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Brain plasticity in childhood: autonomous mental training strategies to enhance social development.

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ABSTRACT

When referring to the areas that humans develop, including the cognitive area, neuronal plasticity is an essential factor in fulfilling executive functions, making it indispensable to provide adequate conditions to establish optimal brain functions. There are different aspects that must be taken into consideration, such as environmental, psychological, social, and cultural aspects, which, if present, can cause delays in their skills in different areas, as well as a deterioration in their quality of life. The documentary review of the three field studies is therefore retrospective; it is an indirect observation that, according to the international tables of measurement of infants' skills of the standard, in short, the objective was to analyze the didactics, tools and knowledge of teachers and parents in cognitive stimulation and its influence on learning through independent games that allows obtaining an autonomous factor in their coexistence with their peers. The results showed that infants who received guidance regarding gross motor skills versus those who performed soft motor activities showed greater development, which in conclusion indicates that games effectively contribute to greater neuronal plasticity, allowing for good cognitive development and other areas. The investigations carried out identified effective methods to stimulate the child's brain, ensuring that children develop their abilities in a favorable and enriching environment.

Keywords: neuronal plasticity, cognitive development, child development, infants, playful.

INTRODUCCION

When discussing neural plasticity, it is understood as the process through which human beings have the opportunity to function more effectively in cognitive development. Indeed, neural plasticity allows individuals, in relation to the environment in which they develop, to progressively increase stimulation based on diverse experiences. These stimulations are considered foundational and, through a logical process, enable effective cognitive development. This process is particularly efficient during childhood, as it provides greater opportunities to consolidate learning. When neurological development is optimal, children's competencies allow for the consolidation of synaptic networks, resulting in improved performance in cognitive, emotional, and social domains, thus promoting better overall mental development.

Human development encompasses multiple areas and organs, with brain development being constant and dynamic, manifesting according to chronological age and maturational stages. Therefore, neural plasticity becomes the process through which the central nervous system stimulates adaptation to diverse environmental factors. These factors may include both positive and negative situations, which nonetheless promote structural or physiological changes that can lead to improved outcomes for the individual.

Concepts such as attention, memory, and mental maturation play a key role in problem-solving interpretation. Within analytical skills, social skills are also identified, as they are linked to emotional aspects that develop progressively according to chronological maturity. Emotional competencies such as empathy, self-regulation, and cooperation are essential elements for effective social interaction with peers and caregivers. These interactions support mental development by enabling the acquisition of effective and healthy tools for social

engagement. Consequently, the implementation of cognitive and basic exercise strategies across different developmental areas is considered essential for achieving more effective and successful development.

In this context, the present study explores how neural plasticity in early childhood achieves optimal outcomes through regular mental exercise strategies targeting the nervous system and synaptic connections. These strategies contribute to strengthening and enhancing social development among children, indicating that meaningful learning, stimulated appropriately according to age-based profiles, is essential for achieving efficient individual and group outcomes.

Theoretical Framework

Neural plasticity refers to the capacity of the central nervous system, particularly the brain, to adapt to changing external and internal environmental conditions. This adaptability allows the brain to cope with physical or emotional trauma, minimizing the effects of structural or physiological alterations regardless of their cause. The effectiveness of this process is closely related to the environments and experiences encountered by individuals, particularly during early childhood, and to the caregiving practices employed by primary caregivers.

Conceptually, neural plasticity is understood as the capacity of the nervous system to reorganize and form new connections throughout life, constituting a fundamental pillar of cognitive and emotional development during childhood. In the early years, neural plasticity facilitates the reception of environmental stimuli, easing the acquisition of new knowledge and skills that evolve into competencies. Even when developmental difficulties arise, neural

plasticity enables feedback mechanisms and improved neural coding, enhancing developmental outcomes (Medina Satizába & Mora Ruiz, 2017).

Among the most common strategies that foster cognitive autonomy and socialization are independent and autonomous mental exercises. These strategies support the development of essential cognitive functions such as memory, attention, concentration, and problem-solving, aligned with healthy socialization according to chronological age.

Neuroscience research demonstrates that mental exercises promote autonomy and strengthen neural networks, enhancing cognitive development and, subsequently, social interaction. These interactions involve emotional processes such as self-awareness, emotional understanding, self-regulation, and decision-making. Functional neural exercise supports children's interactions with peers and adults across family, community, and educational contexts, facilitating engagement in games and challenges that enhance executive functioning.

Early childhood is a sensitive period during which brain plasticity is heightened due to continuous neural changes driven by new experiences. This stage includes critical periods of intense synaptic development that facilitate learning and environmental interaction with reduced effort (Rebollo-Goni & De la Peña-Álvarez, 2017).

Neural plasticity not only supports skill acquisition but also mitigates developmental risks by reorganizing neural circuits in response to environmental inequalities or challenges. This process enables children to develop motor, cognitive, emotional, and social skills essential for adaptation to daily life contexts.

Early learning of skills such as language, fine motor abilities, and emotional self-regulation is directly linked to neural plasticity. Through repeated experiences, guided practice,

and appropriate stimulation, neural networks consolidate learning, bridging biological maturation with educational and social opportunities.

Executive functions are constructed through this neurobiological platform, including sustained attention, working memory, cognitive flexibility, emotional regulation, and decision-making. Educational evidence emphasizes that executive functions encompass planning, organization, self-regulation, attention, working memory, decision-making, cognitive flexibility, and inhibitory control (Ait-Abdellah-Sefian et al., 2025). Their development depends on prefrontal circuits sensitive to caregiving experiences and intentional pedagogical contexts.

Research further highlights that neural plasticity is regulated by intrinsic and extrinsic factors, including environmental influences (Foster & López, 2022). Play-based and structured learning interventions enhance executive functioning while promoting social participation and inclusion (Fusté Forné, 2023).

Additional modulators of neural plasticity include nutrition, exposure to toxins, and hormonal influences, which shape future behavioral outcomes (Cortés, 2022).

Neuroimaging studies using functional MRI and EEG have provided evidence that specific experiences induce changes in brain structure and function during infancy, demonstrating how targeted interventions enhance cognitive and behavioral outcomes (Kolb et al., 2010).

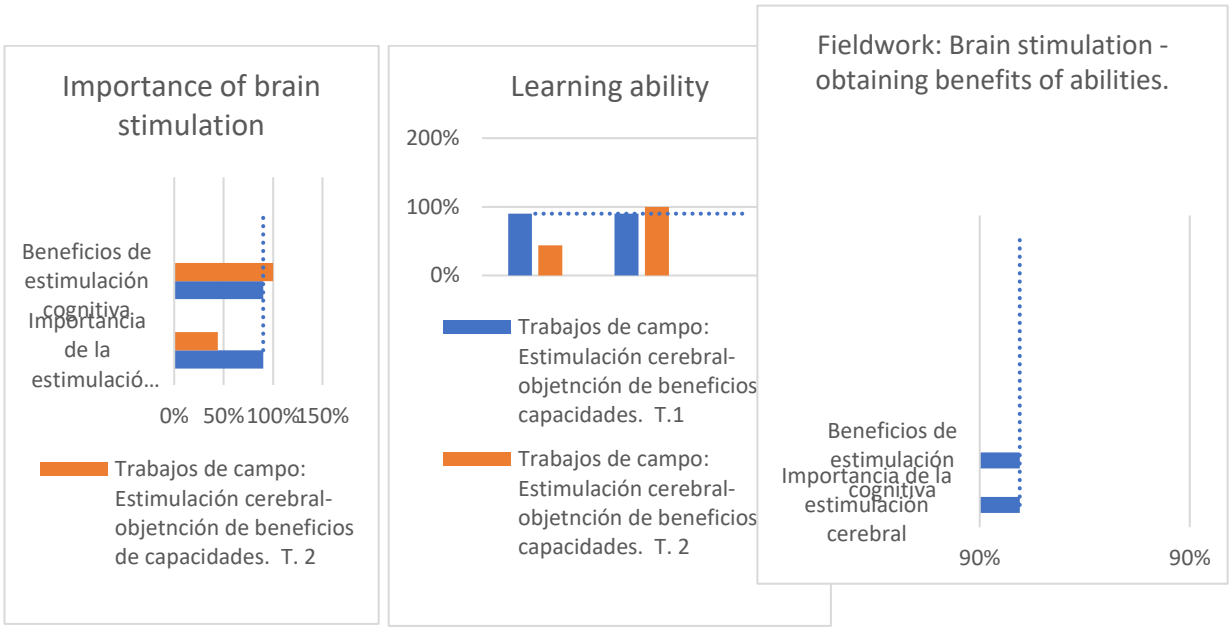
METHODOLOGY

This study was based on a documentary research method, utilizing bibliographic sources related to previous field studies. It constitutes a retrospective, quantitative study with a

descriptive and indirect observational design. Various field studies were reviewed to conduct indirect observations based on researchers' reported findings. Additionally, this research follows an inductive approach, progressing from individual cases to general conclusions.

One of the reviewed studies involved surveys administered to ten preschool teachers at Unidad Educativa Fiscal del Milenio Albertina Rivas de Santa Ana, in Manabí, Ecuador. The study analyzed their teaching practices and knowledge regarding the importance of early brain stimulation in childhood learning. Results indicated that 90% of the surveyed teachers believed that proper brain stimulation allows children to grow in a secure and confident manner, while 80% agreed that such stimulation enhances learning capacity. These findings highlight educators' recognition of the importance of early experiences in forming synaptic connections essential for children's cognitive, physical, emotional, and social development (UNIR, 2021).

Image 1 Meaningful standards on stimulation versus learning



Note. Summary of teachers' impressions regarding the analyzed variables; summary adapted from the authors' research study.

In summary, with regard to the present study, a review of the impressions of the study population—namely teachers as expert professionals in cognitive accompaniment and stimulation—reveals a valid attitude as stimulators and as creators of proposed strategies for the development and strengthening of cognitive competencies. According to this research, these activities promote greater brain elasticity and the rapid and effective formation of neural connections. The study confirms that brain stimulation in early childhood education is not only fundamental for children's holistic development, but also lays the foundation for their future academic success (Castro Cárdenas & Cevallos Cedeño, 2021).

The second study analyzed was Early Stimulation to Promote Cognitive Development in Children Aged 4–5 Years in the Parish of Cunchibamba, Ambato Canton, Tungurahua Province. This study examined the relationship between children's socioeconomic context and cognitive development. The results indicate that, although a direct relationship exists between these two variables, there is a need for further in-depth research into mediating factors that influence development, such as household structure, parenting styles, home-based stimulation, and health from birth through childhood. The study concludes that early intervention contributes not only to adequate cognitive development but also to development across all domains—motor, language, and social. Final results show that more than 50% of the studied population demonstrated an average level of cognitive development, and no child fell within the very low indicator, indicating that the intervention was satisfactory. This approach helps prevent potential learning difficulties at school age (Table 1), generates enthusiasm for learning through play, and strengthens skills and abilities involving higher-order cognitive capacities (Izurieta et al., 2023).

Table 1. Relationship Between Cognitive Development and Socioeconomic Conditions in 25 Children From the Parish of Cunchibamba, Ambato, 2021.

Socioeconomic conditions	**Low and very low cognitive development**		**Normal cognitive development**		**Total**		**p***
	Number	**%**	**Number**	**%**	**Number**	**%**	0,01
Low	4	44,4	0	0	4	16	
Not low	5	55,6	16	100	21	84,0	
Total	**9**	**100**	**16**	**100**	**25**	**100**	

Chi-square: $p < .05$ indicates statistical significance when $p < .05$.

Note. Relationship between socioeconomic aspects and the different strategies used for cognitive development; data adapted from the authors' research.

The third study analyzed was conducted in the city of Guayaquil and was titled The Influence of the Misuse of Technological Media on the Attention of Children Aged 5–6 Years at Unidad Educativa Espíritu Santo in Guayaquil. The results obtained through a survey administered to 22 parents of children aged 5 and 6 years who attend Unidad Educativa Espíritu Santo in Guayaquil reflect a diversity of parental opinions regarding the influence of technology on their children's behavior and cognitive development (Table 2). A significant proportion of respondents perceived that excessive use of electronic devices may negatively affect children's attention, concentration, and ability to recall important information. However, other opinions suggest that technology is not necessarily the determining factor in these difficulties.

Table 2. Do You Believe That Your Child Is Easily Distracted When Using Technology?

Answer	Frequency	Percentage	Valid Percentage	Valid cumulative percentage

Agree	10	45,5	45,5	45,5
Disagree	3	13,6	13,6	59,1
Strongly agree	5	22,7	22,7	81,1
Neither agree nor disagree	1	4,5	4,5	86,4
Totally disagree	3	13,6	13,6	100,0
Total	22	100,0	100	

*Note: This resource analyzes whether technology, as a current resource, allows for cognitive development from the perspective of the primary caregiver at home. Data taken from the authors' own work.***Tabla 1**

Do you consider your child has difficulty concentrating on tasks that require sustained attention, due to excessive use of electronic devices?

Answer	Frequency	Percentage	Valid Percentage	Valid cumulative percentage
Agree	10	45,5	45,5	45,5
Disagree	3	13,6	13,6	59,1
Strongly agree	4	18,2	18,2	77,3
Neither agree nor disagree	2	9,1	9,1	86,4
Totally disagree	3	13,6	13,6	100,0
Total	22	100,0	100	

Note. The authors' perspective on the use of technological resources based on the perception of primary caregivers, such as parents, within the context of children's home environments. Data adapted from the authors' research.

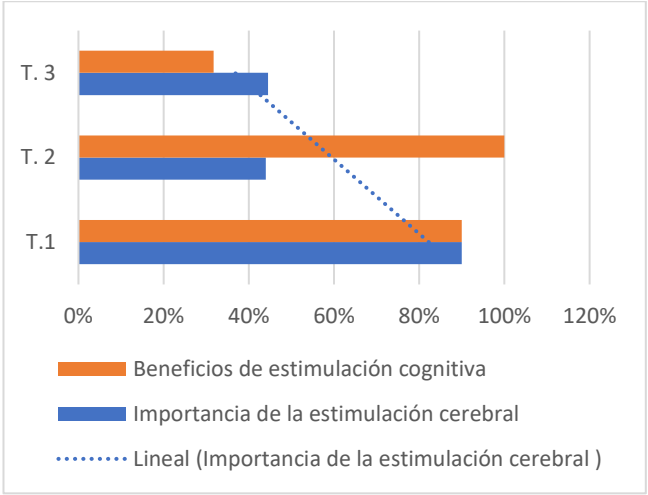
Seventy percent of parents express concern about their children's overexposure to electronic devices, fearing that this situation may compromise their cognitive and social development. They argue that the constant availability of digital entertainment may divert attention from more educational and social activities, which could have negative long-term consequences. In contrast, 30% of parents consider that technology can be beneficial if used appropriately. Parents recognize that one of the most developed competencies today—technological competence—has enabled children to achieve greater autonomy in learning (Table 3). Therefore, it is suggested that the problem is not technology itself, but rather the amount of time, the type of resources, and the thematic content used, which may either favor or hinder the effective use of this resource (Herrera Ruiz et al., 2024).

The different viewpoints regarding the use of technology go beyond the individual decision to accept or reject its use; they extend to understanding the complexity of how this resource is employed. It is essential to address the diverse needs of children who may experience attention-related concerns linked to this issue. In other words, multiple variables may influence or limit the use of technology and the development of cognitive competencies such as memory, as well as social competencies such as healthy peer interaction, with technology being only one of these factors (Table 3). Ultimately, supervision and control by parents and educators are fundamental to ensuring a balanced and healthy use of technology by children. This involves establishing clear limits, providing guidance on responsible device use, and encouraging participation in activities that promote holistic development, such as exploration, creativity, and social interaction (Herrera Ruiz et al., 2024).

Analysis of the 3 studies considered:

Table 4

Fieldwork: Brain stimulation - obtaining benefits of abilities



Note. The benefits of brain stimulation are reflected in the enrichment of learning content.

Among the indicators of the questionnaire developed by the authors, and in contrast to other analyzed studies, emphasis is placed on cognitive stimulation in relation to neural processes. The following analytical data were considered, serving as correlations among variables such as the use of technological resources, specific cognitive stimulation, and various learning outcomes. These currently represent recent resources used in both formal and informal education settings, including educational institutions and the home. Likewise, both intrinsic use and external stimulation were analyzed. Three key inquiries were reviewed, indicating that infants require functional interaction through either concrete or technological resources. An essential factor highlighted by the studies is that children tend

to maintain social interaction with their peers through both virtual and concrete play. According to the analysis, these interactions were found to be above the average level (Table 4).

Discussion

The articles reviewed to analyze the importance of neuronal plasticity and appropriate autonomous mental exercises in early childhood are fundamental for children's safe and confident growth (Castro Cárdenas & Cevallos Cedeño, 2021). These approaches not only enhance learning capacity but also promote the rapid formation of neural connections, thereby facilitating comprehensive development. This development is not limited to cognitive aspects, but also includes motor, language, and social domains, which is essential for preventing future learning difficulties and fostering enthusiasm for learning through play.

Such stimulation strengthens higher cognitive skills and abilities necessary for academic and personal success, which is consistent with the findings of Izurieta et al. (2023) and Herrera Ruiz et al. (2024). These authors also emphasize the importance of both teachers and parents having adequate knowledge about the use of technology in early childhood and its impact on infant neuroplasticity.

Conclusion

Finally, it is essential to pay close attention to the stimulation of neuronal plasticity by strengthening mental strategies aimed at fostering autonomy in early childhood. The study conducted at the Unidad Educativa Fiscal del Milenio Albertina Rivas, located in Santa Ana, Manabí, Ecuador, demonstrates that effective neuronal stimulation helps children grow in a

safe and balanced manner. This learning potential is reflected in the development of skills across the different areas in which human beings grow.

The strategies used by teachers to achieve more engaging and efficient sensory development are evident in various sensory activities, such as promoting more dynamic reading practices and incorporating outdoor activities, for example swimming. These strategies lead to more effective outcomes in sensory development for participants. Consequently, promoting greater cerebral elasticity results in stronger neural connections, which in turn contribute to healthier and more efficient executive functions in task performance.

Similarly, the study conducted for the creation of the Early Stimulation Guide for children aged 4 to 5 in Cunchibamba, Tungurahua province, highlights the importance of early attention. The results demonstrated effectiveness in cognitive, socio-emotional, linguistic, motor, and social development, contributing to the healthy development of the study population. This approach reinforces the understanding of the human being as an integral entity and highlights the importance of leveraging resources such as neuronal development through neuroplasticity to achieve better outcomes and prevent future difficulties, while strengthening skills and promoting higher cognitive abilities.

Additionally, the study carried out at the Unidad Educativa Espíritu Santo in Guayaquil showed that the use of contemporary resources—particularly technology—must be carefully regulated, analyzed, and aligned with clearly defined objectives aimed at achieving previously planned outcomes. This research considered not only the infants as the primary subjects of study but also their immediate caregivers, particularly parents,

demonstrating that families play a crucial role in selecting appropriate resources to create effective stimulation strategies.

The findings indicate that parents assumed responsibility for selecting and implementing technological resources, guided by a positive and conscious approach. However, the study also emphasizes the need to avoid excessive use of technology and the absence of clear objectives, as these factors could cause irreversible harm to children's development.

In conclusion, adequate stimulation of neuronal plasticity, combined with exercises that promote autonomy and healthy independence in early childhood, can lead to effective development across multiple areas, particularly socio-emotional and cognitive domains. This stimulation also provides benefits in physical and affective development, contributing to a healthier and more balanced childhood, and ultimately fostering success in both academic and personal spheres, benefiting not only children themselves but also those around them.

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