ISSN (Printed): 2307-7999
ISSN (Online): 2310-4635

PROPOSITOS Y REPRESENTACIONES, 11(3), 2023
https://doi.org/10.20511/pyr2023.v11n3.1876

RESEARCH ARTICLES

Effect of A Neuropsychological Intervention Program On The Development of Academic Skills in The First Years of School

Efecto de un programa de intervención neuropsicológica en el desarrollo de las habilidades académicas en los primeros años escolares

Astrid Yamile Ayala Arango
Universidad Católica Luis Amigó, Medellín, Colombia
https://orcid.org/0000-0001-6390-5489

Received: 10/10/2023
Reviewed: 10/30/2023
Accepted: 11/12/2023
Online: 12/31/2023

***Correspondence:**

Email: aayalaa75@gmail.com

Cited as:

Ayala, A. (2023). Effect of A Neuropsychological Intervention Program On The Development of Academic Skills in The First Years of School. *Propositos y Representaciones*, *11*(3), e1876. https://doi.org/10.20511/pyr2023.v11n3.1876

EDITED BY UNIVERSIDAD SAN IGNACIO DE LOYOLA - USIL, SCHOOL OF HEALTH SCIENCES, PSYCHOLOGY DEGREE PROGRAM, 2023.

Summary

A quasi-experimental study was carried out with the objective of determining the effect of a neuropsychological intervention program on academic skills in reading, writing and mathematics in a group of first grade girls and boys of primary school at the Cadena Las Playas educational institution. municipality of Apartadó, Antioquia, Colombia, aged between 5 and 6 years, belonging to a low socioeconomic condition. Two groups were formed, the experimental and the control, each with 19 students. Measurement tests in reading, writing and arithmetic were applied to each participant. Subsequently, a neuropsychological intervention program was applied to the experimental group for seven months, consisting of group training using the NeuronUP Kids program. At the end, measurements were applied again in the academic skills of both groups.

At the pretest level, no significant differences were found between the groups except for the word and non-word writing subtest in favor of the experimental group. The post-test assessment showed significant differences that indicate that the experimental group had a better performance in reading syllables, words, non-words, sentences, words with reading errors aloud and speed of reading aloud and in writing syllables. ($p>0.05$), in arithmetic no significant differences were found. In conclusion, the use of a neuropsychological stimulation program contributed favorably to the development of academic skills such as reading and writing, representing an opportunity to implement in the school setting and specifically in the classroom, neuropsychological-based programs that meet an objective. preventive that favors learning processes in the school population who are in less enriched environments.

Keywords: Academic skills; Neuropsychological stimulation; Schoolchildren; Poverty.

Resumen

Se realizó un estudio cuasi experimental con el objetivo de determinar el efecto de un programa de intervención neuropsicológica en las habilidades académicas en lectura, escritura y matemáticas en un grupo de niñas y niños de primer grado de básica primaria de la institución educativa Cadena Las Playas del municipio de Apartadó, Antioquia, Colombia, con edades entre los 5 y 6 años, pertenecientes a una condición socioeconómica baja. Se conformaron dos grupos, el experimental y el control, cada uno con 19 estudiantes. Se aplicó a cada participante pruebas de medición en lectura, escritura y aritmética, posteriormente al grupo experimental se le aplicó un programa de intervención neuropsicológica durante siete meses, constituido por un entrenamiento grupal mediante el programa NeuronUP Kids, al finalizar, se aplicaron nuevamente mediciones en las habilidades académicas de ambos grupos.

A nivel pretest no se encontraron diferencias significativas entre los grupos a excepción de la subprueba de escritura de palabras y no palabras a favor del grupo experimental. La valoración postest evidenció diferencias significativas que señalan que el grupo experimental tuvo un mejor desempeño en la lectura de silabas, palabras, no palabras, oraciones, palabras con error de lectura en voz alta y velocidad de lectura en voz alta y en la escritura de sílabas ($p>0,05$), en aritmética no se encontraron diferencias significativas. En conclusión, la utilización de un programa de estimulación neuropsicológica aportó favorablemente al desarrollo de habilidades académicas

como la lectura y la escritura, representando una oportunidad para implementar en el escenario escolar y específicamente en el aula de clases, programas de base neuropsicológica que cumplan un objetivo preventivo que favorezca los procesos de aprendizaje en la población escolar que se encuentra en entornos menos enriquecidos.

Palabras claves: Habilidades académicas; Estimulación neuropsicológica; Escolares; Pobreza.

INTRODUCTION

Basic academic skills represented in reading, writing, and mathematics have awakened particular interest in various disciplines due to their universal nature and their importance in formal educational processes, in which they are generally part of the required learning, their inclusion in school curricula. For many children, achieving this basic learning becomes a complex task that affects their initial educational performance and even their performance in later years. Thus, the first grades of primary school become a fundamental stage of school life and lay the foundations for the formal process of these initial academic competencies (Bravo, 2003, 2014). Therefore, one of the concerns of the education sector is to guarantee quality education for the optimal performance of this learning because they become the necessary support to assume the challenges of all the levels that make up the educational process, from preschool to tertiary education, not to mention the savings in educational costs due to grade repetition, among other problems (Organization for Economic Cooperation and Development [OECD], 2016; Ministry of National Education [MEN], 2016).

From a recent school dropout study conducted by the Ministry of National Education in Colombia, the intra-annual figure in students of public schools in the country during the last years had its highest peak in 2010 with 4.8%, showing decreasing and increasing fluctuations in the following years, a significant decrease of 2.37% in 2020, and a subsequent increase of 3.58% in 2021. As for the latter year, students who did not enroll in school were mostly those who had dropped out school (49.3%), those who had failed the school year (17.1%), and those who had passed the school year (5.4%). Among the causes identified, several factors were revealed, among which are those of an individual nature, such as school repetition, overage for grade, and late start of primary school (MEN, 2022).

The results of international and national measurements of specific competencies show the educational panorama from the quality perspective, for which there is participation in the PISA tests (Program for International Student Assessment) in reading and mathematics, and the *Pruebas Saber* (Saber Tests) in grades 3, 5, 9 and 11. For the PISA tests presented in 2018, Colombia obtained average scores of 404 in mathematics and 413 in reading that were lower than those of the member countries of the Organization for Economic Cooperation and Development (OECD), with 489 in mathematics and 487 in reading. Similarly, the results compared to those obtained by some Latin American member countries showed reading scores lower than those of Chile, Uruguay, Costa Rica, Mexico, and Brazil and higher than those of Argentina, Peru, and the Dominican Republic. The performance in mathematics was lower than those of Uruguay, Chile, Mexico, Costa Rica, and Peru and higher than those of Brazil, Argentina, and the Dominican

Republic. Specifically, these data also showed higher percentages of low performance in reading and mathematics, with 43% and 66%, respectively, compared to high performance, with only 1% and 0.3% (OECD, 2019), for Colombian students.

The national standardized tests in Colombia, called *Pruebas Saber*, seek to measure knowledge level and skills of grade 3, 5, 9, and 11 students to measure competencies in areas such as Mathematics, Natural Sciences, Social Sciences, Language, and Reading Comprehension. As for Mathematics and Language, the test results for grades 3, 5, and 9 show a significant percentage for insufficient level from 2012 to 2017. During these years, grade 3 mathematics scores fluctuated between 18% and 20% for insufficient level, compared to 23% to 30% for advanced level, a situation that worsens in grade 5 with 38% to 43% for insufficient level, compared to 11% to 14% for advanced level. For its part, grade 9 performance showed 20% to 25% for unsatisfactory level and between 4% and 6% for advanced level. For Language, the picture was not different because grade 3 showed between 18% and 23% for unsatisfactory level and between 18% and 22% for advanced level. Grade 5 had a greater gap for unsatisfactory level with 13% to 21%, compared to 12% to 16% for advanced level, and grade 9 showed a lower population for advanced level with 5% to 7%, compared to 11% to 18% for insufficient level (Instituto Colombiano para la Evaluación de la Calidad de la Educación [ICFES], 2018).

As for the Saber 11 Tests, the results showed that from 2017 to 2021, the average overall score has been decreasing. Considering that the highest overall score is 500 points and the maximum specific score is 100 points, the average score was 262 in 2017, 253 in 2019, and 250 in 2021. Similarly, the specific score in reading and review remained at 54 points between 2017 and 2018, decreasing to 53 points in 2021. The mathematics scores remained at 52 points between 2017 and 2027 and decreased to 51 points in 2021. From the interpretation of the performance ranging from 1 to 4, the latter being the highest performance, the trend in both types of knowledge has been that level 3 has the largest proportion, followed by level 2 (ICFES, 2021).

According to the above, we have found important variables, such as socioeconomic status, type of educational establishment and living area, urban or rural, which are related to academic performance measured both nationally and internationally, an example of which is the Saber 3, 5 and 9 tests that reflected significant differences in the results according to socioeconomic status, whereby the higher the socioeconomic status, the better the performance. Likewise, the Saber 11 tests evidenced that, in addition to the differences by socioeconomic level, there are also those related to the type of school, whether public or private, urban or rural, and the parents' level of education. The PISA test results showed that private school students in Colombia perform better than public school students (OECD, 2016; ICFES, 2018, 2021).

In general terms, the figures show that, both nationally and internationally, Colombia is below expectations in terms of performance in subjects associated with reading, writing, and mathematics skills, which may reflect weaknesses in the teaching and learning process. This scenario has led the Ministry of National Education to establish plans, programs, and projects to improve student core competencies from educational establishments to promote educational quality improvement (MEN, 2016).

Regarding the socioeconomic factor, children in vulnerable situations are surrounded by adverse economic, nutritional, and cultural conditions that affect cognitive and academic development given that according to some studies, poverty has an impact at the brain level from the structural and the functional and implies low performance of skills such as memory, language, socioemotional processing, cognitive control, and self-regulation (Ghiglione et al., 2011; Lipina & Segretin, 2015). Likewise, from the family environment, it was found that inadequate or insufficient stimulation received by the child and parents' low level of education are elements that associate with low cognitive performance (Mazzoni et al., 2014).

Considering the above, children from lower socioeconomic levels who begin schooling would be at a disadvantage in the basic neuropsychological repertoires necessary for the acquisition of basic learning; an example of this is the scientific evidence that states that the performance of tasks that require cognitive control, working memory, long-term memory, and phonological language are compromised, as well as comprehension language, vocabulary level, attentional skills, and executive functions, causing students to fall behind in the educational process due to grade repetition, lack of motivation, overage involvement, or school dropout, thus perpetuating in the medium and long term the family poverty line and therefore higher economic costs to the State and a decrease in the country's economic growth (Arán-Filippetti, 2012; Hermida et al., 2010; OECD, 2016). An example of the above is supported by research that showed that socio-environmental conditions may even moderate the impact of the application of cognitive programs in low-income children, whereby situations such as housing characteristics, social resources, parental occupation, and family composition are considered predictors of cognitive performance (Segretín et al., 2014).

Given the importance of its object of study, neuroscience has been related to different disciplines that respond to the needs of the individual and the community, so disciplines such as education are not outside this binomial (Pérez-Puelles, 2021). According to Zadina (2015), in the nineties, there was talk of brain-based learning as a movement that sought to unite neuroscience and education, which for many at the time was implausible, while for others, it became not only a possibility but a felt need that would contribute to the construction of the educational curriculum, teacher training, and participation in educational reforms. Now, it is clear that neuroscience and education have two different languages and objectives; however, the benefits of this relationship are significant for education, which have been reflected in the contributions of various authors (Lipina et al., 2010; Vargas, 2018).

Fuentes and Collado (2019) highlighted that neurosciences enabled the emergence of the neuroeducation line, which arose in the twentieth century with the contributions of Odell in 1981 as a need to develop educational strategies from the brain base, so it was defined as the use of scientific research for the strengthening of better educational practices aimed to promote the integration between educational sciences and neurocognitive sciences, to contribute to the development of cognitive abilities in the areas in line with the school curriculum, to serve as scientific support in the teaching process and to contribute to the challenges of the new educational policies, emphasizing the need not only to create new educational methods but also to understand them. Other authors have defined it as the discipline that studies teaching and learning processes from the basis of brain functioning and the neurobiological supports that

sustain it, aiming to strengthen the educational process from the understanding of how the brain changes and adapts in learning contexts (Mora, 2017; Valerio et al., 2016).

Portellano (2016) placed school neuropsychology in the wide range of neurosciences, defining it as that area of knowledge that seeks to develop strategies that contribute to school learning. Other authors, such as Zadina (2015), considered that educational neuroscience should be oriented to the transforming function of the school curriculum and the development of neuroscience-based pedagogical strategies. Thus, knowledge in both disciplines on the part of professionals should be an indispensable requirement.

Roselli and Ardila (2016) traced the history of school neuropsychology to the very emergence of child neuropsychology in the mid-twentieth century, which was born precisely from the contributions of neuropsychology and school psychology, motivated by the interest in understanding the biological basis of learning difficulties in reading, writing, and mathematics, subsequently leading to the definition of specific learning disabilities known as dyslexia, dysgraphia and developmental dyscalculia, topics of interest that led to conducting several research studies. Similarly, they refer to school neuropsychology as a field of action of child neuropsychology, which is responsible for learning about learning problems and intervention through psychoeducational techniques.

Martin-Lobo and Arantzazu (2015) described some objectives of school neuropsychology, highlighting the prevention of academic difficulties by identifying risks and weak aspects of development, the potentiation of higher thought functions, and the addressing of student specific needs, guiding the correction of learning difficulties from the application of methodologies and programs. In this same line, Rhenals-Ramos (2021) highlighted the processing of cognitive functions and their adjustment to school activities as objective and a fundamental basis for learning performance, such as reading and writing.

In this scenario, the most important contributions of school neuropsychology have been the understanding of the brain in the learning process and its applicability in educational practices, the attention to students with developmental and learning problems from early diagnosis and teaching guidelines for different learning rates, and the prevention of school problems from the identification of biopsychosocial risk factors and intervention to them. Thus, currently, the participation of this discipline as a source of scientific knowledge, contribution to the work of educational psychology, and also as a specific field of action in the school setting is becoming more relevant (Araya-Pizarro & Espinoza, 2020; Martínez-Álvarez, 2019; Pherez et al., 2017; Pimentel & Córdova, 2019).

Authors such as Ashton (2015) highlighted the importance of narrowing the gap between clinical neuropsychology and educational neuropsychology based on a better contextualization of student needs according to this context and teamwork with the educational psychologist. In the same line, D'Amato (1990) reaffirmed that the application of neuropsychological principles to education is important in the areas of assessment and differential diagnosis, which have been considered the traditional contributions, but much further in the assessment and intervention link based on brain functioning, to resort to the use of appropriate remediation programs.

Portellano (2016) specifically referred to school neuropsychological stimulation, defined as a training program of higher mental functions aimed to improve student school performance by activating myelination, neurotransmission, and neurogenesis processes. From another perspective, reference is made to early neuropsychological care, defined as a set of actions that respond to the transitory or permanent needs of children with developmental difficulties or at risk of developing them, considering the period from 0 to 6 years old. Among the basic premises that should be taken into account for these programs are: a) the preventive nature with emphasis on risk factors; b) the globality that implies the intervention to the various contexts of the child; c) interdisciplinarity and transdisciplinarity through the knowledge of related disciplines (Arnedo et al., 2015).

Neuropsychological stimulation programs are supported by the concept of brain plasticity or neuroplasticity, which is defined as the capacity or sufficiency of the brain to adapt structurally and functionally and adjust to the development of activities demanded by the context (Araya-Pizarro & Espinoza, 2020; Pimentel & Córdova, 2019). From this perspective, changes in the nervous system can occur from continuous processes in the short, medium, and long term as a product of various types of interventions, among which are training, rehabilitation, pharmacotherapy, enriched environments, and learning, among others. This explains the relevance of the interaction between the biological and environmental factors at any stage of development, even more so in the early years, in which the brain is mainly flexible and modifiable, an example of which is that an environment with diverse stimuli generates greater neuronal arborization and connection (Roselli & Matute, 2011). It is clear then that the brain responds to environmental stimuli, so an enriched environment in the main contexts in which the child develops is essential for neuropsychological development.

Developing and applying neuropsychological programs requires considering variables such as child cognitive development and its correspondence with brain maturation, brain plasticity, the development of functional systems, the axes of ontogenetic development, changes throughout the life cycle, and the progressive lateralization of brain functions (Cuervo and Avila, 2010; Roselli et al., 2010). Based on the above, it is important to highlight the importance of identifying the child's cognitive profile from the neuropsychological assessment since, from these results, stimulation and early intervention programs can be suggested (Roselli et al., 2021).

The use of neuropsychological programs in the school context should be supported by scientific knowledge, the understanding of cognitive processes, the relationship of cognitive development and brain maturation, motivation and learning of students, and can be directed to the development of attention, visual, tactile and sensory integration skills, language, memory, multiple intelligences, creativity, executive functions, language, learning difficulties, or to improve performance in cases of developmental disorders (Martin-Lobo and Arantzazu, 2015). As for intervention programs in children aged 3 to 6, the results show that it favors learning processes, becoming a key strategy for prevention from the school context (Martin-Lobo, 2017).

Regarding studies aimed at evaluating the impact of cognitive stimulation on academic skills, Bernal-Ruiz et al. (2020), through comparative research on the stimulation of executive functions on executive performance and academic performance in first-grade school children, found a relevant improvement in executive performance of the experimental group that received

12 weeks of training, contrary to the academic performance that was evaluated from grades in language and mathematics, for which no differences were found between the evaluated groups, which for the researchers, could be related to the time of application of the program or other factors that do not necessarily explain its effect.

Likewise, a group of researchers formed by Fernández-Abella et al. (2019) oriented their work to identify the effect of an intervention program to improve working memory and basic mathematical skills in school children aged between 5 and 6 by using the methodology of two experimental groups, one with intervention through a virtual program, and the second with intervention in pencil and paper format, in addition to a control group. All groups were administered the Corsi Test, which evaluates visuospatial memory, and the Test for the Diagnosis of Basic Mathematical Skills (TEDI-MATCH) before and after treatment of the two experimental groups. The results evidenced that regarding working memory, there were improvements in the performance of all groups, with a statistical value mostly significant in the experimental groups, which showed that the type of format used in the intervention did not generate differences, and in the case of the control group, there was a slight improvement that was attributed to the process of cognitive development itself. As for basic mathematical skills, the experimental groups had the highest performance, which reinforced the theoretical hypothesis of association between working memory and mathematical skills.

We should add a study on a program to stimulate pre-reading skills in preschool children carried out by Velarde et al. (2012) in Peru, which applied a cognitive and psycholinguistic program called "Leíto. Preparémonos para la Lectura" (Leito. Let's Get Ready for Reading) during 60 sessions, with a frequency of four times per week and a duration of four months. They applied in this study a test of pre-reading skills before and after the intervention to the experimental group, in which they found that in the initial measurement, both the experimental group and the control group did not have significant differences in these skills. However, after the intervention, they found that the experimental group perform better in verbal memory from sentence repetition, in oral language from the semantic component, phonological awareness in rhyme recognition, and phonemic awareness in recognition of the initial, middle, and final phonemes.

As a way to intervene in the situation described above, neuropsychology as a scientific discipline has been interested in the promotion of psychoeducational activities and support activities for learning disabilities, especially when countries like Colombia and specifically regions like Urabá, where this research was conducted, have been hit by socioeconomic inequality, violence, and lack of favorable conditions for children to achieve adequate development. Then, it is urgent to bet on cognitive training programs that respond positively to the academic development of children in the early years to significantly increase not only cognitive skills but the impact that this improvement would have on academic skills.

To this extent, this work is relevant as it will allow us to identify whether the application of a neuropsychological program to socially vulnerable children during the first school year leads to better performance in reading, writing, and mathematics development. This proposal will help recognize the influence of early neuropsychological intervention in healthy children in the school context and its contribution to the optimization of learning processes, taking into account that

most of the cognitive training works have been directed to the population with neurodevelopmental alterations. Likewise, works like this one can bring the gap between education and neurosciences closer by using the findings obtained in the practical field and integrating scientific knowledge to the generation of relevant intervention strategies for the educational population according to neurocognitive profiles (Vargas, 2018).

This research is therefore aimed at first-grade children of a public school in the municipality of Apartadó, Antioquia, Colombia, of low socioeconomic level (1 and 2), directly benefiting the intervened students, participating parents, assigned teachers, and the school in general. The results of this proposal could respond to the cognitive needs of the population of low socioeconomic level, approached from the school environment, which is the closest space, of greater access and permanence for this population at an early age, achieving, in turn, the intervention of the family as co-responsible for the educational process. It is important to emphasize that it is a neuropsychological intervention program linked to the school curriculum, where teachers, directors, and the counseling department intervene.

Therefore, we seek to answer the following question: What is the effect of a neuropsychological intervention program applied to a group of first-grade primary school students on their subsequent performance in the academic skills of reading, writing, and mathematics?

METHOD

Design

Quantitative explanatory study, from the analytical empirical approach, with a quasi-experimental design, pre- and post-testing of control group (Hernández et al., 2010). It is a comparative study with two groups of students from the same school. The first one is a first-grade group that received the intervention of a neuropsychological program; the second one is a group in the same grade that did not receive intervention. They were evaluated in the performance of academic skills (reading, writing and mathematics) before and after the treatment.

Participants

Non-probabilistic convenience sampling, initially formed by two groups of first-grade primary school students aged between 5 and 6, both groups of 19 participants for the experimental group, 10 boys (53%) and 9 girls (47%), and 19 participants for the control group, 5 boys (26%) and 14 girls (74%). In both groups, 47% of the children belonged to socioeconomic level 1 and 53% to socioeconomic level 2.

The following inclusion, exclusion, and elimination criteria were taken into account:

- **Inclusion:** Children of socioeconomic levels 1 and 2 who were enrolled in the school. Intellectual capacity equal to or greater than 80. Parental authorization for participation.

- **Exclusion:** To have sensory or motor alterations that hinder the application of the instruments or brain alterations that compromise cognitive development (intellectual disability).
- **Elimination:** Incomplete program evaluation and implementation.

Instruments

Weschler Intelligence Scale for Children – Third Edition, WPPSI III

Intelligence test aimed at measuring the intellectual capacity of children between 2 years old and 7 years 3 months old by carrying out various tasks that are intended to measure cognitive performance. It yields several intellectual coefficients in addition to the total such as execution, verbal, processing speed, and a general composite coefficient of language. It has a reliability coefficient of internal consistency in the subtests of 0.83 to 0.95 and stable scores in the composite coefficients and the total IQ, in addition to satisfactory criterion validity. This scale was used to meet the inclusion criterion for participants who were required to have a global IQ equal to or higher than 80.

Child Neuropsychological Evaluation – ENI

An instrument designed for Spanish-speaking children aged between 5 and 16 that evaluates different domains of reading (syllables, words, non-words, sentences, words with errors in reading aloud a text, reading aloud speed, and reading aloud comprehension), writing (syllables, words, non-words, sentences, words with errors in copying, and speed in copying a text), and mathematics (counting, number reading, number dictation, comparison of written numbers, number ordering, mental calculation, and written calculation). The norms of this instrument were obtained from a sample of Colombian and Mexican children, with reliability criteria based on test-test methodology and inter-rater reliability, indicating an adequate stability and correlation coefficient ranging from 0.85 to 0.98, in addition to construct validity indicating positive correlations with other tests (Matute et al., 2007). This test was used to measure academic skills in reading, writing, and mathematics before and after the neuropsychological intervention program.

NeuronUP Kids Neuropsychological Intervention Program

A technological platform for rehabilitation and cognitive stimulation in the Spanish-speaking market that has existed since 2012, aimed at strengthening the cognitive functions of attention, memory, language, gnosias, praxias and executive functions, and that has a presentation that can be printed on worksheets to be worked with pencil and paper, organized in up to five levels of difficulty: basic, easy, medium, difficult, and advanced.

This neuropsychological stimulation program was carried out for seven months from April to October, with a 5-week break for school vacation: one week in April, three weeks in June, and one week in October.

The methodology of the intervention program is supported by the contribution made by the Neuropsychological Training Program (PEN), taking into account the following characteristics (Portellano, 2016):

- It is delivered within the school timetable as a space included in the curricular contents.
- The program is delivered at the beginning of the school day to influence attention and motivation during the rest of the day.
- It is delivered out daily in sessions of 15 to 20 minutes.
- The program lasts seven months as it is recommended that the program be longer than three months or delivered during the entire school year.
- It is delivered in groups, with the support of printed stimuli.
- Priority is given to the use of visual stimuli due to the cognitive weight of this sensory modality.
- Exercises aimed at stimulating executive functions cover their different domains: cognitive flexibility, working memory, inhibition, planning, and fluency. Exercises that promote inhibition are especially emphasized due to their impact on all types of learning.
- Feedback is given to the children based on their successes and failures.
- Stimulation begins with simple exercises and increases the level of difficulty according to the performance in the previous exercises.
- It is applied to children of younger school age, taking advantage of their greater neuroplasticity.

Procedure

This study was carried out through the phases listed in Table 1.

Table 1.
Phases of the procedure

Preparation phase: inclusion criteria	**Application of the WPPSI-III intelligence scale**
Phase 1. Pre-test neuropsychological evaluation	The initial evaluation of the students in the experimental and control groups, the child neuropsychological evaluation (ENI), which measures academic skills, is carried out.
Phase 2. Application of the neuropsychological stimulation program.	The neuropsychological program NeuronUP Kids is applied to the experimental group, responding to each established intervention line of group training.
Phase 3. Post-test neuropsychological evaluation.	At the end of the neuropsychological program with the experimental group, the child neuropsychological evaluation (ENI) is made in both groups participating in the process, which measures the academic skills.

Source: Elaborated by the author.

Data Analysis

The SPSS v27 statistical processor was used for data processing. The normality was tested using the Shapiro-Wilk test for data less than 50, obtaining non-normal data, which indicates that the data do not follow a normal distribution. The Mann-Whitney U test was used for the analysis of

independent data. The Wilcoxon t-test was used (IBM SPSS Statistics for Windows, version 27.0. Armonk, New York: IBM Corp) for the analysis of related samples.

RESULTS

As for academic skills, no statistically significant differences were found between the two groups evaluated at the pre-treatment level (p>0.05) in the reading and mathematics components, suggesting homogeneous performance in both groups in this first assessment. As for writing, significant differences (p>001) were found in the word and non-word subtests, with an effect size greater than 0.8, placing it in the large range (See Table 2).

Table 2.
Intergroup Analysis of Academic Skills in the Pre-test

Characteristic		Experimental Group (n=19)	Control Group (n=19)	Mann Whitney U test	p-value	G for Hedges
Reading accuracy	Syllables	0.0 (8.0)	1.0 (8.0)	178.0	.937	0.132
	Words	3.0 (7.0)	3.0 (7.0)	130.0	.120	0.462
	Non-words	0.0 (7.0)	0.0 (5.0)	168.5	.690	0.000
	Sentences	0.0 (6.0)	0.0 (6.0)	162.5	.324	0.233
	Words with errors in reading aloud	35.0 (31.0)	35.0 (32.0)	171.0	.553	0.183
Reading comprehension	Reading aloud comprehension	0.0 (4.0)	0.0 (8.0)	170.5	.532	0.264
Reading speed	Reading aloud speed	0.0 (31.0)	0.0 (36.0)	171.0	.553	0.162
Writing accuracy	Name	2.0 (2.0)	2.0 (2.0)	142.5	.079	0.575
	Syllables	1.0 (7.0)	1.0 (2.0)	166.0	.646	0.420
	Words	1.0 (5.0)	0.0 (1.0)	87.0	<.001	1.116
	Non-words	1.0 (5.0)	0.0 (3.0)	85.0	<.001	0.985
	Sentences	0.0 (7.0)	0.0 (0.0)	171.0	.317	0.318
	Words with errors in copying	85.0 (81.0)	85.0 (77.0)	172.0	.596	0.165
Writing speed	Speed in copying a text	0.0 (2.0)	0.0 (1.0)	172.0	.596	0.000
Arithmetic counting	Counting	5.0 (4.0)	5.0 (5.0)	168.0	.704	0.182
Arithmetic numeric management	Number reading	4.0 (2.0)	3.0 (3.0)	122.0	.069	0.582
	Number dictation	2.0 (4.0)	3.0 (3.0)	158.0	.472	0.207
	Number comparison	0.0 (3.0)	0.0 (2.0)	176.5	.875	0.059
	Number ordering	0.0 (5.0)	0.0 (4.0)	180.0	.970	0.049
Mental calculation	Mental calculation	2.0 (3.0)	2.0 (3.0)	175.5	.879	0.048
	Written calculation	2.0 (2.0)	1.0 (2.0)	134.5	.139	0.437

Note. Data are shown as median (MD) and Range (R). Hedges' g effect size < 0.2 = small; < 0.5 = medium; > 0.8 = large.
Source. Elaborated by the author.

As for academic skills, statistically significant differences were found in the reading component in the subtests of syllables, words, non-words, sentences, and words with errors in reading aloud a text, and reading speed. In the case of syllables and non-words, the effect size is large, while in the others, it is medium, and in words with errors in reading aloud a text, it is low.

As for writing, significant differences were found in syllable writing, with a medium effect size; as for the mathematics component, no significant differences were found between the two groups (see Table 3).

Table 3.
Intergroup Analysis of Academic Skills in the Post-Test

Characteristic		Experimental Group (n=19)	Control Group (n=19)	Mann Whitney U test	p-value	G for Hedges
Reading accuracy	Syllables	8.0 (7.0)	6.0 (8.0)	66.5	.001	0.983
	Words	11.0 (8.0)	1.0 (8.0)	78.0	.002	0.719
	Non-words	8.0 (6.0)	6.0 (6.0)	79.5	.002	0.950
	Sentences	10.0 (10.0)	8.0 (10.0)	109.0	.037	0.600
	Words with in reading aloud	0.0 (33.0)	2.0 (22.0)	111.0	.043	0.257
Reading comprehension	Reading aloud comprehension	8.0 (8.0)	6.0 (8.0)	130.5	.146	0.523
Reading speed	Reading aloud speed	35.0 (51.0)	24.0 (93.0)	96.0	.013	0.588
Writing accuracy	Name	2.0 (0.0)	2.0 (0.0)	18.,5	1.00	0.000
	Syllables	6.0 (7.0)	5.0 (8.0)	103.0	.023	0.775
	Words	4.0 (5.0)	4.0 (5.0)	120.5	.080	0.564
	Non-words	6.0 (8.0)	4.0 (8.0)	147.0	.339	0.319
	Sentences	8.0 (15.0)	4.0 (15.0)	144.0	.297	0.363
	Words with errors in copying	8.0 (85.0)	7.0 (18.0)	160.0	.563	0.332
Writing speed	Speed in copying a text	2.0 (5.4)	1.8 (15.9)	156.5	.488	0.044
Arithmetic counting	Counting	6.0 (4.0)	6.0 (4.0)	151.5	.402	0.272
Arithmetic numeric management	Number reading	3.0 (3.0)	3.0 (4.0)	171.0	.795	0.060
	Number dictation	3.0 (5.0)	3.0 (2.0)	139.0	.234	0.506
	Number comparison	2.0 (5.0)	2.0 (6.0)	173.0	.840	0.157
	Number ordering	0.0 (7.0)	1.0 (6.0)	142.5	.271	0.340
Mental calculation	Mental calculation	3.0 (4,0)	2.0 (4.0)	157.5	.506	0.343
	Written calculation	2.0 (2,0)	2.0 (3.0)	147.0	.339	0.283

Note. Data are shown as median (MD) and Range (R). Hedges' g effect size < 0.2 = small; < 0.5 = medium; > 0.8 = large.
Source. Elaborated by the author.

The results of academic skills show that in all reading components, students perform better from one measurement to another, as well as in the writing components, except for name writing, and in mathematics, in arithmetic and mental and written calculation. The effect size is large in all subtests that showed a significant level, except for reading numbers, number dictation, and mental calculation, which obtained a medium effect size (See Table 4).

Table 4.
Pre-Test and Post-Test Analysis of Academic Skills (Control Group)

Characteristic		Pre-test (n=19) Mdn (Range)	Post-test (n=19) Mdn (Range)	Z	p Value	G for Hedges	1-β
Reading accuracy	Syllables	1.0 (8.0)	6.0 (8.0)	-3.536	.000	2.003	1
	Words	3.0 (7.0)	10.0 (8.0)	-3.837	.000	2.374	1
	Non-words	0.0 (5.0)	6.0 (6.0)	-3.837	.000	2.384	1
	Sentences	0.0 (6.0)	8.0 (10.0)	-3.417	.001	1.987	.999
	Words with errors in reading aloud	35.0 (32.0)	2.0 (22.0)	-3.830	.000	3.334	1
Reading comprehension	Reading aloud comprehension	0.0 (8.0)	6.0 (8.0)	-3.246	.001	1.625	.999
Reading speed	Reading aloud speed	0.0 (36.0)	24.0 (93.0)	-3.823	.000	1.452	.996
Writing accuracy	Name	2.0 (2.0)	2.0 (0,0)	-1.000	.317	0.323	.252
	Syllables	1.0 (2.0)	5.0 (8,0)	-3.736	.000	2.182	.999
	Words	0.0 (1.0)	4.0 (5,0)	-3.851	.000	3.256	1
	Non-words	0.0 (3.0)	4.0 (8,0)	-3.836	.000	2.421	1
	Sentences	0.0 (0.0)	4.0 (15,0)	-3.438	.001	2.173	.999
	Words with errors in copying	85.0 (77.0)	7.0 (18,0)	-3.828	.000	4.158	1
Writing speed	Speed in copying a text	0.0 (1.0)	1.8 (15.9)	-3.825	.000	1.046	.935
Arithmetic counting	Counting	5.0 (5.0)	6.0 (4.0)	-2.475	.013	0.900	.859
Arithmetic numeric management	Number reading	3.0 (3.0)	3.0 (4.0)	-2.000	.046	0.570	.532
	Number dictation	3.0 (3.0)	3.0 (2.0)	-2.124	.034	0.629	.601
	Number comparison	0.0 (2.0)	2.0 (6.0)	-2.697	.007	0.862	.831
	Number ordering	0.0 (4.0)	1.0 (6.0)	-2.825	.005	0.900	.859
Mental calculation	Mental calculation	2.0 (3.0)	2.0 (4.0)	-2.309	.021	0.541	.497
	Written calculation	1.0 (2.0)	2.0 (3.0)	-3.095	.002	1.029	.928

Note. Data are shown as median (MD) and Range (R). Hedges' g effect size < 0.2 = small; < 0.5 = medium; > 0.8 = large.
Source. Elaborated by the author.

After measuring the academic skills before and after the neuropsychological stimulation program, the experimental group showed significant changes in all components of reading and writing with a large effect level; as for the mathematics components, changes were observed in counting, number dictation, number comparison, number ordering, and mental calculation. No significant changes were observed in number reading and written calculation (See Table 5).

Table 5.
Pre-Test and Post-Test Analysis of Academic Skills (Experimental Group)

Characteristic		Pre-test (n=19) Mdn (Range)	Post-test (n=19) Mdn (Range)	Z	p Value	G for Hedges	1-β
Reading accuracy	Syllables	0.0 (8.0)	8,0 (7.0)	-3.790	.000	3.254	1
	Words	3.0 (7.0)	11,0 (8.0)	-3879	.000	4.364	1
	Non-words	0.0 (7.0)	8,0 (6.0)	-3.878	.000	3.988	1
	Sentences	0.0 (6.0)	10,0 (10.0)	-3.858	.000	3.972	1
	Words with errors in reading aloud	35.0 (31,0)	0,0 (33.0)	-3.876	.000	4.210	1

Characteristic		Pre-test (n=19) Mdn (Range)	Post-test (n=19) Mdn (Range)	Z	p Value	G for Hedges	1-β
Reading comprehension	Reading aloud comprehension	0.0 (4.0)	8,0 (8.0)	-3.896	.000	3.659	1
Reading speed	Reading aloud speed	0.0 (31.0)	35,0 (51.0)	-3.823	.000	3.170	1
Writing accuracy	Name	2.0 (2.0)	2,0 (0.0)	-2.236	.025	0.822	0.799
	Syllables	1.0 (7.0)	6,0 (7.0)	-3.735	.000	2.637	1
	Words	1.0 (5.0)	4,0 (5.0)	-3.843	.000	1.947	.999
	Non-words	1.0 (5.0)	6.0 (8.0)	-3.848	.000	2.092	.999
	Sentences	0.0 (7.0)	8.0 (15.0)	-3.857	.000	2.914	1
	Words with errors in copying	85.0 (81.0)	8.0 (85.0)	-3.728	.000	3.747	1
Writing speed	Speed in copying a text	0.0 (2.0)	2.0 (5.4)	-3.832	.000	2.040	.999
Arithmetic counting	Counting	5.0 (4.0)	6.0 (4.0)	-3.671	.000	1.467	.997
Arithmetic numeric management	Number reading	4.0 (2.0)	3.0 (3.0)	-0.165	.869	0.062	.072
	Number dictation	2.0 (4.0)	3.0 (5.0)	-2.980	.003	1.058	.939
	Number comparison	0.0 (3.0)	2.0 (5.0)	-2.201	.028	0.735	.718
	Number ordering	0.0 (5.0)	0.0 (7.0)	-2.414	.016	0.435	.372
Mental calculation	Mental calculation	2.0 (3.0)	3.0 (4.0)	-2.795	.005	0.944	.887
	Written calculation	2.0 (2.0)	2.0 (2.0)	-1.155	.248	0.395	.327

Note. Data are shown as median (MD) and Range (R). Hedges' g effect size < 0.2 = small; < 0.5 = medium; > 0.8 = large.
Source. Elaborated by the author.

DISCUSSION

Several studies have analyzed the effect of cognitive stimulation programs on the development of cognitive and/or academic skills; however, most of these studies have been conducted from the clinical approach of neuropsychology, away from the educational scenario, specifically in classroom practice and their potential impact on academic development.

Therefore, the general objective of this research was to analyze the effect of a neuropsychological intervention program on the performance of academic skills in reading, writing, and mathematics in a group of first-grade primary school children of a public school. An attempt was made to test the effectiveness of the neuropsychological stimulation program in a sample of 38 children, 19 in the experimental group and 19 in the control group, who were enrolled in the first grade of primary school, aged 5 to 6.

For this purpose, the results of the initial assessment, pre-test evaluation, was first analyzed, showing homogeneity characteristics in the reading, writing, and mathematics components, with some differences in two of the writing subtests such as word writing and non-word writing, which showed better performance in the experimental group; the other subtests of this domain did not show significant differences.

After applying the neuropsychological stimulation program, significant differences were identified between both groups in reading and writing, specifically in the syllable and non-word reading components, with a large effect size; words, sentences, and reading speed, with a medium

effect size; and words with errors in reading aloud and reading speed, with a small effect size. As for writing, the difference was in syllable writing, with medium effect size. The above results confirm the hypothesis that the application of a neuropsychological intervention program in first and second graders improves the acquisition of basic academic skills in reading, writing, and mathematics in a group of children, taking into account that only in reading and in writing subtest, a significant post-training impact was obtained.

This finding is consistent with the results of other studies that point out the relevance of the neuropsychological functions in fundamental academic skills learning, particularly with reading in the reading accuracy and speed components. An example of this is the evidence that has shown that the skills to identify and discriminate words and recognize known words and less frequent words relate significantly with the performance of selective visual, sustained, and spatial attention (De Abreu et al., 2017; Ison & Korzeniowski, 2016; Roselli et al., 2006; Saj & Barisnikov, 2015). From this point of view, attention plays an important role in the learning process, necessary to carry out sensory, cognitive, or motor activities, functioning as a filter responsible for selecting, prioritizing, processing, and monitoring information, discarding and inhibiting unwanted information (Portellano, 2005; Portellano & García, 2014).

Phoneme identification, phoneme addition, word reading, non-word reading, syllable segmentation, rhyme detection, and word and non-word reading speed are related to oral language development and naming speed (Aguilar et al., 2010; Arango-Tobón et al., 2018; González et al., 2013). Language has an important regulatory function in school learning because it enables how thought is expressed (Allignani et al., 2011) since, in addition to this, children communicate information to others through language and regulates their life in general through the organization and expression of their emotions (Quintanar & Silovieva, 2002).

The ability to discriminate and recognize signs such as figures, letters, words, and numbers is closely related to visual perceptual skills and visual memory (Pino & Bravo, 2005). At early school ages between 6 to 8 years old, there is much greater engagement of these domains in word reading and reading comprehension activities (De la Calle, 2019).

Other studies demonstrated the relationship of executive functions in reading comprehension, specifically those derived from working memory and verbal fluency, an aspect that was not found in this study (Arán-Filippetti & López, 2016), which coincides with the study conducted by Bernal-Ruiz et al. (2020) who found no significant effects on academic skills, following a training program in executive functions for three months.

The above may indicate that early intervention in the above-mentioned neuropsychological functions becomes a support strategy for learning academic skills that should interact with other determinants mentioned in the scientific evidence, such as teaching methodologies and reading strategies (Bravo, 2000, 2018), so teacher participation and approach in each of them becomes a fundamental support (Pascual et al., 2018).

The intra-group analysis showed that both groups significantly improved in academic skills between the first and second measurements. For its part, the control group showed no differences in name writing, and the experimental group show no differences in number reading

and written calculation. The effect size was large in the majority of components in both the control and experimental groups, showing that factors such as the schooling process positively affect the development of basic academic skills in seven months, in which the children were able to acquire important learning according to the institutional curricular processes; likewise, in this case, the effect of the program contributed significantly to the performance of skills in reading accuracy, fewer reading errors and reading speed, and as for writing, in syllable writing.

The improvements in reading performance coincide with that proposed by Ghiglione et al. (2011), who, through a neuropsychological intervention program, sought to demonstrate that cognitive development can be favored in children at risk of poverty by adapting strategies to the school curriculum, concluding that after the intervention, children were able to access word reading. Additionally, other training demonstrated improvement in initial, middle, and final phoneme recognition (Velarde et al., 2012) and even mathematical skills (Fernández-Abella et al., 2019). This means that reading does not emerge suddenly in a process of cultural appropriation that occurs in the school environment, as described by Bravo in 2003, but is part of cognitive repertoires that support this learning.

The results of this study support the relevance that the development of neuropsychological intervention programs in the classroom context, thought from different objectives, would have, first, as an alternative to favor cognitive development at the beginning of the school process, taking into account the socioeconomic differences that generate disadvantages in children in situations of poverty, second, as a prevention program against possible risks of learning difficulties, which would reduce future corrective actions, and, third, as a strategy to enhance and optimize the cognitive resources necessary for the development of basic academic skills necessary for academic success (De Abreu et al., 2017; Ison & Korzeniowski, 2016).

In addition to the above, these programs should become part of the school curriculum as a form of precursor to learning, which can be addressed in the teaching program of the early school years and led by teachers without requiring professionals in psychology or neuropsychology to that end (Aglio, 2016).

As final considerations, it can be highlighted that a neuropsychological stimulation program applied to first-grade children has positive effects on both cognitive development and learning of basic skills, such as reading, an element that adds to the school, family, and social factors that children require to advance in their education process. Family participation in the knowledge of cognitive skills and its importance in academic development supports the awareness of these precursors in the home context.

This study has several limitations in its interpretation. The first limitation is that it was conducted with a group selected at convenience, of socioeconomic level 1 and 2, from a public school; therefore, the results are not generalizable. The number of participants was reduced in the course of the study due to student withdrawal from the school or continuous non-attendance, which is why we ended up with a sample of 38 children. The typical dynamics of schools, such as unschooling for administrative reasons or internal events, interrupted the intervention from one day to another, which was not foreseen in the program.

Author contributions: Astrid Ayala, responsible for research design, conduction, and analysis.

Conflicts of interest: The author declares that she has no conflicts of interest involving the results of this study.

Financing sources: Self-financed project.

Acknowledgments: The author thanks the Cadena Las Playas School in Apartadó, Antioquia, for supporting the implementation of the project with the participation of children, teachers, directors, and parents.

REFERENCES

Aglio, B. (2016). Programa de estimulación para el desarrollo de las funciones ejecutivas en preescolares. En I.Leal, C. Gordinho, S. Maraques, P. Vitoria & J.L. Pais (Eds.), *Atas Do 11 Congreso Nacional De Psicología Da Saudé* (1ª ed.) (pp 105-115). Sociedade Portuguesa de Psicologia da Saúde.

Aguilar, M., Navarro, J.I., Menacho, I., Alcalde, C., Marchena, E. & Ramiro P. (2010). Velocidad de nombrar y conciencia fonológica en el aprendizaje inicial de la lectura. *Psicothema*, 22, 436-442.

Allignani, G., Granovsky, G. & Iroz, M. (2011). Evaluación lenguaje en el niño nacido prematuro. *Revista del Hospital Materno Infantil Ramón Sardá*, *30*(1), 8-9. http://www.redalyc.org/pdf/912/91218702002.pdf

Arán-Filippetti, V. (2012). Estrato socioeconómico y habilidades cognitivas en niños escolarizados: variables predictoras y mediadoras. *Psykhe*, *21*(1), 3-20. http://dx.doi.org/10.4067/S0718-22282012000100001

Arán-Filippetti, V. & López, M. (2016). Predictores de la Comprensión Lectora en Niños y Adolescentes: El papel de la Edad, el Sexo y las Funciones Ejecutivas. *Panamerican Journal of Neuropsychology*, *10*(1), 23-44.

Arango-Tobón, O., Pinilla, G., Gaviria, T., Puerta, I., Olivera-La Rosa, A., Ardila, A., Matute, E. & Rosselli, M. (2018). Relación entre lenguaje expresivo y receptivo y habilidades prelectoras. *Revista Latinoamericna de Psicología*, *50*(3), 135-144. https://doi.org/10.14349/rlp.2018.v50.n3.1

Araya-Pizarro, S. & Espinoza, L. (2020). Aportes desde las neurociencias para la comprensión de los procesos de aprendizaje en los contextos educativos. *Propósitos y Representaciones*, *8*(1), e312. http://dx.doi.org/10.20511/pyr2020.v8n1.312

Arnedo, M., Montes, A., Bembibre, J. & Triviño, M. (2015). *Neuropsicología infantil a través de casos clínicos*. Editorial Médica Panamericana.

Ashton, R. (2015). Educational Neuropsychology. En *Neuropsychological Rehabilitation of Childhood Brain Injury* (pp. 237-253). Palgrave Macmillan UK.

Bernal-Ruiz, F., Rodríguez-Vera, M. & Ortega, A. (2020). Estimulación de las funciones ejecutivas y su influencia en el rendimiento académico en escolares de primero básico. I*nterdisciplinaria*, *37*(1), 1-36. http://dx.doi.org/10.16888/interd.2020.37.1.6

Bravo, L. (2018). El Paradigma de las Neurociencias de la Educación y el Aprendizaje del Lenguaje Escrito: Una Experiencia de 60 Años. *Psykhe*, *27*(1), 1–11. https://doi.org/10.7764/psykhe.27.1.1101

Bravo, L. (2014). Psicología cognitiva y neurociencias de la educación en el aprendizaje del lenguaje escrito y de las matemáticas. *Revista de investigación en Psicología*, *17*(2), 1-37.

Bravo, L. (2003). *Lectura inicial y psicología cognitiva*. Ediciones Universidad Católica de Chile.

Bravo, L. (2000). Los procesos cognitivos en el aprendizaje de la lectura inicial. *Pensamiento Educativo*, *27*(2), 49–68. https://pensamientoeducativo.uc.cl/index.php/pel/article/view/25999

Cuervo, A. & Ávila, A. (2010). Neuropsicología infantil del desarrollo: detección e intervención de trastornos de la infancia. *Revista Iberoamericana de psicología: ciencia y tecnología*, *3*(2), 59-68. https://doi.org/10.33881/2027-1786.rip.3206

D´Amato, R. (1990). A Neuropsychological Approach to School Psychology. *School Psychology Quarterly*, *5*(2), 141-160.

De Abreu, E., Viapiana, V., Hess, A., Gonçalves, H., Sartori, M., Giacomoni, C., Stein, L. & Fonseca, R. (2017). Relação entre Atenção e Desempenho em Leitura, Escrita e Aritmética em Crianças. *Avaliação Psicológica*, *16*(4), 458-467. http://dx.doi.org/10.15689/ap.2017.1604.12989

De la Calle Cabrera, A., Guzmán-Simón, F., & García-Jiménez, E. (2019). Los precursores cognitivos tempranos de la lectura inicial: un modelo de aprendizaje en niños de 6 a 8 años. *Revista de Investigación Educativa*, *37*(2), 345–361. https://doi.org/10.6018/rie.37.2.312661

Fernández-Abella, R., Peralbo-Uzquiano, M., Durán-Bouza, M., Brenlla-Blanco, J. & García-Fernández, M. (2019). Programa de intervención virtual para mejorar la memoria de trabajo y las habilidades matemáticas básicas en la educación infantil. *Revista de psicodidáctica*, *24*(1), 17-23. https://doi.org/10.1016/j.psicod.2018.09.002

Fuentes, A. & Collado, J. (2019). Fundamentos epistemológicos transdisciplinares de educación y neurociencia. *Sophia: Coleccion de la Educación*, *26*(1), 82-113. https://doi.org/10.17163/soph.n26.2019.0

Ghiglione, M., Arán-Filippetti, V., Manucci, V. & Apaz, A. (2011). Programa de intervención, para fortalecer funciones cognitivas y lingüísticas, adaptado al currículo escolar en niños en riesgo por pobreza. *Interdisciplinaria*, *28*(1), 17-36.

González, R., López, S., Vilar, J., & Rodríguez López-Vázquez, A. (2013). Estudio de los predictores de la lectura. *Revista de Investigación en Educación*, *11*(2), 98-110.

Hernández, R., Fernández, C. & Baptista, M. (2010). *Metodología de la investigación* (5a ed.). McGraw-Hill.

Hermida, M., Segretin, M., Lipina, S. & Colombo, J. (2010). Abordajes neurocognitivos en el estudio de la pobreza infantil: consideraciones conceptuales y metodológicas. *Revista Internacional de Psicología y Terapia Psicológica*, *10*(2), 205-225.

Instituto Colombiano para la Evaluación de la Educación (2018). *Resultados Nacionales: Saber 3, 5 y 9, 2012-2017*. https://www2.icfes.gov.co/documents/39286/1642471/Informe+nacional+saber+569+2012+2017.pdf/3c2c0f89-2c7b-6702-7c0f-226426961bd6?version=1.0&t=1647374833904

Instituto Colombiano para la Evaluación de la Educación. (2021). *Resultados agregados examen saber 11 – 2021*. https://portalicfespruebas.icfes.gov.co/documents/39286/2372121/Resumen+infogra%CC%81fico+-+Resultados+agregados+del+examen+Saber+11+-+2021_.pdf/c69f4a99-5c03-5779-4c24-80c19a51d3bf?t=1648054186418

Ison, M. & Korzeniowski, C. (2016). El rol de la atención y percepción viso espacial en el desempeño lector en la mediana infancia. *Psykhe*, *25*(1), 1-13. http://dx.doi.org/10.7764/psykhe.25.1.761

Lipina, S., Hermida, M. & Segretin, M. (2010). Neuroscience and education: Towards the construction of interactive bridges. *Rev Neurol*, *50*(3), 179-186.

Lipina, S. & Segretin, M. (2015). 6000 días más: evidencia neurocientífica acerca del impacto de la pobreza infantil. Psicología Educativa. *Revista de los Psicólogos de la Educación*, *21*(2), 107-116. https://doi.org/10.1016/j.pse.2015.08.003

Martín-Lobo, P. & Arantzazu, F. (2015). La intervención desde la base neuropsicológica y metodologías que favorecen el rendimiento escolar. En P. Martin-Lobo (Ed.), *Procesos y programas de neuropsicología educativa* (pp. 14-33). Centro Nacional de Innovación e Investigación Educativa.

Martín-Lobo, P. (2017). Proyectos de Neuropsicología en las aulas: experiencias e investigaciones. *ReiDoCrea*, *6*(2), 31-39. http://dx.doi.org/10.30827/Digibug.47143

Martinez-Alvarez, I. (2019). Neuropsicología de las estrategias de aprendizaje y la atención en alumnos de 6º de Educación Primaria. *Revista de Estilos de Aprendizaje / Journal of Learning Styles*, *12*(24), 63-76. https://doi.org/10.55777/rea.v12i24.1330

Matute, E., Rosselli, M., Ardila, A. & Ostrosky, F. (2007). *Evaluación Neuropsicológica Infantil ENI (Child Neuropsychological Assessment)*. Manual Moderno/Universidad de Guadalajara/UNAM.

Mazzoni, C.C., Stelzer, F., Cervigni, M.A. & Martino, P. (2014). Impacto de la pobreza en el desarrollo cognitivo: un análisis teórico de dos factores mediadores. *Liberabit, 20(1)*, 93-100.

Ministerio de Educación Nacional (2022). *Deserción escolar en Colombia: análisis, determinantes y política de acogida, bienestar y permanencia*. https://www.mineducacion.gov.co/1780/articles-363488_recurso_34.pdf

Ministerio de Educación Nacional (2016). *Derechos básicos de aprendizaje*. http://aprende.colombiaaprende.edu.co/sites/default/files/naspublic/DBA_Lenguaje.pdf.

Mora, F. (2017). *Neuroeducación*. Alianza Editorial.

Organización para la Cooperación y el Desarrollo Económicos (2016). *La educación en Colombia*. http://www.plandecenal.edu.co/cms/media/herramientas/oecd_educacion_en_colombia_aspectos.pdf

Organización para la Cooperación y el Desarrollo Económicos (2019). *Resultados PISA 2018*. https://www.oecd.org/pisa/publications/PISA2018_CN_COL_ESP.pdf

Pascual, M., Madrid, D. & Estrada-Vidal, L. (2018). Factores predominantes en el aprendizaje de la iniciación a la lectura. *Revista Mexicana de Investigación Educativa*, 23 (79), 1121-1147.

Pérez-Puellez, L. (2021). Neurociencia educacional: un nuevo desafío para los educadores. *Didasc@lia: Didáctica y Educación*, *12*(2), 157-173.

Pherez, G., Vargas, S. & Jerez, J. (2017). Neuroaprendizaje, una propuesta educativa: herramientas para mejorar la praxis del docente. *Civilizar Ciencias Sociales y Humanas*, *18*(34), 149-166. https://doi.org/10.22518/usergioa/jour/ccsh/2018.1/a10

Pimentel, M. & Córdova, T. (2019). Evaluación neuropsicológica en educación básica para la detección de trastornos asociados al neurodesarrollo. *Universidad, Ciencia y Tecnología*, 02, 45-50.

Pino, M. & Bravo, L. (2005). Visual Memory as Predictor of Reading Acquisition. *Psykhe*, *14*(1), 47-53. https://dx.doi.org/10.4067/S0718-22282005000100004

Portellano, J. (2016). Estimulación neurocognitiva en el aula: propuesta de intervención. *POLIBE*A, *119*, 12-18.

Portellano, J. & García-Alba, J. (2014). *Neuropsicología de la atención, las funciones ejecutivas y la memoria*. Síntesis.

Portellano, J.A. (2005). *Introducción a la Neuropsicología*. Mc Graw Hill.

Quintanar, L. & Solovieva. (2002). Análisis neuropsicológico de los problemas de lenguaje. *Revista de psicología general y aplicada*, *55*(1), 67-87.

Rhenals-Ramos, J. (2021). Contribuciones de la Neuropsicología a nivel educativo: un análisis teórico y reflexivo. *Ciencia y Educación*, 5(3), 117-127. https://doi.org/10.22206/cyed.2021.v5i3.pp117-127

Rosselli, M. & Ardila, A. (2016). Historia de la neuropsicología infantil. *EduPsykhé*, *15*(1), 5-13.

Rosselli, M., & Matute, E. (2011). La neuropsicología del desarrollo típico y atípico de las habilidades numéricas. *Revista Neuropsicología, Neuropsiquiatría y Neurociencias*, *11*(1), 123-140. http://nebula.wsimg.com/3a07ffb454bda58d5ce6302979a362e6?AccessKeyId=F7A1C842D9C24A6CB962&disposition=0&alloworigin=1

Rosselli, M., Matute, E. & Ardila, A. (2006). Predictores neuropsicológicos de la lectura en español. *Revista de Neurología*, *42*(4), 202-210.

Rosselli, M., Matute, E., & Ardila, A. (2010) *Neuropsicologia del Desarrollo Infantil*. Manual Moderno.

Rosselli, M., Matute, E. & Beltrán, M. (2021). La relevancia de la evaluación neuropsicológica en el niño de edad preescolar. *Revista Neuropsicología, Neuropsiquiatría y Neurociencias*, *21*(1), 43-62.

Saj, A. y Barisnikov, K. (2015). Influence of spatial perception abilities on Reading in school-age children. *Cogent Psychology, 2: 1049736* http://dx.doi.org/10.1080/23311908.2015.1049736

Segretin, M., Lipina, S., Hermida, M., Sheffield, T., Nelson, J., Espi, K. & Colombo, J. (2014). Predictors of cognitive enhancement after training in preschoolers from diverse socioeconomic backgrounds. *Frontiers in Psycholy*, *5*(205). https://doi.org/10.3389/fpsyg.2014.00205

Valerio, G., Jaramillo, J., Caraza, R. & Rodríguez, R. (2016). Principios de neurociencia aplicados en la educación universitaria. *Formación Universitaria*, *9*(4), 75–82. https://doi.org/10.4067/S0718-50062016000400009

Vargas, R. (2018). Neurociencias y educación: brechas, desafíos y perspectivas. *Revista Papeles*, *10*(20), 39-52.

Velarde, E., Canales, R., Meléndez, M. & Lingán, S. (2012). Programa de estimulación de las habilidades prelectoras en niños y niñas de educación inicial de la Prov. Constitucional del Callao Perú. *Investigación Educativa*, *15*(27), 53-73.

Zadina, J. (2015). The emerging role of educational neuroscience in education reform. *Psicología educativa, 21(2),* 71-77. https://journals.copmadrid.org/psed/art/j.pse.velarde2015.08.005