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Neuro-Architecture in Service of the Autism Spectrum: Designing a School Complex Adapted to Autistic Children in Northern Cameroon

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Abstract:- This research explores the application of neuro-architecture in the design of a school complex adapted for autistic children in the northern region of Cameroon. The literature review highlights the specific characteristics of autism spectrum disorders (ASD) and the particular sensory needs of children with this condition in an educational setting. It analyzes how architecture, through the management of light, colors, materials, and spatial arrangement, can positively influence the well-being and learning of these children. By integrating the principles of neuro-architecture, the design of optimized school spaces can help reduce sensory overload and improve the social and educational inclusion of autistic children. This review also examines international case studies and potential adaptations to the geographic and cultural context of northern Cameroon, which is characterized by a lack of suitable educational infrastructure. The objective of this research is to propose architectural design solutions that meet the specific needs of autistic children while considering local constraints.

Keywords:- *Well-being, Autism Spectrum, Neuro-Architecture, Inclusion, Special School*.

I. INTRODUCTION

Education is a key pillar of a country's socio-economic development, playing a crucial role in the well-being of younger generations. In Cameroon, particularly in the northern regions, access to educational infrastructure that meets the specific needs of vulnerable children remains limited, especially for autistic children. These children, who have unique sensory and cognitive needs, are often marginalized by traditional school systems, despite their right to an inclusive education that values their abilities.

In response to this challenge, neuro-architecture, an emerging discipline combining neuroscience and architecture, offers innovative solutions. By designing built environments that cater to the brain's needs, it helps reduce negative sensory stimuli and creates spaces adapted to the learning needs of autistic children. This project aims to propose school infrastructure tailored to these children, while considering the geographical and cultural constraints of northern Cameroon.

The objective of this work is to explore the principles of neuro-architecture to design a school complex that promotes the inclusion and well-being of autistic children. The study is structured in three chapters: a literature review, a presentation of the methodology, and an analysis of the proposed architectural solutions.

II. DISCOVERING AUTISM

A. Genesis and Description

Autism, as defined by the World Health Organization (WHO, 2023), is a pervasive developmental disorder characterized by impairments in social interactions, communication, and repetitive behaviors. This disorder manifests before the age of three, with significant individual variations. The term "autism" comes from the Greek word *autos* meaning "self," introduced by Eugen Bleuler in 1911 to describe a loss of contact with external reality in schizophrenic adults.

B. Origin of the Concept and Historical Background

Autism was long confused with schizophrenia until the works of Leo Kanner (1943) and Hans Asperger (1944) clarified its specifics. Kanner described autism as an innate affective communication disorder, while Asperger highlighted social and cognitive particularities in children. These works laid the foundation for the recognition of Autism Spectrum Disorders (ASD) as a distinct condition.

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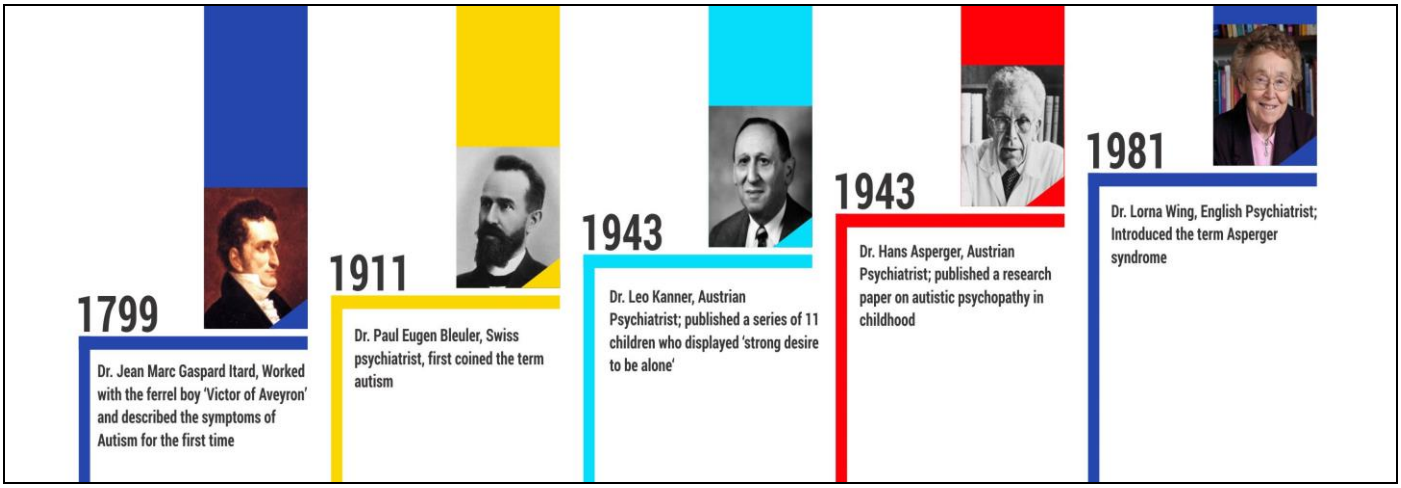

Fig 1 Autism History

C. Characteristics of Autism Spectrum Disorder

Autistic individuals face challenges in two main areas: social communication and restricted, repetitive behaviors. They may exhibit behaviors such as echolalia (repeating words), heightened sensitivity to certain sensory stimuli, or a marked preference for routines.

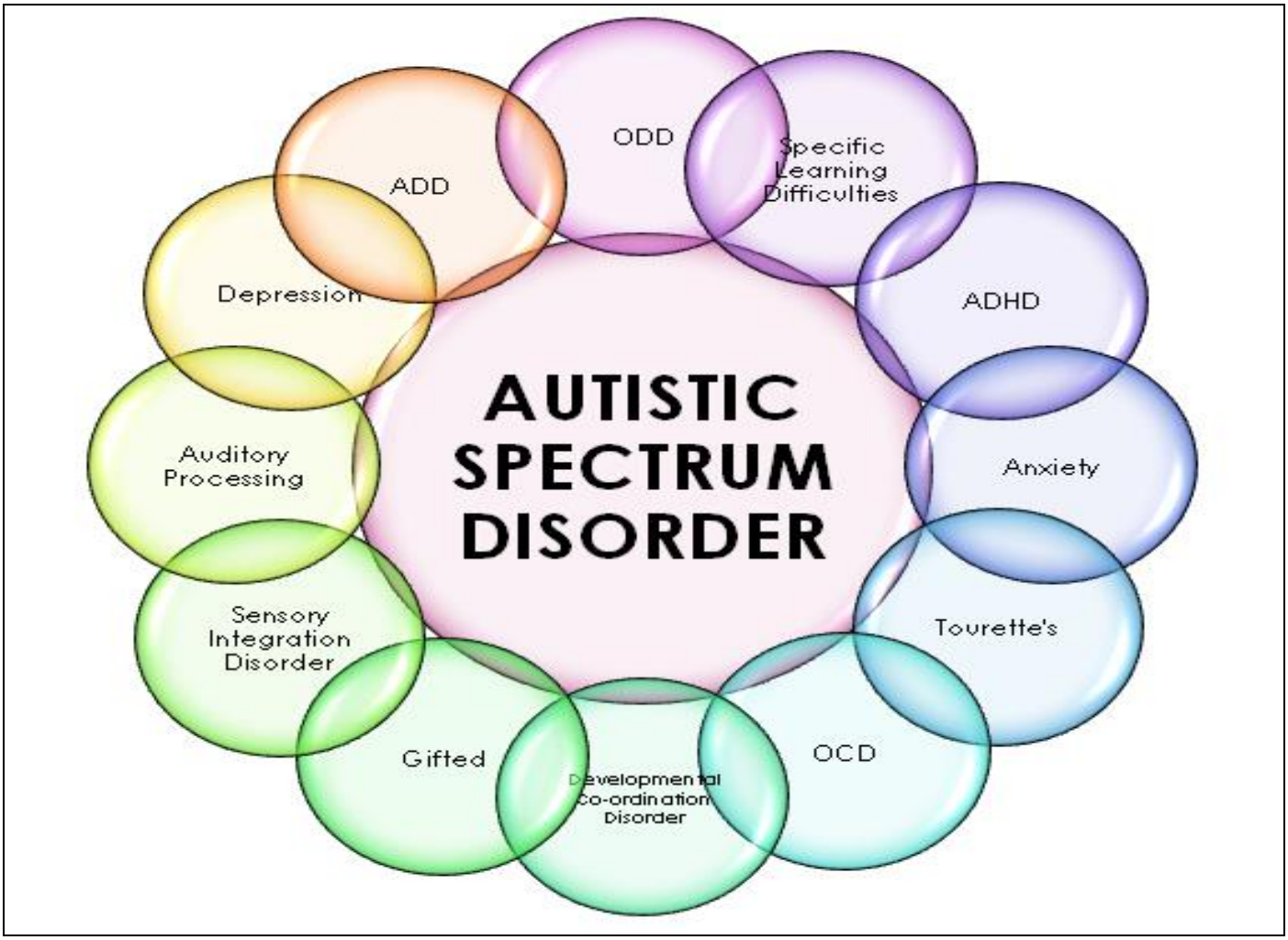

Fig 2 Autitic Spectrum Disorder

D. Global Autism Prevalence and Care

The exact causes of autism remain poorly understood, but they are known to include both genetic and environmental factors. Studies show that about 1 in 160 children worldwide has autism, with variations across regions. Care for autistic children includes behavioral therapies and sensory interventions to improve communication and socialization.

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E. Case of Cameroon

In Cameroon, the recognition of autism is relatively recent and still largely misunderstood. For a long time, the symptoms of the disorder were associated with erroneous beliefs, particularly witchcraft, which contributed to the stigmatization of autistic children and insufficient care.

➢ *Prevalence and Diagnosis*

Approximately 1 in 160 children is estimated to have autism in Cameroon, a figure close to global statistics. However, diagnosis remains rare due to a lack of specialists and appropriate tools to identify autism spectrum disorders, especially in the northern regions.

Région	Psychose	Autisme	dépression	Accès maniaque	Drogue	alcool	TDAH	Troubles émotionnels	démence	traumatisme
Region Adamaoua	882	14	156	13	305	6	1	77	33	41
Region Centre	6108	108	1971	1490	1620	441	74	309	1022	283
Region Est	243	10	283	88	355	117	7	195	63	46
Region Extreme-Nord	1703	14	851	220	468	222	33	165	57	434
Region Littoral	779	77	347	409	148	18	5	249	65	310
Region Nord	139	3	159	16	132	36	2	3	13	33
Region Nord-Ouest	4508	28	2652	229	451	70	72	65	284	208
Region Ouest	765	15	650	190	190	29	15	101	144	88
Region Sud	66	17	231	51	59	77		22	35	36
Region Sud-Ouest	800	9	646	75	144	20	6	4	10	128
Total	**15993**	**295**	**7946**	**2781**	**3872**	**1036**	**215**	**1190**	**1726**	**1607**
	Total Général de tous les cas des 10 régions et des 10 pathologies							**36661**		

Fig 3 Prevalence of Psychiatric Disorders in Cameroon by Region

➢ *Infrastructure and Care*

Cameroon severely lacks infrastructure adapted to autistic children. Specialized centers and inclusive schools are few, leaving the majority of children without access to proper care and educational support. Care initiatives primarily depend on NGOs and a few private organizations, while public institutions are ill-equipped to meet the specific needs of autistic children.

➢ *Challenges*

The main challenges include social stigma, lack of awareness, and insufficient specialized services. Additionally, the available care is often expensive and inaccessible for most families, exacerbating inequalities.

➢ *Perspectives*

Despite these obstacles, some NGOs and local actors are beginning to raise awareness and offer solutions. The adoption of more inclusive national policies, as well as the training of educational and medical staff, are crucial to improving the care and inclusion of autistic children.

III. TRAINING FRAMEWORK

A. Specialized School

UNESCO defines a specialized school as an educational institution designed to facilitate the learning of individuals with specific needs, such as physical, intellectual, or social disabilities, requiring additional support and adapted teaching methods to achieve standard educational goals (UNESCO, 2023).

B. History of the Educational System for Autistic Children

In the 1940s and 1950s, autistic children were often excluded from the educational system due to a lack of understanding of the disorder and inadequate resources (Kanner, 1943). The first adapted educational programs emerged in the 1960s and 1970s, such as the TEACCH program (Schopler & Reichler, 1971), the ABA method (Lovaas, 1987), and the PECS communication system (Bondy & Frost, 1994). These programs marked a turning point in recognizing the specific educational needs of autistic children.

C. Specific Educational Objectives

Specialized schools for autistic children aim to develop skills adapted to their sensory and cognitive needs. Educational strategies include individualized teaching, the use of visual aids, and the creation of structured environments to minimize distractions and promote learning.

D. Role of Parents and the Community

Parents play a crucial role in the education of autistic children, often collaborating with schools to adapt educational strategies to the specific needs of each child. Workshops for parents and community partnerships strengthen family involvement in the educational process, fostering a holistic and inclusive approach.

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E. Spatial Organization

➢ *Building Typo-Morphology*

The spatial configuration of specialized schools for autistic children is designed to meet specific criteria, promoting fluid circulation and accessibility. Spaces are designed to reduce negative sensory stimuli and maximize the use of natural light, a key principle in neuro-architecture (Mostafa, 2014).

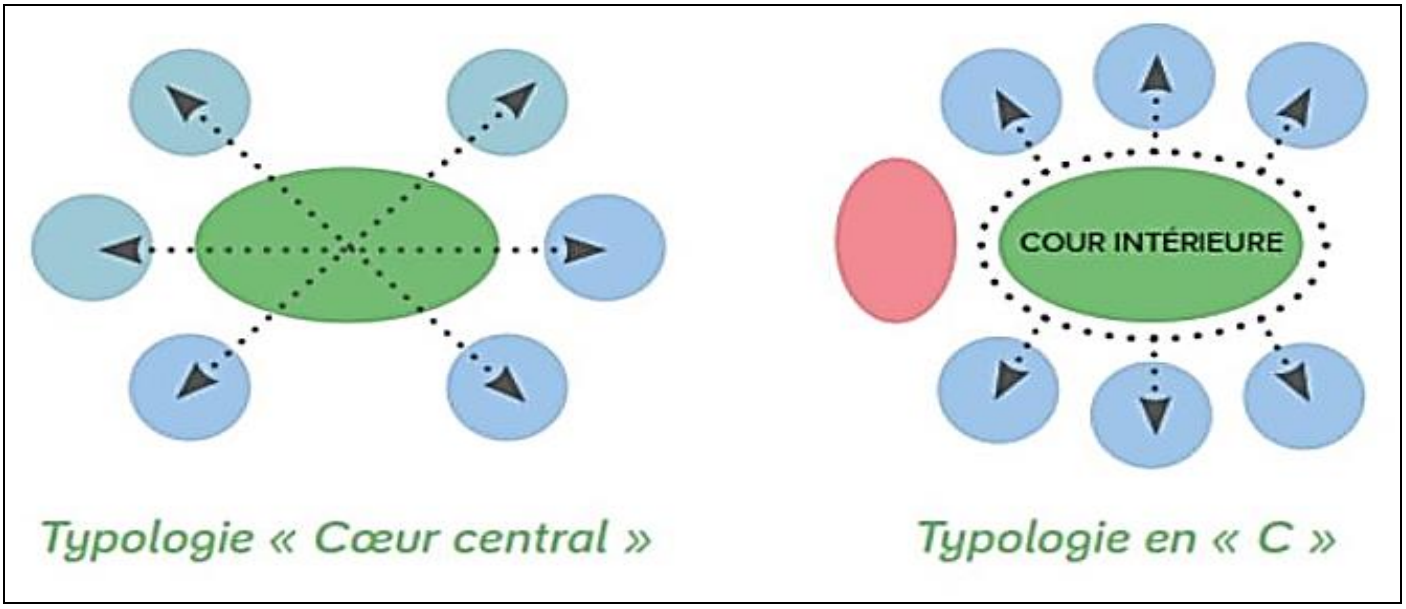

Fig 4 Building Typo-Morphoplogy

➢ *Acoustic Management*

Acoustics are a critical element in the design of these institutions, as autistic children can be highly sensitive to noise. Specific materials are used to limit reverberation and create calm environments conducive to concentration and learning (Sachs & Vincenta, 2011).

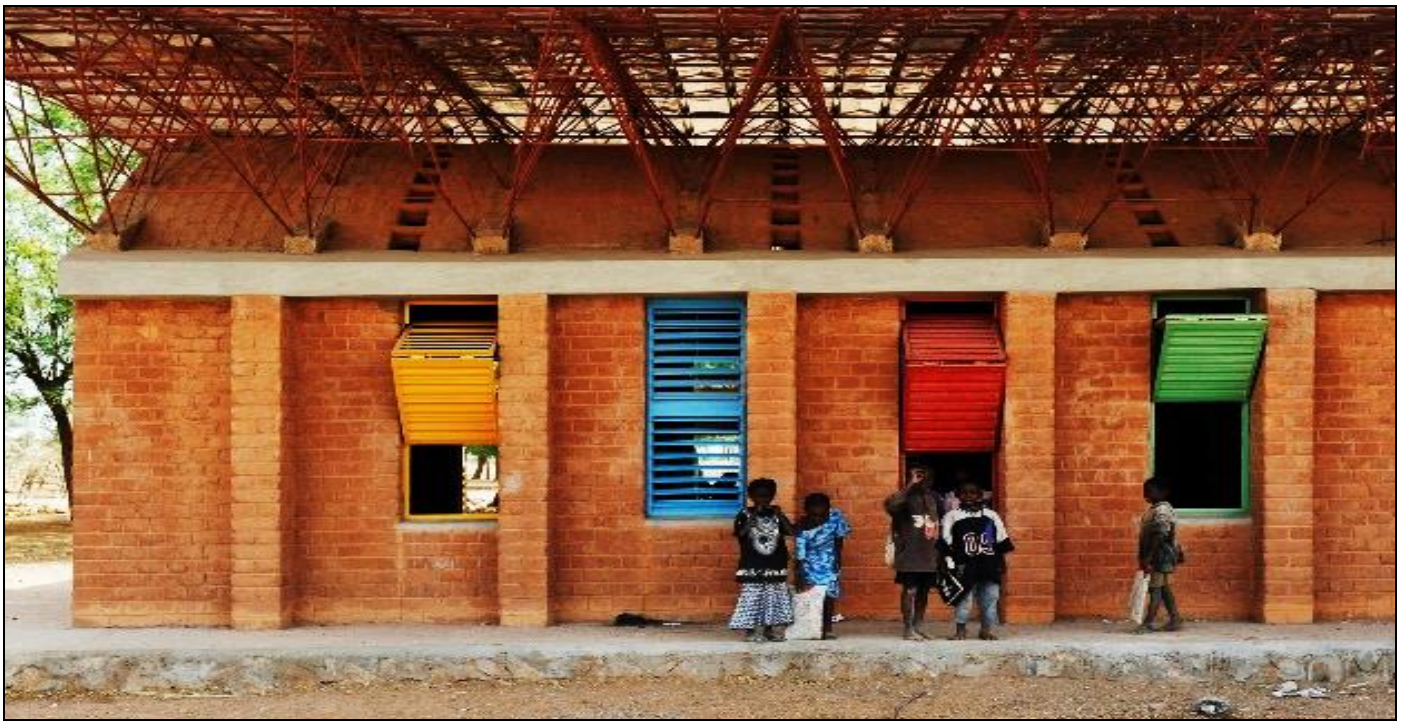

Fig 5 Example of Natural Building Material

➢ *Importance of Lighting and Spatial Design*

The use of soft colors and natural lighting controls visual stimuli and contributes to a calming environment, essential for autistic children (Bellusso & al., 2017). Color codes and spatial arrangement are also used to structure the environment, helping children better understand and interact with their surroundings.

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Fig 6 Integration of Biophilia in the Built Environment

Fig 7 Example of Wide Circulation

IV. NEURO-ARCHITECTURE

A. Definition

Neuro-architecture is an emerging field that combines neuroscience, environmental psychology, and architecture to study the interaction between the human brain and the built environment. It aims to create spaces that positively influence users' mental and emotional well-being. According to Karakas & Yildiz (2020), this field explores how architectural design can be informed by discoveries about brain function to improve quality of life.

B. Architecture Focused on Mental Well-being

Neuro-architecture focuses on the impact of architectural elements such as light, space, texture, and color on cognition and mood. For instance, certain types of lighting can affect productivity and mood, while spatial arrangement can influence social interactions and reduce stress (Edelstein & Macagno, 2012). This discipline allows architects to design spaces that are not only functional but also enhance mental health (ANFA, 2008).

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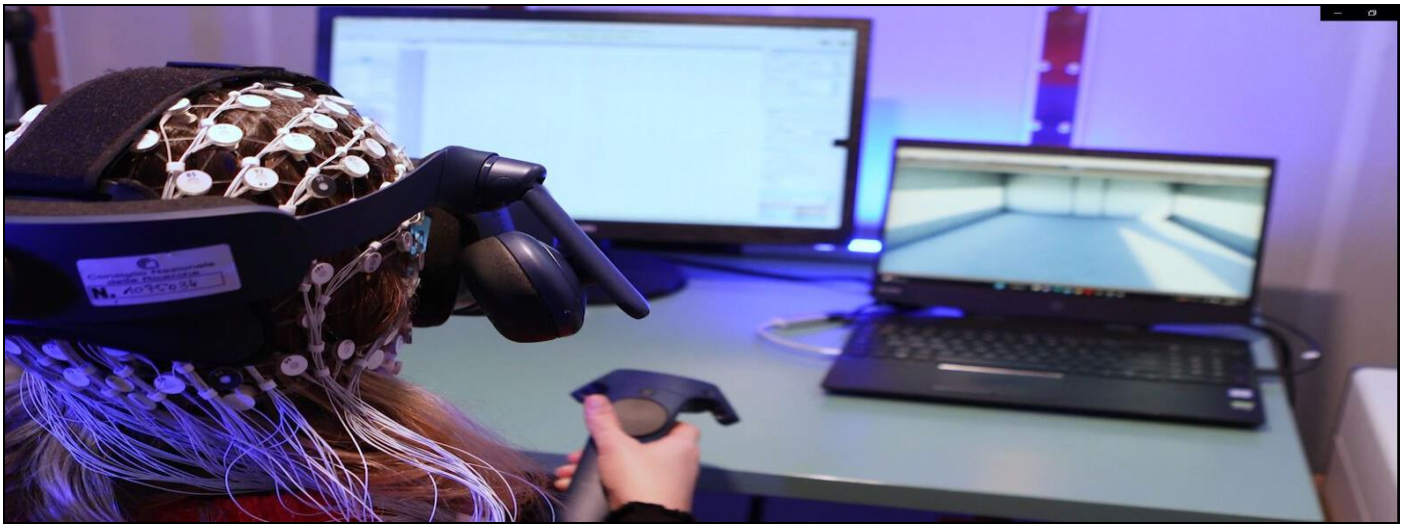

Fig 8 Study on Different Brain Reactions to its Environment

C. History of Neuro-Architecture

Before the formal emergence of neuro-architecture, architects such as Frank Lloyd Wright intuitively incorporated elements that influenced mental well-being, such as the use of natural light and organic materials (Wright, 2003). A significant turning point was the creation of the Academy of Neuroscience for Architecture (ANFA) in 2003, which marked the beginning of systematic research on how the built environment affects the human brain (Eberhard & al., 2009).

D. Key Principles

The key principles of neuro-architecture include:

➢ *Natural and Artificial Light:*

Proper light management regulates the circadian rhythm, influences mood and concentration. Natural light is often preferred to reduce stress and promote well-being (ANFA, 2008).

➢ *Colors:*

Colors have a direct impact on emotions. Cool tones like blue are calming, while warm tones like red stimulate energy (Sussman & Hollander, 2015).

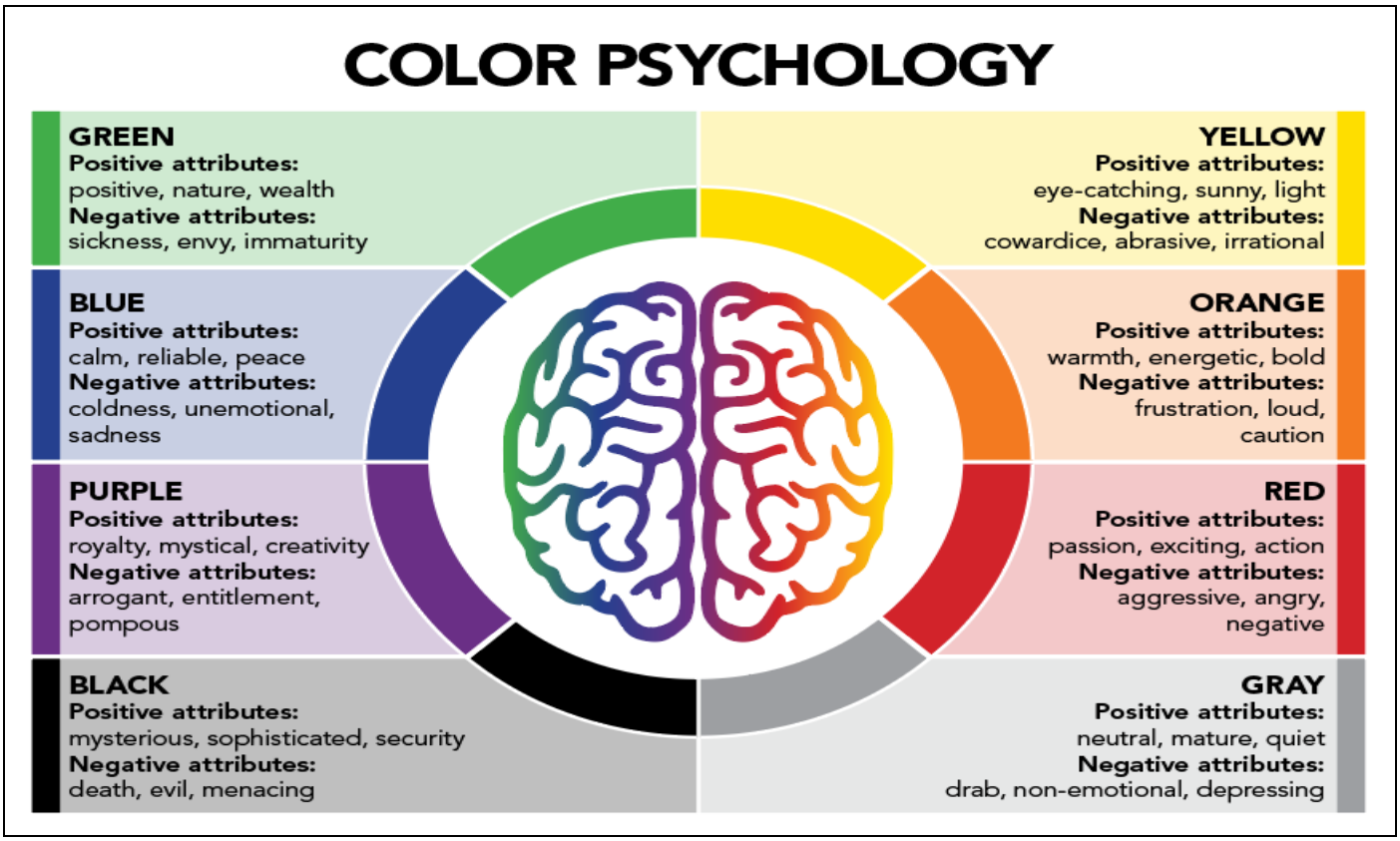

Fig 9 Color Psychology

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➢ *Connection to Nature:*

Integrating natural elements such as plants or views of the outdoors reduces stress and improves concentration.

E. Recent Developments

Today, neuro-architecture is applied in various fields such as schools, hospitals, and workplaces. Recent studies show that well-designed environments can not only improve mental health but also boost productivity and creativity (Sussman & Hollander, 2015).

V. ARCHITECTURAL ANALYSIS OF SEVERAL SCHOOLS

A. DOS School Campus

This project, designed by Japanese and Austrian architects SHIBUKAWA EDER ARCHITECTS, is located in Vienna, Austria. The campus accommodates 1,100 children and includes a kindergarten, an elementary school, and a middle school. It is based on the "Campus Plus" model, which aims to mix children of different ages and includes those with special educational needs in the same spaces. The spatial organization prioritizes multi-purpose areas between classrooms, allowing children to learn, play, and relax in an environment adapted to their needs. The architecture promotes maximum transparency with numerous visual connections that facilitate communication between children.

Fig 10 DOS School Campus

➢ *Architectural Approach:*

The project emphasizes openness and maximum transparency to encourage collaborative learning between children from different groups.

➢ *Spatial Organization and Site Integration:*

The campus makes extensive use of natural light and promotes interaction between students through spacious, flexible common areas.

Fig 11 DOS School Campus Plan

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Fig 12 Color Palette used in the Campus

➢ *Applied Neuro-Architecture Principles:*

The campus employs strategies such as natural light management to improve children's well-being while reducing sensory stress.

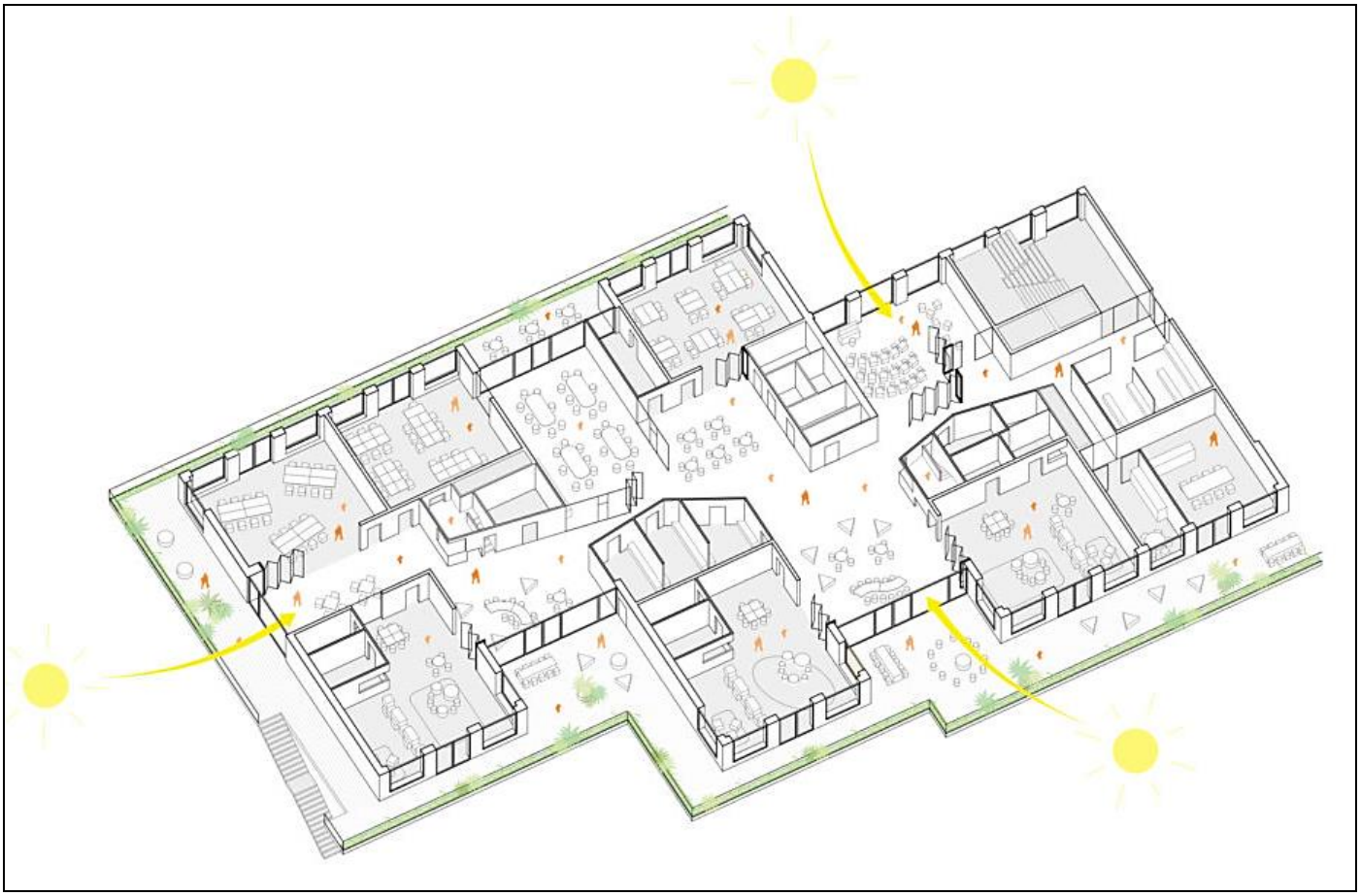

Fig 13 Infiltration of Natural Light within the DOS School Campus

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B. Western Autistic School

Located in Australia, this specialized school for autistic children is designed to meet the specific sensory and cognitive needs of students. The school's organization revolves around a central building, with distributed volumes creating calm and secure learning spaces. Emphasis is placed on separating spaces to minimize distractions and providing outdoor areas dedicated to play and relaxation.

Fig 14 Western Autistic School

➢ *Formal Analysis:*

The school's structure is centered around a core, distributing towards separate volumes, each dedicated to a specific use for children with autism spectrum disorders (ASD).

➢ *Spatial Organization:*

The classrooms are designed to offer a calm environment with outdoor play areas, promoting children's autonomous development.

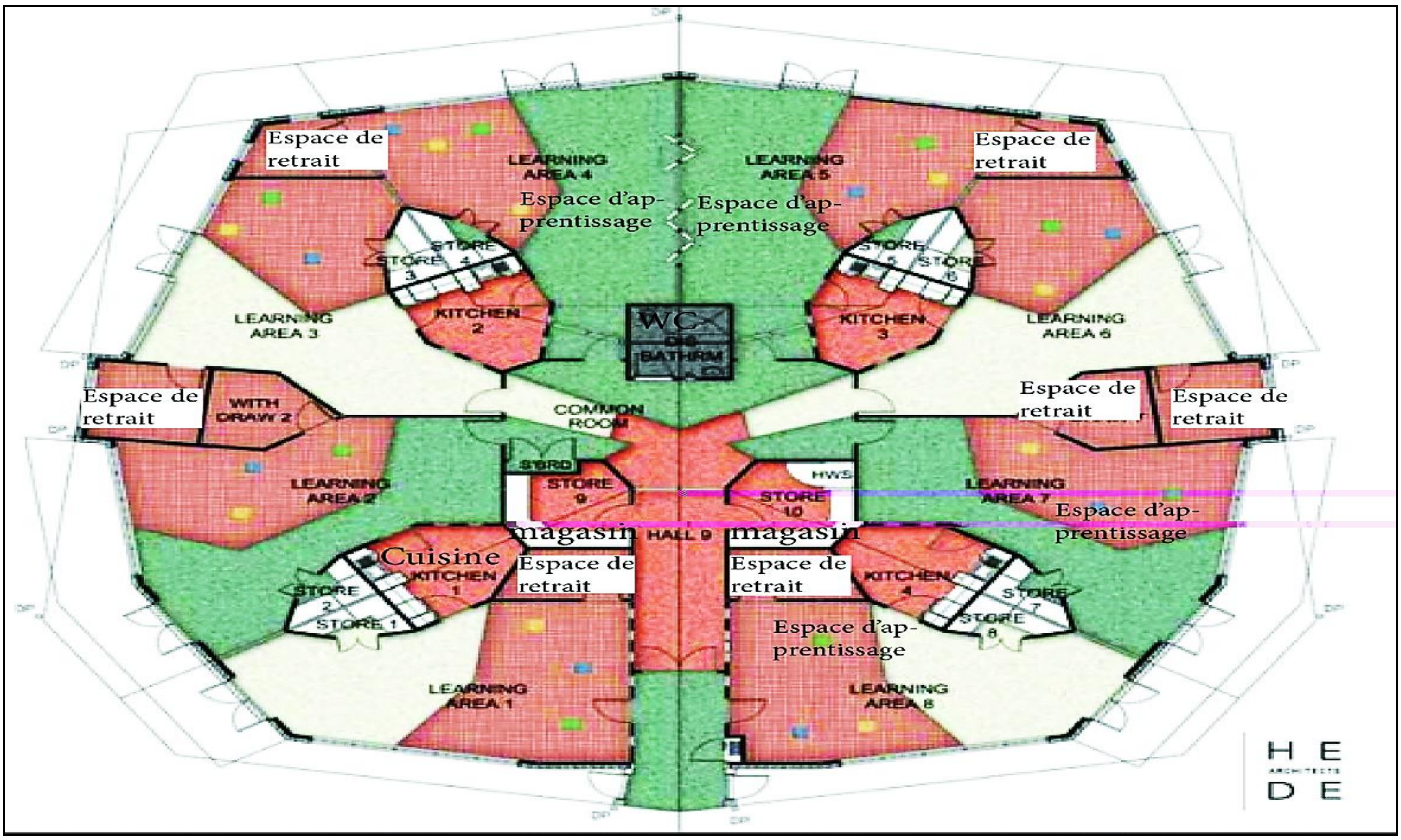

Fig 15 Western Autistic School Plan

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➢ *Applied Neuro-Architecture Principles:*

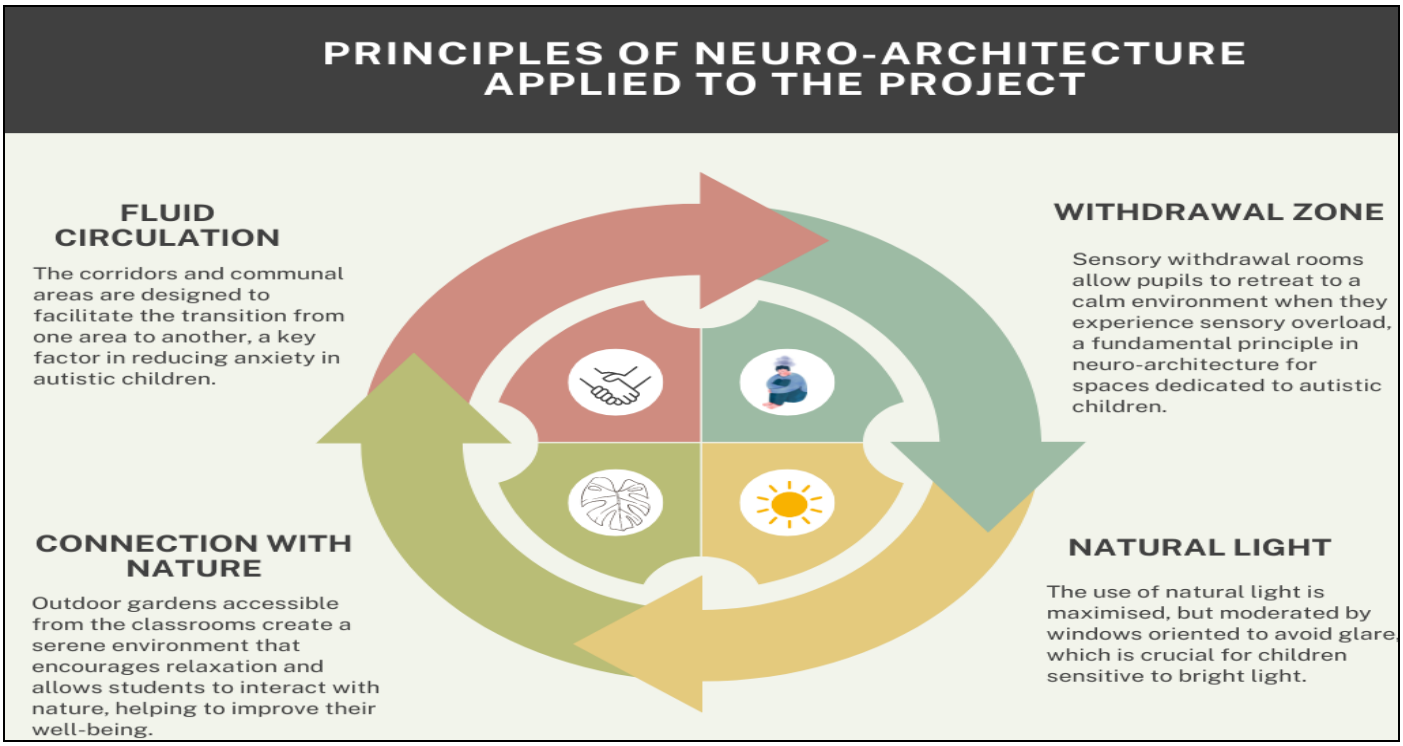

Fig 16 Principles of Neuro-Architecture Applied to the Project

➢ *Limitations:*

Despite the applied principles, there are some shortcomings in the integration of nature and the environment, which could be improved to maximize the calming effects of outdoor spaces.

C. Bangre Veenem School Complex

Located in West Africa, this school complex draws inspiration from vernacular techniques using local materials such as raw earth. Designed by architect Albert Faus, it features sloping roofs for effective natural ventilation and better heat management. The complex is organized into pavilions connected by open corridors, allowing cross-ventilation while harmoniously integrating the natural environment.

Fig 17 Bangre Veenem School Complex

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➢ *Architectural Approach:*

The architecture is based on local materials and sustainable design adapted to the local climate conditions.

➢ *Spatial Organization:*

The complex consists of interconnected pavilions, with each classroom opening to the outside for optimal natural ventilation. A central shaded courtyard serves as both a playground and gathering space for students.

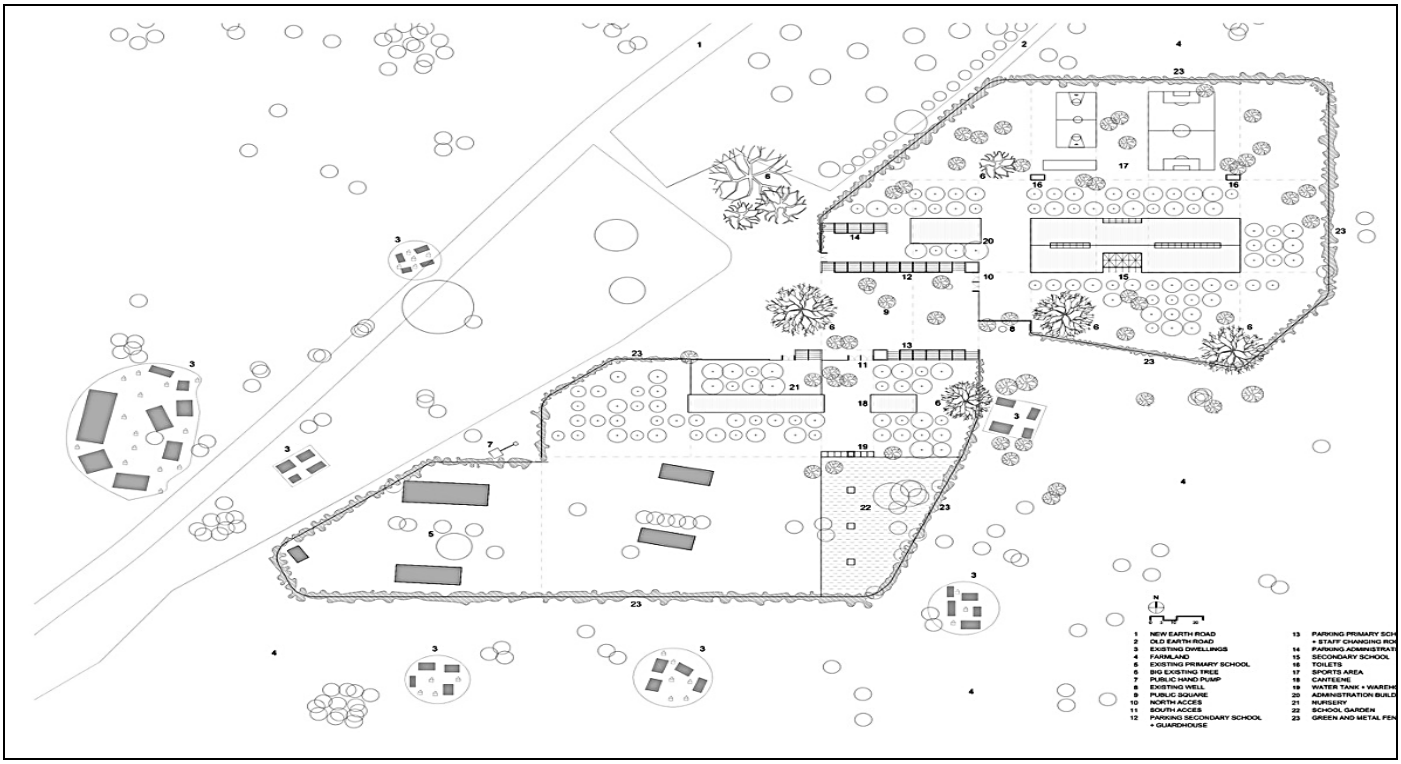

Fig 18 Bangre Veenem School Complex plan

➢ *Applied Neuro-Architecture Principles:*

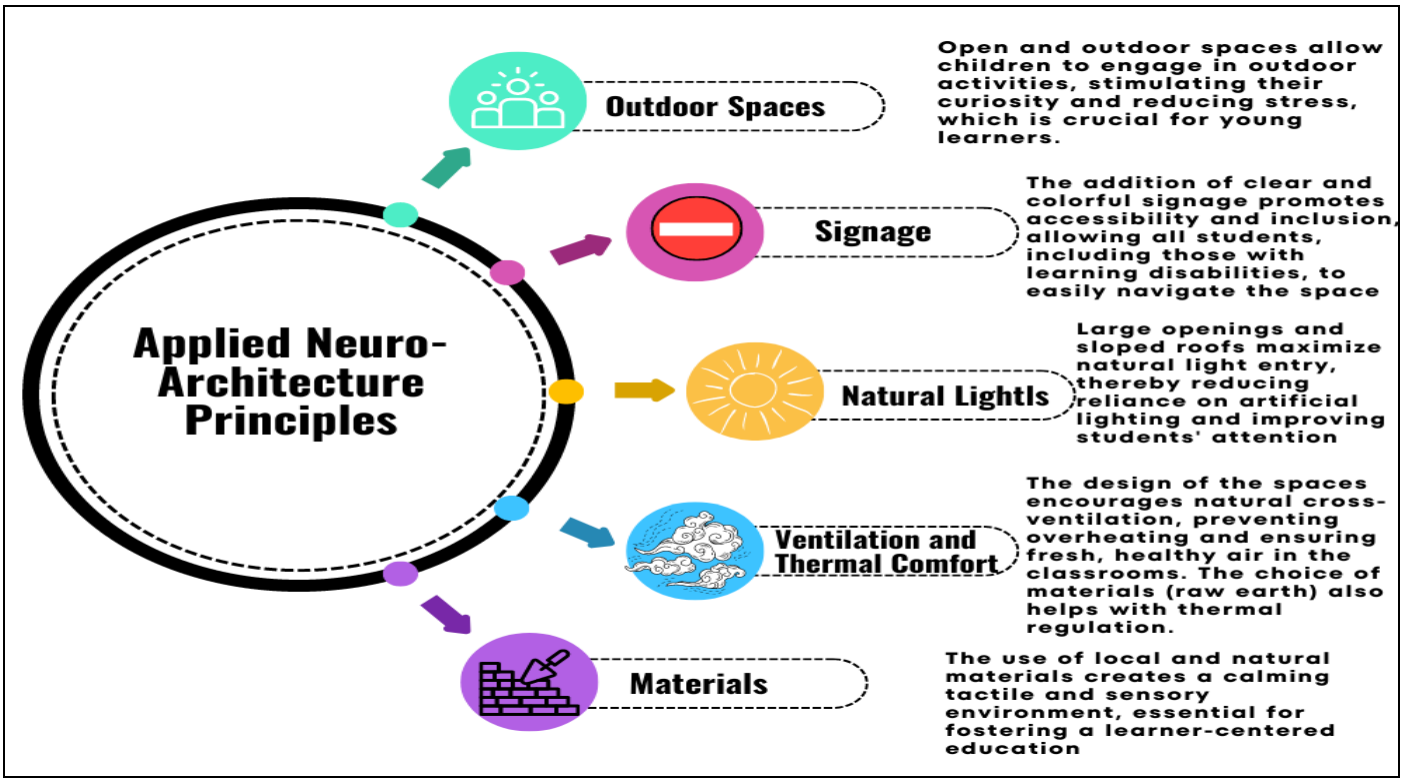

Fig 19 Applied Neuro-Architecture Principles

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➢ *Limitations:*

Despite its many strengths, the project has certain limitations. On one hand, while the use of local materials is environmentally friendly and sustainable, it may limit the integration of modern technologies for better sensory stimulus management. On the other hand, the lack of enclosed and isolated spaces may not suit all autistic children, particularly those who need calm areas less exposed to sensory distractions (Humphrey, 2011). Finally, the spatial organization could benefit from more flexibility to adapt to more specific educational or sensory needs.

VI. CONCLUSION

The application of neuro-architecture to the design of school complexes for autistic children demonstrates the positive impact of architecture on their well-being and learning. By integrating neuroscience with design strategies, it is possible to create school environments adapted to the emotional, cognitive, and sensory needs of autistic children.

The analyzed projects, such as the **DOS School Campus**, the **Western Autistic School**, and the **Bangre Veenem Complex**, illustrate how well-designed spaces can reduce sensory stimuli and promote autonomy. However, limitations remain, particularly in integrating modern technologies or providing flexible spaces to meet the specific needs of autistic children.

In Cameroon, particularly in the northern regions, establishing educational infrastructures adapted for autistic children remains a challenge. The lack of specialized equipment and trained staff contributes to the marginalization of these children. It is crucial to develop inclusive schools based on the principles of neuro-architecture while considering local realities.

In summary, specialized architecture can promote the inclusion and well-being of autistic children in Cameroon. Designing adapted school complexes represents a promising solution to address current challenges and provide these children with an environment conducive to their development.

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