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Cultural differences in neuropsychological tests and intelligence of Cuban preschool children.

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Abstract

The objective of this research was to determine the cultural differences in the execution of neuropsychological tests between a group of preschoolers with typical development in the province of Cienfuegos and another one in Sancti Spíritus, both in Cuba; as well as to identify the neuropsychological functions that influence intellectual performance. Sixty-seven children were selected and subdivided into groups. The Raven's Progressive Matrices Intelligence Test and the Luria Initial Neuropsychological Battery were used as neuropsychological evaluation instruments. The results showed significant differences in intelligence and various neuropsychological functions between the provinces. The neuropsychological variables influencing intellectual performance varied depending on the cultural groups. Taken together, the results suggest that cultural differences demand diverse patterns of cognitive skills that uniquely influence the development of intelligence and neuropsychological factors in preschool childhood.

Keywords: culture, neuropsychological functions, intelligence, preschool childhood.

Resumen

La investigación tuvo como objetivo determinar las diferencias culturales en la ejecución de los tests neuropsicológicos entre un grupo de preescolares con desarrollo típico de la provincia de Cienfuegos, y otro de Sancti Spíritus, ambas de Cuba; así como identificar las funciones neuropsicológicas que influyen en el rendimiento intelectual. Fueron seleccionados y subdivididos en grupos 67 niños. Como instrumentos de evaluación neuropsicológica se aplicaron la prueba de inteligencia matrices progresivas de *Raven* y la batería neuropsicológica Luria Inicial. Los resultados mostraron diferencias significativas en la inteligencia y diversas funciones neuropsicológicas entre las provincias. Las variables neuropsicológicas que influyen en el rendimiento intelectual, varían en dependencia de los grupos culturales. En conjunto, los resultados sugieren que las diferencias culturales demandan diversos patrones de habilidades cognitivas que influyen de forma singular en el desarrollo de la inteligencia y en los factores neuropsicológicos en la infancia preescolar.

Palabras clave: cultura, funciones neuropsicológicas, inteligencia, infancia preescolar.

Introduction

The influence of culture and education on the results of neuropsychological tests has been noted for several years, especially the variability between culturally different groups in functions such as language, memory, visuospatial skills and intelligence (Fog, 2021).

The variability of results in neuropsychological tests is an important indicator to be considered in the scientific community due to the relationship it has with the validity and standardization of the tests, with the effective classification of neuropsychological alterations and with the therapeutic and educational approach in countries with many immigrants such as the United States and the European Community (Mercado et al., 2019).

Faced with this problem, some solution proposals have emerged, firstly, to apply several tests selected from different neuropsychological batteries (cross-battery) (Franzen, et al., 2022), and secondly, to apply non-verbal neuropsychological tests (Ben et al., 2021).

The cross-battery procedure is a suitable opportunity for examiners, as it allows using tests that are more effective for the subject according to his or her cultural and educational condition (Franzen, et al., 2022; Daugherty, et al, 2017; Puente, et al, 2017). Said authors recommend using the procedure to decrease errors in diagnosis due to cultural or educational effect, even to avoid death sentence in the US Supreme Court. According to the authors, the classification standards for an American is not the same as for a Hispanic American, both coexist in the same cultural space, although the diagnosis of a neurological disease or the ruling of a court may be influenced by the effect of the culture and education of the subject. Therefore, an error in diagnosis by classification regulations can change a subject's life, as an inmate with mental retardation or neurological diseases is not sentenced to death (Daugherty, et al., 2017; Puente, et al., 2017).

Another proposed solution is to use several visual type tests, as it is expected not to have a high cultural and educational burden. The subject to answer this type of tasks should preferably use strategies with a minimum of specialized knowledge, such as up - down, right - left, shallow - deep, size and color. However, nonverbal tests are not completely free of cultural bias, as thinking schemes vary from one culture to another. Nevertheless, in the child population it is an adequate solution.

Although these solutions exist, some authors recognize that the variability of neuropsychological tests in the pediatric population is more complex than thought. Solovieva et al., (2021), highlight that sociocultural factors have been identified as

determinants to explain the variability of neuropsychological development, while other reviews highlight the effect on psychometric intelligence (Rea-Sandin et al., 2021).

Scarce neuropsychological research in the child population has shown that children's performance can vary significantly by cultural, educational and socioeconomic effects; in particular, the few results have revealed differences in cognitive and socioemotional development in preschoolers (Lohndorf, et al., 2019). However, Porto et al. (2021), Rea-Sandin and Causadias (2021) specify that the variability is more significant in executive functions due to the effect of the parents' educational level.

The above results have in common the contributions of Ardila (1995), who suggests analyzing neuropsychology and its relationship with culture and education through six units of analysis: (1) the standardization of current basic neuropsychological instruments should consider the cultural and educational changes of the target subjects, as well as the cultural context where standardization takes place, (2) elaboration and validation of neuropsychological tests specific to the cultural context, (3) the analysis of educational factors and subcultural variations in relation to test performance, (4) the analysis of cognitive disorders in cases of brain pathology in different cultural and educational contexts, (5) the search for commonalities in neuropsychological performance among existing human groups, and (6) the analysis of the origins of cognitive activity.

From this position, researchers have used these suggestions to improve the design, validation, and standardization of psychometric and neuropsychological tests in various cultural contexts. Similarly, it has been used to analyze in depth neuropsychological diagnosis in countries with abundant migrants (Daugherty, et al., 2017; Puente, et al., 2017).

However, few scientific studies have been reported where neuropsychological performance is compared in children living together in the same country of origin (Burneo-Garcés, et al., 2018). In addition, the few studies perform a comparative analysis between groups through descriptive statistics and to a lesser extent with more rigorous methodological tools such as Cohen's d.

In Cuba, attempts have been oriented towards the characterization of preschool children with typical development and in clinical populations (Prieto, et al., 2020) however, few studies have been reported focused on comparing neuropsychological performance in different provinces, which could be an alternative to organize stimulation strategies according to the particularities of the province and its culture.

In response to these limitations, the present study aims to: (1) Determine the variability of neuropsychological tests between a group of preschoolers with typical development in the province of Cienfuegos and another in Sancti Spiritus, both located in Cuba, and (2) Identify the neuropsychological functions that influence intellectual performance taking into account that both are provinces with different cultural characteristics, but with a similar education policy.

Methodology

In the present research, a cross-sectional comparative study was conducted in the period from January to December 2019. From a total of seventy-seven children aged 5 and 6 years with typical development, they were selected and subdivided into groups according to the province of the country (Sancti Spíritus and Cienfuegos) (Table 1). The groups were balanced following the criteria of methodological parity according to sex in the different provinces of the country studied. The distribution analysis obtained a normal equivalence between both groups ($\chi 2$: 0.633).

The children were randomly selected from several classrooms, using the list provided by the school teachers. The selection of children and educational institutions was made based on the following criteria of the researchers: (1) The children had to reach percentile ≥ 50 on the Raven's Matrices intelligence test according to a Cuban cut-off point (Ramírez, et al. 2017); (2) The children had to be natives of the province of Cienfuegos and Sancti Spíritus from urban area. All study participants were children with typical development, without medical or neurological problems.

Measuring instruments

Raven's Progressive Matrices Intelligence Test. It consists of 36 problems, which are presented in a paper notebook. Each of them consists of an incomplete figure that the child must complete. It is a classic test to measure fluid intelligence. The Cuban norms of Ramírez et al. (2017) were used. The instrument shows adequate levels of reliability in the Cuban context. The analysis indicated, 91% of the items with good discrimination indices (items - total) (Ramírez et al., 2017).

Luria Inicial neuropsychological battery: The instrument evaluates four domains of cognition for children aged 4 to 6 years, these are: executive, linguistic, speed and memory; as well as, a manual lateralization test (Ramirez, et al., 2015). It is made up of 14 tests that are grouped into executive domain (test 1 to 5: manual dexterity, right-left orientation, manual gestures and orofacial praxis, verbal control of the motor act,

reproduction of visuospatial patterns). Linguistic domain (tests 6 to 10: visual perception of objects and sets of drawings for naming, phonemic hearing, vocabulary in images, reasoning by verbal analogy and numerical operations). Processing speed domain (tests 11 and 12: rapid naming of pictures and colors). Learning and memory domain (tests 13 and 14: verbal memory and visual memory). Manual laterality (preference, speed and manual recognition) in order to know the state of specialization of the cerebral hemispheres. In the proposed research, the Cuban regulations were used (Ramírez, et al., 2015).

Procedure

The purpose of this research was initially explained to school principals. Subsequently, preschool teachers were informed of the characteristics of the different neuropsychological tests; so also parents were contacted and interviewed. Parental consent was obtained and parents were given the time needed to complete the neuropsychological screening battery.

Ethics Committee Approval Statement

The Research Ethics Committee of the Center for the Study of Educational Sciences, Faculty of Pedagogical Sciences of the "José Martí Pérez" University of Sancti Spíritus, Cuba approved the research.

The research was carried out in three sessions, with a duration of 45 to 60 minutes and 5 minutes of rest when the children required it. In the first session, the children's Raven test was performed; and in the second and third sessions, the Luria Initial Neuropsychological Battery was administered. They were distributed in this way, with the aim of avoiding mental fatigue and demotivation of the child by the instrument.

Statistical analysis of the data

Once the primary data were collected, a database was created with the study variables, using the SPSS statistical package for Windows version 11.5, to facilitate the statistical processing of the information. The study variables were characterized using the arithmetic mean, standard deviation and contingency table.

First, the Chi-square test was used to determine the parity criteria between some demographic variables of the study, such as sex. The t-test (mean comparison test for independent samples) was used to compare the mean of the study groups in the different neuropsychological variables and intelligence. The calculation of the magnitude of the

effect size was applied in order to identify the size of the differences in the variables studied. For this purpose, Cohen's d was used, where values of 0.2, 0.5 and 0.8 represent small, medium and large effect sizes, respectively.

A simple linear regression analysis was performed using the values of the neuropsychological tests in the two provinces of the country. Neuropsychological variables were used as predictors (independent variable) and the dependent variables were the values of intellectual performance evaluated with the Raven (nonverbal) for preschoolers. A radial graph was used for the presentation of the results with the purpose of representing the neuropsychological profiles based on the weaknesses and strengths between both provinces of the country. In all cases when the significance of the test was less than 0.05, then we say that significant differences exist.

Results

In the analysis of the demographic variables, no differences were found with respect to sex and age in the two provinces of the country (Table 1).

Table 1. General characteristics of the sample of children aged 5 to 6 years in the different provinces.

Characteristics	**Sancti Spíritus (n-34)**	**Cienfuegos (n-35)**	**t /χ^2**	***p***
Age (SD)	5,61(0,445)	5,46 (0,271)	1,652	0,103
Female (%)	18 (52,9)	16 (45,7)	0,129	0,633
Male (%)	16 (47,1)	19 (54,3)		

Note: SD: standard deviation; χ2: chi-square test; t: comparison index.

The table 2 shows the results of the differences in neuropsychological development and intelligence in preschoolers in the two provinces of the country. According to Students't, there are significant differences in intelligence, manual dexterity, manual gestures and praxis, verbal regulation of the motor act, visual denomination of objects and figures, phonematic hearing, vocabulary in images, numerical operations, quick denomination of colors, in favor of the group belonging to the province of Sancti Spíritus. However, significant differences in picture naming and visual memory were obtained in favor of the group belonging to the province of Cienfuegos (Figure 1).

Table 2. Difference between the province of Sancti Spíritus and Cienfuegos in neuropsychological tests and intelligence in preschool children.

Neuropsychological variables	**Provincia Sancti Spíritus (n-34)**		**Provincia Cienfuegos (n-35)**		**Prueba *T***		
	M	DE	M	DE	t	Sig.	*d*
Intelligence	18.21	2.143	14.40	1.143	9,242	**0,000****	2.23
Manual motor skills	12.15	2.190	9.40	1.241	6,434	**0,000****	1.55
Right-left orientation	10.68	3.373	9.83	1.445	1,364	0,177	0.33
Gestures and praxis	17.88	1.771	13.51	1.358	11,515	**0,000****	2.77
Verbal regulation	11.53	2.501	8.99	1.638	5,011	**0,000****	1.21
Spatial orientation	3.88	1.701	3.80	0.964	0,248	0,805	0.06
Naming objects and pictures	16.00	1.279	12.23	3.154	6,474	**0,000****	1.56
Phonetic hearing	12.29	1.750	11.34	1.846	2,195	**0,032***	0.52
Picture vocabulary	19.24	1.415	18.06	1.924	2,890	**0,005***	0.70
Similarity and difference	2.97	1.425	2.91	.658	0,212	0,833	0.05
Number operations	4.15	1.329	3.09	1.669	2,917	**0,005***	0.70
Picture naming	40.29	9.418	48.11	2.763	-4,709	**0,000****	1.13
Color naming	33.21	7.049	22.43	2.417	8,545	**0,000****	2.06
Visual memory	5.03	1.000	6.26	1.656	-3,716	**0,000****	0.90
Verbal memory	25.09	4.288	19.97	2.717	5,939	**0,000****	1.43
Right limb	5.79	1.038	5.97	1.963	-0,467	0,642	0.11
Left limb	4.88	1.200	5.43	2.404	-1,188	0,239	0,30

Note: M: Mean, SD: Standard Deviation, t: comparison index, Sig: Significance, d: effect size. * $p<0.05$, ** $p<0.01$.

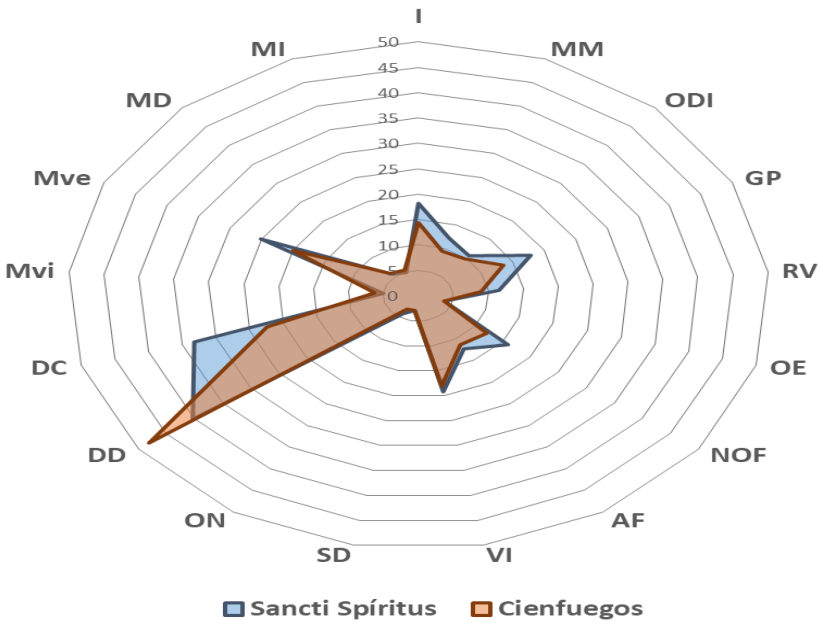

Figure 1. Analysis of neuropsychological tests and intellectual performance in the groups studied. Intelligence (I), Manual motor skills (MM), Right-left orientation (ODI), Gestures and praxis (GP), Verbal regulation (VR), Spatial orientation (OE), Naming objects and pictures (NOF), Phonetic hearing (AF), Picture vocabulary (VI), Similarity and difference (SD), Numerical operations (ON), Picture naming (DD), Color naming (DC), Visual memory (Mvi), Verbal memory (Mve), Right limb (MD) and Left limb (MI).

No differences in manual laterality were found between the two provinces of the country. Cohen's d was calculated to obtain the effect sizes (Table 2).

When the level of prediction presented by the results of the neuropsychological variables on intelligence was checked, disparate and coincident findings were found between the provinces of Sancti Spíritus and Cienfuegos.

First, the processes of right-left orientation, verbal regulation, spatial orientation, naming objects and drawings, similarities and differences; as well as numerical operations were predictors of intellectual performance in both preschool children of Sancti Spíritus and Cienfuegos provinces (Table 3).

Table 3. Linear regression analysis between neuropsychological processes on intellectual performance in preschool children based on different provinces of the country.

Variables	**Sancti Spíritus (n-34)**			**Cienfuegos (n-35)**		
	Adj. R^2	β	p-value	Adj. R^2	β	p-value
Manual motor skills	0.089	0.335	**0.048***	-0.016	-0.107	.507
Right-left orientation	0.091	0.219	**0.046***	0.379	0.499	**0.000****
Gestures and praxis	0.000	0.211	0.324	0.526	0.618	**0.000****
Verbal regulation	0.362	0.529	**0.000****	0.371	0.435	**0.000****
Spatial orientation	0.207	0.605	**0.004***	0.153	0.500	**0.012***
Naming objects and pictures	0.170	0.741	**0.009**	0.723	0.310	**0.000****
Phonetic hearing	0.046	0.336	0.117	0.648	0.502	**0.000****
Picture vocabulary	-0.022	0.141	0.599	0.660	0.486	**0.000****
Similarity and difference	0.117	0.570	**0.027**	0.491	1.234	**0.000****
Number operations	0.237	0.823	**0.002***	0.483	0.483	**0.000****
Picture naming	0.182	-0.104	**0.007***	0.069	0.129	0.069
Color naming	0.045	-0.083	0.120	0.217	0.232	**0.003***
Visual memory	0.004	0.093	0.292	-0.023	-0.034	0.642
Verbal memory	-0.028	-0.128	0.738	-0.030	-0.012	0.922
Right limb	0.252	1.081	**0.001***	0.038	-0.150	0.136
Left limb	0.064	0.543	0.080	-0.030	-0.005	0.951

Note: Adj. R2: adjusted coefficient of determination, β: unstandardized beta coefficient. * p<0.05, ** p<0.01.

Secondly, although neuropsychological variables coincide in both provinces of the country, there are particular differences that are relevant in the research. For example: in the province of Sancti Spíritus, it has been proved that fine motor skills (t= 2.059; p= 0.048), drawing denomination (t= -2.890; p= 0.007) and speed with the right upper limb (t= 3.477; p= 0.001), are neuropsychological variables that significantly predict intellectual performance in preschoolers of this province. The level of prediction for each variable fluctuated between 0.089 and 0.252 (Table 3), while the performance of the same neuropsychological tasks, in the Cienfuegos group, were not predictors for the development of intelligence in children.

On the other hand, gestures and praxis (t= 6.229; p= 0.000), phonemic hearing (t= 7.974; p= 0.000), picture vocabulary (t= 8.187; p= 0.000), and color naming (t= 3.228; p= 0.003)

were found to significantly predict the variability of intellectual performance in children from Cienfuegos province. The level of prediction for each variable ranged from 0.217 to 0.660 (Table 3). The results of the same neuropsychological tests in children from Sancti Spíritus, were not significant in predicting the variability of intelligence performance.

Discussion

The present investigation revealed that the neuropsychological performance of the espirituanos was notably better than the cienfuegueros in the tests that evaluated executive functions (manual motor skills, gestures and praxis, verbal regulation), language (naming objects and figures, phonemic hearing, image vocabulary and numerical operations), speed in naming colors and verbal memory. Cienfuegos preschool children obtained better results in speed in naming pictures and in visual memory. In intellectual performance, there were also significant differences between the two groups.

In the case of executive functions or functions related to frontal lobe development, Ardila et al. (1995) have shown that one factor that may influence the differences between groups is the socioeconomic status of the parents. However, some studies indicate that it has no effect on Cuban child development (Jiménez-Colín, et al., 2018), although others indicate the opposite (Mora & Anangonó, 2016).

Porto et al., (2021) showed the importance of language in parents and its influence on the neuropsychological development of the child. According to these authors, the educational level of the parents is a good measure to expect a good development in the child and differentiate from other infants with different condition. Certainly, it is an accurate position and although it was not the objective of the present research, in Cuba, 7 out of 10 adults are professionals according to the last population CENSUS. Therefore, this condition may not be the ideal one to justify the differences between the Cienfuegos and Santi Spíritus groups; however, it should be reviewed, since sometimes highly educated or professional parents are very busy and share their child's education with other non-professionals (caregivers).

From this last idea, a result of Fernández-Hernández et al. (2022) emerges, which showed that parents who participate little in recreational and sports activities with their children have a negative effect on the development of executive functions in their children. The question is, do parents from Cienfuegos and Espiritu play with their children frequently? What kind of games do they use? These are interesting questions that could justify part

of the results of the study. In this sense, these questions could open the doors to new propositions for future lines of scientific research on preschool children.

If the differences between groups are important, the similarities are a point of analysis of the problem. In both groups, age, sex, urbanity and the educational model (Cuban program in preschool education) were controlled. Therefore, these variables do not justify the neuropsychological variability between the groups. Similarly, the variables right-left orientation, similarity and differences, as well as manual laterality did not show differences between the groups.

These results can be justified according to the intense or low educational stimulation in both groups. It is thought that intense stimulation may explain the similarity because most preschool games contain many activities where comparisons are made between objects (similarities and differences); as well as other motor activities where the child is required to use his right or left hand depending on his manual preference. However, it is also possible to think of low stimulation or slow development in these neuropsychological variables. In other Cuban research similarity - difference and right - left orientation have been identified as skills with slow development in preschool children according to their chronological age (Ramirez, et al., 2015).

Regarding the intellectual development of the groups, it could be observed that the performance in the Raven test of the espirituanos was significantly higher compared to the Cienfuegueros group. These obtained results emphasize the notion that nonverbal tests are not necessarily free of cultural influence (Ben et al., 2021). Furthermore, it highlights that nonverbal tasks contain complex reasoning processes, which mark the differences between subjects. Certainly, Raven's Matrices require simple solution strategies (up-down, right-left), although they also include other implicit strategies such as induction-deduction, comparison of inferences, classification, hypothesis generation and evaluation, identification of relationships and extrapolation of images.

The study showed that performance on various neuropsychological tasks influence variability in IQ, which is consistent with results from previous studies (Muchiut et al., 2021). However, in the group of children from Sancti Spíritus province (higher IQ group) it was detected that fine motor and manual skills, increased as key neuropsychological predictors contributing to higher intellectual performance in preschool childhood.

Indeed, frontal lobe development favors the development of motor and fluid intelligence, both of which benefit from the maturation of these brain structures (Khng & Ng, 2021). Therefore, the evidence verifies that intelligence can be stimulated not only with

reasoning-type tasks, but also with game situations and activities where perception and motor skills lead to reasoning and analysis. In the same sense, this result is consistent with the study by Fernández-Hernández et al. (2022), who revealed that the child's physical conditions contribute to the development and performance of higher cognitive functions. Despite little control of educational and cultural variables, the present investigation shows that there is significant neuropsychological and intellectual variability between groups of children even when they live in the same country. This proves that three points should be considered when applying cognitive and neuropsychological tests in the child population: first, the standardization and validity of tests according to the characteristics of the region. Second, to establish norms for classifying and issuing a diagnosis. Third, to make an assessment of the sociocultural characteristics of the child, including its context, parental stimulation and the educational institutions involved.

Thus, the present research considers that neuropsychological and intellectual development in preschool childhood depends on sociocultural factors. These factors should be analyzed by different categories that will allow a better visibility of their impact, such as the family (organization, functions), the characteristics of the parents (level of education, style of education, stimulation activities (frequency, intensity, type of activities), and the educational institutions (educational programs, type of educator, frequency of stimulation, activities carried out). It would be important for future research to observe these variables from the sociology of culture and their relationship with the development of neuropsychological functions.

Conflict of Interest

The authors declare that they have no conflicts of interest.

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