stress index was used for initial assessment. A repeated assessment with the same tool is not effective. However, questions were asked whether the intervention has in any manner reduced the stress of parents in managing the child.

Sensory profile assessment was conducted in the initial stage. The researchers did not anticipate a measurable change in sensory profile after the study period, since the time period is too short.

The evaluation of the effectiveness of interventions is mainly by the questionnaire. Since only a small number of children are involved in the study a control group is also not meaningful.

Effect of extraneous and intervening variables

Many changes take place in the families in the study period. Primary care giver’s change of occupation affects the amount of time spent with the child. In one case parents had a difference in opinion and started living separately. In another case the child was admitted to occupational therapy at another city and had to spend weekends away from home. Most of the children were attending school and were receiving special education or occupational therapy. Some were receiving speech therapy. There were also some cases where children did not receive any of these therapies. All these factors would have affected the development of the child. Any change observed in the child can be due to these factors also. In such exploratory research it is not possible to control all intervening variables. The research can strengthen or weaken the hypothesis and the study has to be repeated in large groups to accept the theories.
Results

The results of the study are collected using an interview schedule and open ended questions.

Table 2: Post Evaluation Interview Schedule

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Always</th>
<th>Sometimes</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
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<td>3</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>4</td>
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<td></td>
<td></td>
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<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SI No.</th>
<th>After the intervention</th>
<th>Yes</th>
<th>No</th>
<th>Can't say/ Don't know</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Do you find any significant change in the stress level of child?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Less annoyed at the presence of strangers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Less involved in repetitive activities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Less involved in socially unacceptable behavior?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Do you find that the child engages in more social activities involving others?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>More involved in writing, drawing etc.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>More likely to communicate with you/ parents</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Less effort in managing the child</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>The child involves in More social interactions?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>More eye contact?</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The discussions with parents and caregivers suggest a general improvement in the management of the child and an improvement in the learning and focusing.

**Carpets**

In 14 cases carpets were provided and the researchers asked the primary caregivers whether the children showed a habit of rubbing hands against the carpet.

Among children under home care, 78% responded that they always did that, 17% were not seemed interested, and 5% sometimes did this.

![Figure 13: Rub hands in the carpet Children under Home Care](image)

Considering all the children together (including the ones under institutional care) the results are almost the same.
Most children liked to play with cushion. 85% of students showed this habit in both the groups (Children under Home Care and all the children including those under institutional care).
90% and 91% of children like to rock in the rocking chair. Many mothers reported that the child likes to do so and shows less of hyperactivity. Mothers and primary care givers have reported that their children have become calmer and are able to focus on TV or learning activities. In general mothers were happy.
Children in general liked to use the magnetic board. Many parents expressed happiness that they have started scribbling on the wall and subsequently on to their notebooks. The presence of the board has ensured a learning environment for many children. But some children were reluctant to use it. Some would throw pens and letters on to others. So parents were scared to give it to them.

![Use of Building blocks Children under Home Care](image)

**Figure 21: Use of Building block Children under Home Care**

Most children liked to play with building blocks. Parents reported that this activity kept the children concentrate on it and calm down. But some children would throw it. Parents did not give them the blocks to play.

![Significant change in the stress level of child](image)

**Figure 22: Significant change in the stress level of child**

Parents have reported a significant change in the stress level of children during the research period. This can either be a feeling of the parents, or if it is true, it can be also due to other therapies and education which the children undergo.
Figure 23: Less annoyed at the presence of strangers

The majority of the children under home care are less annoyed at the presence of strangers during the research period.

Figure 24: Less involved in repetitive activities

The children under home care are more involved in repetitive activities, while the children under institutional care involve less repetitive activities.
The majority of the children under home and institutional care are less involved in socially unacceptable behavior.

Some of the children under home care engage more social activities involving others. Because the children under home care plays with their siblings. None of the children under institutional care engaged in more social activities involving others.
During the research period, children under home and institutional care are more involved in writing and drawing. Children were interested in writing on the magnetic board. The magnetic board provided helps to improve the writing skills and thereby reduces the stress of parent in managing the child.

A significant number of parents felt that the children made more communication with the parents than before. However a larger fraction did not feel any difference.
22 out of 25 Caregivers reported that they felt less effort in managing the child. This is a very significant result of the study since this can be assumed to effect a reduction in parenting stress and better quality of life for the families.

Only 5 caregivers reported that the children seemed to involve in more social interactions after the interventions.
Figure 31: More eye contact

22 caregivers felt that the children had more eye contact than before. This is a significant change since it is a sign of the child taking steps to communicate with others.

10. DISCUSSION AND CONCLUSION

In general the results indicate a positive change in the learning outcomes, social interactions and a reduction in unacceptable behaviors of the children. Most children made use of the artefacts supplied as part of interventions. Most parents were happy about the outcomes. However the researchers do not claim that the changes are entirely dependent on the design interventions. Other factors such as therapy support at school, increased family care and natural development of the child also would have played their roles.

The most significant results are that the children make more eye contacts and the parents felt it easier to manage the child. More eye contacts and social interactions are indicators that the child will grow into a more self sufficient person. The lesser effort a parent feels in parenting will ultimately result in improved quality of life of the families.

Apart from the central research questions discussed here, the researchers also felt that many more measures have to be taken to develop a support system for families with autistic children.
In one of the cases the parents of the child committed suicide on learning that the child is autistic. They attempted to murder the child before committing suicide and but the child was rescued. In other cases parents, father or mother have left the family due to the presence of a special child. These cases show the absence of counselling and other support systems in the society to help these families cope up with the situation.

Many of the children are confined to the home environment without any interactions with the outside world. These children are never taken out for social functions. Many of the houses are very small and do not have any space for the child to run around or play. There is a need for community level open spaces and parks specially created for these children so that they get better chances of social interaction and play. Department of Architecture, CET has already recommended the setting up of sensory gardens as part of the ongoing smart city project of corporation of Thiruvananthapuram.

Transportation of these children is reported to be difficult. The city buses are not designed as universally accessible (with accessible features) and do not have any special facilities for these children.

Department of Architecture wishes to continue the research into more numbers and also into other aspects of sensory integration and abilities with more accurate measurements. Further research into institutional environments for autistic children has to be taken up in a larger scale. The Department of Education under Government of Kerala have asked the department of Architecture to design Autism Parks associated with schools in all the districts of Kerala. Department of Architecture is committed to making the built environment more inclusive and friendly and would strive towards a better future for all through architecture education and research.
11. BIBLIOGRAPHY


12. ACKNOWLEDGEMENTS

The researchers acknowledge with gratitude the funding agencies Academy of Neuroscience for Architecture (ANFA), San Diego, California, US and Centre for Engineering Research and Development (CERD), Kerala Technological University, Kerala, India for the research fund.

At different stages of the research many obstacles were faced. The faculty, Academic Council and the Research Review Committee of College of Engineering Trivandrum offered all support to the research team to overcome the difficulties. Two non cooperating team members were removed from the team. We express our immense gratitude to former principals of CET Dr. Vrinda V Nair, Dr. Ravindranathan, Dr. J, David, current principal Dr. Jiji C.V. and former Dean (Research) Dr. M.R.Byju.

The research team sincerely thank the support and guidance granted by Prof. Rajasree S. former Head of the department who stood by us in all difficult times. We also thank Dr. Sunil Edward, Prof. Neena Thomas, Prof. Shaji T.L. former Heads of Department of Architecture, Dr. Sheeja KP current HOD and all other faculty members at department of Architecture who supported us in this noble cause.
The cooperation and support of the families of autistic children is acknowledged with great gratitude. The various organizations whom we contacted for selection of subjects, and for case studies of interventions are gratefully acknowledged especially the management and staff of Shalom Special School Thiruvananthapuram and Adarsh Special school, Ernakulam. We also thank ICCONS, Thiruvananthapuram and Saigramam Special School, Thiruvananthapuram. Initial guidance and support granted by Dr. Suja Mathews and Dr. Satheesh Kumar of National Institute of Speech and Hearing have helped us in many ways. Doctors and staff of Sree Chitra Institute of Medical Sciences, teachers of St. Martha’s special school, Kadinamkulam and Volunteers of Helping Hands Organization, Ms. Anuja of Clarivoz are thankfully acknowledged for their generous suggestions on intervention and subject selection. We thank prof. Frederick Marks, Vice President of ANFA for guidance provided at various stages.

We thank all the children who were subjects of the research and wish them a great future.

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Research Associate  Ms. Nithya J.U., Civil Engineer and Planner