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Creating a Positive Environment for Autism Using Sensory Design

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Abstract

The designated learning environment for autism should consider sensory issues to overcome their needs. This paper would review related articles to gain a better understanding of autism needs regarding sensory design, sensory issues, sensory space, internal environment, and physical learning environment. This paper will outline the sensory design of the physical learning environment that would impact by the sensory design towards the physical learning environment. This research paper would be a guide for the designer to overcome sensory input so that autistic can learn more efficiently and develop with less stress.

Keywords: Autism; sensory design; sensory issues; physical learning environment;

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1.0 Introduction

Autism Spectrum Disorder (ASD) are broad terms for a group of multifaceted, complex neuro-developmental disabilities or cluster of neurodevelopmental disorders that impairs verbal and non-verbal communication and social interaction (Chiam, 2016; Altenmüller-Lewis, 2017). Autistic confront their problems in sensory processing and sensory integration which negatively impact their engagement in daily activities (Matin et al., 2017). Children with ASD exhibit inattention and distractibility more than normal children (Matin et al., 2017). Every autistic child is having different academic problems, such as difficulties in class participation, low attention span, and inappropriate behaviors which hinder their ability to take part in educational activities. Matin et al. (2017) also mentioned that autistic children are distracted easily from education by their own repetitive, restless, and disruptive classroom behaviors. Hence, they usually experience disappointment in educational progress, as such the usual intervention strategies, since these strategies do not deal with the sensory issues that may reduce the distressing behavior. As a matter of part, Matin et al., (2017) stressed that ignoring proper changes in the environment may have severe negative impacts on the learning processes of autistic children. The designated learning environment should consider the sensory issues to overcome their needs as they are a unique person. However, designers are lack of experience regarding sensory design while designing learning spaces for autistic children (McNally, Morris, & Mcallister, 2013). They need to have a better understanding of autism and how it may affect learning among autism. They also need help putting appropriate strategies in place to deal with sensory issues that impact autistic children. This paper aimed to gain a better understanding of autism

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needs, physical learning environment and specifically on sensory design. Specifically, Henshall (2008) explained that sensitivity to sensory stimuli occurs along a variety, from hypersensitive to hyposensitive responsiveness. Researcher elaborates the impact on design towards the seven sensory systems which are within the nervous system for examples sound, touch, vision, taste, smell, movement, and body position. Once autistic children are starting their learning process, the quality of the environment is so much important and avoid confusing and frustrating to the autistic mind (Beaver, 2011). This is because autism is an extremely complex condition which affects each person differently and can benefit more from the sensory input that the built environment provides (The National Autistic Society, 2015). ASD also often engage in problematic behaviors such as aggression, self-injurious behavior, and stereotyped behaviors, as they easily disrupt the learning environment. Furthermore, this situation would make other children at risk and making it very difficult for them to transition and access mainstream education settings. The objective of this paper is to determine how autistic would impact by the sensory design, sensory issues, sensory space and internal environment towards physical learning environment. The strategy for the research design was a case study that involved an early intervention center facilitated by the government. This intervention center is a benchmark and located in a non-urban area. The methodology for data collection involved Design Criteria Checklist, personal on-site observation, and photograph. The findings revealed that the Design Criteria Checklist would help the designer with the basic in mind to minimize the sensory issues. Therefore, it hoped that the design criteria checklist would be a guide for a designer to overcome sensory input. Hence, it would overwhelm autistic children so that they can learn more efficiently and develop with less stress.

2.0 Literature Review

In this section, we elaborated about ASD and highlighted the impact of sensory design to autistic behavior. This section reviews related articles to gain a better understanding of autism needs, physical learning environment and specifically on sensory design.

2.1 About ASD

According to the Centers for Disease Control and Prevention, autism is a developmental disability that can create social, communication and behavioral challenges (Schaffhauser, 2018). Children with ASD can have a variety of abilities and impairments, and each child is affected differently. ASD includes Classic Autism, Pervasive Developmental Disorder (PDD), Asperger's syndrome (AS), Rett's syndrome, and Childhood Disintegrative Disorder (Reynolds, 2015; Rudy, 2017). Autistic Disorder occurs in males four times more than females and involves moderate to severe impairments in communication, socialization, and behavior (Raar, 2012).

2.2 ASD and Sensory Processing

Researchers have widely recognized that people with ASD have unusual sensory experiences (Henshall, 2008). Sensory processing is referring to the nervous system in which the brain has trouble receiving and responding to the information that comes in through the senses (Henshall, 2008; Phillips et al., 2011). Understanding sensory processing is important because autistic children easily overreact to environmental stimuli such as traffic noise, an airplane overhead, or even sunlight, while others may fail to notice or respond to this type of input (Autism Research Institute, 2014). Henshall (2008) explained that these individuals might actively seek out or avoid sensory information, for example by putting their hands over their ears to block out sounds. Besides, children may have difficulties and engaging with others because of atypical sensory responses. As a matter of facts, Phillips et al. (2011) also mentioned that behavioral and emotional problems associated with sensory processing differences and sensory symptoms were significantly related to stereotyped interests and repetitive behaviors in ASD. About ignoring proper changes in the environment as mentioned by Matin et al. (2017) may have severe negative impacts on the learning processes of autistic children. Specifically, Henshall (2008) explained that sensitivity to sensory stimuli occurs along a variety, from hypersensitive to hyposensitive responsiveness. Hyper-responsiveness refers to the sensory channel being too 'open', and so there is too much stimulation for the brain to cope with, whereas hypo-responsiveness refers to the sensory channel not being open enough; therefore too little of the stimulation can get in, and the brain is deprived of sensory input (Henshall, 2008) (Phillips et al., 2011). In Table 1, the researcher summaries the seven sensory systems and their functions which are within the nervous system: sound, touch, vision, taste, smell, movement, and body position.

Table 1. The Seven Sensory Systems

Vision	The faculty of seeing.
Hearing	The faculty of perceiving sound.
Vestibular system	Refers to structures within the inner ear that detect movement and changes in the position of the head.
Vestibular system Olfaction (the sense of smell)	Perceiving odors or scents.
Gustation (the sense of taste)	Perceiving the sensation of a soluble feeling caused in the mouth and throat by contact with that substance.
Tactile system	Perceiving touch, pressure, pain, temperature.
Proprioceptive system	Perceiving stimuli produced within an organism, especially relating to the position and movement to the body.

(Source: Henshall, 2008)

2.3 Sensory Sensitivity (SS)

Researchers elaborated about sensory sensitivity that occurs along a variety from hypersensitive to hyposensitive responsiveness.

2.3.1 Sensory Sensitivity of High Stimulation (Hypersensitive)

Hypersensitive means were over-responsive to sensory stimuli. Children with hypersensitive can be easily overwhelmed with the environment that terrifying at times. If the autistic children are starting their learning process, the quality of the environment is so much important as stressed by Beaver (2011) is to avoid confusing and frustrating to the autistic mind. Such as loud or sudden noises that would make them feel physically painful (Gaines, Bourne, Pearson, & Kleibrink, 2016). Some experts believe that this kind of sensory overload is experienced more among individuals with Asperger's syndrome than other individuals on the spectrum (Gaines et al., 2016). Table 2 shows the list of children with ASD appear to exhibit auditory and tactile processing difficulties the most.

2.3.2 Sensory Sensitivity of Low Stimulation (Hyposensitive)

Hyposensitive means under-responsive as if certain sensory information goes unnoticed or certain senses are impaired (Gaines et al., 2016). Children who diagnosed had hyposensitive with auditory tendencies were often thought to be deaf. Hyposensitive are often qualified as "sensory-seeking," meaning they often create or generate their own sensory experiences either for pleasure or to block out other unpleasant stimuli (Gaines et al., 2016). Concerning this situation it is an extremely complex condition which affects an autistic person differently and can benefit more from the sensory input that the built environment provides (The National Autistic Society, 2015). Table 2 shows the list of children with ASD appear to exhibit auditory and tactile processing difficulties the most.

Table 2. Hypersensitive and Hyposensitive Symptoms of ASD

Sense	Hyposensitive	Hypersensitive
Auditory (Sound)	Does not respond when their name called; Enjoys strange noises; Enjoys making loud, excessive noises	Overly sensitive to loud noises; Appears to hear noises before others; Cannot function well with background noise (Avoid)
Tactile (Touch)	Touches people and objects unnecessarily; Has abnormally high pain threshold (does not appear to be hurt after a hard fall); Does not seem to feel extreme temperatures	Avoids wearing certain fabrics; Becomes distressed during grooming; Does not like being wet or going barefoot; Reacts negatively to being touched
Visual (Sight)	Disregards people or objects in the environment; Can see only outlines of certain objects; Likes bright colours and bright sunlight.	Bothered by bright lights (covers eyes or squints); Easily distracted by movement; Stares at certain people or objects
Vestibular (Motion) Smell/Taste	Moves around unnecessarily; Enjoys spinning in circles; Becomes excited about any task involving movement	Seems unbalanced; Becomes distressed when upside-down or when feet leave the ground
Smell/Taste (Olfactory)	Some reports of Pica or eating non-food substances; "Feels" objects with the mouth; Seeks out strong smells; Oblivious to some scents	Picky eater; Will only eat foods with certain textures, with particular smells, or at a certain temperature
Proprioception (Sense of body's location) Unaware	Unaware of body position in space and body sensations like hunger; Often lean against people or objects	Odd bodily posture; Uncomfortable in most situations; Difficulty manipulating small objects

(Source: K. Gaines et al., 2016)

2.4 Physical Learning Environment (PLE)

The learning environment refers to the space allocated for classrooms, science labs, open spaces and offices (Amirul, Che Ahmad, Yahya, Lee Abdullah, Adnan and Mohamed Noh, 2013). They defined the learning environment as the social context, psychological and pedagogical, which can affect learning, achievement, and attitudes of the students. The learning environment in this context comprises of the social environment (the students, the teachers, and the curriculums or programs) and the physical environment (building and infrastructure) (Shaari & Ahmad, 2016). Learning environment and features that are in it played a significant role in improving learning in schools and identified as major determinants of student learning. Learning environment capable of stimulating students to engage in the learning process and be able to influence the behavior of students as well as to assist in the development of their skills or cognitive perception. Stimuli from school environments influence children physical, cognitive, social and emotional development and learning (Shaari & Ahmad, 2016). In the event to have a better understanding of autism and how it may affect learning among autism, Matin et al. (2017) stressed that by ignoring proper changes in the environment may have severe negative impacts on the learning processes of autistic children. The designated learning environment should consider the sensory issues to overcome their needs as they are a unique person. However, designers are lack of experience regarding sensory design while designing learning spaces for autistic children (Mcnally et al., 2013).

2.5 Sensory Spaces (SS)

Calm and low stimulus spaces provide the best learning environment for most children with ASD (Mcnally et al., 2013). An architect should consider designing low stimulus environments to reduces sensory overload, stress, and anxiety such as by proper positioning of spaces like toilets and kitchen away from the classroom and therapy areas, using non-flickering lighting fixtures, and providing good acoustics (Manchala, 2014). Meanwhile, safety and security is important when dealing with autistic children who may have difficulty to understand the dangers in the environment (Mcnally et al., 2013). This is due to their impaired imagination and communication skills (Manchala, 2014). Manchala mentioned that their sensory dysfunction attracts them to harmful objects & equipment. Therefore the environment should offer safe use if fixtures, equipment, and fittings, controlled access to high-risk areas, supervision and ease of observation and presence of help indicators both visual and auditory (Manchala, 2014). Lastly, the sensory garden is used as an

alternative to the classroom and is a therapeutic method of releasing stress and frustration (Scott, 2009). The sensory garden also can encourage autistic children to move around the garden, promote educational development and social skills (Hussein, 2012).

3.0 Methodology

This study had utilized a qualitative methodology which used a single case study. The aim of this research was to collect a description of the strategy used by governmental organizations in dealing with autistic children with special emphasis on early intervention. The data collections involve at least three methods for triangulation – Design Criteria Checklists (DCC), personal on-site observation and photograph documentation.

3.1 Procedure

Before the site visits, consents was first obtained from the Director of Autism Center. Preceded by initial briefings about the setup of the center, the representatives accompanied the site visits and responded to spontaneous general inquiries about the physical environment of the Autism Center. Data collected involved personal observations made with notations and photographic documentation about the facilities provided and on the overall ambience. The Design Criteria Checklist was then filled. Visits to the Autism Centre were done once and lasted about 4 hours.

3.2 Instrument

Before visiting the site, the researcher had prepared DCC that was based on a literature study and reviewed on research done by McNally et al. (2013) and had published before this. In particular, to DCC, researchers share the findings in this research paper, and the theoretical research helped to develop variables for field study. The outlines of DCC developed which has elaborated on the autistic environment. DCC is part of benchmarking tool assisted in identifying the design criteria in the autism center. It identified a design through a series of statements, which encompassed the four areas – Physical Learning Environment (PLE), Internal Environment (IE), Sensory Issues (SI) and Sensory Spaces (SS).

3.3 Site Setting

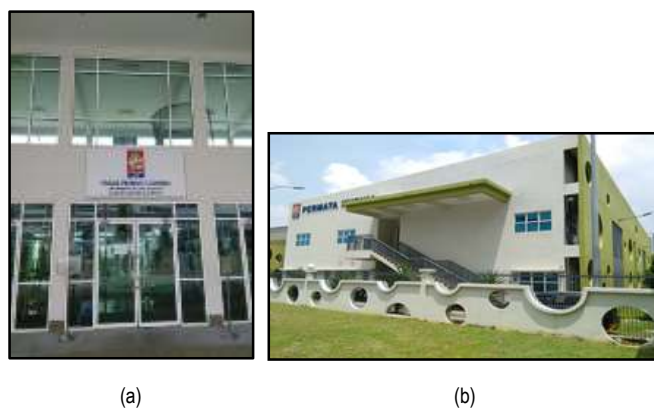
The study took place at the Autism Center for students with severe communication disorders, including students diagnosed with autism. It is a pioneer autism center in Malaysia and become a benchmark and the setting for the study located at the non-urban area. The study involves children at the age of four to six years old and the autism center facilitated by the government. Each learning classroom accommodates a maximum of eight students and two interventionists. This is a guideline set by the Economic Planning Unit (EPU) under the Special Education Program.

4.0 Finding and Discussion

The study conducted by observing the autistic environments in the autism center. Based on the visit, the data collected from observation and notes of autistic environment DCC. The overall result of the study highlighted the criteria that relate to Physical Learning Environment (PLE), Internal Environment (IE), Sensory Issues (SI) and Sensory Spaces (SS).

4.1 Physical Learning Environment (PLE)

The selected case study designed with two storey height. The larger schools can be disorientating and frightening places for autistic children.



(a)

(b)

Fig. 1: The Physical Learning Environment
(a) The Building Entrance; (b) The Building Scale;
(Source: Author)

ASD children would be more tolerable and hopefully even enjoyable when their arrival at school. **The building entrance** designed as straightforward, welcome and stress-free for them however the autism center has double volumn spaces provided at drop off area. However, McNally et al. (2013) suggested that autistic children can benefit greatly from having access to a separate secondary entrance. This is important to avoid the noise and the crowd at the main entrance, thereby helping to reduce the number of socio-sensory hurdles the child has to manage daily. **The building scale** with a large school can be daunting for a pupil with autism; however for this center it is designed with two storey height institutional building. This small institutional building with simple organizational layouts offers the most basic conditions for easy comprehension among autistic. Children with ASD will be most comfortable in an environment that they can easily comprehend (McNally et al., 2013). They mentioned that small schools or those with simple organizational layouts offer the most basic conditions for easy comprehension. Therefore, the layout of the school will help to provide easily navigable environments where all users can orientate themselves both physically and socially in the school.

4.2 Internal Environment (IE)

The internal environment has been designed to comprehend the ASD child impairment. Children with ASD often need more personal space due to their proprioception problem and in processing information. They can find it more challenging to locate themselves in space. In this autism center, the designer has allowed extra space for circulation, especially at corridors and classrooms for their **personal space and movement**. Likewise, research done by McNally et al. (2013) stressed that children with ASD often need more personal space than their peers due to their problems with proprioception and in processing information. It is important to avoid long corridors, complex layout and frequent changes of level and researcher observed that the **wayfinding** around the school is clear and effort is made to ensure that circulation around as comprehensible as possible. In view of wayfinding, it would contribute to a feeling of disorientation and create a sense of anxiety to ASD (McNally et al., 2013). Equally important, the **legibility** of space helps them to orientate themselves and identify the activities associated with various rooms. The researcher found that visual clues provided at each room with its own personalizing using individual colours or objects to facilitate autistic children accessing the environment. Additionally as mentioned by McNally et al. (2013) one of the good environment is ease of comprehension.



Fig. 2: Internal Environment
 . (a) Personal space and movement; (b) Wayfinding; (c) Legibility; (d) Threshold;
 (e) Classroom; (f) Quiet room; (g) Toilet
 (Source: Author)

For example by using a restricted amount of glazing to allow a view into the interior of rooms can help the pupil to understand the school layout and always ensuring that the glazing was positioned in such a way as to minimize the potential distraction of students in the classroom. Furthermore, transition space, for example from classroom to other classrooms, autistic is having difficulty in preparing themselves to change the environment. Therefore, **the threshold** is essential for them to give afforded time and space to prepare for

this change. From researcher observation, there is a seated space within the classroom or in the form of a recess in a corridor provided for them to coping the situation. Similarly, research paper done by Altenmüller-Lewis (2017), mentioned that thresholds or transition zones would help the autistic children adjust their senses as they move from one level to the next stimulus such as the autistic children make a transition from high-stimulus areas to those of low stimulus. Apart from that, **the classroom** is the most important to autistic children. The autistic classroom should feel comfortable, relaxed, a safe place from the chaos and a place of security and familiarity. Before this, researchers found that the choice of colours, textures, and materials are carefully selected physiologically, psychologically and therapeutically. The classroom painted in light blue colour and off-white colour which considered as neutral and calming colors for the ASD

4.3 Sensory Issues.

ASD may experience sensory integration problem to one or any of the seven senses. The designer should consider the sensory issues that would trigger and likely upset the children. The autism center has regarded as the sensory issues especially on **visual distraction** where the choice of colours, textures, and materials are carefully selected physiologically, psychologically and therapeutically. From the observation the classroom was painted in light blue colour and off-white colour which consider as neutral and calming colors for the ASD. Not only the choice of colour, bright shiny surfaces, bold geometric patterns, and strong textures can all be a potential distraction to ASD (Mcnally et al., 2013). The most potential would trigger and a problem to autistic children is **sun and glare**. However, in the autism center the provision of windows, there are blinds provided to minimize distraction. Similarly as mentioned by McNally et al. (2013) bright sunlight and glare can be disruptive for any class, especially for pupils with sensory sensitivity, therefore, designing optimal windows are north facing to avoid glare and direct light (Mostafa, 2014). Another sensory issue is the flicker of fluorescent lighting can be disruptive to autistic, and researchers found that **the lighting** has been taken care in choosing artificial lighting. Likewise, Arnaiz, Segado, & Albaladejo (2011) mentioned that trying to achieve a diffuse, preferably natural, illumination, and again they stressed that remembering to avoid fluorescent tubes, as its flickering and buzzing can alter an individual with auditory or visual hypersensitivity. Too much noise from places such as playgrounds, sports facilities, dining rooms, and plant rooms can be distracting and troublesome to autistic children. However, researchers found that **the acoustics** matter has been taken care of choosing the right materials and acoustic panel provided at the music room & assembly hall. As reminded by Manchala (2014) the autistic children are prone to be distracted with surrounding noise. Therefore, designers are suggested to consider using acoustical materials like flooring, roofing and wall materials one can achieve a noise free environment. Strong and bad **smells** even subtle odors are potentially distracting to autistic children. The autism center has allocated the school kitchen, dining and swimming pool away from the learning area to avoid such smells and odors. This is similar as mentioned by McNally et al. (2013) that kitchen, dining and swimming pool potentially problematic sources of strong smells.



(a) Visual distraction; (b) Sun and glare; (c) Lighting; (d) Acoustic; (e) Smell
 Fig. 3: Sensory Issues
 (Source: Author)

4.4 Sensory Space.

Autistic children struggle with visual distraction; **calm and low stimulus space** would be an ultimate learning environment for most of them. It is essential to determine what and how much to display on the wall. The researcher found that the interventionist has been taken care of by choosing colours for materials of storage, teaching materials, etc. The wall was painted in a light blue colour and also the selection of floor material such as non-slip vinyl in light blue colour which considers as neutral and calming colors for the classroom. McNally et al. (2013) also mentioned that using low arousal colours such as cream (but not yellow or white) or calming pastel shades on walls floors and ceilings can help to provide a good background for teacher chosen artworks, posters, and displays. This would give the best learning environment for most children with ASD. **Safety and security** is the ultimate importance due to autistic children having difficulty to understand the dangers in the environment. They also attempt to escape from the classroom or injuring themselves. However, the autism center has considered regarding safety and security. Especially the doors provided double locks and the grille design in vertical to avoid them to climb. Likewise, research done by McNally et al. (2013) stressed that it could be useful to provide double locks and restrictors on windows or to try to ensure that any escape path from the classroom to the exterior is hampered by the action of at least two doorways. Autistic children responded positively in the garden. Natural environment may promote social interaction and improvement in autism symptoms (Sachs & Vincenta, 2011). From researcher observation, this autism center provides a **sensory garden** with inclusive nature-based and fun places for all children to play and explore. A sensory garden is potentially generating visual, audio, tactile or olfactory stimuli (Arnaiz et al., 2011). As mentioned by Mostafa (2014) sensory garden would be a buffer area and may act as transitional areas between the low-stimulus “focus” zones and the high-stimulus “alertness” zones.



Fig 4: Sensory Design.

(a) Calm, low stimulus space; (b) Sensory garden; (c) Safety and security

(Source: Author)

5.0 Conclusion & Recommendations

Design Criteria Checklist has then filled up to assess how far those criteria and to discover where possible further innovative approaches may exist. This paper has focused on providing a critique of the existing literature based on our observation with respecting the design of educational environments for autistic children. Our observation on the autistic environments in the autism center showed that the basic needs had been applied in designing a physical learning environment. It is important to realize that those elements discussed such as the building entrance, building scale, safety and security, personal space and movement, wayfinding, legibility, threshold, classroom, quiet room, toilet, visual distraction, sun and glare, lighting, acoustic, smell, calm, low stimulus space, and sensory garden would create positive learning environment. Although those sensory issues, internal environment, physical learning environment, and sensory spaces have taken care, it is great if the researcher would look into the most potential that easily triggers the anxiety among them. It is hoped that by creating a conducive learning environment not only optimizes the classroom environment but also upon a parent's and teacher's satisfaction. Perhaps architects and designers could create an appropriate environment to enhance and develop autistic behaviors, emotional and would accommodate autistic children to live their lives like normal children. Hence, this research could contribute to the creation of a quality environment for autistic children within the Malaysian context.

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