Neuropsychological Maturity in Pre-school Children

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Abstract

The purpose of the research was to improve neuropsychological maturity in preschool children; to achieve this; a program of strategies that reinforced the levels of neuropsychological maturity was carried out. The research had a quantitative approach, hypothetical-deductive method and quasi-experimental design; a pre-test and post-test of the Cumanin questionnaire, a valid and reliable instrument, was applied to a sample of 450 students of the initial level. The research found differences between the levels of neuropsychological maturity in pre-school children before and after the application of the program. In this sense, it should be pointed out that before the application of the program, 13.1% were at the beginning level, 72.2% were in process and 14.7% were at the achieved level; after the application of the program, 6.2% of the children were at the beginning level, 72.2% were in process and 21.6% were at the achieved level, which means that the children were at the beginning level, 72.2% were in process and 21.6% were at the achieved level. Therefore, it was concluded that the program generates a positive effect on psychomotor skills in preschool children, since highly significant differences were evidenced (z= -16.065; p<0.000).

Key Words: Neuropsychological Maturity, Psychomotor Skills, Articulatory Language, Expressive Language, Comprehension Language, Spatial Structuring.

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Introduction

There is a growing concern about the maturational problems of children aged 3 to 6 years because it is a crucial stage for the brain development of children, so it is necessary to identify the levels of neuropsychological maturity to provide proposals for improvement (Vericat and Orden, 2013). In this sense, it is important for children to reach the maturation of the central nervous system, because it requires a sequence of more complex processes than other nervous structures, making the nervous system vulnerable, especially to the environment. Furthermore, among the factors attributed to poor school performance, it has been found that in at least one in five cases there is an underlying neurodysfunctional component derived from congenital alterations, perinatal anoxia, neuromaturational delay or dysfunction of the nervous system (Torres-Gonzales et al., 2016).

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It is demonstrated that psychomotor activity, as a regular physical activity, improves general cognitive skills, moreover, children who participated in such planned activities were 15% faster in reaction time tasks; while children who practiced limited physical activity, had 7% more errors in these tasks. Similarly, it was revealed that children practicing collective sports had a 25% improvement in their ability to discriminate between relevant and irrelevant stimuli, and 15% in their ability to discriminate between similar stimuli, compared to those who performed individual sports (Mas, Jiménez, & Riera, 2018).

Regarding word articulation, girls showed better performance. In groups by age, significant differences were found in lexical comprehension errors, visual perception and executive function. Participants showed the presence of developmental SSNs including: language (articulation disorders, oral and written language impairments, word finding difficulty), psychomotor, visual perception and other cognitive functions. There are several factors related to these impairments such as age, socioeconomic context and critical stages in the child's development. Early identification and diagnosis can reduce the risk of school failure (Salvador et al., 2019).

Neuropsychological maturity is defined as levels of organization and maturational development that make it possible to perform in cognitive and behavioral functions in relation to the chronological ages of children (Urzua, et al., 2010 and Morales, et al., 2016). This neuropsychological development is accompanied by various processes such as cell migration, myelination, etc. (Laguado-Herrera, et al., 2015) that lead to the hierarchization and lateralization of brain functions.

Neuropsychology is the science that investigates the relationship between brain and behavior. Developmental neuropsychology adds the developmental perspective both in terms of normal and pathological development. The neuroscience of education is a discipline with a long trajectory, however, the revelations of recent years have given it an extraordinary significance, since it allows the understanding of the reception systems from a neuroscientific point of view, which has allowed the use of this knowledge in the plan of new educational programs and in the advancement of methods that improve the performance of people with learning difficulties (Alonso, 2011).

Approaches based on psychometric and educational paradigms have prevailed in research, therefore, concepts of neurosciences, cognitive neuroscience and neuroeducation are alluded to. In addition, the main contributions from neurosciences to understand the processes of neuroplasticity and the impact of emotions, sleep quality, physical activity and social contexts on learning are analyzed. Finally, the importance of these contributions and how they guide the teaching role and educational practices to enable the achievement of meaningful learning is discussed (Araya and Espinoza, 2020).

Regarding the dimensions, Urzua et al. (2010) and Parra et al. (2015) established psychomotor skills comprised in physical activities such as walking on one foot, touching the nose with the finger, etc. ; the articulatory language dimension is constituted by the repetition of words with articulation difficulties; the expressive language dimension is constituted by the repetition of sentences of increasing difficulty; the comprehension language dimension is comprised in the reading of texts to children and posing questions about the contents; the spatial structuring dimension comprised by tasks that must be performed with psychomotor and graphomotor responses; the visuoperception dimension is considered the reproduction of geometric models of increasing complexity; the iconic memory dimension consists of the visual presentation of a sheet with an engraving of a simple object which is memorized by the examinee and, finally, the rhythm dimension which presents a reproduction of rhythmic series with the gradual increase of difficulties which are presented aurally by the examiner.

On rhythm, Bravo and Carazo (2019) indicated that each music creation protocol in investigations required musical instruments to perform the multifaceted interventions; therefore, these protocols are difficult to implement in large groups, making them less practical for use in the workplace. To increase the practicality of these therapies, it is crucial to develop a music-making strategy that contains fewer components and uses the body as an instrument. As a result, the protocol could be applied to many people at the same time. In addition, although significant positive results have been found in terms of mood improvement, no comparisons of results between women and men have been made.

The need to study child neurodevelopment lies in the fact that it offers a better quality of life for

students; however, it is estimated that, between 10 and 15% of the child population in underdeveloped countries, suffers from some type of neurodevelopmental alteration in different degrees (Parra, Rodriguez, & Chinome, 2015).

Materials and Methods

The research was framed within the quantitative approach, hypothetical deductive method and quasi-experimental design; a pre-test and post-test of the questionnaire called Cumanin, a valid and reliable instrument, was applied to a sample of 450 students of the initial level of 6 public institutions, children of 5 and 6 years of age. A simple randomized probability sampling was carried out. The experimental and control groups were evaluated in two instances: before and after the program intervention; the objective was to strengthen the main components of this function in the children who made up the experimental group. The program was developed systematically over 12 weeks, alternating individual and group activities. The results showed that all the children in the sample increased their scores in the neuropsychological maturity tests. As for the instrument, it presented the psychomotor dimensions with 11 items, articulatory language with 15 items, expressive language with 4 items, comprehension language with 9 items, spatial structuring with 15 items, visuoperception with 15 items, iconic memory with 7 items, rhythm with 7 items. To test the hypotheses, the Wilcoxon test of ranks using the Kolmogorov-Smirnov normality test was used.

Results

Table 1. Comparison of the levels of the neuropsychological maturity variable in pre-school children between the pre-test and post-test results.

			Levels of neuropsychological maturity			Total
			Initial	Process	Achieved	
Condition	Pre	Fi	59	325	66	450
		% fi	13.1%	72.2%	14.7%	100
	Post	Fi	28	325	97	450
		% fi	6.2%	72.2%	21.6%	100

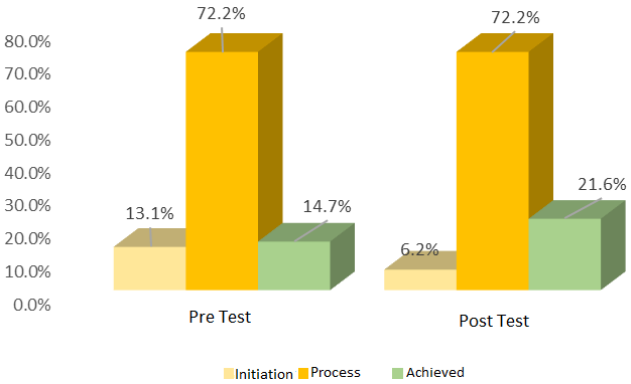

Figure 1. Comparison of the levels of the variable neuropsychological maturity in pre-school children between the pre-test and post-test results.

Table 1 and Figure 1 show the levels of neuropsychological maturity in pre-school children before and after the application of the program. In this sense, it should be noted that before the application of the program, 13.1% were at the beginning level, 72.2% were in process and 14.7% were at an achieved level; after the application of the program, 6.2% of the children were at the beginning level, 72.2% were in process and 21.6% were at an achieved level, which means that the children were able to improve their neuropsychological maturity level.

Inferential Results

Table 2. Comparison of ranges of the variable neuropsychological maturity in initial children

Ranks						
		N	Average rank	Sume of ranks	Z	Bilateral asymptotic sig.
Neuropsychological Maturity Posttest Neuropsychological Maturity Pretest	Negative ranges Positive Ranks Ties Total	0[a]	,00	,00	-16,065	,000
		343[b]	172,00	58996,00		
		107[c]				
		450				
a. Post-test neuropsychological maturity < Pretest neuropsychological maturity b. Posttest neuropsychological maturity > Pretest neuropsychological maturity c. Post-test neuropsychological maturity = Pretest neuropsychological maturity.						

The Wilcoxon signed-rank test allowed observing the comparison of the two conditions, before and after the application of the program; highly significant differences were evidenced (z= -16.065; p<0.000). Therefore, based on the results obtained, the null hypothesis is rejected, establishing that the program generates a positive effect on the neuropsychological maturity variable in pre-school children.

Table 3. Comparison of ranges of psychomotor skills in pre-school children

Ranks						
		N	Range promedium	Sume of ranks	Z	Bilateral asymptotic sig.
Psychomotricity Pos - Psychomotricity Pre	Negative ranges Positive Ranks Ties Total	2[a]	86,25	172,50	-10,617	,000
		151[b]	76,88	11608,50		
		297[c]				
		450				
a. Pos Psychomotricity < Pre Psychomotricity b. Psychomotricity Pos > Psychomotricity Pre c. Psychomotricity Pos = Psychomotricity Pre						

The Wilcoxon signed-rank test allowed observing the comparison of the two conditions, before and after the application of the program, highly significant differences were evidenced (z= -10.617; p<0.000). Therefore, based on the results obtained, the null hypothesis is rejected, establishing that the program generates a positive effect on the psychomotor dimension in pre-school children.

Table 4. Comparison of ranges of articulatory language in pre-school children

Ranks						
		N	Promedium Rank	Sume of Ranks	Z	Bilateral asymptotic sig.
Articulatory language Pos - Articulatory language Pre	Negative ranges	0[a]	,00	,00	-10,030	,000
	Positive Rannks	132[b]	66,50	8778,00		
	Ties	318[c]				
	Total	450				
a) Articulatory language Pos - Articulatory language Pre						
b) Articulatory language Pos - Articulatory language						
c) Articulatory language Pos - Articulatory language Pre						

The Wilcoxon signed-rank test allowed observing the comparison of the two conditions, before and after the application of the program; highly significant differences were evidenced (z= -10.030: p<0.000). Therefore, based on the results obtained, the null hypothesis is rejected, establishing that the program generates a positive effect on articulatory language in preschool children.

Table 5. Comparison of ranges of expressive language in pre-school children

Ranks						
		N	average range	Sume of Ranks	Z	Bilateral asymptotic sig.
Expressive language Pos - Expressive language Pre	Negative ranges	0[a]	,00	,00	-6,533	,000
	Positive Rannks	55[b]	28,00	1540,00		
	Ties	395[c]				
	Total	450				
a. Expressive language Pos - Expressive language Pre						
b. Expressive language Pos - Expressive language Pre						
c. Expressive language Pos - Expressive language Pre						

The Wilcoxon signed-rank test allowed observing the comparison of the two conditions, before and after the application of the program; highly significant differences were evidenced (z= -6.533; p<0.000). Therefore, based on the results obtained, the null hypothesis is rejected, establishing that the program generates a positive effect on expressive language in preschool children.

Table 6. Comparison of comprehension language ranges in pre-school children

Ranks						
		N	Average Range	Sume of ranks	Z	Bilateral asymptotic sig.
Comprehensive Languague Pos – comprehensive Languague Pre	Negatives	0[a]	,00	,00	-8,603	,000
	Ranges positives	95[b]	48,00	4560,00		
	Ties	355[c]				
	Total	450				
a. Comprehensive Languague Pos < Comprehensive Languague Pre						
b. Comprehensive Languague Pos > Comprehensive Languague Pre						
c. Comprehensive Languague Pos = Comprehensive Languague Pre						

The Wilcoxon signed-rank test allowed observing the comparison of the two conditions, before and after the application of the program; highly significant differences were evidenced (z= -8.603; p<0.000). Therefore, based on the results obtained, the null hypothesis is rejected, establishing that the program generates a positive effect on comprehension language in preschool children.

Table 7. Comparison of ranges of spatial structuring in preschool children

Ranks						
		N	Average Range	Sume of ranks	Z	Bilateral asymptotic sig.
spatial structuring Pos spatial structuring Pre	Negatives ranges	1[a]	18,50	18,50	-8,895	,000
	Positive ranges	104[b]	53,33	5546,50		
	Ties	345[c]				
	Total	450				
a. spatial structuring Pos < spatial structuring Pre						
b. spatial structuring Pos > spatial structuring Pre						
c. spatial structuring Pos = spatial structuring Pre						

The Wilcoxon signed-rank test allowed observing the comparison of the two conditions, before and after the application of the program; highly significant differences were evidenced (z= -8.895; p<0.000). Therefore, based on the results obtained, the null hypothesis is rejected, establishing that the program generates a positive effect on spatial structuring in preschool children.

Table 8. Comparison of ranges of visuoperception in pre-school children

Ranks						
		N	Average range	Sume of ranges	Z	Bilateral asymptotic sig.
Visuoperception Pos - Visuoperception Pre	Negative ranges	0[a]	,00	,00	-10,369	,000
	Positive ranges	140[b]	70,50	9870,00		
	Ties	310[c]				
	Total	450				
a. Visuoperception Pos < Visuoperception Pre						
b. Visuoperception Pos > Visuoperception Pre						
c. Visuoperception Pos = Visuoperception Pre						

The Wilcoxon signed-rank test allowed observing the comparison of the two conditions, before and after the application of the program, highly significant differences were evidenced (z= -10.369; p<0.000). Therefore, based on the results obtained, the null hypothesis is rejected, establishing that the program generates a positive effect on visuoperception in pre-school children.

Table 9. Comparison of ranges of the iconic memory in pre-school children

Ranks						
		N	Average range	Sume of ranges	Z	Bilateral asymptotic sig.
Iconic Memory Pos – Iconic Memory Pre	Negative ranges	0[a]	,00	,00	-7,510	,000
	Positive ranges	73[b]	37,00	2701,00		
	Ties	377[c]				
	Total	450				
a. Iconic Memory Pos Pos < Iconic Memory Pos Pre						
b. Iconic Memory Pos Pos > Iconic Memory Pos Pre						
c. Iconic Memory Pos Pos = Iconic Memory Pos Pre						

The Wilcoxon signed-rank test allowed observing the comparison of the two conditions, before and after the application of the program; highly significant differences were evidenced (z= -7.510; p<0.000). Therefore, based on the results obtained, the null hypothesis is rejected, establishing that the program generates a positive effect on the iconic memory in pre-school children.

Table 10. Comparison of rhythm ranges in pre-school children

Ranks						
		N	Average range	Sume of rangos	Z	Bilateral asymptotic sig.
Rhythm Pos - rhythm Pre	Negative Ranges	0[a]	,00	,00	-8,407	,000
	Positive ranges	92[b]	46,50	4278,00		
	Ties	358[c]				
	Total	450				
a. rhythm Pos < rhythm Pre						
b. rhythm Pos > rhythm Pre						
c. rhythm Pos = rhythm Pre						

The Wilcoxon signed-rank test allowed observing the comparison of the two conditions, before and after the application of the program; highly significant differences were evidenced (z= -8.407; p<0.000). Therefore, based on the results obtained, the null hypothesis is rejected, establishing that the program generates a positive effect on rhythm in pre-school children.

Discussion

It was found that the program generates a positive effect on neuropsychological maturity in pre-school children, since highly significant differences were evidenced (z= -16.065; p<0.000). The same Morales, et al. (2016) applied a program and then compared the two groups: the control and the experimental. The experimental group obtained significant improvements in neuropsychological maturity; regarding the dimensions, it was found that the processes of psychomotor, articulatory language, expressive language, spatial structuring, rhythm, verbal fluency, attention, reading and writing did find statistically significant differences in the results between one group and the other. However, for the scales of comprehensive language, visual perception and iconic memory, the scores achieved were not statistically significant: they did not show differences in performance between the groups.

When there are levels of neuropsychological immaturity, there are problems in reading, composition and arithmetic; behavioral problems imaginable in adolescence or adulthood have also been identified; anyway, this is not identified with significant neurological impairment or mental

damage obtained unexpectedly, it is described by its problematic determination and confirmed by a non-intrusive neuropsychological assessment, since neuroimaging images do not easily distinguish irregularities (Chinome et al., 2020).

On the other hand, Pollak et al. (2010) indicated that one of the environmental factors that negatively influence children's neuropsychological development is the deprivation that exists in the contexts in which children develop and that generates cognitive and socioemotional alterations that are maintained over time from early ages to older adulthood. It is important to consider the performance of neuropsychological functions with an increase in average ranges, since the neuropsychological development of children is complex and requires stages and processes in the consolidation of cognitive skills (Fonseca et al., 2016). Conditions that, added to the levels of psychological immaturity could severely compromise their development a posteriori, evidenced in the other levels of educational training, especially at the higher university level, with all the problems that this entails, especially if it is assumed that the educational delivery adopts more than half of the current virtual modality (Salas et al., 2020; Vértiz et al., 2020). This necessarily leads to the modernization of teaching processes and the adaptation of educational institutions in the delivery of quality education in a context of pandemic (Guevara et al., 2021).

Likewise, it was found that the program improved psychomotor skills and, in this regard, Mass and Castella (2016) pointed out that psychomotor skills are a valid tool that contributes to the development of children and helps their future learning. Movement can enhance the development of cognitive structures related to attention, memory, perception, language and thinking, which will help to interpret concepts such as space, time and speed. In addition, their own movement becomes more autonomous and conscious through language and expression. These results suggest that the systematization of bodily experiences from the first months of life facilitates the emergence of motor and cognitive skills and also leads to broaden the acquisition of emotional and affective content. From this perspective, we see psychomotor skills when considered, from an active, critical and flexible pedagogical point of view, as a path that leads to advances in the development of children's intellectual, emotional and social skills.

On the other hand, the program generates a positive effect on articulatory language in pre-school children, since highly significant differences were evidenced and, in this regard, Wong (2010) indicated that language goes beyond lexis and grammar to include non-formal characteristics such as conversational routines, frequency of use of certain expressions, avoidance of certain forms of speech, pragmemes, etc., which can only be satisfactorily explained with references to culture. A person, who is supposed to have learned a language without understanding its culture, at best, masters its lexicon and grammar; but they have not mastered the "essence" of the language.

The program generates a positive effect on expressive language in pre-school children, because highly significant differences were evidenced; in that sense, Keeley et al. (2021) found effectiveness of interactive book reading, structured vocabulary programs, manualized curricula, and approaches involving speech and language therapists. Strengths and weaknesses of our current knowledge are described and implications for practice and research are discussed (Spencer et al., 2017).

The program generates a positive effect on comprehension language in pre-school children because highly significant differences were evident; in this regard, Hagen (2016) found that a variety of classroom language activities ranging from informal language stimulation of everyday situations to more explicit language activities such as book reading, language games, vocabulary training, and school readiness groups. Daily book reading significantly predicted children's language comprehension; therefore, it is important to develop these types of activities for the improvement of comprehensive language. Likewise, language activities such as book reading and vocabulary training correlate with higher verbal outcomes for young children; but most of these studies were conducted in countries with highly structured preschool settings (Coyne et al., 2010; Marulis and Neuman, 2010; Swanson et al., 2011).

The program generates a positive effect on spatial structuring in preschool children, because highly significant differences were evidenced; in this sense, Urzua et al. (2010) and Parra et al. (2015) established that the tasks should be performed with psychomotor and graphomotor responses.

The program generates a positive effect on rhythm in preschool children, because highly significant differences were evidenced; Vernia et al. (2016)

stated that rhythm is a natural and human phenomenon that encompasses multiple manifestations as an art form. Music education devotes much of its efforts to rhythmic development. This article aims to show the bodily elements that affect the teaching and learning of musical language, especially, considering its rhythmic content. A bibliographical synthesis of the main authors who have contributed rhythmic data and proposals is presented together with a brief proposal for educational intervention. The teaching of musical language is strongly linked to rhythmic education and, in this sense; Jaques-Dalcroze was the pioneer in the development and introduction at school levels. Jaques-Dalcroze and his followers organized a method of teaching musical language based on rhythmic skills through a series of exercises designed for that purpose. Also presented, in this article, are proposals for teaching musical language through rhythmic development for different ages both child and adult. Bravo and Carazo (2019) found that rhythmic activities managed to improve tension, fatigue; representing a stress management strategy. Likewise, it is evidenced that, by joining a music creation rhythm therapy program, they can improve their mood and, consequently, their motivation with a benefit associated to their satisfaction with life (Silva, Jiménez, Leyton, Aspano, & Lo-bato, 2017).

Conclusions

It was established that the program generates a positive effect on neuropsychological maturity in pre-school children, since highly significant differences (z= -16.065; p<0.000) were evidenced in psychomotor skills, articulatory language, expressive language, comprehension language, spatial structuring, visuoperception, iconic memory and rhythm in pre-school children. On the other hand, neurobiological maturity in children is one of the great concerns in the educational field, especially in those who are attending the initial level, since, at this stage; the pedagogical work developed with them should enable their brain development. Within this dynamic, it is important that children acquire their maturation and, with it, the development of the central nervous system, since it is necessary to develop complex processes of their nervous structures.

The study concludes that neuropsychological maturity implies the level of organization and maturational development that helps the development of behavioral and cognitive functions according to the age of the individual. Significant data were also found in the dimension of rhythm where the percentage of participants in the post-test was 48.9%, being at the achieved level.

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