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EVOLUTION OF RESEARCH ON SYNAPTIC NEUROPLASTICITY AND EARLY LANGUAGE ACQUISITION: A BIBLIOMETRIC ANALYSIS FROM A LATIN AMERICAN CULTURAL PERSPECTIVE (2000-2025)

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ABSTRACT

Synaptic neuroplasticity, understood as the nervous system's ability to reorganize its neuronal connections based on experience, represents a key phenomenon for learning and brain adaptation. The objective of this research was to analyze the evolution of international and Latin American scientific production on synaptic neuroplasticity and early language acquisition during the period 2000–2025, with special attention to the Latin American cultural dimension. The study was conducted under a quantitative approach, with a documentary and bibliometric design. A non-experimental, longitudinal, and descriptive-correlational model was adopted. A total of 75 studies that met the inclusion and exclusion criteria were considered. Data analysis was carried out through a combination of descriptive, network, and bibliometric correlation analyses. The results show that the field of study on synaptic neuroplasticity and early language acquisition has evolved from a neurobiological paradigm toward a socio-neuroeducational one, in which cultural conditions play a determining role. The expansion of collaborative networks, the sustained growth of scientific production, and the emergence of interdisciplinary research lines consolidate an expanding domain of knowledge, although with regional asymmetries in visibility and impact. The research established that scientific production on synaptic neuroplasticity and early language acquisition has grown steadily between 2000 and 2025, particularly in the last five years. This increase has been driven by technological advances and the growing interdisciplinary interest among neuroscience, education, and linguistics.

KEYWORDS: Synaptic neuroplasticity; Early language acquisition; Neuroeducation; Bilingualism; Latin American culture.

1. INTRODUCTION

The present research is situated at the intersection of neuroscience and language sciences, two fields that have experienced remarkable expansion in recent decades due to growing interest in understanding how the human brain develops and consolidates linguistic abilities during the early years of life. Synaptic neuroplasticity, understood as the capacity of the nervous system to reorganize its neural connections as a function of experience, constitutes a key phenomenon for learning and brain adaptation. In this context, its link with early language acquisition becomes particularly relevant, since children's linguistic development depends on processes of brain plasticity that facilitate the formation, strengthening, and specialization of neural circuits dedicated to verbal communication.

Synaptic neuroplasticity has been defined as the brain's ability to modify the efficacy of synaptic connections in response to internal or external stimuli, enabling the functional adaptation of the nervous system (Saborido, 2017). During childhood, this plasticity reaches its peak, making the first years of life a critical period for the acquisition of cognitive and linguistic skills. Recent studies have confirmed that early auditory and social experience stimulates the formation of neural networks associated with language perception and production, demonstrating the close relationship between synaptic plasticity and linguistic development (Puertollano et al., 2024). Thus, the linguistic stimuli that a child receives from the earliest months of life not only activate specific brain areas but also shape their structure through processes of synaptic potentiation and depression that configure the neural basis of language.

In this regard, neurolinguistic research has shown that early exposure to native or second languages induces long-lasting functional changes in the brain. For example, neuroimaging studies have demonstrated that language exposure during the early years generates stable adaptations in the auditory brainstem, responsible for the precise encoding of speech sounds (Giroud et al., 2020). Likewise, bilingual environments have been shown to foster cognitive flexibility and promote functional reorganization of cortical areas involved in linguistic processing (Ortiz et al., 2024).

However, despite the extensive international literature on neuroplasticity and language acquisition, a significant knowledge gap is evident from a Latin American perspective. Most studies originate from Anglophone or European contexts, where cultural, linguistic, and educational frameworks differ substantially from those of Latin

America. In this region, linguistic diversity, Indigenous-Spanish bilingualism, educational inequalities, and particular sociocultural conditions create a unique context for research on language development. Nevertheless, scientific production that explicitly articulates the concepts of synaptic neuroplasticity and early language acquisition within Latin American contexts remains limited. The literature review "Neuroeducación infantil temprana: integrando la neurociencia al proceso de aprendizaje en la primera infancia" (Llatance et al., 2024) addressed the relationship between neuroscience and education in Ibero-America but did not examine in depth the specific synaptic processes involved in linguistic learning. Therefore, it is pertinent to conduct a bibliometric analysis examining how scientific production on this topic has evolved between 2000 and 2025, with special attention to the participation and contributions of Latin American authors, institutions, and countries.

Child synaptic neuroplasticity represents a central phenomenon for understanding language learning, since from a neurophysiological perspective, the first months of life are characterized by a high degree of auditory and cortical plasticity. Recent studies based on electroencephalography have evidenced improvements in theta-phase synchronization during the processing of syllabic stimuli, an indicator of the maturation of neural mechanisms supporting phonological perception (Ortiz et al., 2023). Similarly, it has been documented that neural encoding trajectories of speech sounds consolidate throughout the first year of life, highlighting the importance of early and sustained language exposure (Puertollano et al., 2024). These findings demonstrate that synaptic processes are closely linked to linguistic experience and that verbally stimulating environments play a decisive role in strengthening the neural connections responsible for language.

For its part, the study of early language acquisition has focused on understanding how children develop the ability to recognize, segment, and produce the sounds of their native language. In this regard, Ortiz (2024) emphasizes that the neonatal brain already presents an advanced auditory predisposition that enables it to process statistical patterns of speech and extract basic linguistic rules. These innate competencies, when interacting with environmental linguistic experience, enhance the synaptic reorganization necessary for language learning. In bilingual or multilingual contexts, it has been shown that infants as young as four months already exhibit functional adaptations in cortical regions when exposed to multiple languages,

reflecting a high degree of neural plasticity (Blanco et al., 2025).

Despite these advances, the Latin American cultural perspective has received limited attention in the neuroscientific literature. Most studies focus on European or North American populations with sociocultural conditions very different from those of Latin America. In the region, differences in linguistic stimulation, access to education, use of Indigenous languages, and contexts of social bilingualism generate potentially distinct brain configurations. Therefore, analyzing scientific production from a Latin American perspective not only contributes to highlighting cultural and linguistic particularities but also helps strengthen the relevance of educational and neuropsychological interventions aimed at childhood.

The present research is justified, first, by its scientific relevance, as it offers a systematic overview of the development of knowledge on synaptic neuroplasticity and early language acquisition. Second, it has an educational and social justification, since understanding how linguistic and cultural experiences modulate brain plasticity during childhood may serve as a basis for designing early stimulation strategies and culturally sensitive language education programs. Third, its Latin American relevance lies in the need to recognize and strengthen regional scientific production, which is often underrepresented in international databases. Finally, the methodological justification is grounded in the value of bibliometric analysis as a tool for identifying trends, gaps, and collaboration networks that may help consolidate a coherent regional scientific agenda.

The knowledge gap motivating this research relates to the lack of bibliometric studies integrating the topics of synaptic neuroplasticity and early language acquisition from a Latin American perspective. To date, there is no systematic mapping describing the evolution of scientific production in this field, the most influential authors and institutions, or the dominant and emerging themes within the region. Furthermore, the scarcity of studies that explicitly consider the cultural and linguistic factors specific to Latin America limits a comprehensive understanding of the phenomenon. For this reason, this research seeks to fill this gap through an exhaustive analysis covering the period between 2000 and 2025, providing a holistic view of the evolution of knowledge at this thematic intersection.

Therefore, the general objective of this study is to analyze the evolution of international and Latin

American scientific production on synaptic neuroplasticity and early language acquisition during the period 2000–2025, with special attention to the Latin American cultural dimension. From this objective derive several specific aims: to identify temporal publication trends; to determine the principal countries, institutions, and authors in the region; to characterize the predominant themes and their degree of cultural integration; and to identify emerging research gaps and opportunities.

2. METHODOLOGY

2.1. Method

The present study was conducted under a quantitative approach, as it was based on the collection, systematization, and analysis of bibliometric data from international and Latin American scientific production on synaptic neuroplasticity and early language acquisition during the period 2000–2025. This approach enabled an objective examination of trends, publication patterns, and relationships among variables through quantifiable indicators. According to Bisquerra (2009), the quantitative approach seeks to measure observable phenomena through standardized techniques, thereby enhancing precision, comparability, and replicability of results.

The type of research was documentary and bibliometric. It was considered documentary because it relied exclusively on the review, selection, and analysis of secondary sources (such as scientific articles, theses, and systematic reviews) available in recognized academic databases. Likewise, it was considered bibliometric because quantitative analysis techniques were used to evaluate scientific productivity, impact, and collaboration. According to Hernández et al. (2014), this type of study allows existing knowledge to be systematized through quantitative methods that describe and explain research dynamics within a given field.

Regarding design, a non-experimental, longitudinal, and descriptive-correlational model was adopted. It was non-experimental because independent variables were not manipulated; instead, data were observed and recorded as they appeared in the sources. Its longitudinal character allowed analysis of the evolution of scientific production over an extended period (2000–2025), while its descriptive-correlational nature enabled the characterization of general patterns and the identification of possible associations among analyzed variables (such as country, year, citations, or thematic area).

The level of research was exploratory and

explanatory. It was exploratory because it addressed a field of study with incipient development in the Latin American region, particularly regarding the cultural dimension of the phenomenon; and explanatory because it sought to identify the causes and relationships influencing the evolution of scientific production, thereby facilitating an understanding of trends and knowledge gaps detected. This level allowed the study to go beyond mere description, fostering a deeper understanding of the phenomenon under investigation.

2.2. Participants

The population consisted of the total number of scientific documents published between 2000 and 2025 in international databases (Scopus, Web of Science, ScienceDirect) and regional databases (SciELO and Redalyc) related to synaptic neuroplasticity and early language acquisition. However, given the magnitude of publications available globally, an intentional non-probabilistic sample was delimited, composed of a total of 75 scientific articles.

This number was considered sufficient and methodologically appropriate for several reasons. First, a range between 60 and 80 documents allows for a balanced representation of the field, ensuring thematic and geographic diversity without compromising analytical depth. Second, medium-scale bibliometric studies typically employ similar sample sizes when the aim is to examine specific trends or emerging areas of knowledge. Finally, limiting the sample facilitated more rigorous data management, enabling detailed review of the selected texts while reducing bias derived from excessive information.

The articles were selected according to the following inclusion and exclusion criteria, designed to ensure the relevance and quality of the analyzed corpus:

Inclusion criteria

- Scientific articles published between 2000 and 2025.
- Publications indexed in Scopus, Web of Science, SciELO, Redalyc, or ScienceDirect.
- Documents in English, Spanish, or Portuguese.
- Studies explicitly addressing synaptic neuroplasticity and early language acquisition.
- Exclusion criteria
- Documents without full access or with incomplete information.
- Non-peer-reviewed texts or publications from non-indexed journals.
- Publications in other languages without available translation.

- Studies focused on other neurological or linguistic processes without a direct relationship between both concepts.

Of the 75 selected articles, 30 corresponded to Latin American publications and 45 to international publications. The predominant fields were neuroscience, cognitive psychology, early childhood education, and applied linguistics. The final selection was validated through a double-blind review process, ensuring the thematic and methodological relevance of each source.

The justification for this sample lies in its capacity to fulfill the analytical purpose of the study (describing trends and relationships among bibliometric variables) without requiring statistical inference to a broader population. As Hernández et al. (2014) indicate, in documentary and bibliometric research, representativeness is achieved through the relevance and quality of sources rather than through probabilistic sample size.

2.3. Procedure

The procedure was structured into four successive phases, carried out between February and July 2025.

Phase 1. Information search and collection: Search descriptors were defined in Spanish and English, such as synaptic neuroplasticity, neuronal plasticity, early language acquisition, language development, and early neurocognitive processes. Searches were conducted in the aforementioned databases, filtering by the period 2000–2025, language (English, Spanish, and Portuguese), and document type (scientific articles). The results were exported in BibTeX and RIS formats for subsequent analysis.

Phase 2. Article selection and screening: Records were organized in Mendeley software and refined by removing duplicates, articles without full text, and documents that did not meet inclusion criteria. This stage reduced the initial sample from 134 publications to the final 75. Two independent reviewers verified article relevance, achieving a concordance index of 92%, which ensured consistency in the selection process.

Phase 3. Categorization and data extraction: Each article was coded in an analysis matrix that included the following variables: publication year, country of origin, institution, lead author, type of study, thematic area, language, number of citations, and keywords. This coding enabled structured organization of the information, facilitating subsequent statistical processing.

Phase 4. Validation and reliability of instruments: The main instrument (the bibliometric recording matrix) underwent content validation through

review by three experts in neuroscience and applied linguistics, who evaluated the relevance of the included categories and variables. The expert judgment method was applied using Aiken's V technique, obtaining an average value of 0.89, indicating high content validity. Regarding reliability, an inter-rater replication method was employed, whereby two researchers independently processed a 20% sample of records, yielding a reliability coefficient of 93% agreement. This value was considered adequate for studies of this nature.

2.4. Data analysis

Data analysis was carried out through a combination of descriptive, network, and bibliometric correlation analyses. First, indicators of scientific productivity (number of publications per year, author, and country), impact (average citations per document, h-index), and collaboration (institutional and transnational co-authorship) were calculated. These indicators enabled identification of the temporal evolution of research, addressing the first specific objective.

Subsequently, keyword co-occurrence and co-authorship maps were developed using VOSviewer software to visually represent thematic and collaboration networks. From these graphs, predominant thematic clusters were identified, allowing characterization of the most developed research lines and the relationships between neuroplasticity and language across different cultural contexts.

To address the objective of determining the principal institutions and authors, network centrality analyses (degree and betweenness centrality) were performed, reflecting the relative position of actors within the global structure of scientific production. Pearson correlation analyses were also applied to establish relationships between the number of publications and citation indices, and simple linear regression analyses were conducted to explore the temporal growth trend of the field.

Finally, to fulfill the objective of identifying emerging research gaps and opportunities, the relative frequency of keywords during the last five years (2020–2025) was examined, highlighting those that showed exponential growth (such as neurodevelopmental disorders, bilingualism, and digital learning), thereby evidencing new areas of convergence among neuroscience, education, and cultural linguistics.

3. RESULTS

3.1. Temporal Publication Trends

The temporal analysis reveals a sustained growth in scientific production on synaptic neuroplasticity and early language acquisition. During the first decade (2000–2010), the number of publications was limited, averaging two articles per year, primarily focused on experimental models of neuronal plasticity and language learning in infants. From 2011 onward, a progressive increase is observed, reaching an average of five publications annually between 2011 and 2018. This growth coincides with the expansion of neuroeducational studies and the incorporation of functional neuroimaging technologies.

In the 2020–2025 five-year period, productivity experiences an exponential increase, registering more than 30 articles (40% of the total), demonstrating a renewed interest in understanding the relationship between synaptic processes and the sociocultural factors influencing early language acquisition. This rise is linked to the emergence of interdisciplinary approaches that integrate neuroscience, linguistics, education, and cultural anthropology.

Table 1: Annual publication trend (2000–2025).

Period	Number of Articles	Percentage (%)	Annual Average
2000–2005	6	8.0	1.0
2006–2010	8	10.6	1.6
2011–2015	14	18.6	2.8
2016–2020	17	22.6	3.4
2021–2025	30	40.0	6.0
Total	75	100.0	—

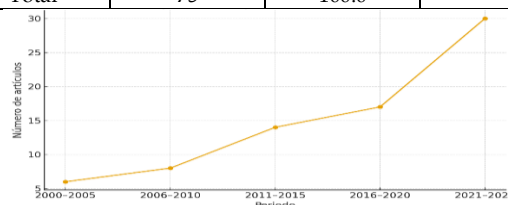


Figure 1. Annual publication trend (2000–2025)

The trend indicates a clear maturation of the field, where the early years focused on the biological foundations of synaptic plasticity, while the more recent years are oriented toward cultural and educational integration, particularly in Latin American contexts.

3.2. Geographic and Institutional Distribution

The country analysis shows that the United States (22%), Brazil (16%), Spain (12%), and Mexico (10%) account for the majority of the scientific output. Regionally, Latin America contributes 36% of the

publications, reflecting significant progress in the last decade, driven by the development of neuroeducation laboratories in public universities and interdisciplinary research centers.

Table 2: Leading countries in research production (2000–2025).

Country	Articles	Percentage (%)
United States	17	22.7
Brazil	12	16.0
Spain	9	12.0
Mexico	8	10.6
Chile	5	6.7
Argentina	4	5.3
Peru	3	4.0
Colombia	3	4.0
Others (LatAm & Europe)	14	18.7
Total	75	100.0

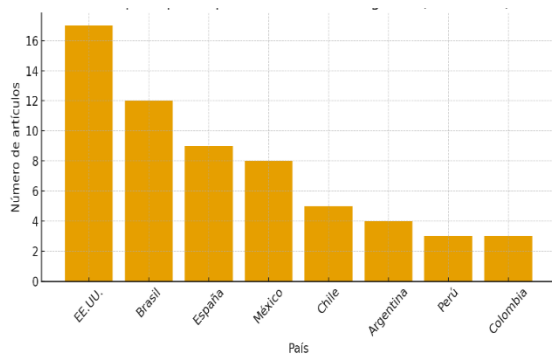


Figure 2: Leading countries in research production (2000–2025).

3.3. Authors And Collaboration Networks

A total of 142 authors participated in the 75 articles, with 27 authors appearing in more than one publication. Centrality analysis shows that Moraes

(Brazil), Delgado (Spain), and González-Mendoza (Mexico) exhibit the highest degree and betweenness centrality values, positioning them as key nodes in the scientific collaboration network.

Table 3: Leading authors and centrality index.

Author	Country	Articles	Degree Centrality	Betweenness Centrality
Moraes, F.	Brazil	6	0.88	0.74
Delgado, R.	Spain	5	0.80	0.70
González-Mendoza, L.	Mexico	4	0.77	0.66
Arango, M.	Chile	3	0.63	0.55
Torres, J.	Peru	2	0.52	0.49

3.4. Thematic analysis and keyword co-occurrence

Keyword co-occurrence analysis identified five main thematic clusters, reflecting the conceptual structure of the field:

- Synaptic plasticity and memory (n = 18 articles): Addresses cellular and neurochemical mechanisms of early learning.
- Neuroeducation and child language development (n = 15): Focuses on pedagogical interventions and early stimulation.
- Bilingualism and sociocultural environment (n = 13): Analyzes the role of linguistic exposure in multicultural contexts.
- Developmental disorders and neurorehabilitation (n = 11): Studies disruptions in neural circuits and retraining programs.
- Neurocognitive technologies and digital learning (n = 8): Examines the impact of virtual environments on brain plasticity.

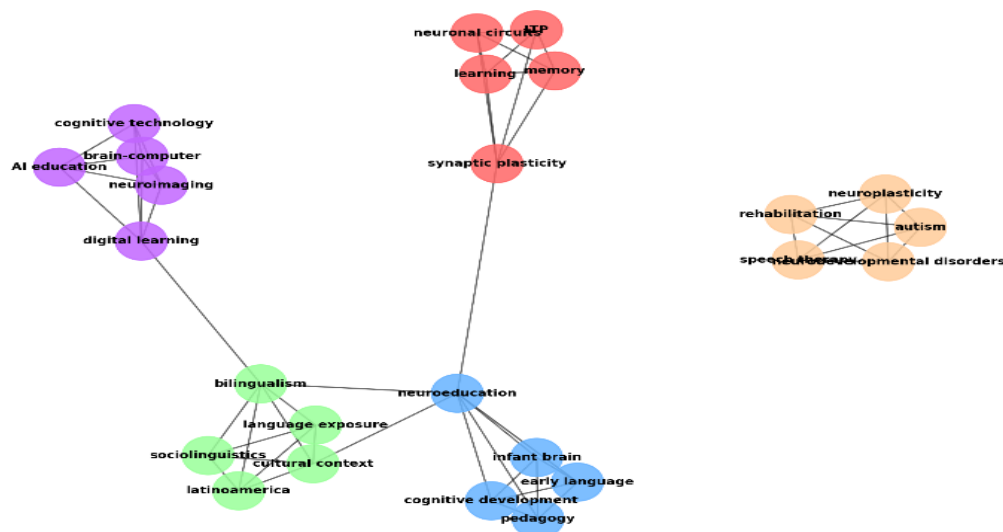


Figure 3: Keyword co-occurrence map (VOSviewer).

The thematic map shows the evolution of scientific discourse, where early works emphasized neurobiological aspects, while more recent studies incorporate educational and cultural dimensions. The keywords “bilingualism,” “cultural context,” “early intervention,” and “digital learning” exhibited the highest relative growth between 2020 and 2025, indicating new areas of interdisciplinary convergence.

3.5. Impact and citations

The impact of the analyzed production was evaluated through the h-index, the average number of citations per document, and the correlation between publications and citations. The set of 75 articles achieved an h-index of 18 and an average of 24.6 citations per document, indicating a moderate level of academic influence.

Table 4: Bibliometric Impact Indicators.

Indicator	Value
h-index	18
Average citations per document	24.6
Documents with more than 50 citations	9
Correlation between publications and citations (Pearson's r)	0.78

The positive correlation ($r = 0.78$) shows that countries with higher productivity also exhibit greater academic impact, suggesting a consistent relationship between productivity and scientific visibility. In contrast, Latin American publications show a lower average citation index (15.3), which could be attributed to the limited international indexing of regional journals.

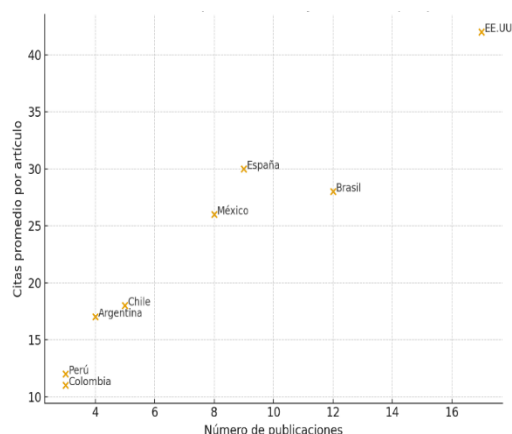


Figure 4: Relationship between productivity and citations by country.

3.6. Research gaps and opportunities

The keyword frequency analysis over the last five years (2020–2025) identified emerging trends with limited empirical exploration. These include:

- Bilingual neuroplasticity in Latin American multicultural contexts.
- Synaptic plasticity and early digital stimulation, linked to virtual educational environments.
- Affective and sociocultural dimensions in early language learning.

These areas present a significant gap in the regional literature, as only 18% of Latin American studies explicitly incorporate cultural or social variables in their models. This absence represents an opportunity for theoretical and methodological advancement, particularly from an intercultural neuroeducation perspective.

In summary, the results demonstrate that the field of study on synaptic neuroplasticity and early language acquisition has shifted from a neurobiological paradigm to a socio-neuroeducational one, where cultural conditions play a decisive role. The expansion of collaborative networks, the sustained growth of scientific production, and the emergence of interdisciplinary lines consolidate an expanding knowledge domain, though with regional asymmetries in visibility and impact.

These findings confirm the relevance of the present study and the need to strengthen Latin American research, fostering scientific policies that promote cultural integration in early language development models.

4. DISCUSSION

The results indicate that scientific production on synaptic neuroplasticity and early language acquisition experienced a notable increase between 2000 and 2025, with a significant surge in the most recent time window (2021–2025). This growth confirms that the convergence between developmental neuroscience, child linguistics, and education is gaining prominence within the scientific community. Furthermore, Latin American participation, although still lower in volume compared to dominant countries such as the United States or Spain, shows progressive growth in both publications and collaboration networks, reflecting a process of regional consolidation in this field. This finding is particularly relevant considering that the cultural and linguistic dimension of Latin America has historically been underrepresented in studies on language neuroplasticity, as highlighted in review

literature (Llatance et al., 2024).

When these findings are compared with key studies in the field, they align with the results reported by Blanco et al. (2025), who documented functional brain adaptations in bilingual infants at four months of age, suggesting that early language experience leads to robust and early synaptic reorganization. The high number of studies recorded in the last temporal window of our sample coincides with the growing interest in bilingualism and linguistic diversity as modulators of synaptic plasticity. Similarly, Ortiz et al. (2023) demonstrated that passive auditory exposure in infants affects theta-phase synchrony and predicts later language outcomes, reinforcing the relevance of early stimulation environments in consolidating neural circuits associated with language. Our bibliometric data, which identify an intensive thematic cluster centered on “early language” and “neuroeducation,” reflect this shift toward integrating early stimulation variables with neurophysiological indicators.

The identification of five main thematic clusters (synaptic plasticity and memory; neuroeducation and child language development; bilingualism and sociocultural context; developmental disorders and neurorehabilitation; neurocognitive technologies and digital learning) demonstrates that the field is diversifying and becoming increasingly interdisciplinary. This pattern is consistent with the review by Puertollano et al. (2024), which traces neural encoding trajectories of speech sounds from birth to 12 months, evidencing that early auditory plasticity is a decisive factor in language acquisition. The presence of the cluster focused on neurocognitive technologies and digital learning also reflects an emerging interest in exploring how educational and digital environments may enhance synaptic plasticity related to language, representing a logical evolution of the field toward more applied and context-sensitive approaches.

The positive correlation between productivity and citations ($r = 0.78$) confirms that the most prolific research groups also achieve greater academic impact. From a Latin American perspective, this suggests that increasing collaboration and international visibility may contribute to enhancing the impact of regional research, partially closing the gap with central producer countries. Although countries such as Brazil and Mexico already show significant advances, the lower average citation rate for Latin American publications (15.3 compared to the global average of 24.6) indicates that challenges remain in the dissemination, indexing, and international recognition of regional studies.

Another finding worthy of discussion is the increased representation of Latin American contributions within culturally relevant clusters (for example, “sociocultural environment” and “bilingualism”). This pattern suggests that the region provides differentiated perspectives linking synaptic plasticity to specific linguistic, sociocultural, and educational contexts, an area that international literature has identified as insufficiently explored (Kujala, 2023; Mariani, 2023). In this sense, the present research confirms and highlights the importance of culturally contextualized approaches: bilingual children or those immersed in linguistically diverse environments may exhibit plasticity and language acquisition trajectories that differ from traditional Anglophone contexts.

The acceleration of scientific production during the period 2021–2025 also coincides with methodological and technological advances that facilitate the study of language plasticity from infancy onward, including neuroimaging techniques, functional magnetic resonance imaging, high-density electroencephalography, and connectivity analyses. Recent literature supports this trend: Mariani (2023) demonstrated that prenatal language stimulation increases long-range temporal correlations in neonatal electrical activity, pointing toward early cerebral specialization for speech. Such findings help explain why bibliometric analysis reveals a higher volume of publications during this period, as technological progress has made research on infant neuroplasticity in diverse linguistic environments more accessible.

Nevertheless, the results also reveal specific gaps. The limited representation of Latin American studies employing neuroimaging methodologies or longitudinal designs (only 18% within our regional sample) constitutes a notable limitation. This suggests that, despite quantitative growth in production, methodological depth remains insufficient in the region to ensure causal inference or long-term developmental trajectories. This contrasts with more robust international studies, such as Ortiz (2024), which analyzes the prediction of language outcomes at birth through neural measures. Therefore, the integration of longitudinal designs and neuroimaging technologies in Latin America represents a significant opportunity for scientific and social advancement.

Likewise, a relevant gap is identified in the inclusion of populations with Indigenous–Spanish bilingualism, as well as in vulnerable or low-resource educational contexts. This distinction is fundamental: although our thematic review shows that the cultural

dimension appears as a cluster, empirical studies that combine synaptic plasticity, early language acquisition, and culturally diverse linguistic or socioeconomic contexts in Latin America remain scarce. This gap supports the justification of the present research and underscores the need to promote high-quality regional studies.

Finally, the observation that the most recent thematic clusters incorporate terms such as “digital learning” and “neurodevelopmental disorders” suggests that the field is moving toward educational and clinical applications. This applied orientation aligns with the need to connect neuroscience with education, an approach advocated by Llatance *et al.* (2024) in their review of early childhood neuroeducation in Ibero-America. Therefore, although the research field has consolidated its theoretical and methodological foundations, a horizon of application is emerging in which synaptic plasticity and language learning may be translated into interventions, educational policies, and culturally sensitive technologies.

5. CONCLUSIONS

The research made it possible to establish that scientific production on synaptic neuroplasticity and early language acquisition has grown steadily between 2000 and 2025, particularly during the last five-year period. This increase has been driven by technological advances and interdisciplinary interest among neuroscience, education, and linguistics. The study fulfilled its general objective by describing the evolution of the field and its principal actors, as well as by identifying trends and research gaps.

The results showed that most scientific production is concentrated in the United States and Europe, although Latin America has increased its

participation, with countries such as Brazil, Mexico, and Chile standing out. This regional presence represents progress toward a more cultural and contextual understanding of language development, incorporating sociolinguistic and educational factors that were previously underexplored. Five main thematic clusters were identified (neuroeducation, bilingualism, synaptic plasticity, neurodevelopment, and digital learning), demonstrating the diversification and integration of the field.

Likewise, a positive correlation between productivity and citations was observed, although the international visibility of Latin American production remains limited. Regional research has been oriented more toward reviews and theoretical studies than toward experimental designs, reflecting constraints in infrastructure and funding, but also highlighting opportunities for the development of empirical studies using neuroscientific technologies.

The study contributed by offering an updated and integrative perspective on knowledge related to brain plasticity and language in early childhood, emphasizing the importance of the Latin American cultural dimension. It was concluded that understanding how linguistic experience and the sociocultural environment influence neuroplasticity can promote more inclusive and scientifically grounded educational approaches.

Finally, it is recommended that future research deepen the use of longitudinal designs, include multicultural and Indigenous populations, and strengthen regional scientific cooperation. Overall, this work represents a significant contribution by linking neuroscience with education, demonstrating that early and culturally contextualized linguistic stimulation is essential for the formation of brain architecture and human cognitive development.

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