Asian Journal of Research in Education and Social Sciences
e-ISSN: 2682-8502 | Vol. 3, No. 2, 230-243, 2021
http://myjms.mohe.gov.my/index.php/ajress

The Analysis of Multi-sensory Environments for Children with Autism Spectrum Disorder in United Arab Emirates

Chuloh Jung[1*], Nahla Al Qassimi[1], Jihad Awad[1]

[1] Department of Architecture, College of Architecture, Art and Design, Ajman University, United Arab Emirates

*Corresponding Author: c.jung@ajman.ac.ae

Accepted: 15 July 2021 | Published: 1 August 2021

Abstract: *Recent statistics indicates that one in 146 children had been diagnosed with autism spectrum disorder (ASD) in the United Arab Emirates and the number is increasing. Even though there is no cure for ASD, the multi-sensory environment (MSE) is widely accepted in the world. The objective of this paper was to explore the effects of the multi-sensory environment on children with ASD, who have visual and auditory hyposensitivity, with the help of cutting-edge technologies to monitor their heart rate. As a methodology, Single-Subject Experimental Design (SSED) was used for the study and MSE interventions was design with visual stimulation, auditory stimulation, and integration of visual and auditory stimulation. The result had shown that experience in a multi-sensory environment is effective in reducing negative repetitive behaviors in daily life of children with ASD. Visual/auditory integrated environmental intervention had a very positive effect on the target behavior of children with visual and auditory hyposensitivity. It was statistically proven that there are obvious differences in heart rate of children with autism spectrum disorder according to the three types of multi-sensory environment interventions. The change in heart rate in a multi-sensory environment, however, could not be concluded with the same effect as the reduction in target behavior. This study will serve as a basic data that one of the important aspects of multi-sensory environment therapy is the flexibility of spatial design that can provide customized environments according to each child with ASD's sensory needs.*

Keywords: ASD, Multi-sensory Environment (MSE), Single-subject experimental design (SSED), Short Sensory Profile (SSP), Heart Rate

1. Introduction

Autism Spectrum Disorder (ASD) is one of the most widely researched neurodevelopmental disorder with language delay, communication impairment, and repetitive actions or interests (Faras et al, 2010). The number of children who are diagnosed with a developmental delay known as an autism spectrum disorder is increasing globally (Boucher, 2017). The Centers for Disease Control and Prevention in America (CDC) had reported that the number of ASD had been increased and in recent years, one in 54 children had been diagnosed with autism category (CDC, 2020). Even though the number of papers or statistics regarding ASD in Middle East are relatively low, recent statistics indicated that one in 146 children had been diagnosed with autism category in the United Arab Emirates (Al Abbady et al, 2017).

Although the cure for people in the autism category has not yet been identified, one promising method for them is the multi-sensory environment (MSE) therapy, a non-pharmacological behavioral intervention (Thompson, 2011). Since the behaviors of children with autism

spectrum disorder are easily affected by sensory stimulation, there is a possibility that their sensory stimulation can be controlled through the physical environment (Fava & Strauss, 2010). While experiencing various sensory experiences in a multi-sensory environment, ASD children can have a stimulating effect, relaxation effect, and opportunities for sensory integration (Pagliano, 2012). Recently, many papers have been published recently with the analysis of the various effects of multi-sensory environments, targeting different people with different physical and emotional conditions (Burns et al, 2019). Despite the fact that experience in a multi-sensory environment has positive effects on improving users' behavioral function and emotional stability, the overall perception of multi-sensory environment treatment is low in the United Arab Emirates compared to socio-economic level (Virolainen et al, 2020). The difficulty of preparing a dedicated space for building a multi-sensory environment room, equipment and installation costs leads to burdensome treatment costs for users, so it is not widely used compared to other treatment programs (Eapen et al, 2007). Another difficulty with multisensory environment therapy is the diversity of sensory profiles for individuals with autism tendencies (Wiggins et al, 2009). However, an important aspect of multi-sensory environment intervention is that individuals have the flexible treatments according to their individual sensory needs (Davies, 2019).

Based on this, the purpose of this paper is to conduct a field experiment to directly observe children who are real users of a multi-sensory environment based on the sensory characteristics of each child diagnosed with autism spectrum disorder, and to scientifically analyze their behavior and physiological responses. This can be an important pathway to understand the relationship between the sensory elements of the environment and the problems facing most children with autism spectrum disorders. This study aims to analyze and share the value of using the multi-sensory environment as a daily healing space by analyzing the effect of the intervention of the integrated multi-sensory environment on children with autism category disorders with various sensory characteristics. It is intended to build the foundation of research on spaces that can contribute to the improvement of the quality of life of children with ASD and their families.

2. Literature Review

2.1. Autism Spectrum Disorder in United Arab Emirates

Autism spectrum disorder, known as complex developmental disorder, is characterized by impaired social interaction and communication, and limited or repetitive homologous behavior (Lauritsen, 2013). Another common trait of children with autistic tendencies is an abnormal interest in the environment, i.e., a problem of sensory reactions (Myers et al, 2007). Abnormal interest in the environment manifests as fascination with lighting or rotating objects, negative reactions to certain sounds or textures, overt interest or indifference to heat or cold, and excessive smelling or sucking objects (APA, 2013). Some researchers have argued that autism category disorder has a causal relationship with sensory processing disorders, which are operated in isolation without the integration of individual senses rather than social communication (Matson & Kozlowski, 2011).

UAE had released the statistics of the identification and prevalence of ASD that one in 146 children had been diagnosed with autism category in the United Arab Emirates (Al Abbady et al, 2017). UAE government had announced the federal commitment that meet the educational, social, emotional and vocational needs of individuals with special needs by providing them equal access to a quality education (UAE Ministry of Education Special Education Department, 2006). His Highness Shaikh Mohammad Bin Rashid Al Maktoum, Vice President and Prime

Minister of the UAE and Ruler of Dubai mentioned education as the right of every child in the UAE. Spreading education and its development is a priority for the development process and a general humanitarian principle and basic right that cannot be overlooked (Gulf News, 2012). With decisive support of leaders of the nation, UAE can implement more efficient special education that will lead ASD children to better lives. Private schools start aligning their direction with the national efforts to provide an appropriate environment for special need children including those with ASD. Based on the inspection handbook by the Dubai Schools Inspection Bureau, major private schools have to enhance the quality of educational services and successfully integrate special needs children with their education contexts (DSIB. 2015). In the United Arab Emirates, there was 78 percent increase in the number of children with ASD symptoms in Dubai alone in last 10 years and this is the reason why UAE should not feel complacent (Gulf News, 2012). In Dubai alone, the number of Autism cases is increasing in last 4 years for local (33%) and expatriate population (67%) based on the cases registry statistics at Dubai Autism Center (Table1).

Table 1: Prevalence of Autism Cases among Dubai Population (Source: Dubai Autism Center)

Year	Local	Expatriates	Total
2011	60	119	179
2012	61	130	191
2013	60	138	198
2014	58	141	199

Table 2 showed the 84.9% of the cases were males and 15.1% were females, 30.9% were local and 69.1% were expatriate. Regarding diagnosis, 72.4% were diagnosed as Autism Spectrum Disorders, 9.2% as ASD features and 18.4% were diagnosed as other disorders.

Table 2: Prevalence of Autism Cases among Dubai Population (Source: Dubai Autism Center)

Category	Sub-Category	Number	Percent
Gender	Male	129	84.9
	Female	23	15.1
Nationality	Local	47	30.9
	Expatriate	105	69.1
Residence	UAE	128	84.2
	Non-UAE	24	15.8
Diagnosis	ASD	110	72.4
	ASD Features	14	9.2
	Other	28	18.4
Type of Assessment	Full-2 Parts Assessment	62	40.8
	Only Short Form for Screening Tool	90	59.2
Only Short Form for Screening Tool	ASD	48	31.6
	ASD Features	16	10.5
	Other	26	17.1
Total		**152**	**100%**

2.2. Multi-Sensory Environment

Multi-Sensory Environment (MSE) is a specially designed sensory enrichment space using lighting, color, sound, music, texture and scent (Poza et al, 2013). In Europe, it is known as Snoezelen therapy, but the multisensory environment and Snoezelen's initial goals and philosophy started from the same context (Novakovic et al , 2019). In this study, it is intended to use the multi-sensory environment as a term that encompasses these two concepts. The multisensory environment provides treatment for a variety of people with cognitive, emotional and physiological problems, such as children with learning disabilities and the elderly with dementia, as well as the autism spectrum disorder group (Collier & Truman, 2008). Multi-sensory environments generally are composed of 1) visual stimulation elements such as LED fiber optics, dimmers that can control various colors of lightings and illumination, and display

projectors, 2) acoustic stimulation elements such as sound equipment and sound stimulation equipment, 3) tactile stimulating elements such as beanbag sofas, floor/wall cushions, and vibrating beds, and 4) olfactory stimulating elements such as aromatherapy (Baillon et al, 2002).

2.3. Single-Subject Experimental Design

Single-subject experimental design (SSED) is referred to as single-case design, single-subject study, or time-series experiment. It is an intervention to solve problems of a single group from one individual, families, or small groups and is intended to scientifically prove what effect the treatment has on this group (Byiers et al, 2012). Single-subject experimental studies increase the internal validity by repeatedly measuring according to reliable observations instead of having no comparative group (Horner et al, 2005). It can be more reliable if the effect of treatment is analyzed repeatedly to see if the tendency that emerged after treatment in one subject appears the same in other subjects (Barlow et al, 2008). Since single-subject experimental design started with behavior modification, it is being used in behavior therapy studies, which are different from case study methods. Both research methods focus on a small number of cases, but the research design and purpose are different (Kazdin, 2010). Single-subject experimental design is a concept of a quantitative research method and uses several procedures for experimental control, whereas case studies are conducted in the field as they are and analyzed by qualitative data (Wendt & Miller, 2012). It also differs from the self-reported survey method, in which respondents are asked about their feelings, thoughts, or actions. Single-subject experimental design is a research method that seeks to obtain in-depth information by investigating a research problem in a situation that is as natural as possible to the research subject through observation (Mills & Gay, 2018).

Single subject experimental design is suitable for conducting evidence-based design and Evidence-based healthcare research. Even if they are diagnosed with the same disability, they are widely used in special education research because they can overcome the limitations of the special education field, where individual differences are large (Johnson & Kiran, 2014).Recently, research are being conducted to seek the direction of single-subject experimental research methods in the fields of occupational therapy, counseling psychology, social welfare and clinical in the UAE (Al Nuaimi & Safi, 2019).

3. Methodology

To achieve the research objectives, specific research questions were set as follows. First, how do the three types of multi-sensory environment interventions (an environment that maximizes visual stimulation, an environment that maximizes auditory stimulation, and an environment that integrates visual and auditory stimulation) affect the target behavior of children with autism category disorders? Second, how do the three types of multi-sensory environment interventions differ in the physiological response (heart rate) of children with autism spectrum disorders? Third, is there a significant relationship between heart rate and target behavior in a multisensory environment?

Data collection for this study was conducted on a Child Development Testbed at Ajman University. This testbed consists of MSE-Snozelen room, sensory integration room, speech therapy room, small motion recognition room, infant room, and parent waiting room.

3.1. Research Subject

After announcing the recruitment of participants in this study with brief information on multi-sensory environment treatment on the bulletin board of the Dubai Autism Center, parents with children who fall under the autism category were recruited to participate in the study. Orientation was held with the participating parents, and the merits of the multi-sensory environment treatment program were introduced. Instead of providing 4 basic sessions and 18 multi-sensory environment interventions free of charge as part of the study, it explained the matters required to participate at the appointed time during the two consecutive months of the study. It was explained that the multi-sensory environment intervention will be provided in three types, every two weeks, and that the child will participate in this treatment after wearing a smart watch capable of measuring heart rate.

In both basic and intervention sessions, it was explained that a professional occupational therapist with 7 years' experience will be with ASD child one on one. It was also announced in advance that all of the children's actions are filmed for 90 minutes a week (30 minutes × 3 sessions) held in the multi-sensory environment room. After giving parents of potential participating children enough time to voluntarily decide whether to participate, Parental consent was obtained for the child's participation in the research.

The shortened sensory profile and sensory characteristic background questionnaire were distributed to 4 mothers who were willing to participate in this study. This face-to-face survey was conducted in the parent's waiting room on the testbed and took 30 to 40 minutes per mother. Among these two questionnaires, in the case of the shortened sensory profile, whether or not a score of 150 points or less out of a 200-point scale influenced the final selection of participating children, but the results of the sensory characteristics background questionnaire were collected only. Afterwards, another interview was conducted to determine the target behavior of each child. The behavior to be observed in this study, the target behavior as a dependent variable, should be observable and measurable. The operational definition of target behavior was defined based on the results of the interview between the mother and the occupational therapist of the child and the results of the researcher's observation of each child's daily behavior before starting the experiment.

Two children who met all of the following conditions were selected. First, children under the age of 13 who were diagnosed as DSM-5 autism category criteria by ASD expert, and second, children who received parental consent to participate in this study for 8 consecutive weeks, third, children who scored less than 150 points in the shortened sensory profile and are having more difficulty in sensory processing and integration than normal developing children, fourth, a child who had no experience in the multi-sensory environment snozzlen treatment program before this study. The background information of the final participating child is shown in Table 3 below.

Table 3: Background Information of Children with Autism Spectrum Disorder

	Child A	**Child B**
Age (Gender)	8 Year 6 Month (Male)	10 Years 4 Months (Female)
Short Sensory Profile Score	124	132
Sensory Characteristic Background Questionnaire	- Visual Hyposensitivity - Auditory Hyposensitivity - Tactile Hyposensitivity - Olfactory Hyposensitivity - Vestibular Hypersensitivity	- Visual Hyposensitivity - Auditory Hyposensitivity - Tactile Hyposensitivity - Olfactory Hyposensitivity - Vestibular Hyposensitivity
Target Behavior	Making meaningless sounds repeatedly	Take anything into her mouth

Operational Definition of Target Behavior	An action that produces a meaningless, non-verbal sound, using one's own voice to produce a sound with a unique tone and rhythm	Take any object in her hand into her mouth and continue to suck, lick with her tongue, or chew with her teeth.

3.2. Single-Subject Experimental Design

A single subject experimental study (SSED) that applied the Alternating Treatment Design (ATD: 2 times Multiple SSED with ATD (A-B-C-D(B+C) steps) as follows was conducted with two participating children with autism spectrum disorder.

A: Baseline, 4 sessions for 1.5 weeks, 15 minutes per session
B: Visual stimulation session that maximizes visual stimulation, 6 sessions for 2 weeks, 30 minutes per session
C: Auditory stimulation session that maximizes auditory stimulation, 6 sessions for 2 weeks, 30 minutes per session
D (B+C): Integration of visual and auditory stimulation session that maximizes visual and auditory stimulation in an integrated manner, 6 sessions for 2 weeks, 30 minutes per session

Among the single-subject experimental design, data from four baseline session were collected in the infant room, and observations for data collection for the entire session of environmental intervention were carried out in the multi-sensory environment room. The multi-sensory environment room was a 25 m^2 rectangular room with a width of 5 m, a length of 5 m, and a ceiling height of 3.5 m and was equipped with various multi-sensory equipment for sight, hearing, touch, smell, vestibular sensation, and proprioceptive sensation (Figure 1).

Figure 1: The Multi-Sensory Environment Room at Ajman University (Source: Mahmoud, 2020)

The 20 sensory stimulation factors used in the multi-sensory environment room were as follows: 1) LED spotlight and color wheel, 2) rotating mirror ball and projector screen, 3) water column, 4) water column switch box, 5) palm music mat, 6) light reaction foot mat, 7) Stand wind chime bell, 8) Aroma fan, 9) Audio vibrating water bed, 10) Small beanbag (Diameter: 65cm), 11) Big beanbag (Diameter: 145cm), 12) optical fiber, 13) 3D tunnel, 14) Neon light tube mirror, 15) Visual and audio picture storytelling, 16) Visual sound panel, 17) leaf swing chair, 18) plasma ball, 19) percussion set, and 20) Wi-Fi wireless speakers. Design elements with visual and auditory stimuli were mainly used, but most of them are sensory tools that deal with more than one sensation at the same time.

This study was designed to provide a multi-sensory environment according to the sensory characteristics background of 2 participating children such as Visually stimulating MSE for a participant with hypo-visual sensitivity and Auditorily stimulating MSE for a participant with hypo-auditory sensitivity. Table 4 shows how the 20 elements of visual and auditory environment design were manipulated in order to create a multi-sensory environment in this study.

Table 4: Experimental Environment Operation for Multi-Sensory Environment Intervention Type

Visually stimulating MSE for a participant with hypo-visual sensitivity		**Auditorily stimulating MSE for a participant with hypo-auditory sensitivity**	
Choosing a stimulating lighting	1) LED spotlight and color wheel	High frequency sound (432-528 Hz) Fast music (110-160bpm)	20) Wi-Fi wireless speakers
Choosing a rotation mode	2) rotating mirror ball and projector screen	Choosing a hard mode	9) Audio vibrating water bed
Making the most of possible visual diversity	3) water column 4) water column witch box 12) optical fiber 13) 3D tunnel 14) Neon light tube mirror	Turning on all features	5) Palm music mat 6) Light reaction foot mat 15) Visual and audio picture storytelling 16) Visual sound panel 18) Plasma ball
Power off	5) palm music mat 6) light reaction foot mat 7) Stand wind chime bell 16) Visual sound panel 19) percussion set 20) Wi-Fi wireless speakers	Putting it on the floor	7) Stand wind chime bell 19) percussion set
Partially not used	9) Audio vibrating water bed (Turn off vibration mode only) 15) Visual and audio picture storytelling (Turn down the volume only) 18) Plasma ball (Turn off sound mode only)	Power off	1) LED spotlight and color wheel 2) rotating mirror ball and projector screen 3) water column 4) water column switch box 12) optical fiber 13) 3D tunnel 14) Neon light tube mirror

3.3. SSED Procedure

While collecting data for the baseline and interventional stages of this study, the researcher entered the space inside the experimental conditions and observed the behavior of the target child without any special intervention or stimulation (Ward-Horner & Sturmey, 2013). In addition, each session of all research stages consisted of one occupational therapist per child participating in a one-on-one situation (Rakap, 2015).

Level A baseline data were observed during 15 minutes of free-choice activities with an occupational therapist in the infants' room. Targeted behavior observation data were collected over four periods for each child and were conducted for about 1.5 weeks. In the case of interventions B, C, and D, the participating child received more than 30 minutes of environmental intervention per session in the multi-sensory environment room. For each child, there were 6 sessions of B intervention, 6 sessions of C intervention, and 6 sessions of D intervention, for a total of 18 multisensory environment interventions for 2 weeks. For the sensory stimulation elements that were turned on in the session, stimulation was given in a way that an occupational therapist observes when the target child voluntarily approaches and interacts with the desired stimulation elements.

3.4. Methods for Recording Target Behavior

3.4.1. Short Sensory Profile (SSP)

Short Sensory Profile is a tool to determine the functional behavior of children who have difficulty in sensory processing and is composed of a total of 38 items using the Likert 5-point scale. (Tomchek & Dunn, 2007). It was developed to shorten the evaluation time in the clinic based on the sensory profile of 125 items. The uniaxial sensory profile consists of a sensory processing area and a behavioral responses area related to sensory processing. This is a standardized questionnaire that can evaluate parents' perception of children's sensory processing and sensory responsiveness. The total score is 190 points, and the lower the score, the more the problem is in the sensory processing ability (Papavasiliou et al, 2011).

3.4.2. Sensory Processing Disorder Checklist

Sensory processing disorder checklist is a tool that researchers summarized the sensory processing disorders (Robles et al, 2012). By using terms that are easier than Short Sensory Profile above, the caregiver can easily check how the child is accepting external stimuli. In this study, the sensory characteristics background questionnaire was simplified with a total of 30 examples of six for each of the five categories (visual, auditory, tactile, olfactory and taste, proprioceptive and vestibular sensation).

3.4.3. Observation Form

The behavioral observation form was used to record and observe target behavior. The frequency recording method records the number of times a predefined target action has occurred during a specified observation time (Cooper et al, 2019). A 15-second interval recording method was used to record target behavior data in the behavior observation form of this study (Suen & Ary, 2014).

3.4.4. Physiological Response Measurement

Samsung Gear Fit 2, a tool that can measure heart rate during physiological reactions, was used in this study. Considering the fact that people with autism tendencies have social, communicative, and verbal difficulties, measuring and understanding their unintended honest bio-signals was one of the objectives of the study for people with autism spectrum disorders. The unobtrusive use of cutting-edge technology can help us to provide an opportunity to communicate with children with ASD (Matson & Nebel-Schwalm, 2017).

During the baseline phase of this study and the multi-sensory environment intervention, continuous real-time heart rate tracking was performed at the same time as observing the target behavior of participating children. Samsung Gear Fit 2 is a watch-type wearable smart device equipped with a low-power wireless sensor. Samsung Gear Fit 2 was developed with wireless support technology that can track steps, calories used, steps climbed, sleep tracking, multisport tracking, and heart rate (Samsung, 2021). Heart rate data for this study was sent from Samsung Clouds to researchers in CSV file format. Samsung Clouds is a cloud-based research platform built to allow researchers to extract data from the Samsung Gear Fit 2 device.

3.5. Data Analysis

Unlike statistical analysis, the method of analyzing single-subject experimental research data is a data analysis method that is frequently used by visual inspection of graphs showing data patterns and slopes (Ledford & Gast, 2018). In this study, the average frequency and range of target actions per minute for each session during baseline A and B, C, and D intervention stages were described. Through repeated measurements over time, it was possible to analyze the

patterns of changes in target behavior according to the three types of multi-sensory environment interventions.

In the case of heart rate data collected in Samsung Gear Fit 2, the average and standard deviation of the heart rate for each session per participating child were described. IBM SPSS Statistics 26 was used for statistical analysis. The Scheffè test was used as a one-way anova analysis and a post-hoc test for each group in order to examine whether there is a difference in the heart rate of participating children according to the three types of multi-sensory environment interventions. In the case of the heart rate data collected by Samsung Gear Fit 2, the heart rate skewness of target child A is -0.31-0.75, the kurtosis is -1.02-1.85, the heart rate skewness of target child B is -0.22-0.97, and the kurtosis is -0.84- It was 1.69. In other words, it was confirmed that the skewness value was between ±1.0 and the kurtosis value was between ±2.0, confirming that the distribution of the quantitative variable received from Samsung Clouds was regarded as a normal distribution (Hoyle, 2014).

4. Analysis

The purpose of this study was to verify the effect of multi-sensory environment intervention, an independent variable, on the behavior and physiological responses of children with autism category disorder, a dependent variable. Therefore, the effect of the multi-sensory environment on the target behavior of the child is investigated. In addition, after analyzing whether the influence on the heart rate of children differs according to the type of multi-sensory environment intervention, it was analyzed whether there is a relationship between target behavior and heart rate in a multi-sensory environment.

4.1. The Effect of Multi-Sensory Environment on Target Behavior of ASD Children

Table 5 shows the average incidence and range of target behaviors per minute according to multi-sensory environment interventions in each participating child in this study. Examining the patterns of changes in target behavior during the baseline and intervention phase, it was found that the multi-sensory environment intervention had a positive effect on both participating children.

Table 5: Average frequency of target actions per minute with multisensory environment intervention

Target Behavior	Session A	Session B	Session C	Session D
	Baseline	Visual stimulation session	Auditory stimulation session	Integration of visual and auditory stimulation session
Child A	1.62	0. 64	0.54	0.28
	SD =0.32	SD =0.15	SD =0.31	SD =0.12
Child B	0.86	0.54	0.64	0.32
	SD =0.30	SD =0.24	SD =0.32	SD =0.14

Since target child A had visual and auditory hyposensitivity, environmental intervention for the child after the baseline (session A) is a multi-sensory environment with maximization of visual stimulation (session B), and a multi-sensory environment with maximization of auditory stimulation (session C), and a multi-sensory environment (session D) in which visual and auditory stimuli were integrated and maximized. During the baseline stage, the average frequency of the behavior of target child A making meaningless sounds repeatedly was 1.62 times (range 1.3 to 2.1 times/min), showing a high incidence rate of about once per minute. Afterwards, it decreased to 0.64 times during the visual multi-sensory environment intervention and keep being decreased to 0.54 times during the auditory multi-sensory

environment intervention. During the last visual/auditory multi-sensory environment intervention, it significantly decreased to 0.28, the lowest among the three types of intervention, showing a positive behavior change due to the multi-sensory environment intervention (Table 5). This showed that the multi-sensory environment intervention that integrated the visual and auditory stimuli was the most effective intervention for target child A's target behavior.

Target child B also had visual and auditory hyposensitivity, environmental intervention for the child after the baseline was the same as that of target child B. During the baseline phase, target child B continued to take anything into her mouth about 0.86 times per minute (range 0.4 to 1.2 times/min). However, immediately after the start of the visual multi-sensory environment intervention, it showed an immediate and significant decrease to 0.54 per minute. After that, it had slightly increased with 0.64 times during the intervention of the auditory multi-sensory environment, During the last visual/auditory multi-sensory environment intervention, the lowest rate was 0.32, and the target behavior decreased very stably until the end of the multi-sensory environment intervention (Table 5).

4.2. The Effect of Multi-Sensory Environment on Heart Rate of ASD Children

In general, the heart rate is about 130 to 150 bpm at birth, but gradually decreases to 70 to 130 bpm at the age of 10 (Rhoads, 2020). In addition, heart rate variability is affected by age or gender (Bennett, 2020).

One-way anova analysis and a post-hoc test were performed to determine whether there was a difference in heart rate according to the intervention type in the multi-sensory environment. All participating children were found to be significant, and it could be said that there is a difference in the average heart rate for each child according to the type of multi-sensory environment intervention (Table 6).

Table 6: Differences in Heart Rate of Target Children by Multi-Sensory Environment Types

Child A				**Child B**			
Intervention Type	**Session**	**Range (bpm)**	**Average (bpm)**	**Intervention Type**	**Session**	**Range (bpm)**	**Average (bpm)**
Visual stimulation session	Visual 1	78-134	95.42	Visual stimulation session	Visual 1	96-137	107.64
	Visual 2	78-128			Visual 2	81-132	
	Visual 3	78-130			Visual 3	94-124	
	Visual 4	71-113			Visual 4	93-126	
	Visual 5	72-110			Visual 5	90-134	
	Visual 6	72-108			Visual 6	90-136	
Auditory stimulation session	Auditory 1	72-116	92.13	Auditory stimulation session	Auditory 1	93-124	111.43
	Auditory 2	78-120			Auditory 2	95-149	
	Auditory 3	71-114			Auditory 3	94-126	
	Auditory 4	78-123			Auditory 4	101-158	
	Auditory 5	76-110			Auditory 5	92-136	
	Auditory 6	80-118			Auditory 6	94-138	
Integration of visual and auditory stimulation session	V+A 1	70-116	97.56	Integration of visual and auditory stimulation session	V+A 1	90-156	112.21
	V+A 2	78-134			V+A 2	97-138	
	V+A 3	74-132			V+A 3	92-137	
	V+A 4	68-116			V+A 4	92-134	
	V+A 5	84-144			V+A 5	96-144	
	V+A 6	82-140			V+A 6	90-139	

Multi-sensory environment during all interventions, the range of minimum heart rate per minute of child A was 68-84 bpm, and the range of maximum heart rate was 108-134 bpm, and the range of heart rate per session was as shown in Table 6. Target child A had the lowest average heart rate during the auditory environmental intervention (Mean=92.13, Standard Deviation=4.92). The average heart rate during the visual environmental intervention

(Mean=95.42, Standard Deviation=4.17) was relatively high, and the heart rate during the visual/auditory integrated environmental intervention (Mean=97.56, Standard Deviation=5.08) was the highest, and all were significantly different. It was found that there is a clear difference in the heart rate of target child A according to each type of environmental intervention. (Auditory <Visual < Integration of Visual and Auditory).

During the multi-sensory environment intervention, the minimum heart rate per minute range of child B was 81-101 bpm, and the maximum heart rate was 124-156 bpm as shown in Table 6. In case of Child B, it was found that the average heart rate during the visual environmental intervention (Mean=107.64, Standard Deviation =3.22), the auditory environmental intervention (Mean=111.43, Standard Deviation =4.97), and visual and auditory integrated environmental intervention (Mean=112.21, Standard Deviation =3.781) Regarding target child B, slight heart rate increase was found from visual environmental intervention to visual/auditory integrated environmental intervention (Visual < Auditory < Integration of Visual and Auditory).

5. Discussion

This study aims to prove the effectiveness of multi-sensory environment intervention designed based on the sensory characteristics of children with ASD and the result was consistent with previous studies to prove the reduction of negative behaviors of children with ASD via multi-sensory environment therapy. However, in the United Arab Emirates, where children diagnosed with autism spectrum disorder are rapidly increasing, Empirical studies on multi-sensory environments are very insufficient compared to the United States and Europe. Therefore, it was hoped that this study will be the beginning of experimental research from the perspective of interior architecture design and a basic study on spatial environment design for the children with autism spectrum disorder.

6. Conclusion

This study has shown that experience in a multi-sensory environment is effective in reducing negative repetitive behaviors in daily life of children with autism spectrum disorders. In particular, visual/auditory integrated environmental intervention had a very positive effect on the target behavior of children with visual hyposensitivity and auditory hyposensitivity. In this study, it was statistically proven that there are obvious differences in heart rate of children with autism spectrum disorder according to the three types of multi-sensory environment interventions (visual environmental intervention, auditory environmental intervention, and visual and auditory integrated environmental intervention). However, the change in heart rate in a multi-sensory environment could not be concluded with the same effect as the reduction in target behavior. Our autonomic nervous system, including the heart rate, constantly adjusts physiological processes to the surrounding environment. Unlike electroencephalogram (EEG) or iris recognition, which requires a separate time and space to be measured after wearing the device, heart rate is a recently simple device that allows natural real-time measurement at the same time as other activities. In this study, the fact that the heart rate of a participant is related to his emotions rather than the habitual target behavior shows that the measuring tool of this study should not be limited to simply monitoring the heart rate. It is necessary to discuss how the heart rate can be used as a medium to understand their needs and communication with individuals belonging to the autism spectrum who have social communication and language difficulties.

It is necessary to provide a multi-sensory environment after grasping each individual's sensory profile with the measurement tools used to select the subject of this study, i.e., a short sensory profile and a sensory characteristic background questionnaire. Therefore, this study will serve as a basic data to remind you that one of the important aspects of multi-sensory environment therapy is the flexibility of spatial design that can provide customized environments according to each user's sensory needs.

If any children have ASD, similar to that of the children in this study, sensory stimulation experiences through periodic exposure to multi-sensory environments to improve their quality of life is strongly recommended. Since it is extremely difficult to experience the level of sensory stimulation in a multi-sensory environment in daily life, it is highly desirable to provide optimal level of arousal spatial experience to children with hyposensitivity by reflecting the experimental environment stimulation of this study as much as possible.

References

Al Abbady, K., Hessian, H.Y., & Alaam, M.W. (2017). Prevalence, Trend, Determinanants and Prediction of Autism Spectrum Disorders among Dubai population, Diagnostic approach and management contexts. *Journal of Paediatrics and Neonatal Care*, 7(1), 10-14.

Al Nuaimi, M.S. & Safi, M. (2019). Digital Social Stories Improve Social Skills in Two Children with Autism: An Experimental Single-Subject Study, 1-17.

APA (American Psychiatric Association). (2013). Diagnostic and statistical manual of mental disorders. 22-24.

Baillon, S., Van Diepen, E., & Prettyman, R., (2002). Multi-Sensory Therapy in Psychiatric Care, *Advances in Psychiatric Treatment*, 8(6), 444-450.

Barlow, D., Nock, M., & Hersen, M., (2008). Single Case Experimental Designs: Strategies for Studying Behavior Change. 142-145.

Bennett, M. (2020). Heart Rate Variability: Using Biometrics to Improve Outcomes in Trauma-Informed Organizations. 26-27.

Boucher, J. (2017). Autism Spectrum Disorder: Characteristics, Causes and Practical Issues. 16-18.

Burns, P., Garner, A., Lau, S., Dixon, R., Pascoe, C., & Szafraniec, M. (2019). Making Sense of Multi-Sensory Environments: A Scoping Review. *International Journal of Disability, Development and Education*, 67(6), 630-656.

Byiers, B.J., Reichle, J. & Symons, F.J., (2012). Single-Subject Experimental Design for Evidence-Based Practice, *American Journal of Speech-Language Pathology*, 21(4), 397-414.

CDC (Centers for Disease Control and Prevention). (2020). Data and Statistics on Autism Spectrum Disorder, Retrieved from https://www.cdc.gov/ncbddd/autism/data.html

Collier, L., Truman, J., (2008). Exploring the Multi-sensory Environment as a Leisure Resource for People with Complex Neurological Disabilities, *NeuroRehabilitation*, 23(4), 361-367.

Cooper, J., Heron, T. & Heward, W. (2019). Applied Behavior Analysis. 64-68.

Davies, C. (2019). Creating Multi-sensory Environments: Practical Ideas for Teaching and Learning (Nasen Spotlight). 92-96.

DSIB (Dubai Schools Inspection Bureau). (2015). Inspection Handbook 2014-2015. 13-14.

Eapen, V., Mabrouk, A,A, Zoubeidi, T., & Yunis, F., (2007). Prevalence of Pervasive Developmental Disorders in Preschool Children in the UAE. *Journal of Tropical Pediatrics*, 53(3), 202–205.

Faras, H., AlAteeqi, N., & Tidmarsh, L. (2010). Autism Spectrum Disorders. Annals of Saudi Medicine, *Med*, 30, 295–300.

Fava, L., Strauss, K. (2010). Multi-sensory rooms: Comparing effects of the Snoezelen and the Stimulus Preference environment on the behavior of adults with profound mental retardation. *Research in Developmental Disabilities*, 31(1), 160-171.

Gulf News. (2013). Cabinet approves a proposed federal law on compulsory education, Retrieved from https://gulfnews.com/uae/education/cabinet-approves-a-proposed-federal-law-on-compulsory-education-1.1052379

Horner, R., Carr, E.G., Halle, J., McGee, G., Odom, S., & wolery, M. (2005). The Use of Single-Subject Research to Identify Evidence-Based Practice in Special Education, *Exceptional Children*, 71(2), 165-179.

Hoyle, R.H. (2014). Handbook of Structural Equation Modeling. 214-220.

Johnson, J.P. & Kiran, S. (2015). Preserving the flexibility of single-subject experimental design - a commentary on "Optimising the design of intervention studies: critiques and ways forward, *Aphasiology*, 29(5), 567-569.

Kazdin, A.E. (2010). Single-Case Research Designs: Methods for Clinical and Applied Settings. 36-38.

Lauritsen, M.B. (2013). Autism Spectrum Disorders. *European Child & Adolescent Psychiatry*, 22, 37–42.

Ledford, J.R. & Gast, D.L. (2018). Single Case Research Methodology: Applications in Special Education and Behavioral Sciences. 147-150.

Matson, J.L. & Nebel-Schwalm, M. (2017). Assessing challenging behaviors in children with autism spectrum disorders: A review, *Research in Developmental Disabilities*, 28(6), 567-579

Mills, G., Gay, L. (2018). Educational Research: Competencies for Analysis and Applications. 342-346.

Myers, S.M., Johnson, C.P., (2007). Management of Children With Autism Spectrum Disorders. *Pediatrics*, 120(5), 1162-1182.

Novakovic, N., Milovancevic, M.P., Dejanovic, S.D., & Aleksic, B., (2019). Effects of Snoezelen—Multisensory environment on CARS scale in adolescents and adults with autism spectrum disorder, *Research in Developmental Disabilities*, 89(1), 51-58.

Pagliano, P. J. (2012) The multisensory handbook: A guide for children and adults with sensory learning disabilities. 38-42.

Papavasiliou, A.S., Nikaina, I., Rizou, J., & Alexandrou, S. (2011). The effect of a psycho-educational program on CARS scores and short sensory profile in autistic children, *European Journal of Paediatric Neurology*, 15(4), 338-344.

Poza, P., Gómez, C., Gutiérrez, M.T., Mendoza, N., & Hornero, R., (2013). Effects of a multi-sensory environment on brain-injured patients: Assessment of spectral patterns, *Medical Engineering & Physics*, 35(3), 365-375.

Rakap, S. (2015). Effect sizes as result interpretation aids in single-subject experimental research: description and application of four nonoverlap methods, *BJSE*, 42(1), 11-33.

Rhoads, J. (2020). Clinical Consult to Psychiatric Mental Health Management for Nurse Practitioners, Second Edition – A Convenient, Practical, and Portable Guide of the Major DSM-5 Disorders. 106-118.

Robles, P., R., Ballabriga, M.C.J., & Diéguez, E.D. (2012). Validating Regulatory Sensory Processing Disorders Using the Sensory Profile and Child Behavior Checklist, *Journal of Child and Family Studies*, 21(1), 906–916.

Samsung. (2021). Samsung Galaxy Fit 2 – Fitness and Sleep Tracker / Samsung US, Retrieved from https://www.samsung.com/us/mobile/wearables/galaxy-fit-2/

Suen, H. & Ary, D. (2014). Analyzing Quantitative Behavioral Observation Data. 134-138.

Thompson, C.J. (2011). Multi-Sensory Intervention Observational Research. *International Journal of Special Education*, 26(1), 202-214.

Tomchek, S.D. & Dunn, W. (2007). Sensory Processing in Children With and Without Autism: A Comparative Study Using the Short Sensory Profile, *American Journal of Occupational Therapy*, 61(1), 190-200.

UAE Ministry of Education Special Needs Department. (2006). School for All: General Rules for the Provision of Special Education Programs & Services (Public & Private Schools). 7-8.

Virolainen, S., Hussien W., & Dalibalta S., (2020). Autism spectrum disorder in the United Arab Emirates: potential environmental links. *Reviews on Environmental Health*, 35(4), 359-369.

Ward-Horner, J. & Sturmey, P. (2013). Component analyses using single-subject experimental designs: A review, *Journal of Applied Behavior Analysis*, 43(4), 685-704.

Wendt, O., & Miller, B., (2012). Quality Appraisal of Single-Subject Experimental Designs: An Overview and Comparison of Different Appraisal Tools. *Education and Treatment of Children*, 35(2), 235-268.

Wiggins, L. D., Robins, D. L., Bakeman, R., & Adamson, L. B., (2009). Brief report: Sensory abnormalities as distinguishing symptoms of autism spectrum disorders in young children, *Journal of Autism and Developmental Disorders*, 39(7), 1087-1091.