Designing for pupils with the autism spectrum disorder, case study of the Autism Centre in Muroor, Abu Dhabi

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Abstract. The number of diagnosed cases of autism spectrum is increasing. The peculiarity of the perception of the outside world by people with ASD leads to reflection on the impact of architectural solutions on their sensory comfort and the effectiveness of therapy. Leo Kanner was one of the first to speak out about the needs of patients with autism. He said they see a world built from small elements which make up layouts and sequences. The experience acquired under the given conditions will not be accepted when any element is disturbed (Kanner, 1943, p.249). Teams of therapists, neurologists and psychiatrists need a properly prepared infrastructure which will provide stable conditions to work with an autism spectrum student. It is, therefore, necessary to develop benchmarks for the specialised design of new buildings, on the basis of which the existing buildings will be possible to be adapted properly. The article is a case study for the Autism Centre in Muroor in Abu Dhabi designed by Simon Humphrey. The facility was classified as the best suited for people with autism according to the Autism ASPECTS™ developed by Magda Mostafa at the American University of Cairo. The study was based on the opinions of designers. Previous design studies in this area are an important part of the design process and require detailed definitions to be formulated. The basis for careful analysis is the question: what is autism and why we say it is a spectrum. Autism is a triad of disorders that occur in communication, social interactions and stereotypical behavioural patterns. Spectrum refers to the fact that in each affected person, the disorder consists of different mechanisms and causes which are responsible for the developmental difficulties. Sensory sensitivity of people with autism has different faces. It is not possible to develop a universal pattern that will work in any case. The bases of developmental dysfunctions are sensory perception disorders, i.e. hypersensitivity or insensitivity to sound, light, touch or smell. The study shows that an important aspect is the conscious use of the elements that affect these senses. The studies presented in the article concern the assessment of the impact of selected elements shaping the sensory aspects of the internal environment of the building, such as acoustics, lighting, finishing materials, colours, ventilation and visual identification. The evaluation of the building presented in the article is an expert one, and is based on the opinions of specialists working with people with such a spectrum. It was carried out on the basis of archival design and photographic documentation provided by the designer. The result of interdisciplinary cooperation is defining these elements by analysing the solutions used in the Autism Centre special school in the context of their impact on the perception of people with such a spectrum. Certain rules will help to eliminate the erroneous design assumptions. Shaping the space of educational facilities can greatly help in revalidation. Therapeutic and architectural treatments should be aimed at providing an enclave in which the student will be able to achieve the psychophysical comfort.
1. Introduction
Statistics data relating to the diagnosis of children with autism indicate a continuous increase in occurrences of this disorder. Research conducted in the 1970s of the 20th century shows that autism was diagnosed in a group of 0.7-4.0 per 10,000 children [1, 2]. Statistics by the Centres for Disease Control and Prevention show that between 2000 and 2002, autism was diagnosed in 67 out of 10,000 children aged 8 years; after 10 years the number of cases doubled [3]. In view of the above, multidisciplinary teams of researchers study this phenomenon and seek to reduce the negative effects associated with it through an individual approach to each case and the implementation of appropriate treatments. However, this is not enough. Specialists are also looking for measures that will help to increase the attention span and will support the concentration of the student. Perception is crucial in the fight to achieve the best possible results of therapy. We know that it is different for people with autism. While a person with autism experiences unwanted sensory stimulation they enter the mental discomfort zone and stimulate the centre of fear which is responsible for anxiety conditions [4]. Sensory system dysfunctions are most common in hypersensitivity or hyposensitivity to auditory, visual and tactile stimuli. Technology allows research in this regard, but the transfer of its results to practical application is only possible through cooperation with the team involved in the design and adaptation of buildings to be suitable for autistic people. Current design research for people with autism is insufficient and it leaves a lot of questions unanswered. The aim of the work is to determine the impact of individual elements of architecture on the perception of a child with autism by developing a case study [5] for the Autism Centre in Muroor in Abu Dhabi designed by Simon Humphrey. An expert method of research was adopted [6]. The chosen method is justified by appropriate qualifications both in the field of architecture and the therapy for people with autism spectrum. Based on the analysis of the materials provided by the school designer and the proper qualifications in the field, a set of key elements of the building was developed primarily related to acoustics, lighting, finishing materials, colours, ventilation and visual identification. In line with the law on education, a student with autism is a student with special educational needs, thus such a person should have an individual curriculum developed. This is linked to the definition of the spectrum and the diverse level of functioning of children. This is also important in teaching process planning. The objectives contained therein are achievable only through a properly selected learning model. This, in turn, involves choosing the right school conditions in which the child will feel comfortable and will be able to develop. For some children, a mass school is a good solution, but in most cases, it is recommended to place them in specialized facilities. Such a model of education has been adopted for the design of the above mentioned building. It is a school focused on educating children with classic symptoms of autism. Small classes are introduced, the size and method of teaching of which is adapted to their individual needs. However, when designing we can go one step further, we have an impact on the creation of the environment in which the educational process takes place. It is possible to adapt not only the learning path, but also all elements that have a potential impact on the concentration of the child's attention.

2. Case study of the Autism Centre in Muroor, Abu Dhabi

2.1. About the architect of the building
The building was designed by architect Simon Humphrey, whose brother had been diagnosed with autism. Based on his behaviour, he developed his theory of autistic people-friendly design. The architect in his research seeks a link between the natural passion for the order and immutability manifested by people with autism, and the ascetic architectural form of buildings. Based on the thoughts of the classics of medieval architecture and Mies van der Rohe, Le Corbusier, John Pawson, Hans Van Der Laan, he created a set of guidelines for the design. They are based on values visible above all such as harmony, containment, perception, proxemics, restraint. He presented his work entitled "Autism & Architecture" at a conference hosted by Lorne [7].
2.2. Functional program of the building

The building was designed for 120 students between the ages of 4 and 17. The facility is a building which occupies the whole quarter in the very centre of Abu Dhabi. It is surrounded on every side by a road. The entrance zone and the entrance and exit from the underground car park are located on the western façade of the building. The building is surrounded by a monolithic fence and takes the form of a cuboid sheltered on each side with a pane of milk glass dissipating the sun's rays. The main entrance zone to the building is withdrawn. The building has 4 floors including one partially underground in which there is not only a parking lot, but also a gym and a swimming pool as in Figure 1. The rooms in the central shaft of the building are kitchen and warehouses. The distribution of meals is carried out by means of independent vertical communication.

On the ground floor, there is the main entrance to the building, which is located on the same axis as the centrally separated shaft of vertical communication. Functions that can potentially be a source of noise e.g. hydrotherapy, physiotherapy on the first floor, canteen on the second, theatre hall on the third floor, form a structurally separate core. The access there is only provided by four staircases in the surrounding ring, which is available to students of younger classes studying on the ground floor. The nursery and kindergarten are located directly at the entrance to the building, on the right. Then there is the corridor of unusual shape from which the classrooms of the primary school classes are accessible. On the left, there is the medical zone and classrooms for older children. The above functional layout is shown in Figure 2. Each class has a separate exit to the outside and a separate zone from which there is an access to the fenced terrace.
The second floor has a similar structure. Classes for children under the age of 17 are located on the right and left side of the building. Above the nursery and kindergarten, there is an administrative zone containing, among other things, the head-teacher office and masjid. On the opposite side, above the medical zone, there are music therapy offices, art therapy and speech therapy offices. The "escape room" is available from the hallway for silence. Access to the canteen shaft is provided by bridges located directly at two staircases, Figure 3. On the third floor, there is a theatre room, which together with the surrounding communication ring is extended above the roof of the building.
2.3. Studies of the impact of building architecture elements on the perception of a person with autism

The Autism Centre in Muroor was classified as the best suited for people with autism according to Autism ASPECTs™ developed by Magda Mostafa at the American University of Cairo. The study was based on the opinion of the designer [8]. Leo Kanner was one of the first to speak out about the needs of patients with autism. He said they see a world built from small elements which make up layouts and sequences. The experience acquired under the given conditions will not be accepted when any element is disturbed. The aim of the research was to determine the impact of the individual architectural elements of the special school in Abu Dhabi on the perception of a child with hypersensitivity and hyposensitivity; visual, auditory, tactile. The table was based on the response of autism therapists. There were two response options possible: „+” the element has a potentially positive impact on the child, „-” the element has a negative impact and causes many problems with the attention of the pupil.

| ELEMENTS                      | VISUAL | AUDITORY | TACTILE |
|-------------------------------|--------|----------|---------|
| Functional structure         | -      | +        | +       |
| Internal communication system | +      | +        | +       | -       | +       |
| Vertical communication system | +      | +        | -       | +       | -       | +       |
| Location of classrooms       | +      | +        | +       | +       | +       |
| Shape of corridors           | +      | +        | +       | +       | +       |
| Classroom entrance zone      | +      | +        | +       | +       | +       |
| Materials:                   |        |          |         |         |         |
| floors                       | +      | +        | +       | +       | +       |
| walls                        | +      | +        | +       | +       | +       |
| Lighting                     |        |          |         |         |         |
| natural                      | +      | +        | +       | +       |
| artificial                   | +      | -        | +       | -       |
| skylight                     | +      | +/-      | +       | +/-     |
| Colours                      | -      | +        |         |         |         |
| Visual identification        | -      | +        |         |         |         |

1 - insensitivity, 2 - hypersensitivity.

3. Results and discussions

So far, it has not been possible to establish a typical sensory profile for autism. Irregularities related to perception vary in severity and should be approached individually on a case-by-case basis [9]. The studies concern the assessment of the impact of selected elements shaping the sensory aspects of the internal environment of the building. The analysis shows the design trend in which it is possible to achieve the right balance between the individual elements of the buildings and their functionality. The architect has used a number of solutions which help students with autism achieve the peace and balance necessary to improve cognitive abilities. Children with other disorders may have problems with a sense of direction, thus it would be beneficial to introduce a system of visual identification for individual sectors. The use of the above solutions is beneficial mainly for people with ASD with a classic profile of developmental dysfunctions. Such prepared working environment allows for the control of the intensity of stimuli on the part of both therapists and students. The research by University of California doctors shows that sensory therapy, based on stimulating two sensory systems interchangeably, brings noticeable improvements. [4] Reducing the negative impact of individual building elements on the perception of a group of people with autism may be key to drawing up design guidelines.
Table 2. Conclusions from Table 1

| BUILDING ELEMENTS                                | IMPACT ON PERCEPTION                                                                 |
|--------------------------------------------------|---------------------------------------------------------------------------------------|
| Functional structure                             | The use of a symmetrical system is very beneficial for hypersensitive people, it creates the impression of constancy, order and immutability. |
| Internal communication system                    | The divisions resulting from the division into zones have a positive impact on the movement of pupils in the building and their sense of direction while in the building. |
| Vertical communication system                    | Multiplying the number of access paths to the main communication passage reduces the possibility for more students to gather in one place. The solution suggested shortens the path between points and supports a sense of direction. |
| Location of classrooms in the layout of the building | Classrooms are separated by a double corridor from the shaft with additional functions which are necessary for any school but they can generate uncontrolled noise and the spread of intense odours. |
| Shape of corridors                                | It reduces reverberation by limiting the possibility of self-stimulation for aurally hyposensitive people. In addition, it gives the opportunity to take refuge in the recesses of the corridor or to calm down in adjacent “escape rooms”. |
| Classroom entrance zone                           | In front of the classroom, there is a prefield that prevents congestion and gives the possibility to calm down before entering the class. In addition, it does not lead directly to the classroom, only to the hallway; people entering the classroom during the lesson do not generate noise. |
| Materials:                                        |                                                                                       |
| floors                                           | Light and sound-absorbing material is especially beneficial for sensory hypersensitive people. |
| walls                                            | Both stone texture of walls and its physical properties are beneficial for hypersensitive people. It limits the possibility of self-stimulation (e.g. echo) for aurally hyposensitive people. |
| Lighting                                          |                                                                                       |
| natural                                          | Beneficial for hypersensitive people, does not distract them by its buzz.              |
| artificial                                       | Unfavourable for people with hypersensitivity; flickering and sounds.                  |
| skylight                                         | Objects that appear unexpectedly in the sky and shadows they cast can distract people with hypersensitivity to stimuli. |
| Colours                                           |                                                                                       |
| Visual identification                             | Lack of visual identification is unfavourable for hyposensitive people as they can have problems with a sense of direction. |

4. Conclusions
The structure of the external environment significantly improves the functioning of human life. A child with autism spends most of his or her time in spaces that are not adapted to their perception of the world. Everywhere, they are bombarded with sensory stimuli; in public spaces, shopping malls,
even in the home environment. The school as a building should generate associations with a safe, sensory-friendly place and create special conditions in which the child will be able to acquire new skills. Certain rules will help eliminate erroneous design assumptions. It can be achieved by providing a calm and simple aesthetic. It is important to limit the details, use natural lighting, neutral colours and non-reflective textures. This kind of shaping the space of educational facilities for autism pupils can greatly help in the revalidation process.

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