Exploring the influence of neuroscience on literacy: A systematic review

Geraldine Rambao Tamara[1], Nelys Martínez Almanza[1], Erick Fruto Silva[2] , Edgardo Sánchez Montero[2], Liliana Canquiz-Rincón[2], Diana García Leyva[2], Rober Miranda Acosta[2], Arnold Díaz Jiménez[2], Kadry García Mendoza[2],Adriana Alvarino González[3], Carlos Hernández Mejía [4]

Abstract

The purpose of this article is to demonstrate how neuroscience can be used as a cognitive stimulant to counteract the lack of interest in reading and writing processes in childhood. It highlights the importance of primary education in the cognitive development of children, as well as the relevance of neuroscience in understanding the brain processes associated with reading and writing. It also mentions that learning to read is fundamental in human development and that it begins at an early age, being transcendent in the development of vocabulary and phonology. This research was supported by a systematic review, which included previous studies and research on reading and writing and neuroscience as categories of analysis. It is emphasized that reading and writing not only enrich academic knowledge, but also strengthen critical and creative thinking skills, as well as the development of motor and linguistic skills; therefore, it implies an interactive process of cognitive complexity.

[1]Student of the Bachelor's Degree in Basic Primary Education – Universidad de la Costa
[2]Department of Humanities -Universidad de la Costa.
[3]University Foundation for Research, Technological Development and Innovation
[4]Universidad Metropolitana de Educación, Science and Technology

Keywords: Neuroscience, literacy, cognitive development, neuroeducation, learning.

Introduction

The primary education stage is of utmost importance for child development, since, in this period, they reach a high level of cognitive abilities, acquire physical and mental skills, and begin to recognize various forms of learning, guided by their individual interests and exploring their autonomy.

Leading researchers such as Cassany (2022) state that reading and writing is a complex communicative process that requires cognitive, linguistic, and motor skills. In addition, it points out that writing is a skill that is learned less compared to other language skills, and highlights the importance of involving students in the writing process through self-regulated learning strategies. Other researchers such as Solé (1992), Cárate, Casillas and Faute (2024), González (2020), Gutiérrez (2022) affirm that reading involves an interactive process of cognitive complexity, therefore, the teacher's action plays a preponderant role as a participant in effective learning. Likewise, it is highlighted that writing is a skill that is learned differently compared to other linguistic, motor, informational, physical, and socio-emotional skills, emphasizing the importance of involving students in this process through self-regulated learning strategies (Cassany, 2022). In this context, neuroscience, a scientific discipline that studies the nervous system and its relationship with behavior and cognition, plays a fundamental role in strengthening reading and writing in students. And it is there where neurodidactics appears as a branch of pedagogy, supported by the former, to affirm that reading and writing is a sample of intellectual and neural connectivity, since it is one of the most complex learning that people do; because it involves the coordinated interaction of visual, auditory, motor, cognitive, and language brain systems (Vargas, Jara, Lozada, & Dume, 2019; Montes, Sánchez, & Luna, 2023).

The development of these skills is essential for learning and effective communication; Therefore, understanding the cognitive processes associated with literacy at the brain level can offer effective strategies to improve these skills in students. It is essential that students learn to use reading comprehension strategies autonomously, as this will allow them to face diverse texts with greater chances of success (Solé, 1997). As for learning to read, it is recognized as a fundamental aspect in the integral and cognitive development of people.

According to Dehaene (2023), for a child to learn to read well, they need to have excellent vocabulary in the spoken language and excellent phonology. This can take some time to develop, so it is necessary to stimulate young children with spoken language, but it is usually only around the age of 5, 6 or 7 that children are ready with enough vocabulary and phonological distinctions to learn to read," suggesting that the process of inclusion in reading is linked to the individual's interactions with the environment from an early age (Franco and Gómez, 2021), covering cognitive development to the interpretation and reasoning of everyday concepts through reading and writing.

On the other hand, learning to write involves the development of motor and creative skills, which involves communicating ideas expressively and creatively, thus consolidating cognitive development through aspects such as attention, memory, critical thinking, vocabulary, and understanding of the environment (Orrala, Guamangallo, & Tigua, 2024).

Methodology

The research was developed under a documentary research with a qualitative approach in order to analyze, understand and reflect on the use of neuroscience as a cognitive influence on students' reading and writing. This approach recognizes the complexity of the cognitive processes involved in reading and writing, seeking to interpret and understand the different studies through a critical and reflective process, allowing an interpretation regarding the complexity of the categories of study; Consequently, this study traces patterns, trends, and emerging links of the cognitive approach to literacy learning.

The systematic review was carried out through an exhaustive search and selection of relevant research found in specialized databases such as Redalyc, Latindex, MIAR, Redib, SciELO, Clase, ErichPlus, Dialnet, and Scopus; developed in the years from 2019 to 2024, therefore, their choice obeyed a first criterion which was update of the source consulted.

The second criterion was its relevance and correspondence with the categories under study. Once the publications were selected, they were analyzed and critically evaluated, and the pertinent information was extracted in relation to the research categories. This process made it possible to identify trends, convergences and divergences in terms of the knowledge that is generated and socialized and that require greater attention in terms of the contribution of neuroscience to the development of the cognitive processes involved in the learning of reading and writing to improve educational practices in this field; with the aim of providing solid recommendations based on scientific evidence that can be implemented in real educational settings to strengthen students' literacy and promote better cognitive and academic development in general.

Year	Author	Title	Analysis category	Argumentative position
2024	Gabriela Ivette Yagual Cedeño	The Montessori alphabet in the reading and writing process in children from 5 to 6 years old	Literacy	Reading and writing is a fundamental skill in the learning process of children, it allows them to communicate and express themselves effectively with the outside world. The search for new ways of teaching is essential to ensure effective learning. The Montessori method has gained popularity due to its innovative, exploratory, and experiential approach that is student-centered. This descriptive bibliographic research with a multidisciplinary approach to psychopedagogy was carried out in an educational institution in Ecuador, where a group of 40 children between 5 and 6 years old who were learning to read and write, received classes using the Montessori alphabet as a didactic resource, every day during the last semester corresponding to the 2022-2023 school year.
2024	Inés Montejo	The action of teachers in the detection of students who present Specific Learning Disorders (ASD) in a rural primary school	Literacy	Learning disorders consist of the lack of ability to acquire, retain, or use specific skills or information extensively, as a result of deficiencies in attention, memory or reasoning and affect school activity (...) This mention presents an explanatory approach to the detection of disorders related to learning, it is of interest because it exposes the different problems that occur in the teaching-learning process of reading and writing.
2024	Elizabeth Madroñero	Sensations and interests that mobilize reading in fifth grade students.	Literacy	For this research, the voice of the students is fundamental in the subject of reading, specifically listening to them about their sensations and interests in this communicative skill. It is considered vital that in order to teach and to learn to read, it is necessary to approach the aspects that mobilize them. to approach a reading and what it provokes in them; because the transcendence towards adolescence depends to a large extent on it. This observation presents a focus on the student as the main axis of the reading process, where their tastes and needs must be stimulated to encourage the love of reading.
2024	Andrés Mahecha Ovalle	Systematic Review of Writing Practices in the Colombian Educational Scenario	Literacy	This research refers to the different strategies that encompass writing as the primary axis of learning from assumptions applied to metacognitive, sociocultural, and technological practices, presenting it as the awareness of knowing through the application of the senses in the writing process.
2024	Paul Alexander Calero-Brito1 Technical University of Ambato - Ecuador	Fine Motor Skills for Handwriting Development of students: literature review	Literacy	Motor skills in the development of writing consists of the ability to coordinate and control these fine motor movements efficiently and precisely. The lack of motor skills is aimed at a delay in the development of a person's motor skills, these motor skills can be the control of movements, skills, balance, coordination, among others. This mention alludes to the importance of early stimulation of the child and how this will influence their process of integral formation in the future; In this case, reference is made to writing, so it is intended to give relevance to stimulation to achieve optimal development of students in their learning process.
2023	Solórzano Álava,	The Teaching-Learning of	Neuroeducation applied to reading and writing	Currently, neuroscience contributes significantly to the teaching-learning processes in higher education, this discipline allows the integration of education and

	W. L., Rodríguez Rodríguez , A. ., & García Macías , V. M	Neuroscience in Higher Education		psychology in order to implement new educational strategies to optimize the training process in students.
2023	Elena Lilia Montes-Robinson; Cynthia Michel Sánchez-Caluña; Edgar Ezequiel Luna-Sánchez	Neurodidactics and its link with the learning of reading and writing	Neuroeducation applied to reading and writing	Neuroeducation as a new transdiscipline that emerges from three different spheres of knowledge that are coupled and interpenetrate, neuroscience, psychology and education, with the main objective of integrating knowledge about brain functioning and development in the educational field, in this case specifically the learning of reading and writing, since it provides innovative and contextualized tools in the learning of students
2023	Katty Cárate, Blanca Casillas, Silvia Fauta	The methodology of learning to read and write in the teaching process	Literacy	This quote proposes a series of methods as an alternative to traditional learning strategies, the proposed methodologies include cognitive and linguistic processes involved in the teaching and learning of reading and writing, exploring approaches based on phonetics, reading comprehension, creative writing, among others; It also seeks to review and effectively evaluate students' progress using appropriate tools and techniques to measure reading comprehension, reading fluency, spelling, so it presumes to be a very useful article in the implementation of this systematic review.
2023	Sanmartín González, María Ruth Curipoma Silva, Gloria Esperanza Bermeo Sinchi, Janneth Esperanza Pullaguari Uchuari, Belgium Lucía	Main problems in the process of reading and writing learning in the first years of schooling	Literacy	This research analyzes the main problems that children have in achieving adequate reading and writing management. To achieve this objective, a secondary information search has been developed using the PRISMA model, in which 525 documents were located. and after developing an analysis and systematization of the data, it was possible to obtain 97 documents with which the study was prepared, indicating that 18% are presented by genetic factors, 25% by neurological problems, 35% by phonological processing problems and 23% by psychological factors, concluding that the problems that children have so that they cannot develop an adequate management of reading and writing are several, but they must be attended to in a timely manner, diagnosing the situations that each student presents.
2023	Chaverra Rivas, Ana Julia Mosquera Córdoba, Alfonso Antonio	Using anecdotes to strengthen literacy skills	Literacy	In this study, they report a qualitative research that explored the effectiveness of the use of anecdotes under an intensive reading approach aligned with reading comprehension strategies in a reading and writing course at a Colombian state university. The study revolved around determining how the use of anecdotes triggered by intensive reading in a group of thirteen students of the Language Program with reading and writing deficiencies. The findings showed a work with motivating, enthusiastic and creative anecdotes. And so, reading comprehension and writing dynamics were favored. The analyses offer elements for reflection to guide future decisions regarding how to promote students' reading comprehension and writing through the use of anecdotes.
2023	Oyola, Erika	Analysis of the relationship between academic	Literacy	In this reference, the relationship that exists between the mastery of reading and writing skills in students with academic performance during an elective period is

		performance and lack of reading and writing skills in students in the third year of basic education		identified, in order to be able to collect information, the use of an observation sheet was used with which it was possible to verify that the students under study were lagging behind because they are leaving a virtual study period in which for different reasons the teaching did not arrive adequately. A qualitative approach was provided with a non-experimental design using as reinforcement the hypothesis raised in this topic the averages of previous periods, as well as the current one to verify if the lag in reading and writing is related to the averages, which was evidenced once the research was completed since the relationship is direct because the students do present a lack of reading and writing skills. as well as their weighted averages are low.
2023	Jeniffer Johanna Cuasapud Morocho, Milagros Isabela Maiguashca Quintana	Playful strategies for the improvement of reading and writing in students of Basic General Education	Literacy	Playful strategies in the educational environment are of great importance, since they are those activities that allow the child to develop through play effectively. In this sense, this research aims to describe the benefits of the application of playful strategies in reading and writing with students of Basic General Education in Ecuador. It should be noted that the deductive method and documentary research with a qualitative approach were used for the development of the work.
2022	Gutierrez F. Raúl.	Influence of cognitive reading strategies on improving comprehension skills in primary school students	Literacy Neuroscience	This research aimed to find out if through proposals that enhance cognitive operations aimed at extracting relevant information from the text together with the formulation of questions of different typologies (literal, inferential, reorganizational and critical), the comprehension capacity of expository texts is improved in students who finish the stage of Primary Education, The results obtained show that the exercise of macro-rules together with the Formulating questions contributes to improving students' reading ability.
2022	Mary América Arteaga Rolando, Gilberto Carrión Barco	Reading and writing model. Perceptions and challenges from conceptual pedagogy	Literacy	Reading and writing is defined as a set of communicative skills that favor the construction of meanings and allow the individual to function in his or her social environment. The objective of this research is aimed at determining the level of reading and writing skills presented by students of basic secondary education, according to the perception of the teachers of an educational institution in the north of Guayaquil and proposing as an alternative solution, the design of a psychopedagogical model that strengthens the processes involved in reading and writing. Therefore, different strategies can be extracted that favor the teaching-learning of reading and writing.
2022	Lilia E. Fonseca	The teaching of reading and writing in Argentina. Reflections and contributions from neurosciences and neuroeducation	Literacy Neuroscience. Neuroeducation	One of the most consistent models that explain the reading process is the simple reading model, according to which reading comprehension is conceptualized as the product of decoding skills and oral language comprehension; This mention highlights the transversality of decoding and comprehension of a text to achieve a good reading level.
2021	Onieva J., Maqueda E., Felipe A., García A.	Neuroscientific study on the reading process in primary school students with paper	Literacy	A case study is presented in which participants were placed with five neuromarketing devices during the process of reading and performing exercises in both paper and digital textbooks. The data obtained showed different physical and emotional reactions with high scores in the case of the paper textbook, both in frontal

		and digital textbooks		asymmetry, electrodermal activity and pupillary dilation. In terms of emotional parameters, there were participants with very high levels of stress and rejection, especially with the digital textbook, while others obtained high enjoyment scores, specifically with the paper book.
2021	Cárdenas-Cordero, Nancy Marcela Sapatanga-Villavicencio, Diana Marlene	Didactic strategy for the development of reading and writing in the virtual modality	Literacy	This reference makes known the limitations in the teaching-learning of reading and writing in the virtual modality from different realities. Where the development of a didactic strategy arises that provides a model to follow through sequences of activities distributed in four phases based on the experiences of teachers in the virtual modality so that the teaching of reading and writing is efficient.
2021	Asdrúbal-Emilfo Ayala-Mendoza, Karolina-Alexandra Gaibor-Rios	Learning to read and write in times of pandemic	Literacy	This reference determines the factors that influence and arise at the educational level due to the confinement that has generated difficulties in the preparation of reading and writing. The objective is to synthesize bibliographic information on the different reading and writing techniques that were developed in times of pandemic. From this perspective, the study is oriented to a documentary bibliographic research with a qualitative analysis, in which information was collected from different bibliographic sources
2021	Franco Acevedo, J., & Gómez, G. D. .	Literature and inclusion: influences of reading and literary training on inclusive education in the city of Medellín, Colombia.	Literacy	This article analyzes, from some articles and books related to the themes of inclusion and reading training, the way in which the reading of literary texts allows the understanding of the individual and collective reality of students of basic primary, secondary and secondary education in the city of Medellín. In this way, reading and literary training is offered as a strategy, among others, that enable and strengthen the processes of educational inclusion in the school context of this city.
2021	Canquiz L., Mayorga D., Sandoval C.	Didactic planning for the development of reading comprehension	Literacy	The objective of the research was to analyze the development of reading comprehension in elementary school students and the didactic planning processes carried out by teachers at that level. A mixed study was carried out, with a sample of 132 students and 12 teachers of 3rd and 5th grade, from a public school in Colombia. As results, it is evident that despite the fact that didactic plans are designed that are coherent with the structural requirements set by the Ministry of National Education and taking into account the quality references, objectives, strategies, activities and the time indicated, they do not favor the development of students' reading comprehension. those who present difficulties at the inferential and critical levels.
2020	Ligia Elizabeth Ulco Simbaña, Paúl Francisco Baldeon Egas	Information and communication technologies and their influence on reading and writing	Literacy	This work was developed with the purpose of determining the levels of acceptance of practical cases, in the implementation of Information and Communication Technologies (ICT) in the process of teaching reading and writing, in which the main actors worldwide were students, teachers and parents. It was carried out through a bibliographic research, where it refers to the analysis of cases applied in different countries, reflected in books, theses, web documents and academic articles inherent to the subject. The results show that both students and parents and teachers consider that the use of ICT in the development of reading and writing is important.

2020	Mariela González López	Skills to develop reading and writing in primary school children.	Literacy	It is highlighted that for reading and writing it is essential to have pre-academic and linguistic skills that are learned before entering school, children need skills for lifelong learning, so the early stimulation of these basic skills will allow students to fully and efficiently develop during their academic literacy process.
2020	Luna-Miranda, Cristian Javier García-Herrera, Darwin Gabriel Castro-Salazar, Ana Zulema Erazo-Álvarez, Juan Carlos	Alternative use of ICT in Basic Elementary Education to develop reading and writing	Literacy	In this reference, they determine the levels of acceptance and implementation of Information and Communication Technologies (ICT) in the teaching process of reading and writing at the elementary sublevel, they establish a proposal for the implementation of ICT for the development of reading and writing in the School, which motivates students towards a balanced and interpretive education. based on the acquisition of competencies, skills and the development of imagination, embodied in enriched texts with the use of technological tools, which increase individual and collective participation inside and outside educational institutions.
2020	Rosell Aiquel, R, Juppet, M, Ramos Marquez, Y, Ramírez Molina, R and Barrientos Oradini, N.	Applied neuroscience as a new tool for education	Neuroscience applied to reading and writing	The article consists of information, knowledge and judgments in the relationship between neuroscience and education, thus definitions and implications will be analyzed today. The objective is to emphasize the use of neuroscience in training from an educational perspective.
2020	Mariela González López	Literacy Development Skills in Elementary School Children	Literacy	In this reference they teach skills for the development of reading and writing. This proposal proposes the FAS method; a mixture of the phonetic, alphabetic and syllabic model of Mariela González López. One of the problems in the world of teaching-learning is the lack of skills to achieve literacy. It is carried out in five stages; diagnosis, planning, educational intervention, analysis and conclusion. The teaching-learning of reading and writing requires the development of thinking, linguistic, motor, informational, physical and socio-emotional skills.
2019	Vargas, Karina Jara, María Angélica Lozada, Mariela Dume, Marjorie	Influence of Neuroscience on Literacy Learning	Neuroscience and Literacy	This reference determines the contributions of neuroscience in the learning of literacy, considering that this is one of the difficulties that occur most frequently in educational institutions, in order to improve the teaching-learning processes by guiding teaching actions with activities based on Neuroscience. To this end, a qualitative-quantitative methodological design was developed, with a field study and bibliographic analysis through descriptive research. Observation and surveys of teachers were used as an instrument for data collection. The importance of neuroscience in literacy learning is concluded, so teachers must apply innovative strategies that strengthen learning.

Discussion and results

The exhaustive analysis of these selected references as they coincided with the selection criteria, which were, firstly, the updating of the source (last 5 years), the relevance and correspondence of the same with the categories under study, as a second criterion and its open access publication in the main international databases such as Latindez, SciELO, MIAR, Clase, Scopus, as the third criterion for its selection, revealed a variety of significant findings that support the potential of neuroscience as a cognitive stimulant to strengthen reading and writing in primary school students. As Paz and Acosta (2018) put it, neuroscience

is revolutionizing the way we understand our behaviors and, more importantly, how our brain learns, how our brain stores information, and what are the biological processes that facilitate learning.

The studies reviewed suggest that understanding the brain processes involved in literacy can inform the design of more effective and personalized teaching strategies. In addition, an emerging trend towards the integration of neuroscientific approaches in the educational field was observed, which points to a growing interest in taking advantage of scientific knowledge to improve learning outcomes in this cross-cutting area. Reading and writing is recognized as a fundamental skill in the learning process of children, which allows them to communicate and express themselves effectively with the outside world.

However, challenges and limitations in the practical application of these approaches were also identified, including the need for further teacher training in educational neuroscience and the adaptation of strategies to individual student needs. It is recommended to search for new ways of teaching, innovate in active methodologies, as well as in the use of information and communication technologies (ICT) to ensure effective learning. As a result of the research, factors that significantly affect the effective development of reading and writing were identified, among which genetic, neurological, phonological, and psychological factors, among others, stand out.

Ultimately, this review underscores the importance of continuing to explore the opportunities offered by neuroscience to enrich literacy teaching, as well as suggesting to teachers the continued exploration of the opportunities offered by neuroscience to enrich literacy teaching and promote optimal academic and cognitive development in the new generations.

Conclusions

As closing ideas, this systematic review highlights the innovative potential of neuroscience as a cognitive influence to strengthen reading and writing in primary school students. Through the exhaustive analysis of the scientific evidence previously examined, there is evidence of an ascending understanding and recognition of the cognitive processes involved with effective learning and the integration of neuroscientific approaches in the educational field, which offer significant opportunities to improve teaching strategies, personalize learning and promote impeccable cognitive development in students. However, the need to address challenges such as teacher training in educational neuroscience and the adaptation of strategies to the individual needs of students is recognized. In this last instance, this contribution underscores the importance of continuing to explore and take advantage of the potential of neuroscience in the teaching of reading and writing, with the purpose of providing new generations with the necessary tools to reach their maximum academic and cognitive potential.

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