THE EFFECT OF INTEGRATING THE DESIGN OF THE BUILT ENVIRONMENT WITH NEUROSCIENCE ON DESIGNING LEARNING ENVIRONMENTS FOR CHILDREN IN EARLY CHILDHOOD

أثر دمج تصميم البيئة المبنية مع علم الأعصاب في تصميم بيئات التعلم للأطفال في مرحله الطفولة المبكرة

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-- Paper Extracted from Thesis –

ABSTRACT

This study focuses on the interrelationship between architecture and neuroscience to form better built environment for children in early childhood as well as investigating its impact on their educational environment in kindergartens and nurseries. The research commits to theoretical approach in understanding how the designed architectural environment affects stress, emotions and memory according to the age group in terms of memories, dimensions, focus and learning abilities. The research carried out analytical approach and comparative analysis of kindergarten and nurseries. Through research it was discovered that the brain is constantly being reshaped by the environments in which children live. Where the study of neuroscience contributed to understanding how the brain, sensations and cognition affect all children's physical activities and thus their behavior and emotions. Where perception forms memory through the use of the senses. What children encounter in their built environments ultimately influences their behavior, and as a result a new field of design has emerged called neuro-Architecture.

KEYWORDS

Neuroarchitecture; Spatial Environment; Neuroscience; Learning Environments;

الملخص

تهدف الدراسة البحثية الى القاء الدور على الترابط بين العمارة وعلم الأعصاب لتكوين البيئة المكانية المناسبة للأطفال فى مرحله الطفولة المبكرة وتأثيرها على البيئة التعليمية الخاصة بهم فى الحضانات. يعتمد البحث على الدراسات النظرية في فهم كيفية تأثير البيئة المعمارية المصممة على العمليات المرتبطة بالتوتر والعاطفة والذاكرة وفقا للفئه العمرية من حيث الذكريات والأبعاد والتركيز وقدرات التعلم، والدراسات التحليلية من خلال التحليل والتحليل المقارن للحضانات. ومن خلال البحث تم اكتشاف أن الدماغ يعاد تشكيلها باستمرار من خلال البيئات التى يعيش فيها الأطفال. حيث ساهمت دراسة علم الأعصاب فى فهم كيفية تأثير الدماغ، الأحساس والأدراك على جميع أنشطه الأطفال الجسدية وبالتالي على سلوكهم وعواطفهم. حيث يشكل الأدراك الذاكرة وذلك من خلال استخدام الحواس. ما يواجه الأطفال فى بيئاتهم المبنية يؤثر فى النهاية على سلوكياتهم، ونتيجة لذلك ظهر مجال جديد فى التصميم يسمى "الهندسة المعمارية العصبية".

الكلمات المفتاحية

العمارة العصبية؛ البيئة المكانية؛ علم الأعصاب؛ بيئات التعلم

1. INTRODUCTION

As children in early childhood starts to explore, interact and experience different modes like playing and learning in built environments and learning environments in particular which has a unique set of spatial characteristics for such environment. The WHO has calculated that we are awake between 80% and 90% of the time, which is why it is so important that our emotional and physical health is taken into account when designing these places (World Health Organization).

This research will attempt to highlight the importance of interdisciplinary integration between neurosciences and architecture to produce better spatial design that will provide better experiences for children in learning environments. Spending a lot of time in these environments is a crucial factor for child to develop, generate their own understanding for spatial recognition, perception and linking built environment with emotions and cognition. Neurosciences have come to understand brain, also its impact on the environment, neuroscientists work with architecture Designers on their ideas and designs for environments that will allow humans to fully embrace these environments. (Gage, 2018).

With the advances of neurosciences studies and its concern about self-perception, personal behaviors and other related elements, it is important to conceptualize the key elements that should be utilized in designing built environments and its impact on learning environments and child development in early childhood.

The relationship between the brain and architectural design is surprisingly strong, since the brain controls our behavior; Genes drive the blueprints of the brain's design and structure; The environment can can control the functions of the genes, and then the structure of the brain changes; Changes in the environment affect the brain; As a result, so changes in the environment changes in behavior; and therefore, our brains and our behavior can change through architectural design. (Paiva, 2019).

Although many studies highlighted the basis of integration between neurosciences and architecture in several building types, limited studies were concerned about learning environments for children in early childhood and how this integration will have a significant effect on child’s self-perception, spatial recognition and development in such learning environments.

RESEARCH OBJECTIVES

The main objective of this research is to study the important relationship between the built environment and neurosciences and its impact on the learning environments of children (2-7 years old), which is the age of early childhood.

RESEARCH PROBLEM

Lack of integration between neuroscience and built environment in the design of early childhood learning environments, which have not been clearly used as well as the lack of comprehensive studies in this regard.

RESEARCH HYPOTHESIS

Designing early childhood learning environments is important and has a significant impact on children's development at this stage as designing these spaces according to neuroscience standards and indicators will provide better experience and environments for children in early childhood stages.

RESEARCH METHODOLOGY

- The research work in this study was organized into three main research tasks aimed at achieving the research objectives as follows:
- Contextualization: Theoretical investigation of the basics of neuroscience and its relationship to neural structure and built environments.

- Analytical approach: analysis and comparative analysis of nurseries projects
- Synthesis: This stage includes extracting the results of the research to understand the neural architecture.

2. NEUROSCIENCE: OVERVIEW

Neuroscience is interested in studying the human nervous system and the brain, which is the biological basis of awareness, cognition, memory and learning. The lower part of the brain which controls the basic motor sensory functions, the medium part of the brain which controls memory and emotions, the anterior brain is associated with the higher brain functions such as thought, language, intelligence, knowledge and work.

The brain is the control center of our bodies that allows us to perceive the world around us and interact with internal and external stimuli. Neurology concerned about studying the nervous system and how the processes of awareness, perception, memory and learning are carried out and how the brain can control all our physical and mental activities and then their impact on our behavior (Brown, 2016)

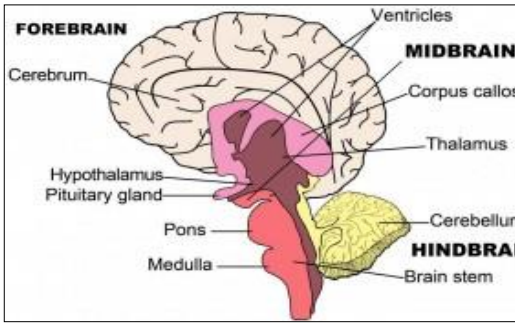

Figure 1: The structure of the human brain (source: Sushil Humagain, 2018)

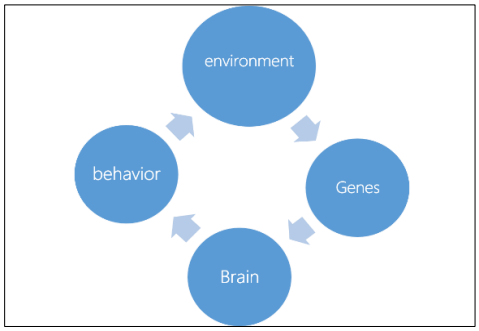

Figure 2 : The mutual effect between the built environment and neuroscience (source: Author, 2021)

Human brain systems the human brain consists of two systems, the first works at the subconscious level, which is fast thinking, while the second system operates at the conscious level, which is slow thinking. The environment affects the first brain system by up to 99% in relation to the second brain system system (Figure 4). It affects the subconscious mind without the awareness of the conscious mind. (Psychol,2018).

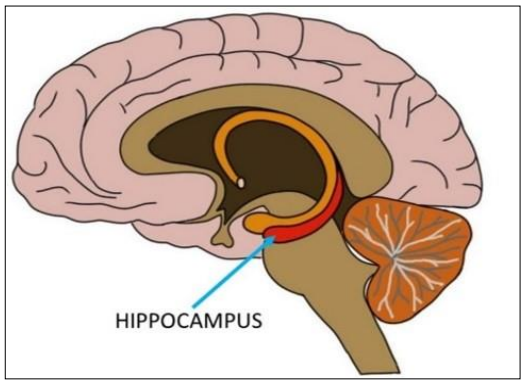

Figure 3: Illustration of the hippocampus (source: neuroscientific challenge, 2014)

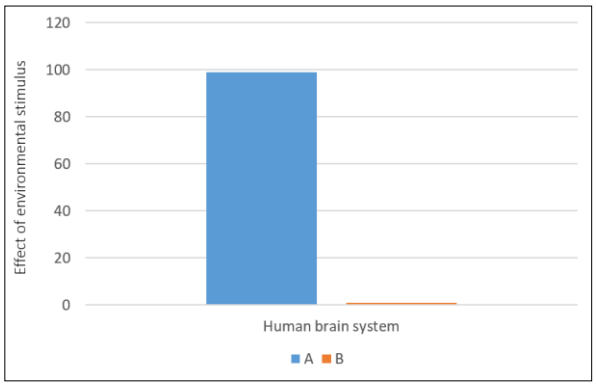

Figure 4: The difference between brain systems in relation to the built environment. (Authors,2021)

Perception this is how people trace their relationship to the surrounding world, and direct their experiences with objects to understand and discover both our physical environment and the world (Ruiz, 2015). It encourages them to think and understand the relationships that have developed with their surroundings through their experiences (Shemesh, et al, 2015). Human perception changes as we move in different

environments. Neurons that respond to a sense of place are more than the organs of our senses. Multisensory perception includes memory, visual, emotional, and touch experiences, all of which influence human behavior and reactions and encourage us to think and understand the relationships with our environment created by our perceptual experiences.

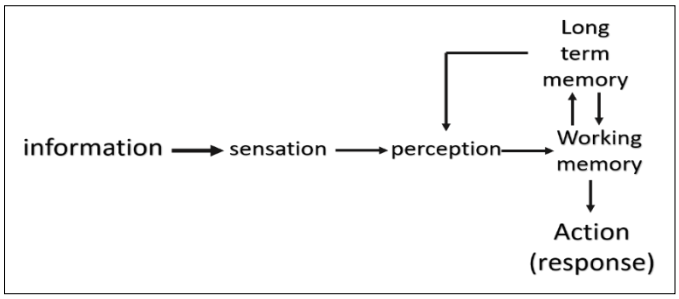

Figure 5: An illustration of the perception process in the human brain (Source: Mikayla Ferlaino,2019)

Memory differs from cognition in that the event does not occur in the present. Memory is the way we create place and identity in the world, but cognition is the way we see the world (Kirkbride, 2008). Memory is important in decision-making, evaluation, interaction, emotions, and movement, as it allows the accumulation of knowledge and the ability to remember faces, events, places and things. Neuroscience has demonstrated that memory has key insights regarding the formation, storage, and recall of information. To understand the function of memory in neural architecture, research has found that the area of the brain associated with memory from an architecture point of view is the hippocampus. Hippocampus responsible for identifying and analyzing inputs and information that serve long-term memory (Epstein et al., 1999).

Emotion is used to describe a wide range of phenomena, including moods, feelings, anger, and feelings. These phenomena occur as a result of a sensory experience triggered by a specific subject, space, or event. Emotion is defined by neurological theories as: an activity that is fundamental to human nature through which we share or perceive the world, and activity within the brain leads to responses such as emotional responses, moods and feelings are all examples of affective states. Emotions can be elicited by an event within the environment or a change within ourselves, such as memories (Ekman, Paul. Et al, 1994).

3. NEUROARCHITECTURE

Neuroarchitecture is defined as the application of neuroscience in built environment with the aim of better understanding the effects of architecture on the human brain and behavior (Andrea Pavia, 2018). Neuroarchitecture broadens the field of research on the relationship between built environments and the target user group and improves understanding of various messages conveyed by the environment, including those at less conscious levels of perception. (Eberhard, 2008).

The contributions of neuroscience, which allow a more complete understanding of the functioning of the brain and the physiological reactions of the organism when exposed to environmental stimuli, are one of the most significant differences between Neuroarchitecture and Environmental Psychology. In this sense, it is possible to say that Neuroarchitecture encompasses Environmental Psychology as well, but it goes further by involving studies on the nervous system, the endocrine system, and the immune system, for example.

According to Samarzija in his research paper in 2018, the real beginnings of neuroarchitecture was when The Academy of Neuroscience for Architecture (ANFA) was founded back in 2003

By architect John Eberhard. Eberhard eventually was interested in studying interdisciplinary approaches to architecture. These studies led to his collaboration his colleague, neuroscientist Fred Gage. They

collaborated on a mouse experiment to demonstrate how different environments can affect on our brain and change it. Their reflections sparked widespread interest and research by neuroscientists and architects.

At first, architecture and neurosciences may be perceived as non-intersecting disciplines with totally different paths, but in fact they did have many parameters and backgrounds in common, Cities and buildings are where people spend most of their lives, people grow, develop, interact, socialize, learn and work with others. They interact and shape their perception, and the built environment and the experiences they have in their have a direct impact on their choices and behavior (Paiva, 2019).

According to Eberhard, architecture has the greatest impact when the designs used in buildings reflect the understanding of how the brain reacts in various environments. Neuroscientists can assist Designers in scientifically understanding.

Fred Gage also notes that in their understanding of the brain and how the environment affects it, neuroscientists have reached a point where neuroscientists can work with architects on their designs of environments that will allow people to be in those environments to function.

Neuroarchitecture is located where neurology, psychology and architecture intersect to provide an empirical framework to create better environments that leads to improve human behavior, overall health and leisure. Architects realize that their designs for spaces directly affects users of these spaces as well as knowing the effects of light, color on users' spatial perception. As a result, neuroarchitecture takes a step further in explaining how architecture-designed environments affects our overall behavior in order to optimize the design process and providing high quality experiences for users.

Being that important, designing learning environments for such fundamental stage like early childhood for children should have a significant impact on children in this built environment and leads to improve their well-being, learning experience and overall development.

While environmental behavior was examined alongside observation of the brain influenced by the environment, the scope was broadened, which now includes the concepts of location, personalization, territory, and path-finding. (John Zeisel, 2006).

- Place: when space is defined as "place" and takes on additional meaning for the user, the term ends up in the research area of cognitive neuroscience, where spatial neurons rely on a strong sense of direction within the environment and different in environments different patterns of neural activity intervene. Because the activity of these neurons determines our "sense of place," understanding the factors that influence them can help explain how architectural design elements influence us (John Eberhard, 2008).

-Personalization: Getting involved in a place, connects with memory signals (Cagil Kayan, 2011).

-Territory: Expansion of the family zone in which one feels safe. Where it connects to the brain (Cagil Kayan, 2011).

-Wayfinding: Spiritual and physical activities that help us find our way between places and territories.

People are more aware of their surroundings when they are looking at them. (Cagil Kayan, 2011).

Human feel environment with all of the body through all senses - seeing, listening, smelling, touching, and in the case of young children also through taste. Each of the senses has a role in the realization of the experience of nature, and therefore the built environment must all be nourished by it. Senses operate simultaneously and in connection with each other within the environment. Forgetting a single sensory experience in design can ruin an entire space, our senses have evolved over time in the building environment (Jokinemi, Jukka, 2007). Today, sight has become the primary meaning in terms of access to information, it is through vision that one gets an accurate picture of the environment. On the other hand, hearing and smell are passive senses but are more emotional and usually attract more attention. Affective senses elicit different kinds of feelings, more sensitively than visual experiences, (Virtanen, Ann, 2000) In addition to

seeing, hearing and smelling, we also sense the space around us by touching it. Touch is our most intimate sense. All senses must be given equal attention, so that the spatial experience can create spaces that nourish all the comfortable and healthy sensory senses.

As for the visual response, it is the most important sense from the point of view of architectural design because it is the process by which we realize the objects, colors, lighting and tactile swing, it is always moving and captures all the details of the surrounding built environment of dimensions, shapes and other elements.

We can say that the field of neuroscience affects architectural design and therefore affects users their nervous and psychological system and thus affects their behavior so that the relationship between the two fields becomes a mutual relationship

4. INTERDISCIPLINARY STUDIES

Neurologists' studies how people react differently towards different environments in order to provide better explanations for correlation between built environment and human behavior (Eberhard, 2008). Self-perception differs based on human age, memories and overall health. Our brains are continuously stimulated by what we see, experience and link specific memories with particular places.

The most important contribution of the collaboration between neuroscience and architecture is to create an understanding not only of conscious tendencies but also of subconscious and unconscious tendencies of man, innate, idiosyncratic and inherited from our evolutionary past. (Karakas et al., 2020).

As a result, it is recommended to provide better integration in neuroarchitecture in order to achieve optimized responses and improved behavior and mitigate undesired circumstances as well. According to figure 6, neurotransmitters in the human brain have specific chemical structures that can be unlocked based on different experiences.
Understanding, among other things, the survival instinct, emotions, and brain plasticity will make architec ture an even more effective tool for behaviour change.

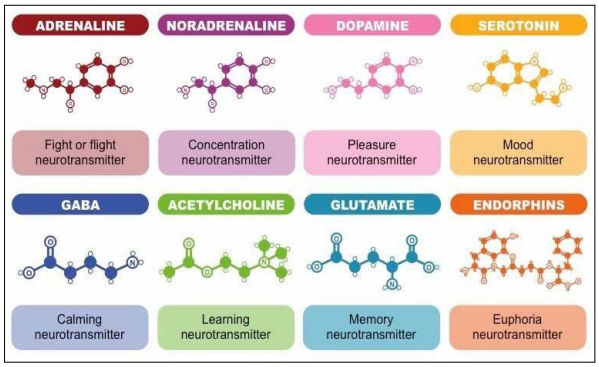

Figure 6: Chemical Structures of Neurotransmitter (Source: Compound Interest,2015)

Brain stimuli with enriched environment have been demonstrated through experiments on rats kept in different environments. A group of them were sorted into three different environments, enriched environment, standard environment, and impoverished environment, all rats had the same conditions in terms of access to food and similar lighting, for the enriched environment is the environment in which things were provided for climbing and exploration. Environmental elements were changed two to three times a week to provide renewal and challenge; The frequent replacement of things within the enriched environment was an essential element, as for the other environments, 3 rats were placed in a small cage without exploration or renewal tools. After 30 days in their environments, the results clearly indicated that

rats that are kept in enriched environments, have more brain cells - more intelligent compared to those who live in normal conditions (Figure 7).

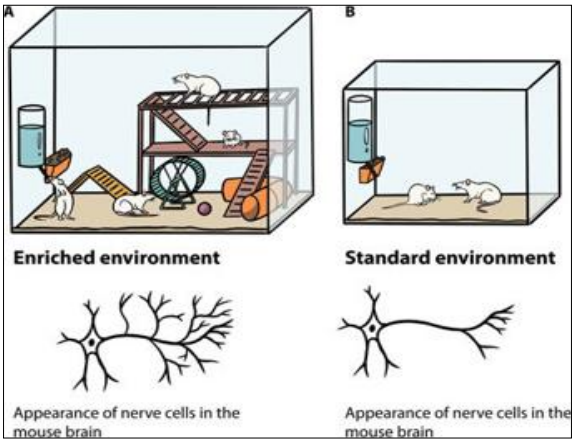

Figure 7: an illustration of an experiment on mice preserved in different environments. (Source: Sara Vive, et al, 2020)

5. LEARNING ENVIRONMENTS FOR EARLY CHILDHOOD

Early childhood projects and developments especially educational ones requires particular attention, according to Maria Montessori, first years of education in child's life are the most important ones in shaping their personalities and self-recognition. Children are different that adults in that regard as they absorb knowledge using their senses as first impressions leaves a wider effect on their personalities way more than adults. Not only that but also it contributes shaping his perception using built environment around him all the time. (Montessori, 1949).

Children in early childhood acquire information through movement, and once children realize that they are able to move, they do move in order to be able to develop their own perception for environment as well as spatial recognition (Gibson, 1979). Neuroscience community praised Maria Montessori's studies of how environments directly affect children's perception. Montessori discovered that a child's brain divided into two stages during early childhood: the unconscious absorbent mind (0 to 3 years old) and the conscious absorbent mind (3 to 6 years old). This theory asserts that a child absorbs everything from the environment in which they find themselves from birth. This is why it is critical to design appropriate spaces for them. If we prepare an educational environment, it must be commensurate with the child's dimensions, strengths and psychological abilities, and if we allow them to live freely, we will have taken a huge step towards solving the educational problem, because we will give the child his environment (Montessori, 1929). A child who is raised in an environment suitable for him from birth produces more positive brain responses. Children who are raised in environments that positively stimulate their brains have some good characteristics such as being faster learners, more focused and more motivated.

In order to understand the effects of the built environment on children, all aspects of healthy child brain development must be understood (Dunn 2012). The domains of child development were established as follows: social knowledge, Emotional development and maturity, Language development, Cognitive development, Healthy physical development and communication skills. Data from these domains focus on aspects of children's development from a neuroscientist point of view. For this reason, Dunn explained the studies conducted in Vancouver, namely, the effect of surrounding environments on children's ability to learn (Oliver et al. 2007).

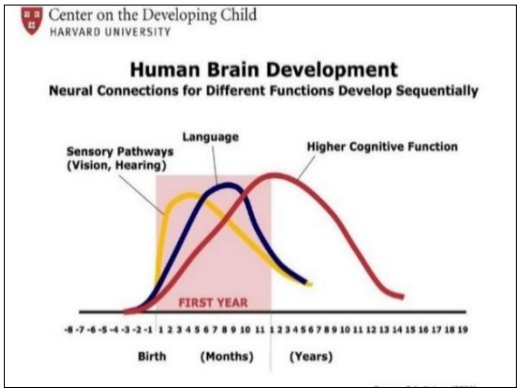

Figure 8: Children's Brain Development (Source: Nelson 2000)

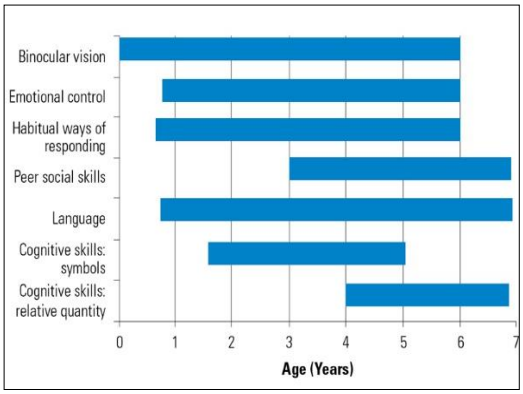

Figure 9: Sensitive periods for different areas of healthy child development (source: Dunn ,2012)

It is noticeable that implementing neuroarchitecture approaches on the spaces of the educational environment and according to the Academy of Neuroscience of Architecture there are many parameters that should be considered when designing educational spaces such as alertness, focus, attention, the formation of new neurons, and finally stress reduction.

Also, senses have a great influence and role on the design spaces of the educational environment for children, as they are important and influential factors such as: sight, smell, hearing and touch.

Sight and vision: It is important to consider the colors and lighting around him. Light and pastel colors create a calmer and more peaceful environment, whereas warm, strong colors may encourage children to be more energetic than usual. It is preferable to use natural light in children's classrooms and learning spaces, but adequate artificial lighting must also be provided to keep the child active and focused. According to studies, better-lit classrooms improve learning by up to 20%. Spatial organization, a key component of neuroarchitecture, contributes significantly to improving the visual aspect of the environment. (Audrey Migliani, 2020).

Touch: The ability to touch objects is very important for children (especially in early childhood). Children's development is greatly aided by their ability to feel the textures and temperatures of various objects. To that end, it is advised to create an environment with a touchable texture (Audrey Migliani,2020).

Hearing: With regard to the development of children's hearing, it is necessary to treat two factors: music and silence. There are many studies that prove the effects of classical music in learning development and also in early childhood however, silence is necessary to ensure greatest level of understanding in children's environment. The best is the balance between the presence and absence of sound.

Smell: Olfactory memory is widely discussed because it is the most powerful type of memory in the human brain. As a result, it is critical to consider the smells of the environment, which may become part of children's olfactory memory in the future. Indoor plants could be a better way to improve sense of smell. Also, improving relaxation.

Playgrounds are one of the most important design factors that influence these senses as an integral part of the design of childcare centers. It gives children excellent visual contact and freedom of movement from the inside out (Gary T. Moore and others,1996), gives children the ability to touch different materials, and helps the child develop their senses and thus better develop their skills.

In 2016, an empirical and analytical study was launched in Darmstadt, Germany (Marianne et al, 2017) with the primary goal of involving children in the design of active learning environments. The first step was to collect a series of interactions and data collection methods to gain a more detailed empirical basis on students' perception and use of learning spaces. With this in mind, the researchers created and developed

a prototype toolbox that includes Design for Health information for teachers and students, interview materials, and a fun mobile application.

Table 1: Spatial categories and explanation text (source: Marianne, et al, 2017)

Category	Explanation text
Relaxing	I feel that I relax in this place. I can rest without worries.
Physical activity is permitted.	I'm able to move around and be active here.
My favorite place	I really like it here. I can do a lot here, and I'm always at ease doing it.
Good place to study/learn	I can always study well and comfortably here.
A place I dislike	I'm not at ease or comfortable here.

Spaces have been classified using the same approach, based on the six basic aspects of environmental and behavioral experience. It is being presented to children in the form of a mobile application, which provides a fun experience through free navigation and images of the spaces. Following that, the use of digital technology demonstrated some advantages in assisting designers in analyzing children's perceptions of their learning environment. The process was rated as enjoyable and positive by the children. The final step is a workshop in which children are encouraged to share their ideas and opinions through drawings and paintings. The goal of this step is to learn what the child wants to achieve and, on that basis, to change the spaces and make the modifications they suggested.

Figure 10: Screenshot of the mobile application. Translation: "How would you describe this environment?" (Source: Marianne, et al,2017)

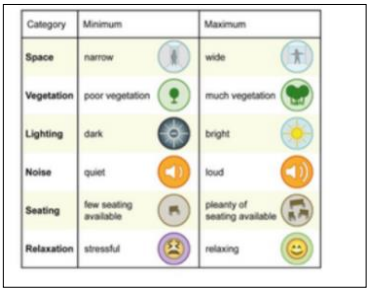

Figure 11The six polar adjectives that describe environmental and behavioral experiences in English, as well as their representation as stickers (source: Marianne et al, 2017).

Figure 12: Collages made by participants to describe their vision of what they want to change or use (source: Marianne, et al,2017).

Initial results of the study focused on the importance of getting the children involved in evaluating learning environment and facility during design stage and post occupancy as well.

6. CASE STUDY

The criterion of the study focuses on children in early childhood stage which starts from being baby born until enrollment in school (2-7 years). According to neuroscience and psychological approach, Child activity in this stage is mainly shaped through motor skills as well as sensory ones. (Moore, 1978) As every child gets affected by built environment through his senses.

This study focuses on classroom design as the classroom is considered as one of the most important spaces that contributes to child's education, especially as children spend majority of their childhood in the classrooms and its adjacent spaces. With this said, it is very important to think about how classes are designed.

Environmental psychologist Ann Taylor's primary concern has been the experience of the traditional classroom, which focuses on the teacher and does not provide areas for self-exploration. She denounces the lack of a relationship between the physical design of the classroom and the information to be taught to children. It has been outlined in research (Olds, 1979) that differences in floor and ceiling heights, lighting, building materials, and lighting increase the child's sense of comfort in the classroom.

DS Nursery in Japan

An educational building for children in early childhood or pre-school period. the Nursery area =1464 m², located in Ibaraki, Japan.

The building was designed with inclusivity and considering psychological aspects as well as the study of the child's brain and how it gets stimulated all are solid motivations for this project during design stage.

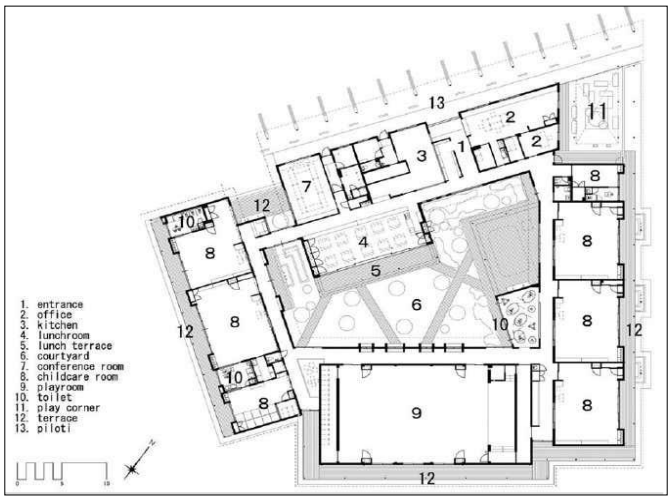

Figure 13: plan show all rooms around the central garden (source: Bauhaus Studio)

The fan layout of the building created different levels of spatial independence, in addition to natural sunlight and ventilation which were also provided by opening high-sided windows from classrooms, playrooms, corridors and even in the children's toilet to avoid creating spaces where children were afraid to go alone. The toilets are partitioned to provide optimum levels of privacy, so this space is as sunny and pleasant as the rest of the building.

The nursery is designed where the green yard can be seen and accessed from any space and planned as a place where children play and discover the plants and green areas. The deep windows are designed to create seating shelters between the outdoors and the corridors that connect the classrooms to the office and toilets. This building is designed so that all its spaces are connected with nature and can be accessed through the classrooms directly.

Figure 14: The central courtyard connecting the spaces. (Source: Studio Bauhaus)

Figure 15: Access to the outdoors is provided by various elements such as window seats along the corridor. (Source: Studio Bauhaus)

Educational spaces contain a variety of spaces, colors and diversity in materials to stimulate all children's senses. For example, a black plate was painted on the walls of the games room to allow children to draw directly on it, as these different combinations inspire creativity for children, and light colors such as white were also used.

Figure 6: Surfaces with different textures inspire creativity (source: studio Bauhaus)

Figure 7: An illustration of the seasons and the strong relationship between indoor and outdoor spaces (source: studio Bauhaus)

Conclusion:

Sight and vision: The colors and lighting around the child were taken into account. The educational spaces contain light colors such as white to create a calmer environment, while strong colors are used in some other spaces to encourage children to be more active.

Using natural light in classrooms and learning spaces, while providing appropriate artificial lighting to keep the child active and focused.

And also, the design of a courtyard to create a visual link between the interior and the exterior, linking all educational spaces, classrooms, corridors, and between natural spaces.

Touch: Creating a tactile environment through different materials such as: creating special rooms for drawing on the walls, these different martials inspire creativity for children.

Hearing: The design did nothing about developing children's hearing.

Smell: A green courtyard was designed to be filled with different structures that children can access from all spaces and can be accessed directly from the classrooms. Taking into account the smells of the environment is important because it will become a part of children's smell memory in the future.

Farming kindergarten in Vietnam

Farming kindergarten is an educational building for children, Located in Dong Nia, Vietnam. Area of the Site = 10,650m2 , And GFA = 3,800m2

The building has been designed as a continuous green roof, providing a food and agricultural experience for children, in addition to a wide playground in the sky. The green roof is a triangular shape drawn with one stroke, and surrounds three courtyards inside as safe playgrounds characterized by openness and transparency across various spaces. With the roof lowered into the courtyard, it provides access to the upper floor and the vegetable gardens at the top - a place where children learn the importance of planting and restore contact with nature. The building consists of a continuous narrow strip with two operable side windows maximizing cross ventilation and natural lighting.

Figure 8: View of an interior courtyard (source: Dezeen, 2014)

Figure 9: view of the nursery from the outside (source: Dezeen, 2014)

All the spaces of the nursery are directly connected to the courtyards and contain a good amount of natural lighting. The educational spaces also consider providing light colors, but this project does not depend on the diversity in the educational spaces for the classes, the diversity only in the courtyards, and there is no diversity in the colors and raw materials that depend on the development The child's senses that help him perceive better.

Figure 10: Classroom view (source: Dezeen, 2014)

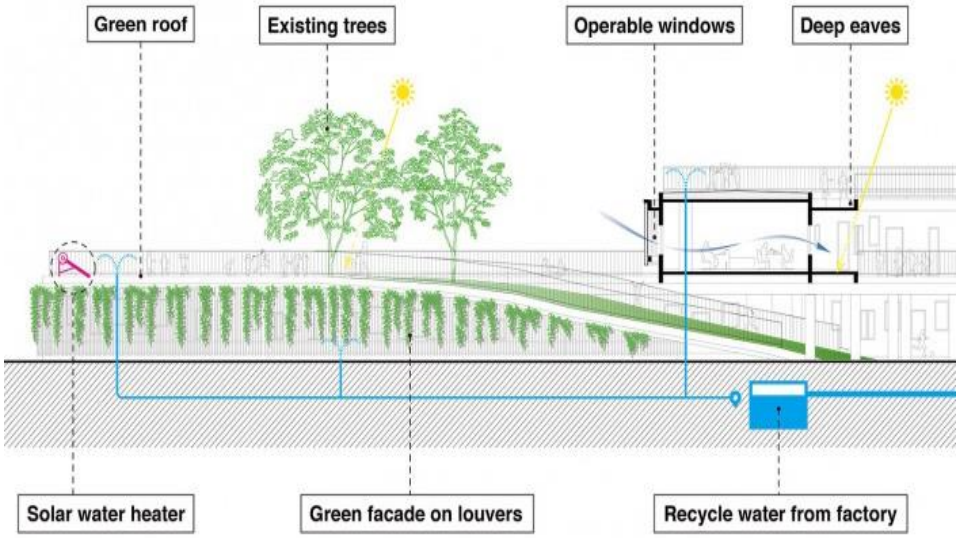

Figure 10 Natural lighting and ventilation in the classroom (source: Dezeen, 2014)

Conclusion:

Sight and vision: It were taken into account to provide light colors to create a calmer environment, but the design did not succeed in diversifying the colors.

All nursery spaces are directly connected to nature and contain a good amount of light and natural ventilation that helps children focus better.

Touch: The design did not pay enough attention to the variety of raw materials that depend on the development of the child's senses and that help him perceive the educational materials better.

Hearing: The design was not concerned with developing children's sense of hearing.

Smell: Several yards, various courtyards, and vegetable gardens are designed for children to easily reach. The smells of the environment were given attention to be a part of children's olfactory memory in the future and help them remember and perceive educational materials better.

7. FINDINGS

Throughout the analysis of neuroarchitecture approaches, studies and analytical case studies, a set of parameters are directly affecting the quality of built environment and promoting self-perception, these parameters as per the following table using 5-point likert scale where 5 is best:

Table 2:table of points and ratings (Source: Author)

Parameter	DS Nursery	Farming Nursery
Variety in spaces within educational spaces	5	2
Natural lighting and ventilation	5	5
Variety in colors and materials	5	3
Playing areas and open spaces	5	5
Integration with nature	4	5
Hearing environment	1	1

The brain's evolutionary history explains why the natural components of environments influences mental resources. These elements include daylight, Visual communication of green spaces through the window, and sometimes direct access to the outside, spending a lot of time outside every day, and also the presence of plants in the rooms and near the building. (Bringslimark, Hartig, & Patel, 2009).

Diversity in spaces: Neuroscience has proven in this study that diversity in spaces used for learning in early childhood is important and can improve children's learning skills, for example, diversity in types of spaces (library – classrooms – music room – playroom – Experimental laboratory - studio), as well as spatial connectivity between these spaces in addition to the presence of a variety of materials, colors and shapes within the spaces.

Materials, colors, and textures: One of the most obvious ways to provide areas of learning that are interesting and stimulate creativity is to use colors, materials, and textures, by stimulating all the senses (Taylor 1991) and recommends (Weinstein 1987) that: "Warm colors, textures, and plants, animals, and fun items" to draw the child into the void and create a feeling of warmth and welcome.

Lighting: Daylight affects the interior spaces, so some attention should also be paid to the psychological effect of lighting. For example, seasonal affective disorder is a serious mental illness that results from deprivation of sunlight. (Gallagher 1999). Lighting is one of the most important factors that have a strong impact on the effectiveness of spaces, especially natural spaces.

Play areas, open areas and connecting with nature: Play is the child's favorite learning method. It is preferable to design diverse areas of play that encourage all forms of social, individual, imaginative, discovery, dramatic and constructive play for the child.

The activity of playing and exploring is an important factor in childhood because it teaches important creative and social skills (Steiner, Rudolf 2003). This factor raises self-esteem, form personal unique identity, facilitates self-realization, and enhances life satisfaction and self-perception for built environment.

Playgrounds can be educational and fun as well. Accommodating variety of landscapes, textures, shapes, and spaces can stimulate creativity. Preferably the playground should be accessible directly from the classroom and can contain areas such as: a landscape area, a garden area, free play, and play structures.

8. CONCLUSIONS

Through the research, the impact of the environment based on the experience of children in early childhood was discovered using neuroscience methods, and then the psychological and neurological impact on children, their brains and behavior, and their influence on their learning spaces.

Integrating architectural design with neuroscience contributed to improving the child's behavior, increasing his ability to learn, knowledge, and developing his social and educational skills.

Coming up with basic design criteria by paying attention to the senses such as: sight, smell, hearing and touch, which have a major role in designing the spaces of the educational environment for children, as they help children to stimulate their educational abilities better and help them to perceive better and among these criteria (Diversity in spaces / Materials, colors, and textures / Lighting / Play areas, open areas and connecting with nature).

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