

REVIEW

Neuropsychological strategies and learning environments to enhance neurodevelopment and inclusion in childhood

Estrategias neuropsicológicas y entornos de aprendizaje para potenciar el neurodesarrollo y la inclusión en la infancia

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Cite as: Rivadeneira Intriago MJ, Villao Rivadeneira KA, Torres Rizo IR. Neuropsychological strategies and learning environments to enhance neurodevelopment and inclusion in childhood. Salud, Ciencia y Tecnología. 2025; 5:1565. <https://doi.org/10.56294/saludcyt20251565>

Submitted: 14-08-2024

Revised: 03-12-2024

Accepted: 01-08-2025

Published: 02-08-2025

Editor: Prof. Dr. William Castillo-González 

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ABSTRACT

Introduction: child neurodevelopment is a fundamental process for the acquisition of cognitive, socio-emotional, and behavioral skills, which are decisive in school and social life. This theoretical-propositional article aims to articulate neuropsychological strategies and inclusive learning environments as complementary elements to enhance integral development in childhood.

Method: it was developed through a documentary review, analyzing relevant literature extracted from indexed databases such as Scopus and Web of Science, prioritizing recent studies (2019-2024). After the analysis, an integrative model is proposed that considers three levels: cognitive-neuropsychological, pedagogical-environmental, and socio-community. The role of the teacher as a mediator, the participation of families, and the support of inclusive public policies are emphasized.

Results: the results demonstrate that strategies such as strengthening executive functions, multisensory stimulation, neurofeedback, and emotional self-regulation significantly favor children's attention, working memory, and emotional regulation. The proposal confirms the importance of integrating inclusive environments, conceived as physical, pedagogical, social, and digital spaces to guarantee equity and inclusion.

Conclusions: this research contributes to the academic debate by offering an innovative perspective that strengthens the link between neuropsychology and inclusive education, with implications for research, pedagogical practice, and educational policies.

Keywords: Inclusive Environments; Childhood Education; Neuropsychological Strategies; Educational Inclusion; Neurodevelopment.

RESUMEN

Introducción: el neurodesarrollo infantil constituye un proceso fundamental para la adquisición de habilidades cognitivas, socioemocionales y conductuales, decisivas en la vida escolar y social. Este artículo, de carácter teórico-propositivo, tiene como objetivo articular las estrategias neuropsicológicas y los ambientes de aprendizaje inclusivos como elementos complementarios para potenciar el desarrollo integral en la infancia.

Método: se desarrolló mediante una revisión documental, analizando la literatura relevante extraída de bases de datos indexadas como Scopus y Web of Science, priorizando estudios recientes (2019-2024). Luego del análisis, se propone un modelo integrador que tiene en cuenta tres niveles: cognitivo-neuropsicológico, pedagógico-ambiental y sociocomunitario. Se enfatiza el rol del docente como mediador, la participación de

las familias y el respaldo de políticas públicas inclusivas.

Resultados: los resultados demuestran que estrategias como el fortalecimiento de las funciones ejecutivas, la estimulación multisensorial, el neurofeedback y la autorregulación emocional favorecen significativamente la atención, la memoria de trabajo y la regulación emocional de los niños y niñas. La propuesta confirma la importancia de integrar los ambientes inclusivos, concebidos como espacios físicos, pedagógicos, sociales y digitales para garantizar la equidad y la inclusión.

Conclusiones: la investigación contribuye al debate académico ofreciendo una perspectiva innovadora que fortalece el vínculo entre neuropsicología y educación inclusiva, con implicaciones para la investigación, la práctica pedagógica y las políticas educativas.

Palabras clave: Ambientes Inclusivos; Educación Infantil; Estrategias Neuropsicológicas; Inclusión Educativa; Neurodesarrollo.

INTRODUCTION

Child neurodevelopment is a fundamental focus in the social and educational sciences, as the early years of life are crucial for acquiring cognitive, socio-emotional, and behavioral skills that will influence future performance. Neuropsychology and neuroscience have shown that processes such as memory, attention, self-regulation, and executive functions are consolidated more effectively in stimulating and structured contexts, which makes learning environments essential factors in enhancing these abilities.

In this context, inclusive education is a pedagogical and social project that goes beyond integration, as it involves transforming practices, methodologies, and spaces to guarantee participation and the right to quality education for all. Learning environments should be understood as physical spaces, as well as social, emotional, and technological environments, capable of promoting enriching educational experiences, particularly when they are linked to neuropsychological strategies.

Research advances have demonstrated the value of approaches such as multisensory stimulation, strengthening executive functions, utilizing interactive digital resources, and combining musical and motor stimulation in early childhood learning. However, gaps remain in their articulation with the principles of inclusion, especially in Latin America, where factors such as lack of resources, curricular rigidity, poor teacher training in neuroscience, and infrastructure limitations create obstacles to the creation of truly inclusive environments.

Inclusion, viewed from a sociological and educational perspective, extends beyond the school environment to encompass values of equity, social justice, and respect for diversity. Thus, the integration of neuropsychological strategies with inclusive environments presents itself as an innovative alternative to strengthen the academic, socio-emotional, and participatory development of children. This article, therefore, proposes a theoretical reflection that articulates the contributions of neuropsychology and educational neuroscience in relation to the principles of inclusive education, suggesting a conceptual model that serves as a basis for academic debate, future research, and pedagogical practices aimed at children.

DEVELOPMENT

1. Neurodevelopment in childhood

Child neurodevelopment is a complex process that involves the maturation of brain structures and the acquisition of cognitive, linguistic, motor, and socio-emotional skills. During the first years of life, there is a high degree of brain plasticity that facilitates the formation of neural circuits essential for learning and social adaptation. The literature agrees that functions such as attention, working memory, and self-regulation are mainly consolidated between the ages of 0 and 8, a critical stage for comprehensive development.^(1,2)

Educational neuropsychology emphasizes the importance of early interventions to stimulate executive functions and promote efficient learning. Research on disorders such as ADHD and SLD shows that structured environments and specific neuropsychological strategies improve both academic performance and adaptive skills.^(3,4,5) These findings confirm that neurodevelopment is strongly influenced by the quality of the educational and social context, beyond biological factors.

2. Neuropsychological strategies to enhance learning

Neuropsychological strategies are interventions based on knowledge of the brain and cognitive processes, designed to enhance learning and cognitive function. Among the most relevant are:

- Neurofeedback and non-invasive brain stimulation, which have shown positive effects on attentional self-regulation and reduction of ADHD symptoms.^(3,6)
- Multisensory and musical interventions, capable of activating various areas of the brain and

enhancing memory, creativity, and emotional regulation.⁽⁵⁾

- Executive function training, which focuses on planning, cognitive flexibility, and inhibitory control, is essential for optimal school performance.⁽¹⁾

Likewise, social-emotional self-regulation programs strengthen children's resilience and improve the school climate, integrating emotional well-being as an indispensable part of neurodevelopment.^(7,8)

3. Inclusive learning environments

The learning environment is an ecosystem that transcends the physical classroom, integrating pedagogical, emotional, social, and technological factors. An inclusive environment ensures accessibility, participation, and equity, adapting to diverse needs.^(1,3,9)

Universal Design for Learning (UDL) serves as a key reference point, as it proposes multiple forms of representation, expression, and engagement to eliminate barriers to learning. Evidence shows that the use of interactive digital resources, active methodologies, and collaborative spaces encourages involvement and strengthens cognitive and socioemotional skills.⁽¹⁾

However, inclusion does not depend solely on infrastructure or curricular adaptations, but also on a climate of respect and cooperation among teachers, students, and families.⁽⁶⁾ In this process, the teacher acts as an essential mediator in the application of neuropsychological strategies and in the construction of stimulating and safe environments.

4. Educational inclusion and neurodevelopment

Educational inclusion is recognized as a guiding principle of international policies and a fundamental right.^(12,13) However, limitations related to resources, rigid curricula, and a lack of teacher training in neuroscience persist in Latin America.^(12,13)

Ibero-American literature emphasizes the importance of coordinating public policies, teacher training, and neuropsychological strategies to create inclusive environments from an early age.^(7,13,14) Inclusion goes beyond physical integration, requiring profound pedagogical transformations that respond to diversity. In this context, educational neuropsychology offers contributions to address both students with neurodevelopmental disorders and those at risk of exclusion, through early stimulation programs, interventions in executive functions, and the design of flexible environments.^(1,2)

5. Towards a theoretical-propositional model

Despite advances, gaps have been identified in the articulation of neuropsychological strategies within inclusive environments, particularly within a unified framework. The literature addresses both components separately, but few studies integrate them as complementary elements.

Hence, the need for a model that considers:

1. Strengthening of executive and socio-emotional functions through neuropsychological strategies.
2. Designing inclusive environments based on UDL and family-school collaboration.
3. Recognition of neurodevelopment as an integral process that requires cognitive, emotional, and social stimuli.

This theoretical framework proposes an innovative conceptual basis that articulates neuropsychology and inclusive education, contributing to the academic debate and providing a foundation for research and pedagogical practices aimed at children.

METHOD

The research is framed within a qualitative documentary approach, from a theoretical-propositional perspective, given that its purpose is not the empirical verification of hypotheses, but rather the construction of a conceptual model that articulates neuropsychological strategies and inclusive learning environments aimed at enhancing child neurodevelopment.

The methodological process was carried out in four phases. First, a systematic literature search was conducted in high-impact (Scopus, Web of Science) and open-access (SciELO, Redalyc) databases, prioritizing publications from the last five years (2019-2024). Although classic references were included to contextualize the field of study, the focus was on recent publications. Second, keywords were defined in both Spanish and English (e.g., child neurodevelopment, neuropsychological strategies, learning environments, educational inclusion, among others), and combined using Boolean operators.

Subsequently, the documents were organized in the Zotero manager, which enabled the filtering of duplicates and classification of the literature. Of the 56 texts reviewed, 17 were selected for their thematic relevance and methodological rigor. In the third phase, a critical and comparative analysis was applied,

structured into four categories: neuropsychological strategies applied to early childhood education, design and adaptation of learning environments, neurodevelopmental processes in childhood, and educational and social inclusion. Finally, based on these findings, a theoretical-propositional model was constructed that integrates neuropsychological strategies and inclusive environments, highlighting the role of teachers and the need for educational policies aimed at inclusion.

RESULTS

Based on the literature review, trends, gaps, and limitations in the studies analyzed were identified, as well as categories of analysis that structure the findings. Finally, the theoretical-propositional model developed and its implications for pedagogical practice are presented.

1. Trends identified in the literature

The review revealed significant advances in the articulation between neurodevelopment, neuropsychological strategies, and inclusive education (table 1).

Category	Strategy/Approach	Citation	Benefit in childhood	Application in educational inclusion
Neuropsychological strategies	Neurofeedback	(3)	Improved attention and self-regulation	Support in classrooms with children with ADHD
Neuropsychological strategies	Musical and multisensory stimulation	(5)	Language development and creativity	Promotes integration of children with ASD
Neuropsychological strategies	Executive function training	(1)	Strengthening of working memory and inhibitory control	Improves school performance and coexistence
Inclusive learning environments	Universal Design for Learning (UDL)	(9,13)	Accessibility and equity in diverse contexts	Inclusion of students with functional and cultural diversity
Inclusive learning environments	Adaptive digital resources	(15)	Greater student motivation and involvement	Active participation of students with different abilities
Neurodevelopment and comprehensive development	Early stimulation programs	(2)	Consolidation of executive functions	Prevention of developmental delays in childhood
Educational and social inclusion	Training for families and caregivers	(16)	Greater community involvement	Complementary support for school practices
Educational and social inclusion	Inclusive public policies	(12)	Reduction of structural gaps	Strengthening equitable education systems

Analysis of these trends shows that executive functions (planning, working memory, inhibitory control) are predictors of academic performance and social integration.^(1,2) Likewise, strategies such as neurofeedback, multisensory stimulation, and musical intervention have shown positive effects on attention regulation, language development, and intrinsic motivation.^(3,5)

Similarly, inclusive environments are positioned as mediators of child development. Studies such as those at ^(1,9,13) show that classroom organization, the use of adaptive digital resources, and the Universal Design for Learning (UDL) approach strengthen student participation and educational equity in diverse contexts.

2. Gaps and limitations

Despite these advances, significant limitations have been identified. First, there is a lack of conceptual integration between neuropsychological strategies and inclusive environments, as most studies address them in isolation. Second, teacher training remains insufficient: although there is evidence of the usefulness of applying neuroscience principles in education, training programs are still scarce.^(15,17)

Additionally, structural barriers are observed in Latin America, where the lack of resources, infrastructure, and institutional support restricts the implementation of inclusive environments.^(7,18) Finally, most studies come from European or North American contexts, which creates a gap in empirical evidence adapted to Latin American sociocultural realities.

3. Categories of analysis

Critical analysis allowed us to organize the findings into four central categories:

1. Neuropsychological strategies applied to childhood: strengthening executive functions, neurofeedback, and multisensory stimulation, with effects on attention, self-regulation, and motivation.

2. Inclusive learning environments: application of UDL, use of accessible technologies, and creation of safe socio-emotional climates, with the teacher as mediator.
3. Neurodevelopment and comprehensive development: influence of brain plasticity, critical periods, and the role of school and family environments.
4. Educational and social inclusion: public policies, regulatory frameworks, and pedagogical practices that promote equity, although challenges remain in Latin America.

These categories constitute the pillars on which the theoretical-propositional proposal is based.

4. Theoretical-propositional proposal

The proposal articulates the contributions of educational neuropsychology and inclusion, organized into three interrelated levels (table 2).

Table 2. Levels of the proposal	
Level	Description
Cognitive-Neuropsychological	Executive functions Attention and working memory Emotional regulation Multisensory strategies Neurofeedback and digital stimulation
Pedagogical-Environmental	Universal Design for Learning (UDL) Accessible and flexible environments Use of inclusive and collaborative ICT Positive social-emotional climate Teacher's mediating role
Social and community	Family and community participation Interinstitutional support networks Inclusive public policies Social justice and equity

The objective is to design a model that enhances children's neurodevelopment from a cognitive, pedagogical, and socio-community perspective, promoting equity in diverse contexts.

Table 3. Theoretical proposal: integration of neuropsychological strategies and inclusive environments						
Level	Main components		Strategies/Actions	Actors involved	Expected impact on children	
Cognitive-Neuropsychological	Executive functions, working memory, emotional regulation, intrinsic motivation		Executive function training and self-regulation Mindfulness programs Multisensory stimulation (music, movement) Neurofeedback and adaptive digital environments	Educational psychologists, specialized teachers, therapists	Improved attention, planning, and inhibitory control; language development and creativity; greater emotional resilience	
Pedagogical-Environmental	Design of inclusive environments, accessibility, school climate		Application of DUA Classroom organization with accessible resources Use of inclusive and collaborative ICT Cooperative learning strategies	Teachers, school administrators, peers	Increased participation of all students; universal accessibility; improved performance and school coexistence	
Social and community	Family involvement, community networks, public policy, social justice		Training and support programs for families Integration of social services, health, and culture Design of inclusive education policies Reduction of structural barriers	Families, community, government, social organizations	Strengthening of the social fabric; greater community involvement; equity and sustainability of inclusive programs	

This proposal acknowledges that neuropsychological strategies must be implemented within an inclusive educational ecosystem, taking into account both individual conditions and social and structural factors.

5. Implications for educational practice

The findings suggest three key implications:

- Teacher training in neuropsychology and inclusion is crucial for equipping educators with practical tools to address diversity in the classroom.
- The implementation of comprehensive school programs must combine cognitive, socio-emotional, and motor stimulation under principles of accessibility.
- It is essential to strengthen partnerships among schools, families, and communities, recognizing that children's neurodevelopment extends beyond the school environment.

The critical review showed that the relationship between neuropsychological strategies, learning environments, and inclusion is a growing but still fragmented field. The proposed approach aims to address this gap by developing an integrative model that encompasses cognitive, pedagogical, and socio-community dimensions, offering a comprehensive view of child neurodevelopment.

DISCUSSION

1. Coincidences with previous research

The results obtained are consistent with research that highlights the relevance of executive functions as predictors of learning and social adaptation in childhood. ^(1,19) indicate that working memory, attention, and emotional self-regulation are central axes of neurodevelopment, in line with this proposal. Similarly, the study by ⁽³⁾ confirms that neurofeedback and other neuropsychology-based interventions promote self-regulation and academic performance in structured environments with teacher support.

Regarding inclusive learning environments, the findings are consistent with those of ⁽¹⁵⁾; ^(3,13) who highlight accessibility and equity as essential conditions for ensuring participation. The Universal Design for Learning (UDL) approach, supported by ^(20,21), emerges as a necessary reference for diversifying pedagogical strategies and addressing cultural and functional diversity in classrooms.

Furthermore, the relevance of the socio-emotional and community climate is confirmed in the work of ⁽⁵⁾, who show that family participation and the creation of positive emotional bonds enhance both learning and socio-emotional development. These results support the need for a socio-community approach, complementary to school intervention, as proposed in this research.

2. Divergences and limitations of the existing literature

Despite these similarities, the review revealed divergences that justify the development of the proposed model. Much of the research on neuropsychological strategies focuses on specific populations, such as children with ADHD or language development disorders; ⁽⁶⁾ ⁽²⁾ reflecting a tendency to pathologize their application, restricting it to the clinical setting rather than exploring its potential in inclusive contexts for all children.

Another limitation encountered is the fragmentation between theory and practice. While the importance of inclusive environments is recognized, many studies reduce their analysis to infrastructure or digital resources, without integrating the cognitive, emotional, and social components of learning. ^(3,5) The proposal presented seeks to bridge this gap through a comprehensive model that articulates neuropsychological strategies with inclusive environments from an interdisciplinary perspective.

In the case of Latin America, the divergence is even greater. Most of the evidence originates from European or North American contexts. In contrast, in Latin America, structural limitations that hinder inclusion persist, including inadequate teacher training, a lack of resources, and weaknesses in educational policies. ^(12,13,16) In response to this, the proposal presented offers a contextualized approach, aimed at addressing the challenges specific to the region and adapting neuropsychological strategies to the heterogeneous educational realities.

3. Innovative contributions of the proposal

The central contribution of this research lies in the theoretical integration of neuropsychology and educational inclusion, two fields that have generally been studied separately. The former provides precise strategies for strengthening cognitive and socio-emotional development; the latter establishes a pedagogical and social framework based on equity and educational justice. By articulating both perspectives, an integrative theoretical model with three levels of action is proposed: cognitive-neuropsychological, pedagogical-environmental, and socio-community.

This approach represents an advance over the existing literature, as it is not limited to describing isolated interventions but proposes a coherent conceptual structure capable of guiding teaching practice, public policy formulation, and future research. In this way, the proposal addresses identified theoretical gaps and opens up the possibility of designing teacher training programs that integrate neuropsychological knowledge with inclusive methodologies.

4. Implications for research and educational practice

The findings discussed have significant implications. At the research level, there is a need to move toward interdisciplinary empirical studies that allow the theoretical model to be tested in diverse school contexts, generating more solid and contextualized evidence, especially in Latin America.

In educational practice, the proposal invites us to rethink teacher training from a comprehensive perspective that takes into account neuropsychological knowledge and the ability to design inclusive environments. This implies overcoming reductionist views of inclusion as mere integration and embracing it as a transformative process that requires changes in pedagogical practices, curricula, and institutional culture.

Finally, in the realm of public policy, the discussion highlights the importance of regulatory frameworks that guarantee access to resources, infrastructure, and family and community support programs. Only then will it be possible to consolidate educational environments that enhance neurodevelopment and provide the full inclusion of children.

CONCLUSIONS

The study allowed us to articulate, from a theoretical-propositional perspective, neuropsychological strategies and inclusive learning environments as complementary axes for enhancing child neurodevelopment. The critical review of the literature revealed significant advances in both fields, although gaps in their conceptual integration remain. In response, an integrative theoretical model was formulated that combines cognitive, pedagogical, and socio-community dimensions as the foundations of inclusive education.

It is concluded that neuropsychological strategies, such as strengthening executive functions, multisensory stimulation, neurofeedback, and emotional self-regulation, are valuable resources for both children with specific disorders and the general child population, as they optimize attention, memory, and emotional regulation processes. Likewise, inclusive environments, based on principles such as Universal Design for Learning (UDL) and a favorable socio-emotional climate, are essential conditions for ensuring equity and participation in the classroom.

Ultimately, it is acknowledged that inclusion and neurodevelopment necessitate an interdisciplinary and community-based approach that involves families, communities, and public policies. The proposed model provides an innovative foundation for guiding future research and pedagogical practices, underscoring the need for empirical validation in Latin American contexts and for teacher training programs that integrate neuropsychology and inclusive practices. In summary, promoting child neurodevelopment and ensuring educational inclusion requires the convergence of knowledge and practices, placing childhood as a priority to build more just and democratic societies.

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FUNDING

The authors did not receive funding for the development of this research.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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