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The Contribution of Cognitive Neuroscience to Interlearning Process of the English Language

The contribution of Cognitive Neuroscience to the interlearning process of the English language

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ABSTRACT

Cognitive Neuroscience revolutionizes the way we understand learning, providing empirical foundations that allow us to redesign teaching methodologies based on brain function. The objective of this paper is to critically review the scientific literature on the implementation of principles presented by Cognitive Neuroscience associated with Neuro-education in relation to the inter-learning process of English as a foreign language. It focuses on how motivation, attention, and learning consolidation influence students' academic performance. Research conducted in Latin America and Europe is analyzed, contrasting the applied approaches and their effectiveness. The findings show that strategies based on Cognitive Neuroscience, such as gamification, multisensory learning, and emotional focus, significantly improve the educational experience. However, the persistence of neuromyths among teachers underscores the need for rigorous training in how the brain actually learns. It is concluded that Cognitive Neuroscience not only optimizes the English language interlearning process but also promotes more inclusive, personalized, and student-centered teaching.

KEYWORDS: cognitive neuroscience, English teaching, methodological strategies, neuroeducation, neuromyths.

RESUMEN

La Neurociencia Cognitiva revoluciona la forma en que comprendemos el aprendizaje, proporcionando fundamentos empíricos que permiten rediseñar metodologías pedagógicas con base en el funcionamiento cerebral. El objetivo del presente trabajo consiste en una revisión crítica de la literatura científica sobre la implementación de principios que presenta la Neurociencia Cognitiva asociados a la Neuro-educación en relación al proceso de interaprendizaje del idioma Inglés como lengua extranjera, centrándose en cómo influye la motivación, la atención y la consolidación de aprendizajes en el rendimiento académico del estudiante, para lo cual se analizan investigaciones realizadas en América Latina y Europa, contrastando los enfoques aplicados y su efectividad. Los hallazgos evidencian que las estrategias basadas en Neurociencia Cognitiva, como la gamificación, el aprendizaje multisensorial y el enfoque emocional, mejoran significativamente la experiencia educativa. No obstante, la persistencia de neuro-mitos entre los docentes subraya la necesidad de una formación rigurosa en como realmente aprende el cerebro. Se concluye que la Neurociencia Cognitiva no solo optimiza el proceso de interaprendizaje del idioma Inglés, sino que también favorece una enseñanza más inclusiva, personalizada y centrada en el estudiante.

PALABRAS CLAVE: Neurociencia Cognitiva, enseñanza del Inglés, estrategias metodológicas, Neuro-educación, neuro-mitos.

INTRODUCTION

In recent decades, Cognitive Neuroscience has emerged as a key field for understanding the mental processes underlying learning. This discipline provides empirical foundations that allow us to rethink pedagogical practices, especially in the process of interlearning foreign languages such as English. It is important to note that neuroeducation, derived from the integration of Cognitive Neuroscience, Psychology, and Pedagogy, offers a promising new vision for improving diverse methodologies that are more effective, inclusive, and personalized, based on how the brain learns.

This article aims to conduct a critical review of the scientific literature on the implementation of principles presented by Cognitive Neuroscience associated with neuro-education in relation to the inter-learning process of English as a foreign language, focusing on how motivation, attention, and consolidation of learning influence student academic performance.

Applied research in Latin American contexts, such as Chile, Ecuador, and Peru, as well as comparative studies in the United Kingdom and the Netherlands, is analyzed, highlighting both the benefits and challenges of applying Cognitive Neuroscience in real-life educational settings. The relevance of this approach lies in its ability to activate key mental processes, such as memory, emotion, attention, and curiosity, which are essential for meaningful foreign language learning.

MATERIALS AND METHODS

The methodology used was a documentary bibliographic review, in the search 320 articles were obtained, for which the keywords were used: Cognitive Neuroscience, English teaching, methodological strategies, Neuro-education, neuro-myths of which according to the inclusion criteria 42 articles and 9 books published between 20 07 and 2025 were determined, prioritizing those with empirical evidence on the application of neuro-educational strategies in the English language interlearning process, which responded to the stated objective. It is necessary to highlight that one of the selection criteria was that the language did not matter

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and that the study population was from school to university levels and even older adults, which were found in the following scientific information sources: WOS 2, Scopus 13, Latindex 7, in Scielo 6, in Dialnet 11, in Doaj (Directory of Open Access Journals) 1, in university repositories (theses) 2 and Books 9. When analyzing the information, it focused on three main axes: (1) theoretical foundations of Cognitive Neuroscience applied to education; (2) neuro-didactic methodological strategies used by English teachers; and (3) results of empirical studies on the impact of these strategies on language learning.

RESULTS

In recent decades, advances in Neuroscience reveal how certain brain processes directly influence the way we act and how learning is consolidated, which lead to a discussion on the theory of natural learning from brain function (Cañas et al., 2015) seeking to understand how the brain learns in contexts rich in stimuli for learning (Blakemore and Frith, 2008) considering multiple sensory pathways (Zadina, 2008; Cañas et al., 2015). This guides us to propose a proposal to generate new interpretations from Cognitive Neuroscience that serve to strengthen the pedagogical practice of teachers within their educational reality.

Researchers Cañas et al., (2015) express that effective education must encourage the search for diverse teaching-learning strategies, valuing the diversity of responses, creativity and flexibility, which is why the importance of including the contributions of Cognitive Neuroscience in teacher training programs is evident, specifically in relation to brain function and its educational implications since it is essential to train innovative educators, sensitive to the role of emotions in the inter-learning process, who are willing to adopt a multisensory pedagogical approach, focused on the interaction between teachers-students, students-students and in a stimulating learning environment.

The findings of the reviewed studies reveal a partial but growing incorporation of neuro-educational practices based on cognitive neuroscience for the teaching of English. It was evident that teachers who received specific training in cognitive neuroscience more frequently implement strategies that stimulate key brain areas such as Broca's and Wernicke's, which are essential for language production and comprehension (Pantusin & Jama, 2025).

Therefore, it is necessary to implement pedagogical strategies focused on overcoming the specific challenges of the English language interlearning process, primarily those related to language macro skills, actions that strengthen oral and written expression. Therefore, it is proposed that English teachers explore new methodologies based on multisensory stimulation, in an affective and supportive context. Thus, the goal is to promote dynamic teaching models that connect with the brain's learning nature (Cañas et al., 2015).

The OECD's Brain and Learning project (2002) highlighted numerous misconceptions about the brain among education professionals, termed them neuromyths, which can have negative consequences for educational practice. This project investigated the frequency and predictors of belief in scientific misconceptions about how the brain learns among teachers in selected regions of the United Kingdom and the Netherlands, with a sample of 242 primary and secondary school teachers. On average, teachers believed 49% of neuromyths, especially those related to commercialized educational programs; these results underscore the importance of improving interdisciplinary communication between cognitive neuroscience and education to avoid misinterpretations and foster effective collaboration (Dekker et al., 2012).

For researchers Dekker et al. (2012), these results reflect the prevalence of neuromyths among teachers with a strong interest in the neuroscience of learning, offering crucial information about those who might implement misconceptions. This underscores the need to

improve teacher professionalization and interdisciplinary communication to reduce misunderstandings.

In Ecuador, the educational institution EMDI School implemented Neuro-didactic strategies, which benefited from increased performance in international English tests, reaching up to 95% of students who passed the A2 level. However, a worrying presence of Neuro-myths was also identified that was applied by teachers interested in Cognitive Neuroscience, which suggests the need for rigorous training based on scientific evidence (Benítez, 2016), which is why the researcher considered ongoing training in this field essential.

There is an urgent need for a transformation of the educational system that prioritizes personalization and closes the gap with the avalanche of information brought by technology. Therefore, it is essential to prepare students for an ever-changing world. This implies that educators must abandon the mere transmission of abstract concepts without real-life applications (Mendez et al., 2018). For this researcher, today, students need to learn how to learn, a process that schools must facilitate in order to develop the skills required for daily life. In the field of language teaching, the challenge is to foster communication skills, which can be enhanced by leveraging the development of students' socio-emotional intelligence. Therefore, it is necessary for teachers to understand how the brain works in learning contexts in order to design strategies that guide them in planning their classes.

Cognitive Neuroscience contributes significantly to the study and approach to learning difficulties, developing methods that help mitigate them (China & Ferreres , 2016; Fischer, 2009; Immordino -Yang, 2007; Lipina , 2016; Gago & Elgier, 2018), which leads to the formulation of inclusive public policies, recognizing that the way of learning varies according to each difficulty (Gabrieli, 2016). Furthermore, Cognitive Neuroscience clarifies the importance of intervention moments through the concept of sensitive period, which is understood as optimal moments to stimulate certain capacities, and thanks to neuronal plasticity, cognitive rehabilitation can create or recover skills since it denies the Neuro-myth of the so-called critical period, which suggests that a skill not developed in time is unrecoverable (Cicchetti & Curtis, 2006; China & Ferreres , 2016).

Cognitive Neuroscience also introduces the concept of mirror neurons, which are essential to understand the processes of imitation and interaction, and the neurological basis of observational, procedural, imitative and associative learning (Barrios-Tao, 2016; Catmur & Heyes, 2017). Finally, the need to implement more physical activity and adequate sleep that students should have in order to perform better in educational institutions is highlighted, as they promote mental, physical, brain and cognitive health (Blakemore & Frith, 2011; Gago & Elgier, 2018).

Studies on mirror neurons indicate that merely observing a character on screen is not enough to learn a language or vocabulary. This type of exposure does not stimulate memorization or grammatical development, operating under a behaviorist approach. Since both animals and humans are inherently social beings, face-to-face interaction is essential for the development of language skills. Therefore, the need to promote interactive learning rather than relying exclusively on technology is emphasized (Baño-Lucio et al., 2023).

Neurodidactics represents an innovative pedagogical proposal that should be further explored, with the aim of providing students with adequate support and fostering a form of interlearning that differs from the traditional model. This approach is not limited solely to brain stimulation but also seeks to strengthen motivation through the development of emotional competencies, which highlights the need to raise awareness among educational stakeholders about the importance of implementing Neurodidactics in interlearning processes (Ramos & San Andrés, 2019; Benavidez & Flores, 2019).

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A study conducted in Ecuador, using a qualitative -quantitative approach applied to teachers and students, determined that the application of neuro-didactic strategies promotes the use of activities that stimulate students' creativity, facilitating their understanding of how the brain works and its capacity for adaptation in educational processes. This approach considers social, cognitive, and emotional elements that help build lasting learning experiences that enrich teaching practice and enhance students' ability to learn (Carrillo & Zambrano, 2021).

A research carried out in Cuenca-Ecuador by Estévez et al., (2015) in which a quasi-experimental method was applied to older adults, with the purpose of analyzing how learning a new language influences the development of cognitive functions, determined that there is a statistically significant relationship between the two variables.

Another study served as a basis for determining that the beginning of bilingualism before neuronal pruning enhances child development, especially by activating cognitive abilities through learning a second language. However, if linguistic elements are not repeated or used frequently, progress in their acquisition may be limited, even if the neuronal connection between perception and action in the child was adequately stimulated (Despaigne-Negret et al., 2023).

Neuroscientific studies provide crucial information about how the brain works (in children and adults), suggesting technical and emotional improvements for teaching. Furthermore, they highlight the benefits of bi /multilingualism, since learning a second language improves cognitive abilities, activates new brain networks, and favors the process of neuroplasticity (Pacífico & Agüero, 2022). Furthermore, they suggest that educators should receive basic training in neuroscience before obtaining their degree. This training does not need to be as in-depth as that of a neuroscientist, fostering a reciprocal dialogue between both fields.

Cognitive Neuroscience helps us understand the brain, its plasticity, and how complex skills such as language and thinking develop. Although questions remain about how individual learning mechanisms work, it is clear that exposing children to sensory-rich environments from an early age is crucial for the development of their communication skills and learning (Irisarri-Vega & Villegas-Paredes, 2021). Although Cognitive Neuroscience is not an instruction manual, its findings open a path for collaboration with education, thus proposing flexible strategies for teachers that can be adapted to each student.

Teacher training has a direct impact on the quality of education for students. In recent years, Neuroeducation has begun to be recognized as a valuable resource for improving teachers' skills in this area by enhancing three key competencies: reading, mathematics, and socio-emotional skills (including empathy). These findings highlight the potential of Neuroeducation in schools and its implications for educational policies, teacher training, and school practices. Neuroeducation is a powerful tool that helps teachers become leaders of educational change, connecting science with the art of teaching (Caballero-Cobos & Llorent , 2022).

Thus, in the research by Caballero-Cobos & Llorent (2022), notable progress was observed in reading, mathematics, and empathy skills in the three participating schools, confirming that school learning improves these skills. The research also showed significant improvement in these three areas, specifically in the groups that received neuroeducation training, reinforcing the idea that applying neuroeducational principles in the classroom is effective (Jolles & Jolles, 2021).

The teaching of English is incorporating new knowledge; however, teachers of this language still do not frequently apply it in their daily practice. The rapid advancement of Cognitive Neuroscience, both in the study of the brain and in the understanding of mental processes, gives a boost to Neuro-education as it seeks to connect Neurology with teaching

methodologies to improve the interlearning process in the English classroom. This means that teachers must adopt innovative, flexible, and fun activities to capture students' interest and attention to reinforce the topics (Yánez-García et al., 2021).

The Neuroeducation Teacher Training Program stands out as one of the few studies to implement a comprehensive neuroeducation program (BRAIM) in a real-life classroom setting, demonstrating its value by integrating a holistic methodology for teacher training (Privitera, 2021). The results indicate that making learning mechanisms visible to both teachers and students significantly improves key skills, especially in secondary education.

Some authors are skeptical about the current contributions of Cognitive Neuroscience to education (Bowers, 2016; De Vos, 2016; Gago & Elgier, 2018). However, many other researchers maintain an optimistic stance on its present and future impact (Gabrieli , 2016; Howard-Jones et al., 2016; Stringer and Tommerdahl , 2016). From this perspective, Cognitive Neuroscience must collaborate with other disciplines to achieve a comprehensive understanding of interlearning processes, analyzing behavior at the molecular, neuronal, psychological and social levels. Therefore, it is essential to carry out debates, novel research and scientific articles with direct applicability to the educational reality (Satel & Lilinfield , 2013).

Progress in brain knowledge has given rise to new disciplines such as Neuro -didactics, which enables the implementation of pedagogical strategies in the classroom based on brain function, in order to optimize the inter-learning process (Gonzalez -Caballero et al., 2023). This research, which was aimed at determining whether there are differences in the use of Neuro-didactic strategies among teachers of English as a foreign language in the stages of Early Childhood and/or Primary Education, was carried out with the participation of 111 teachers from educational centers in the Region of Murcia.

The results revealed that female teachers more frequently employ neurodidactic strategies than male teachers, both in face-to-face English classes and in online sessions. However, both male and female teachers consider students' feelings important and try to apply teaching strategies that engage emotions, which is essential for students to feel comfortable communicating in a foreign language (Morilla, 2016; Gonzalez -Caballero et al., 2023).

Researcher Carballo (2017) states that, although many teachers already apply these strategies unconsciously when teaching their classes, it is time to do so intentionally, with adequate training in Neuro-didactics, to promote conscious learning of how our minds work. This study opens an innovative field for integrating evidence from Neuro-didactics into educational practice, as it highlights the importance of incorporating strategies based on knowledge of the brain and its implications for learning a foreign language.

After analyzing the Neuro-didactic strategies used by English teachers in Early Childhood and Primary Education, it is observed that most teachers consider it crucial to incorporate didactic strategies that are linked to emotions to promote a positive classroom environment, an interaction that is essential in learning a foreign language, since an environment of trust facilitates communication (Morilla, 2016; González-Caballero et al., 2023).

If students feel comfortable and relaxed, communication in English flows naturally, contributing to the development of communicative competence as expressed by Benavidez and Flores (2019) arguing that the integration of emotions intensifies neural connections, making learning more lasting and effective, favoring the learning of English.

Cognitive Neuroscience, thanks to its findings on how the brain learns, provides sufficient knowledge to make substantial contributions to education and educational policies. One of the key discoveries is that brain maturation extends into the second decade of life, and

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that exposure to diverse experiences and development opportunities are essential throughout this extensive period, without underestimating the importance of any specific stage (Martin-Loeches, 2015).

Researchers Leisman et al. (2015) and Martin-Loeches (2015) study brain development, differentiating between critical and sensitive periods, and how brain maturation occurs in different regions. Goswami (2015) highlights the importance of basic development (perceptual and motor) as a foundation for school skills such as literacy. Furthermore, Lipina & Segretin (2015) argue that the first 1,000 days are not the only crucial ones, but that the other 6,000 days of brain development (up to the second decade of life) are also vital, which is essential for educational policies and the prevention of school failure. In short, there is already a significant body of neuroscientific knowledge applicable to education, and the future of educational neuroscience looks extremely promising (Martin-Loeches, 2015).

Learning English as a second language is a major challenge today for Educational Psychology and Cognitive Neuroscience, especially because conventional teaching-learning methods often fail to consider the cognitive and emotional processes involved in learning. Given this, Neuroeducation emerges as an innovative proposal, merging Neuroscience, Psychology, and Pedagogy to improve the language learning process (Morocho et al., 2025). Scientific evidence shows that neuroeducational strategies such as gamification, multisensory learning, and emotional regulation impact motivation and knowledge retention.

Likewise, thanks to advances in neuroimaging techniques and a more precise methodology, current evidence tends to converge towards the idea that brain substrates are shared between languages (Hull & Vaid , 2007). Contributions that allow us to propose new psycholinguistic models that more effectively explain the complex functioning of language (Guerra, 2007).

Rocha and Tonelli (2015) highlight the importance of establishing an ongoing dialogue with other areas of knowledge so that language acquisition becomes increasingly established as a field that promotes new pedagogical and didactic practices by teachers, adapting to the contemporary reality of the language interlearning process. Castorina (2016) points out that there are theoretical biases in certain proposals made by neuroeducation, which limit the transfer of knowledge through applied research, especially for professionals not directly linked to education who need this information for their updating.

In summary, the contributions made by Cognitive Neuroscience have significant potential to improve teachers' attitudes and professional performance in the teaching process, demanding an increasing mastery of the Central Nervous System (structure and function), associating it with neuro -didactic proposals for the application of various stimuli, neuronal plasticity, sensitive periods, and biological factors that influence learning. This suggests a need to improve curricular designs for teacher training, integrating updated knowledge that promotes professional development and research, from sciences related to the understanding of the human being, such as neuroeducation (Calzadilla-Pérez, 2023).

Although most English teachers use a large number of neuro-didactic strategies such as physical movement and relaxation, they are unaware of the reason for their application, which suggests that many teachers apply neuroeducational principles unconsciously (Carballo, 2017), greatly benefiting students by considering brain function during the teaching process.

Researchers such as González-Caballero et al., (2022) express that teachers use neuro-didactic strategies in their English classes, both in person and online, thus benefiting the inter-learning process of students. Cognitive Neuroscience suggests that mental imagery is an essential component of the thinking underlying knowledge. At the same time, certain educational approaches already employ mental imagery in the classroom to foster

comprehension and recall, which improves reading comprehension in a second language (Berger & Ehrsson, 2013).

Kuhl 's language acquisition model emphasizes the importance of early perception of linguistic patterns, vocal imitation, and how experience and the neural substrate influence critical periods. Furthermore, linguistic interference in bilingualism, especially in contexts such as Spanish/English and the multiple languages in Latin America, is crucial to consider in order to generate didactic proposals that improve the inter-learning process of a language (Díaz-Sánchez & Álvarez-Pérez, 2013).

CONCLUSION

The literature review confirms that Cognitive Neuroscience can significantly contribute to the English language interlearning process by providing a deeper understanding of how the brain learns. Emotion, attention, motivation, and memory are key factors that should be integrated into pedagogical design, and strategies based on brain stimulation can significantly enhance the learning experience (Araya-Crisóstomo & Urrutia, 2022).

However, limitations are also identified. Despite the enthusiasm of many teachers to apply these principles, the lack of specialized training can lead to the adoption of pseudoscientific or ill-founded practices, such as the neuro -myths Cañas et al., (2015). This raises the urgent need to include Cognitive Neuroscience content in initial and continuous teacher training, with a critical and updated approach in line with what Villanueva (2018) expressed: they have basic knowledge of Neuroscience, however, a large number of these teachers do not apply it in their classrooms.

Likewise, evidence shows that educational models based on Cognitive Neuroscience, especially those with a constructivist approach, achieve higher levels of motivation, autonomy, and performance in students, according to Araya-Crisóstomo & Urrutia (2022). However, their implementation remains uneven, depending on the institutional context and teacher commitment.

In conclusion, cognitive neuroscience offers a powerful and necessary framework for enriching the process of interlearning English as a foreign language. To achieve a real transformation in educational practices, it is essential to foster closer collaboration between neuroscientists and educators, as well as to ensure teacher professionalization in this emerging field (Dekker et al., 2012).

CONFLICTS OF INTEREST

The researchers declare that neither they nor their supervisor have any conflicts of interest. "The authors declare no conflicts of interest.".

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