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Original Research Article

A Comparative Study of the Effectiveness of the Biophilic Approach and Therapeutic Landscapes in Developing the Senses of Autistic Children*

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Abstract | With an increase in the number of children born with autism, their special sensory needs and perceptions have been highlighted in official and unofficial national and international statistics. Scholars have voiced concerns about training the special skills of affected children. According to research, interaction with nature and education in open spaces can be effective. Landscape therapy has been proposed as one of the most effective strategies for different human groups. Biophilic landscapes are among the branches of landscape therapy that offer strategies for landscape design to reduce anxiety, improve the spirit, and increase social relationships. Considering the problems of autistic children and their special needs, it is not clear if the strategies based on Biophilic landscapes might address their needs. The research seeks to understand whether the strategies of Biophilic landscapes have a positive effect on the education of autistic children with special needs. ? To answer the question, mixed-methods research was used and an exploratory approach was adopted to compare the educational strategies of autistic children and Biophilic landscape therapy. In this descriptive-analytical study, the specialized educational strategies for autistic children were compared with the strategies used for designing Biophilic landscapes and then shared strategies were extracted. Some of the strategies were used in real space, and children were exposed to them through an experiment. For this purpose, the sensory processing questionnaire was conducted before the experiment and after the experiment, and the children's progress was assessed through the fourteen items. The results of the research indicate that the auditory, vestibular, tactile, and multi-sensory strategies and their integration with body position and movement (proprioception) and visual aspects have been significantly effective in terms of emotional processing, activity level, and emotional and social responses. However, the proposed strategies related to the visual and sensory-oral senses were not effective for autistic children, and their integration with sensory processing (e.g., physical endurance) and activity level influencing movement and sensory input affecting emotional responses were not useful. There were no big changes in the behavioral consequences of sensory processing or the response thresholds of children. This could be associated with children's different sensory perceptions. However, concerning children's daily performance in the sessions, it seems that increasing the number of sessions and adopting the above-mentioned strategies can have a positive effect on these senses as well. This study highlights the need for researchers to expand the therapeutic strategies and increase the exposure of children to landscapes.

Keywords | *Landscape, Healing, Autism, Senses, Biophilic.*

Introduction| Autism is a lifelong developmental disability that usually appears during the first three years of life and affects the way people perceive their environment and interact with others (Nagib & Williams, 2018, 1). In 1911, Bleuler was the first psychiatrist to use "Keeping up to yourself" to describe the behaviors of an autistic patient.

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Richardello proposed the term "autism" for the first time in 2005 and considered interacting with nature as one of the most effective strategies for autistic children. In recent years, according to official and unofficial statistics, the percentage of autism disorder among newborns has increased. According to a 2015 statistical report, the prevalence of autism in the United States has reached one in every fifty people. This disorder shows a 123% increase compared to the first statistical report of prevalence in 2002 (Russell & McCloske, 2016, 2). According to unofficial statistics based on field observations and interviews in Shiraz, the research's spatial scope indicates that there are currently about 1000 children with autism disorder; in other words, one out of every 50 babies born in Shiraz suffer from autism. Because of the importance of education and its effectiveness on autistic children, the Organization of Exceptional Education compiled a collection of books for six levels entitled "Learning Skills" in 2017 based on the needs of autistic children and to increase self-help, communication, and interactive skills, and authors have made some suggestions based on the visual support of this group. In recent studies, communication with nature has proven effective in improving all groups of autism spectrum disorders. On the other hand, landscape therapy and the design of therapeutic gardens were academically proposed in 1992 for different human groups by Gesler, and until now, broader ideas, including Biophilic design from the scale of interior design to urban scales, have developed therapeutic landscape strategies. Many studies have been presented to explain the framework of Biophilic landscapes, but none have been conducted on autistic children based on landscape therapy using a Biophilic approach. Due to the difference in the perception and senses of autistic children, their education, and needs compared to non-afflicted peers, the question is if general strategies provided by the therapeutic landscape with an emphasis on the Biophilic approach can be effective for autistic children. Are the strategies provided in the Biophilic framework effective for autistic children who have special needs?

Literature Review

Hussein investigated the use of sensory gardens by observing the areas and how they are used by children with special educational needs in a research study entitled "The Influence of Sensory Gardens on the Behavior of Children With Special Educational Needs." The methods used in this research were interviews, observation, and behavior analysis, which were framed by Gibson's environmental capability theory. The landscapes to which the children were exposed were classified based on the capability of furniture design and the hardness and softness of the landscape, with activity categories: sensory stimulation, physical skills, and social skills. The result showed that users spent more time in areas where sensory value rather than aesthetic value was emphasized (Hussein, 2012). In an article entitled "Analysis of Therapeutic Gardens for Children with Autism Spectrum Disorders," Lipscomb and Steward emphasized autistic children's sensory problems in terms of visual, smell, auditory, speech, and taste; and proprioceptive, tactile, and vestibular, exploring how outdoor design elements can help (Lipscomb & Stewart, 2014, 3&4). Table 1 depicts various theories about garden therapy and the benefits of connecting with nature, as well as its efficacy for autistic children. In a 2019 pilot study entitled "Caring for local biodiversity in a therapeutic garden: therapeutic benefits in young subjects with autism," Reeve and his colleagues proved that contact with nature and gardening care had important effects on people with autism (Reeve, Nieberler-Walke & Desha, 2017, 13). In an article entitled "Designing an Effective Sensory Garden for Children and Adolescents with Autism Spectrum Disorder," Wagenfeld and his associates addressed garden design feedback with careful attention to detail and thoughtful arrangement of plants, materials, furniture, and spaces. The researchers found that a series of stimulating and soothing sensory experiences led to the reduction of stress and anxiety in teenagers and had a slow effect on their senses, including visual, olfactory, touch, taste, auditory, vestibule, and proprioception, and strengthened meaningful interactions (Wagenfeld, Sotelo & Kamp, 2019, 7). In an article entitled "The Sensory Garden: Systematic Design of a Playground for the Texas Tech University Child Development Research Center with Considerations for Children with Autism Spectrum Disorder," Rana Bazaide presented the design of a site in southwest Texas. The purpose of this project is to design an outdoor learning environment—a sensory garden—that increases sensory integration for preschool children, with special attention to children with autism. According to the designers, children with autism perceive their surroundings and sensory data differently than neurotic children. Their sensory processing of the surrounding sensory integrations is provided through the reactions of the vestibular senses, proprioception, touch, auditory, visual, and olfactory. This project focuses on the design of a sensory garden that considers children with autism spectrum disorders in an outdoor educational environment for preschool children (Bazaid, 2019, 1&2). In an article entitled "The Sensory Garden: Systematic Design of a Playground for the Texas Tech University Child Development Research Center with Considerations for Children with Autism Spectrum Disorder," Bazaide discussed the design of a site in southwest Texas. She showed how designing an outdoor learning environment—a sensory garden—could increase sensory integration for preschool children, especially autistic ones. According to the designers, autistic children perceived their surroundings and sensory data differently

Table 1. Theorists of the therapeutic garden for autistic children. Source: Authors based on Kaihara Arce, 2019.

Theoretician	Theories
Moor (1993)	It affirms that all the senses are stimulated by plants, including visual, taste, touch, and auditory.
Herbert (2003)	Therapeutic gardens can be places to treat and increase care for autistic children based on their special needs. This will help autistic children within or outside the classroom show a significant improvement in their behavior; for example, they will show less aggression, less self-stimulation, and more cooperative behavior.
Wilson (2006)	A therapeutic garden can have calming effects for hyperactive children with ASD and stimulating effects for hyporeactive ones.
Mostafa (2014)	He created seven criteria for autism that address sensory integration. These principles are acoustics, spatial sequence, escape space, compartmentalization, transition spaces, sensory zoning, and safety. Paying attention to these principles in education leads to the reduction of noise, echo, and reverberation and improves attention span, response time, and behavioral mood.
Barakat, Bakr & El-Sayad (2019)	Among the benefits of therapeutic gardens is the reduction of sensory input to prevent sensory overload. Strategies include stimulation of the vestibular and proprioceptive systems using swings, rocking chairs, and merry-go-rounds. Such strategies release the energy required to deal with autism by creating escape time and free play.
Milburn (2019)	Landscape plays a relevant role in the interaction between autism and nature. Landscape architecture is a link that modifies natural elements to create sensory impulses that have a positive impact on autistic people.

than neurotic children. Their sensory processing of the surrounding sensory integrations was provided through the reactions of the vestibular senses, proprioceptive, tactile, auditory, visual, and olfactory. This project focused on the design of a sensory garden for children with autism spectrum disorders in an outdoor educational environment for preschool children (ibid.). In an article entitled "Design Interventions for Sensory Comfort of Autistic Children," published in 2018, Gopal and Rahvaan divided autism spectrum disorder into two categories: passive and active. The researcher's premise was that autism disorder is based on neural theory and places emphasis on the visual sense in processing the environment, and based on the opinions of autism experts in the field of differences in processing the sense of visual, strategies were proposed for the design of landscapes for autistic children (Gopal & Raghavan, 2018, 4). The results of this research can be reviewed in the table below (Table 2).

In the research that Ramshini and her colleagues carried out in Iran in 2017, entitled "Effect of Family-Centered Nature Therapy on the Symptoms of Autism Spectrum Children," they investigated the effectiveness of family-centered nature therapy on the symptoms of children with autism spectrum disorder with a practical method using a semi-experimental (pre- and post-test) design with the control group. They found that family-oriented nature therapy (ecotherapy) could reduce symptoms in children with an autism spectrum disorder. These children showed remarkable progress, especially in social and communication skills. The results of the research indicate that the use of this method is effective as a complementary method along with other treatments to reduce the symptoms of children with autism spectrum disorder due to its positive effect, simplicity, and convenience (Ramshini, Hasanzadeh, Afroz & Hashemi Razini, 2018). In Biophilic landscapes, Kellert identifies nine Biophilic values: utilitarian, naturalistic, scientific, aesthetic, symbolic, humanistic, moralistic, dominant, and negative. Furthermore, Kellert referred to biophilia as "the innate human tendency to depend on natural systems and processes, especially features of life and living (e.g., ecosystems) in the nonhuman environment" (Zhong, Schröder & Bekkering, 2022, 10, 11, 13). Peter and Depona's five theories that incorporate Biophilic ideas include place attachment theory, attention recovery theory, stress reduction theory, landscape/shelter theory, and restorative environmental design. They examine but do not directly address the term "Biophilic" or "Biophilic design" (Peters & D'Penna, 2020, 3&4). Zhuang et al. divide the Biophilic design into three categories: 1. Incorporating nature: introducing or artificially creating natural elements, phenomena, and processes and emphasizing them through multisensory experiences, 2. Inspiration from nature: Mimics of nature (often known as "biomimicry") evoke a sense of nature through the placement of natural features. 3. Interaction with nature: arrange spaces based on evolved human-nature relationships to experience nature-like environments and communicate with the natural system or between different spaces. Researchers have explained the benefits of Biophilic designs under three categories: reducing energy costs, increasing cognitive performance (attention capacity, creative performance, and memory reconstruction), and increasing environmental awareness that is created by using air, daylight, plants, materials, and texture. The second category includes demonstrating the use of virtual reality in designs, creating accessible and public green or blue spaces, and increasing livability through the use of forms and shapes, patterns and geometry, and mechanisms. The third category includes reducing stress,

Table 2. Therapeutic landscape strategies for autistic children, with an emphasis on sufferers' differences in visual processing. Source: Authors based on Gopal & Raghvan, 2018.

Theorist	Difference theory of visual processing	Explan/ation	Researchers design strategy
Happe	Lesser susceptibility to visual illusions	Autistic people are less prone to visual hallucinations (such as Ponzo's triangle) (Happe, 1996)	Avoiding obstacles in the expected path of the child's movement to minimize the problem of detecting the real distance from the object. Avoiding marked changes in the size of objects adjacent to each other to minimize the problem of spatial detection (Gopal & Raghavan, 2018, 6).
Happe	Failure of shape	There is a failure in shape constancy in autistic children. The ones with autism are less affected by prior knowledge used in visual judgments (Happe, 1996).	Use simple geometric shapes (circles, squares) to minimize visual confusion (Gopal & Raghavan, 2018, 6).
Bogdashina	Gestalt perception	Autistic people are bombarded by sensory stimuli, resulting in infinitely detailed sensory information being received holistically at the same time, which is described as "gestalt perception" (Bogdashina, 2003).	The use of dominant edges, texture gradients, color contrast, and light as cues to distinguish form from the ground (Gopal & Raghavan, 2018, 6).
Bogdashina	The deficit in visual form processing	Autistic people have defects in visual form processing. They used patterns of correlated dot triplets, in which structured elements were mixed with random elements, and found deficits in visual form processing in autism (Bogdashina, 2011).	Avoid overlapping objects in the main viewpoints as they may not be perceived as having the simplest form and cause visual disturbances (Gopal & Raghavan, 2018, 6).

increasing the rate of recovery, strengthening positive emotions, and encouraging physical activity that is created by the use of landscape, shelter, and temptation (danger and mystery) (Zhong, Schröder & Bekkering, 2022, 10,11,13). In none of the research studies has the effect of Biophilic landscapes on autistic children with special needs been investigated.

Theoretical Foundation

Based on the hypothesis of the research and effective strategies on the senses of autistic children through the Biophilic landscape, the basics of this research presents strategies to reduce stress and improve social relations for all people, regardless of their special needs and this section comes under two categories: education for autistic children and Biophilic landscapes. Although autism was first described as early as 1943 by Connor, the nature of the underlying defects in the disorder is still unclear. Several theories and hypotheses explain persistent deficits in autistic children. The theories that explain autism and its related symptoms can be generally classified into cognitive theories and neurological theories; the first is based on cognitive differences, and the second is based on neuroanatomical differences (Gopal & Raghavan, 2018, 3, 4). Many cognitive theories explain the sufferers' social and communication problems, but they do not explain sensory symptoms (ibid., 3). In neurological theories, more emphasis is placed on the disorder of the senses in sufferers. Children with autism can have sensory symptoms such as hyporesponsiveness, hyperresponsiveness, and sensory seeking. It was discovered fifty years ago that children with autism become agitated and defensive in response to these sensory experiences (Álvarez, 2020, 1). Some authors have added a fourth pattern to the sensory symptoms of autistic children: increased perception (Posar & Visconti, 2018, 1). Autistic people have a wide range of sensory experiences, from hypersensitive (active) to hypersensitive (passive). In addition to the traditional five senses, proprioception, and vestibular senses are important in understanding autism (Lipscomb & Stewart, 2014, 3). In some articles, in addition to the mentioned senses, body sensation, taste, and food sensitivity have been added (Posar & Visconti, 2018, 3). Autism therapists generally classify children into three levels from 1 to 3; level 1 has more abilities in sensory processing and adapting to the environment than level 3.

• Effective strategies for the senses of children with autism

According to the literature review and interviews, the treatment strategies suggested by the autism experts are multi-sensory; in other words, the experts believe that education that involves several senses of the child simultaneously is more effective. For example, in research,

Lockhart investigated the immediate effects of rhythmic auditory stimuli with proprioceptive input on children with an autism spectrum disorder. The findings of the research showed that children with proprioceptive deficits in autism performed better in auditory and visual processing after receiving proprioceptive rhythmic input. They even outperformed those who received proprioceptive input alone. As a result, participants who received mixed rhythmic and proprioceptive input performed better than participants who received only proprioceptive input (Lockhart, 2017, 42-66). Table 3 presents experts' effective strategies that influence different senses of sufferers.

• The Biophilic therapeutic landscape

Biophilia is defined as people's innate desire for the natural world and has been studied in psychology and sociology since the 1980s (Peters & D'Penna, 2020, 1). In many pieces of evidence, biophilia can be linked to research in one or more of the effects on the three mental systems—physiological-cognitive, psychological, and physiological—to varying degrees in laboratory studies. Some field studies also confirmed that the natural environment or simulation of nature affects the health and well-being of people (Browning, Ryan & Clancy, 2014, 13). The positive feelings associated with biophilia are likely caused by the stimulation of different senses such as visual, auditory, and olfactory. For example, there is evidence from research that the scent of flowers can have a positive effect on human emotions and feelings (Wijesooriya & Brambilla, 2021, 17). By affecting the visual, auditory, and multisensory senses, similar to what is experienced in nature, the Biophilic design reduces stress, improves mood, enhances perceived productivity, improves cognitive performance, and increases undivided attention to the environment (Aristizabal et al., 2021, 11). The basics of the Biophilic landscape in this research were drawn from the Biophilic theory of Browning et al. (Browning, Ryan & Clancy, 2014; Browning & Ryan, 2020). This theory has three main categories that include 15 patterns (Table 4).

Research Method

In terms of goal, the research is one of the applied studies that used a mixed research method. In the qualitative part of the research, in a descriptive-analytical way, the Biophilic design strategies were compared with the educational and therapeutic strategies of autistic children to extract the strategies of therapeutic landscapes suitable for autistic children based on the Biophilic approach. From the analysis of the strategies, three of them were selected and used in landscape design with the consultation of therapists in the real space, assuming an effect on the seven senses of the child. In the quantitative research, the experimental method was used, and the interventional group was exposed to the designed landscape. The sample for the study were children with autism in Fars Province, with age ranges of 3– 9 years old, who attended an autism charity center including:: in spectrums 1 and 3. The sample size was chosen under the supervision of autism experts from eight people on two spectrums (one and three). Two of the samples were used as pilots from levels 1 and 3 to check the test conditions, and six were the final test samples. According to the suggestions of autism experts, children were directly exposed to the built environment for 18 sessions over two months. During

Table 3. Effective strategies influencing the senses of children with autism through the lens of therapists Source: Authors.

Sense	Therapeutic strategies of therapists and specialists for autistic children
Proprioceptive	Jumping on a therapy ball, jumping on a trampoline, brushing teeth, therapy ball chairs, compression of joints with massage, weighted pillows, weighted vests (Lockhart, 2017, 4), rolling on the floor, squatting, pushing objects, throwing and catching balls, and walking like animals (observations and interviews).
Vestibular	Froggy Bobby, Bhattacharya, XR-Board Dueller, Pixel Balance, Fruit Catcher game, Circus in Motion, Hay Collect (Peña, Cibrian & Tentori, 2020, 2-4), Tai Chi Chuan training (Sarabzadeh, Bordbar Azari & Helalizadeh, 2019, 2-5), climbing the stairs, jumping with two feet, walking on a rope, holding a book on the child's head and making him walk, practicing the tree pose, walking forward and backward, playing with a hoop, balance board (observations and interviews).
Visual	Using liquid crystal glasses (Morris et al., 2015, 2, 3, 6, 7), a mailbox game (Lea Mailbox Game), finding hidden images (optical illusions), a 3D puzzle game (Lea Puzzle), a gray-black rectangle game (Lea Rectangle Game) (Bhaskaran, Lawrence, Flora & Perumalsamy, 2018, 2), throwing a laser in a dark room, following the path of a magic line, and using a camera (observations and interviews).
Tactile	Using sand, touching textured surfaces, vibrating toys (Foss-Feig, Heacock & Cascio, 2012, 4&5), caressing and hugging, specialized sensory massage, touching artificial grass, sand therapy, and touching spiked balls (observations and interviews).
Auditory	Repeating different types of auditory stimuli (Font-Alaminos, et al., 2019, 8, 9, 21), using headphones, playing the sounds of nature and animals, and playing with cans that have different sounds (observations and interviews),
Taste	Involving the child in preparing food, developing individual skills in the child, and creating a reliable relationship between parents and children (Zulkifli, Kadar, Fenech & Hamzaid, 2020,15)
Olfactory	Pleasant smells, a special smell (Tonacci et al., 2017, 15&16), and drops that have a relatively pungent smell (observations and interviews)

Table 4. Biophilic design patterns and categories (adopted from Browning & Ryan, 2020) and strategies proposed by Biophilic experts. Source: Authors.

Categories	Design patterns	Strategies
Nature in spatial patterns	Visual connections with nature	Pond, aquarium, creating space to keep animals
	Non-visual connection with nature	Horticulture, including edible plants (fruits and vegetables), audible and/ or physically accessible water features, urban agriculture, and muted "earth" colors characteristic of soil, rock, and plants
	Non-rhythmic sensory stimuli	Shadows or sunken lights that change with movement or time, the chirping of birds, the smell of flowers, trees, and fragrant plants
	Thermal and airflow variability	Using natural and seasonal light shades of trees, and radiant surface materials
	Presence of water	River, pond, visual access to rainfall and natural flow of rain, fountain
	Dynamic and diffuse light	Direct sunlight, integration of light with spatial features, aesthetic shapes, and forms, and suitable canopies to prevent glare
	Connection with natural systems	Weather patterns (rain, hail, snow, wind, clouds, fog, lightning), natural patina of materials (leather, stone, copper, bronze, wood), gravity, fractal grid
Patterns of natural analogs	Biomorphic forms and patterns	Wall decals, color or texture style, natural geometries including fractal, golden ratio, and Fibonacci sequence, the natural shapes of textures, and the shape of the earth
	Material connection with nature	Using the colors of plants and animals and stones in the environment, wood surfaces, stones, etc. instead of concrete and metal
	Complexity and order	Complex skyline and complex structure, auditory stimuli, and complexity in a coherent and readable way
The nature of spatial patterns	Prospect	Complex skylines and complex structures, views including shady trees, bodies of water, or evidence of human habitation, and the eye of nature-related emissions create landscapes in places such as constructed wetlands, grasslands, plains, forests, and other habitats.
	Refuge	Spaces with weather protection, speech, and visual privacy, dimming or changing color, temperature, or light brightness, an adjustable canopy (to create open, semi-open, or semi-enclosed spaces),
	Mystery	Curved edges, curved paths of light and shadow
	Risk/ Peril	Creating heights to induce a sense of danger, water and the risk of getting wet, paths to change the height, and spaces with more than twice the natural height all create a sense of suspense.
	Fear	Large suspended transparent (invisible) objects that connect the bridges

the sessions, according to the description of the session, all three stages were performed for each child, and to check the short-term performance, the children's performance report was written at the same time. To investigate the long-term effect, the sensory processing questionnaire was used to record children's information before the test (August 1401) and after the test (October 1401). The sensory processing questionnaire is a standard questionnaire in the world that examines fourteen different factors about children; Fourteen factors are involved: auditory, visual, vestibular, tactile, multi-sensory, oral sensory, physical endurance, body posture, movement, emotional responses, emotional processing, and activity level, social emotional responses, and behavioral consequences of processing. The sensibility and response threshold, which were recorded in the behavioral states before and after the placement of the children in the desired environment, were compared and analyzed using the paired t-test at a 95% confidence level. This questionnaire is designed based on the Likert scale with a five-point scale (always = 1, often = 2, sometimes = 3, rarely = 4, never = 5), and a higher score is desirable in the calculation of all factors. Due to the small number of samples, the normality of the data was first checked with the Kolmogorov-Smirnov (k-s) test using SPSS software. All factors had a normal distribution. After ensuring the normality of the data, pairwise averages were compared. In this test, the assumption of zero means that the environment is ineffective.

Findings

Based on the theoretical basis of the education of autism disorder in a specialized way, the strategies for the effectiveness of the senses were extracted separately (Table 3). Patterns and design categories in Biophilic landscapes were investigated, analyzed, and classified based on the research of Browning et al. For example, regarding vestibular sense, the skills and games that experts consider effective for the vestibular sense of autism disorder were extracted from

A to J according to Fig. 1. Then based on the design patterns and categories presented in Biophilic landscapes, the strategies associated with vestibular sense were determined. They include 1 to 13 strategies. According to the matrix, jumping off two feet is a specialized training exercise associated with the vestibular sense corresponding with the patterns of Biophilic landscapes, including the gravity of the earth, the creation of footpaths and bridges, the creation of double activity and movement, and spaces with more than twice the natural height. For example, in Sarab-Zadeh et al.'s research, it was proven that "this exercise can enhance visual and vestibular performance as well as proprioceptive systems of children with autism disorder in three spectrums" (Sarabzadeh, Bordbar Azari & Helalizadeh, 2019, 2–5). The equivalents of the aforementioned exercise were categorized based on Biophilic patterns, including passing over, under, and through water, creating a sense of suspension, and using elements such as bridges and using edges, and ropes

Educational program for autistic children / **Biophilic patterns**			Froggy Bobby	Bhattacharya	XR-Board Dueller	Pixel Balance	Fruit Catcher	Hay Collect	Circus in Motion	Tai Chi Chuan	Climbing up the stairs	Jumping off two feet
			A	B	C	D	E	F	G	H	I	J
1. The creative interaction of light and shadow and the integration of light with spatial features will take the form of beautiful forms.	**Nature in spatial patterns**	١										
2. Earth's gravity (all objects in nature are in a gravitational balance, and this shows our mental respect for stable structures.)		٢										
3. Biomimicry function (we can refer to the bioclimatic controls of termite mounds, the structural strength of spider webs, and the ability to trap heat in some animal hairs).	**Natural analog patterns**	٣										
٤. Imitating the lines and patterns of creatures		۴										
5 .Creating footpaths and bridges		۵										
٦. Using computer algorithms for textures and colors		۶										
٧. Complexity in a coherent and readable way		٧										
8. Creation of pedestrian and traffic flow		٨										
٩. Activity and movement	**The nature of spatial patterns**	٩										
١٠. Passing under and over water		١٠										
١1. Large suspended transparent (invisible) objects that connect the bridges; Create a sense of suspense		١١										
12. Spaces with more than twice the natural height		١٢										
١٣. Using ropes and infinite edges		١٣										

Fig. 1. Educational adaptive matrix of autism and Biophilic patterns with emphasis on vestibular sense. Source: Authors.

(Fig. 1). A similar table for the six senses; visual, olfactory, taste, auditory, proprioceptive, and tactile was created. Winding paths with a height higher than the child's height, for example, and the play of light and shadow with the movement of the sun to recognize geometric surfaces were among the effective Biophilic-autism strategies for the visual sense. Regarding olfactory sense, the adaptive strategies of using aromatic vegetation with various scents, and for taste, preparing agricultural landscapes, and horticulture were identified. Concerning the proprioceptive sense, the inferred strategies were throwing a ball, jumping off, rolling on a trampoline, and imitating animal movements. For the auditory sense, strategies such as using the flow and sound of water, singing birds, and the rustling of plants were encouraged. To engage the tactile sense, some of the extractive strategies of Biophilic-autism research included textured surfaces, positive contact with animals, the creation of warm and cool surfaces with diversity in hard landscape materials, protruded details, urban agriculture, and touching the soil and planting plants (Table 5). Due to the interaction in outer space, the proposed strategies are often not single-functional, or rather, single-sensory, but stimulate several senses at the same time. For example, if the emphasis is on the visual sense in a winding path, due to the presence of both hard and soft landscapes, olfactory and auditory will also be affected by the presence of plants and the sounds of nature. Therefore, strategies often affect several senses (Table 5).

Among the proposed adaptive strategies, due to space and time limitations and in-depth interviews with autism therapists, three combined strategies were implemented. It was predicted to engage seven children's senses. The required props were prepared on a real-world scale to test children in the outdoor space. These three strategies include building a winding path with an emphasis on stimulating visual and proprioceptive senses. This occurred by making changes in the child's visible frame and placing colored elements such as colored balls and the balls were requested to be collected and placed in the basket along the path to stimulate the children's visual sense. The coach guided the child along the path and told him or her to jump circles drawn on the ground when they arrived them. The final intervention became more advanced by placing colored tires and asking the children to pass through them, simulating the footprints. By passing over the footprints, we expected to stimulate the proprioceptive sense of the children (Fig. 2). The second space included hidden images and interaction with light and shadow. The basic shapes of triangle, circle, and rectangle were created in a tent structure (Fig. 3). The structure was situated in a place where shadows would form under the child's feet with the change in the sun's radiation angle. Then, with the help of the coach, the children were asked to find the shapes, say their names, and fill in the border between light and shadow using colored stones. Geometric shapes similar to shadows were given to the children, and they were asked to match the shapes with the appropriate shadow. The third part of the collaborative landscape (Fig. 4) was designed to stimulate the tactile, vestibular, olfactory, auditory, and visual senses of the children. For this purpose, a water pond with a fountain was placed in the center of the space, and around the pond, there were gardens for planting plants. The space between the water and the gardens was covered with trees at a suitable height. The children were asked to go over the sticks, take water from the pond and then go back over the sticks and water the saplings they planted.According to the reports, the effect of the strategies on children in the types one and three spectrums was different; the children in level three had the most effective interventional sessions in the daily time frame, which resulted in a greater effect on their speech and cognitive performance. According to the reports, level 1 children were not influenced as much as level 3 children due to their better

Table 5. Adaptive strategies between the education of autistic children and Biophilic landscapes according to the created matrices. Source: Authors.

Senses engaged	Adaptive Strategies
Visual	Creating meandering paths and diverse frames of view; creating water reflection on another surface or water imagery; creating ambiguous landscapes using topography and vegetation; creating light and shadow using roofed spaces designed from including tent canopies; designing a simple maze in which the child must find his or her way; and designing landscapes by creating various perspectives.
Auditory	Using various plant species to attract special animals such as birds (such as walnuts and berries that attract birds), water spaces (such as artificial lakes, water ponds, and waterfalls), and water sounds (such as designing a steep path and creating wind sounds with natural wind twists). In addition to the obstacle, affected children are sensitive to louder and quieter sounds, that's why the sound of the wind in nature usually does not stimulate the auditory sense of the affected.
Taste	Collaborative productive landscapes
Olfactory	Plants and flowers with various scents
Tactile	Wind tunnel simulation, fault simulation, creation of mirage, children's connection with animals, textured materials
Vestibular	Designing suspended paths using natural materials such as wood, designing paths where the child must place her hands and feet

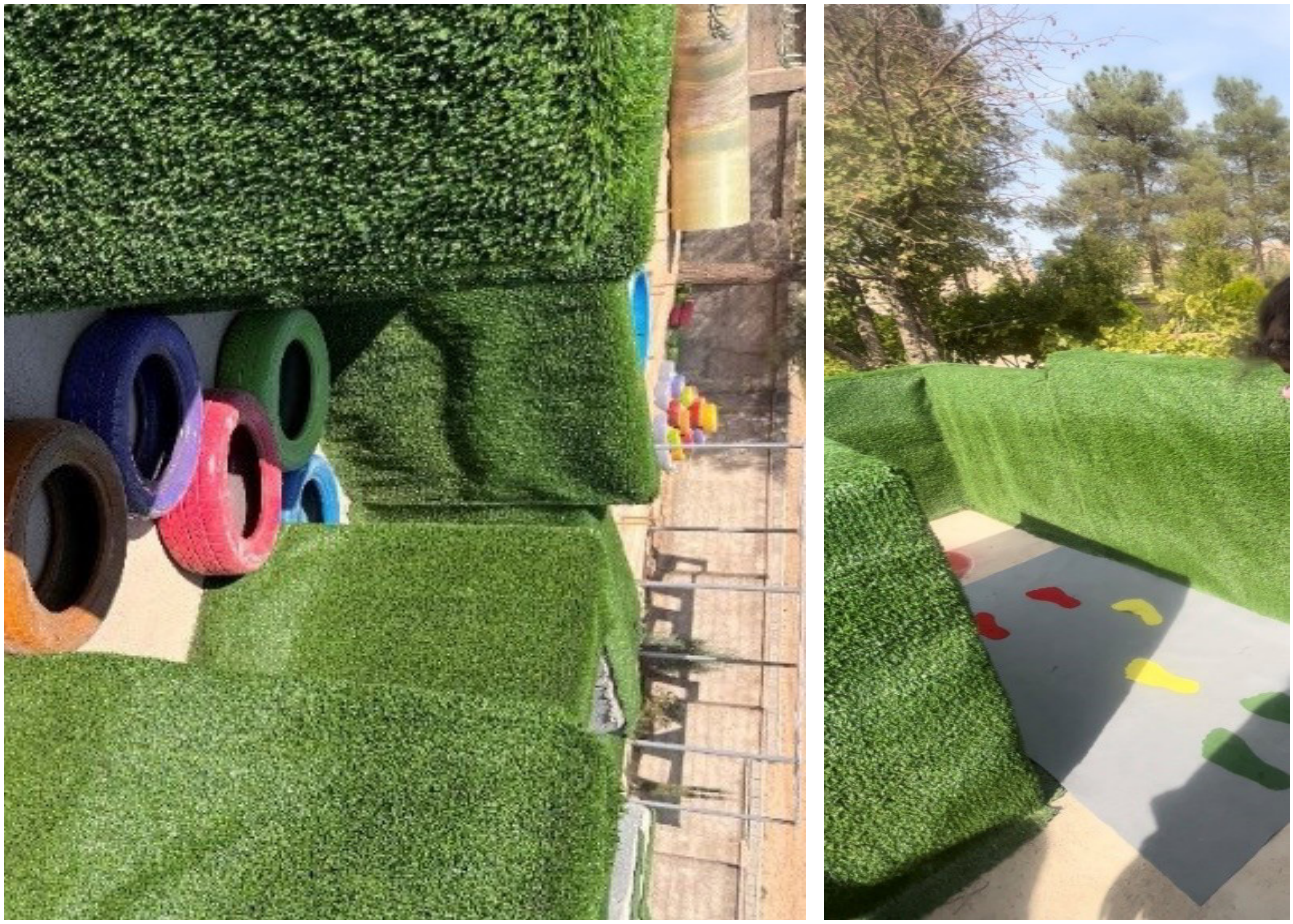

Fig. 2. The maze made for the test. Research. Source: Authors Archive.

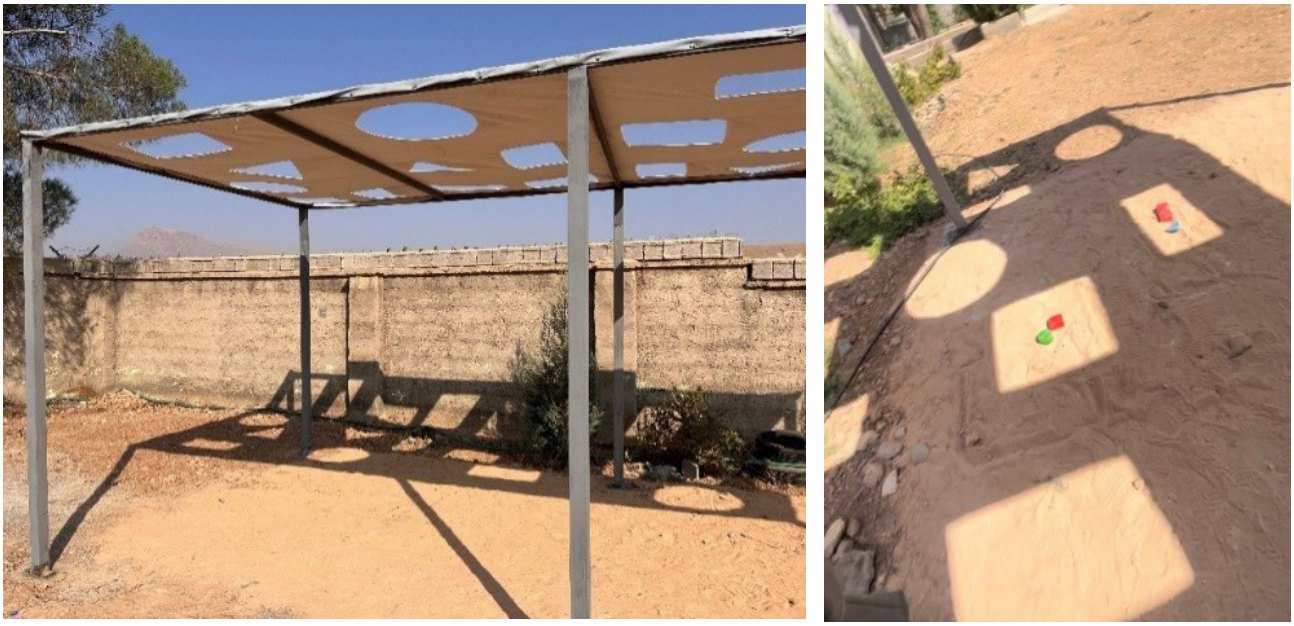

Fig. 3. The tent structure made for the test. Source: Authors Archive.

cognitive performance. In terms of vestibular sense, it was reported that landscape therapy utilizing the element of water was extremely effective for all children on two spectrums by creating a sense of danger and being suspended in the path of Biophilic landscape strategies. This would help children to be quite attentive. According to the observations, the change in levels, such as the play of light and shadow, did not have much effect on the child's performance, and in the spaces where the change was due to the difference in level and volume of the space, the child was more inclined to. In education, the

Fig. 3. Collaborative landscape created for the test. Source: Authors Archive.

sound of water and playing with water disturbed the child's attention. It seems that in the landscape specific to autistic children, the interference of functions with each other leads to the children's distraction. For example, the sound of the fountain in a collaborative scene next to the winding path caused the children not to focus on learning, and the desire to reach the water disturbed the children's senses. According to the examination of pre-test and post-test questionnaires and pairwise comparison of data, for example, in visual processing, according to the ratio of 0. 05 > 0.102, the null hypothesis, which states the educational environment does not affect the visual processing of the interventional group, is accepted. In auditory processing, the ratio of 0.0180. 05 the null hypothesis, which states that the educational environment does not affect the auditory processing of these children, is rejected and the designed educational environment has a positive effect on the children's auditory processing in a meaningful way (Table 6). According to Table 6, the tested strategies have been significantly effective on auditory, vestibular, tactile, multi-sensory, body posture, and movement (vestibular) senses. From research limitations to emphasis on education and effectiveness on the seven primary senses of affected children; however, the global standard Sensory Processing Efficacy Questionnaire addresses 14 factors, including the seven emphasized senses, except for the sense of smell. Moreover, in the report of the interventional sessions, the progress of the child was continuously evaluated, and it was indicated that during the session some of the senses, such as visual and oral were affected, but the questionnaire showed that the intervention did not affect the visual sense. This could be related to the focus on the totality of changes in the two months. In addition, extracted strategies were also assumed to affect the olfactory sense in the sensory processing questionnaire. However, the questionnaire did not include any

Conclusion

The results of the research indicate that the strategies improved auditory, vestibular, tactile, and multiple senses. The strategies affected the senses integrated with body position and movement (vestibular sense), and the integration of other senses with the visual one facilitated emotional processing, activity level, and emotional responses. The proposed strategies did not engage senses such as visual, sensory-oral, and integration of sensory processing related to physical endurance (proprioceptive). They also did not influence senses integrated with activity level affecting movement (proprioceptive) and did not affect the integration of sensory input contributing to response-emotional effects, behavioral consequences of sensory processing, and response thresholds. This could be associated with children's different sensory perceptions. The visual analysis of autistic children's sensory processing reveals that normal people's strategies such as mystery, ambiguity, and exploring the design of Biophilic landscapes are less effective on autistic children. Moreover, the cognitive performance of affected children across the three ranges of disorders should use simple and unambiguous scenes. On the other hand, according to the report of each session of research, autistic children were not affected by changes in color and shape when it came to the visual sense, and the most important factor in changing the external environment that affected their visual sense was the change in volume and tangibleness of such changes. In the design of outdoor spaces for these children, the educational functions should be arranged separately in the space in such a way that stimulating the auditory or visual sense does not arouse their other senses so that the children can complete the education process at any level without distractions. The use of an element such as water should be significant in each function separately and predicted in such a way that even the sound of water in one educational function does not interfere with another educational function; otherwise, it disrupts the learning process. This is contrary to landscape designs for ordinary people for whom water is a key element associated with climatic, instrumental, and aesthetic functions. Moreover, the results indicate the therapeutic landscape for level three autistic children is not effective. The findings show that those who have weaker cognitive performance than others need more sessions and a simpler environment with no ambiguity where different educational functions do not interfere. Future research needs to focus on testing the proposed strategies because the results indicate that the understanding of the environment of autistic children is different, and as a result, the impact of the environment on them is also different.

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Table 6. The effect of the design environment on the senses of autistic children based on the sensory processing questionnaire. Source: Authors.

Significance	The p-value of the designed environment impact test	Factor
0.018<0.05 ✓	0.018	Auditory processing
0.102>0.05 ×	0.102	Visual processing
0.013<0.05 ✓	0.013	Vestibular processing
0.047<0.05	0.047	Tactile processing
0.022<0.05 ✓	0.022	Multisensory processing
0.084>0.05 ×	0.084	Oral sensory processing
0.092>0.05 ×	0.092	Integration of sensory processing related to physical endurance
0.032<0.05 ✓	0.032	Integration of posture and movement
0.067>0.05 ×	0.067	Incorporating activity levels affecting movement
0.128>0.05 ×	0.128	Integration of sensory input affecting emotional responses
0.030<0.05 ✓	0.030	Visual integration affecting emotional processing and activity level
0.046<0.05 ✓	0.046	Emotional and social responses
0.082>0.05 ×	0.082	Behavioral consequences of sensory processing
0.103>0.05 ×	0.103	response thresholds

Endnote

This article is extracted from the master's thesis titled "Designing a Therapeutic Garden for Children with Autism in Shiraz with a Biophilic Approach" by Samar Dami, conducted under the supervision of Dr. Maryam Esmaeeldokht at Hafez Institute of Higher Education in Shiraz.

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