# *Signos Neurológicos Blandos y procesos cognitivos en niños escolares mexicanos de 6-11 años*

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Resumen

Los Signos Neurológicos Blandos (SNB) son indicativos de interrupciones generalizadas en las redes de trabajo neuronal de áreas cortico-subcorticales, cuya presencia conlleva a problemas en el desarrollo neurocognitivo del niño que representan repercusiones académicas negativas. En la presente investigación se evaluó y comparó la presencia de SNB con los procesos cognitivos de 144 participantes mexicanos de estrato socioeconómico medio-bajo con edades entre los 6 y 11 años sin antecedentes neurológicos o psiquiátricos por medio de los Cuestionarios de Madurez Neuropsicológica (CUMANIN) y Madurez Neuropsicológica Escolar (CUMANES). Los resultados indicaron diferencias significativas por sexo, ya que las niñas presentaron mejor desempeño en la articulación de palabras. En los grupos por edad, las diferencias significativas se encontraron en leximetría-comprensión, visopercepción y función ejecutiva-errores; y, en general, los participantes mostraron presencia de SNB de desarrollo, que incluyen afectaciones en: lenguaje (problemas articulatorios, alteraciones del lenguaje oral y escrito, dificultad para encontrar palabras), psicomotricidad, visopercepción y otras funciones cognitivas. Al final, se concluye que la identificación y diagnóstico temprano de los SNB permite disminuir el riesgo de fracaso escolar.
*Palabras clave*: signos neurológicos blandos, integración sensorial, desarrollo neurocognitivo, escolares, infancia.

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# *Neurological Soft Signs and cognitive processes in Mexican schoolchildren aged 6 to 11 years*

Abstract

Neurological Soft Signs (NSS) are indicative of generalized disruptions in neurological networks of cortico-subcortical areas. Their presence leads to problems in children's cognitive development with future academic repercussions. The presence of NSS was assessed and compared in 144 children aged 6 to 11 years of low-medium socioeconomic status from Mexico City and the metropolitan area through the Infant Neuropsychological Maturity Questionnaire (CUMANIN, for its Spanish acronym) and the School Neuropsychological Maturity Questionnaire (CUMANES, for its Spanish acronym). Results indicate significant differences by sex. Girls showed better performance in word articulation. In groups by age, significant differences were found in leximetric-comprehension, visual perception and executive function-errors. Participants showed the presence of developmental NSS which include: language (articulation disorders, oral and written language disturbances, difficulty finding words), psychomotricity, visual perception and other cognitive functions. There are several factors related to those impairments such as age, socioeconomic context and critical stages in child´s development. Identification and early diagnosis can reduce the risk of school failure.
*Key words*: Neurological soft signs, sensory integration, neurocognitive development, schoolchildren, childhood.

# *Sinais Neurológicos Sutis e processos cognitivos em crianças escolares mexicanas de 6 a 11 anos*

Resumo

Os Sinais Neurológico Sutis (SNS) são indicadores de interrupções generalizadas nas redes de trabalho neural de áreas córtico-subcorticais, cuja presença leva a problemas no desenvolvimento neurocognitivo da criança que representam repercussões acadêmicas negativas. Na presente pesquisa, foi avaliada e comparada a presença de SNS com os processos cognitivos de 144 participantes mexicanos de estrato socioeconômico médio-baixo com idades entre 6 e 11 anos, sem antecedentes neurológicos ou psiquiátricos, por meio dos *Cuestionarios de Madurez Neuropsicológica* (CUMANIN) e *Madurez Neuropsicológica Escolar* (CUMANES). Os resultados indicaram diferenças significativas por gênero, já que as meninas apresentaram melhor desempenho na articulação de palavras. Nos grupos por idade, as diferenças significativas foram encontradas na velocidade de leitura e compreensão, visuopercepção e função executiva e erros. Em geral, os participantes mostraram presença de SNS de desenvolvimento, que incluem interferências na linguagem (problemas articulatórios, alterações da linguagem oral e escrita, dificuldade para encontrar palavras), psicomotricidade, visuopercepção e outras funções cognitivas. Ao final, conclui-se que a identificação e o diagnóstico precoce dos SNS permite diminuir o risco de fracasso escolar.
*Palavras-chave*: sinais neurológicos sutis, integração sensorial, desenvolvimento neurocognitivo, escolares, infância.

## Introduction

The Neurological Soft Signs (NSS) are not easy to locate exactly in the nervous system (Chan et al., 2016; Bombin, Arango & Buchanan, 2005). These are detected by a clinical neurological exam, in the absence of characteristics of a permanent or transitory disorder (neurological injury). They are regarded as a non-identifiable deficit in some area of the central nervous system (Malhotra, Borade, Sharma, Satija & Gunjan, 2017), which could be become evident by alterations in motor, sensitive and integration functions. (Bombin, Arango & Buchanan, 2005).

Neurological Soft Signs include a wide range of subtle neurological deficits, such as perceptive-sensory integration, motor coordination, balance, sequencing of complex motor acts, excess of movements and, occasionally, clumsiness and the occurrence of primitive reflexes (Hirjak et al., 2017).

Consequently, NSS are considered important early signs of an evolutionary disorder that originates in neurological development (Ojagbemi, 2017). It is important to highlight the need for assessing and detecting NSS in early phases of development, when they are more susceptible to occur. However, it is a fact that these difficulties in neurodevelopment go unnoticed by a large part of the population, being a predictive factor of failure and school dropout (Mateos, 2009).

The presence of NSS, as pointed out by Faruk-Demirel, Demirel, Tayibb-Kadak, Emül & Duran (2016), constitutes a non-specific vulnerability factor associated with different psychological and psychiatric disorders such as schizophrenia ( Chan et al., 2016; Chrobak et al., 2016; Emsley et al., 2017; Mithun, Kamal, Aparajeeta & Subrata, 2016; Schulze, Papiol & Fatjo, 2016), obsessive-compulsive disorder (Chetail-Vijay & Shubhangi , 2016; Dhuri & Parkar, 2016; Peng et al., 2012) and attention deficit hyperactivity

disorder (Abdel-Aziz, El Sheikh, Mohsen, Khalil & Hassan, 2016; Cardo, Casanovas, Banda & Servera, 2008; Jingbo-Gong, Jingtao-Xie, Yajie-Zhang, & Su-Hong-Wang, 2015). These disorders lead to considerable negative results in the psychosocial realm, even affecting mental processes such as social cognition (Pitizianti et al., 2017).

There is evidence that the manifestation of NSS has a close relationship with the presence of learning difficulties, such as reading (Poblano, Borja, Elías, García-Pedroza, & Arias, 2002) or a low IQ during childhood and adolescence (Manaut-Gil, Vaquero-Casares, Quintero-Gallego, Pérez-Santamaría, & Gómez-González, 2004). In a study of patients with specific learning disability (SLD), it was observed that 58.6% presented mainly NSS (n = 100) with anomalies in motor coordination (dysdiadochokinesia) and sensory extinction (Somale, Kondekar, Rathi, & Iyer, 2016). Likewise, Patankar, Sangle, Henal, Shah, & Kamath (2012) observed that 84% of patients with ADHD presented NSS (n = 52) of which, 34.6% received a diagnosis of SLD, as it is dyslexia.

Furthermore, among the factors attributed to low school performance, it has been found that at least in one of five cases, there is an underlying neuro-dysfunctional component derived from congenital alterations, perinatal anoxia, neuro-maturational delay or nervous system dysfunction (Torres-González, Salvador-Cruz, Flores, & Ricardo-Garcell, 2016).

In children from low socioeconomic status, the possible presence of NSS is emphasized, associated with conditions of little environmental stimulation, which in turn result in an increased risk of pre and postnatal complications, as well as poor nutrition and diseases during growth. By integrating the previous information, it is found that in Mexico the population between 5 and 14 years of age is approximately 20 million (INEGI, 2015), of which it is estimated that about 15% present problems in the development of the nervous system, a fact that has considerable repercussions in the schooling and affective domain of children (Lipina, 2016; Salvador-Cruz et al., 2016; Torres-González, Salvador-Cruz, Flores, & Ricardo-Garcell, 2016). This background justifies the relevance of studying NSS in diverse contexts, especially in those in which the child population has specific sociodemographic excluding factors and is more vulnerable, that is to say, they belong to a low socioeconomic stratum.

In consideration of the foregoing, studies carried out since the mid-twentieth century have shown that the condition of poverty significantly affects children's cognitive and emotional development (Hermida, Segretin, Lipina, Benarós & Colombo, 2010). In this respect, approaches that rely on psychometric and educational paradigms have prevailed in research. From the neuroscience approach, some investigations have demonstrated the role that socioeconomic status plays in the performance of cognitive tasks such as attention, language, executive functioning and mnemonic processes (Hermida et al., 2010; Mazzoni, Stelzer, Cervigni, & Martino, 2014). According to UNICEF, in 2014, one in every two girls and adolescents in Mexico suffered from poverty and one in nine cases was in extreme poverty. Moreover 53.9% of the population aged 0 to 17 in Mexico (21.4 million) lacked the minimum conditions for education, access to health, social security, quality housing with basic services and food. Given the social impact that this entails and its repercussions on the normal development of the nervous system, the objective of the present study was to evaluate and compare the presence of NSS and higher-order cognitive processes in Mexican schoolchildren from a medium-low socioeconomic stratum without presence of neurological and / or psychiatric record.

## Method

For the present study a non-experimental descriptive cross-sectional design was used, through which the presence of NSS in the child population was assessed (Kerlinger, 2002).

*Participants*

The selection of the sample was intentional, non-probabilistic by quotas (Kerlinger, 2002). It was made up of 144 Mexican children of medium-low socioeconomic status, 75 males and 69 females, aged between 6 to 11 years. Table 1 shows the distribution by age and sex. Participants were selected from six public elementary schools in Mexico City and the surrounding area. Participants who mentioned the presence of metabolic, neurological and / or psychiatric history, uncorrected visual or auditory impairments, or who did not complete the evaluation in the neurological and psychiatric history questionnaire (Salvador & Galindo, 1996) were excluded.

Table 1
*Distribution of the sample according to sex and age*

| Age (years) | Boys | | Girls | | Total | |
|---|---|---|---|---|---|---|
| | N | % | N | % | N | % |
| 6 | 19 | 13.19% | 23 | 15.97% | 42 | 29.17% |
| 7 | 13 | 9.03% | 13 | 9.03% | 26 | 18.06% |
| 8 | 18 | 12.50% | 17 | 11.81% | 35 | 24.31% |
| 9 | 6 | 4.17% | 8 | 5.56% | 14 | 9.72% |
| 10 | 10 | 6.94% | 5 | 3.47% | 15 | 10.42% |
| 11 | 9 | 6.25% | 3 | 2.08% | 12 | 8.33% |
| Total | 75 | 52.08% | 69 | 47.92% | 144 | 100.00% |

*Instruments*

The NSS were evaluated using the Childhood Neuropsychological Maturity Questionnaire (CUMANIN, for its Spanish acronym) (Portellano et al., 2009), and the School Neuropsychological Maturity Questionnaire (CUMANES, for its Spanish acronym) (Portellano, Mateos & Martínez, 2012).

CUMANIN (Portellano et al., 2009) is a neuropsychological maturity test for the pre-school age, designed for children between 3 and 6 years old. It is composed of eight main scales (Psychomotor, Articulated language, Comprehensive language, Expressive language, Spatial structuring, Visual perception, Iconic memory and Rhythm) and five auxiliary scales (Attention, Verbal fluency, Reading, Writing and Laterality). The instrument for Spanish population is valid and its internal consistency ranges from $r = 0.71$ to 0.92 in its different subscales. As a measure of reliability, internal consistency was obtained in the sample of the present study, with a Cronbach's alpha $r = 0.690$.

CUMANES (Portellano, Mateos & Martínez, 2012), is a test that allows to assess in an extensive way the cognitive development of children between 7 and 11 years old, in six domains or different areas: Language, Visual perception, Executive Function, Memory, Rhythm and Laterality. Both assessments allow to determine the degree of neuropsychological maturity, as well as the possible presence of signs of cerebral dysfunction. The reliability of the instrument in the Spanish population was obtained with a Cronbach's alpha of $r = 0.79$ and its internal consistency ranges from r = 0.61 to 0.85 in the different subscales making it up. As a measure of reliability, internal consistency was obtained in the sample of the present study, with a Cronbach's alpha $r = 0.736$

Likewise, a brief questionnaire was used, consisting of 10 questions, with their respective dichotomous responses associated with the collection of neurological, psychiatric, prenatal, perinatal, and postnatal data and learning difficulties (Salvador & Galindo, 1996).

*Procedure*

The evaluation process was carried out with the authorization of the administrators of the educational institutions visited. Subsequently, the volunteer parents were given a neurological and psychiatric clinical history questionnaire (Salvador & Galindo, 1996), in order to identify children who met the criteria required for the present research. Once the children were identified, the corresponding evaluation was carried out, which lasted approximately 40 minutes and was performed within the school context. The evaluation procedure for the age groups was divided into two groups: 1) children aged 6 years, with whom the Childhood Neuropsychological Maturity Questionnaire was used (CUMANIN, Portellano et al., 2009); 2) children aged between 7 and 11 years, with whom the School Neuropsychological Maturity Questionnaire was used (CUMANES, Portellano et al., 2012).

Among ethical considerations, a written informed consent was obtained from each of the parents or guardians, in addition to having the participants' verbal approval.

*Data Analysis*

The centile scores of the CUMANIN and CUMANES subtests report the position of the direct scores obtained with respect to the whole set of observations made during the validation of the test. Therefore, the centile scores are taken as a measure that identifies difficulties during the performance of each of the subtests, where the higher the centile position, the lower the difficulties, and vice versa.

To estimate the centrality and dispersion of the subscales scores that evaluate the NSS, a description of the subscales applied was made through medians, means and standard deviations. For the comparisons by sex and age, the classifications were obtained by centiles (CUMANIN) and sten scores (CUMANES) according to the performance of the participants. Finally, nonparametric statistical tests were used due to the lack of normality in the distributions of each variable measured by the instruments used and that were observed through the Kolmogorov-Smirnov (K-S) normality test. Therefore, the Mann-Whitney U test and Kruskall-Wallis test were used with the purpose of comparing the differences with respect to the variables sex and age (Coolican, 2014). All the analyzes were carried out through the statistical software program SPSS ® 20.

The qualitative analysis that was carried out to characterize the problems reported followed the guidelines proposed by the authors of the assessment instruments CUMANIN (Portellano et al., 2009) and CUMANES (Portellano et al., 2012) presented in the user's guidebook of each evaluation instrument.

## Results

The descriptive results divided by the main scales of the measuring instruments of child neuropsychological maturity (CUMANIN) and academic maturity (CUMANES) are presented below.

Table 2 shows the NSS that were observed in children aged 6 to 11 years, highlighting the alteration in sensoperceptual integration, motor coordination and left and right orientation.

*CUMANIN (6 years)*

For the first age-group of participants, an analysis of central tendency and centile dispersion measeurements

Table 2
*Neurological Soft Signs that continue to occur in children aged 6 to 11 years*

| Clasificación | Neurological sign |
|---|---|
| Motor | Sensory Integration |
| | Disdiadochokinesis |
| | Coordination disorder |
| | Thin and gross motor disorder |
| | Motor impersistence |
| | Immature grip of the pencil |
| Perceptive | Spatial orientation disorder |
| | Difficulty for right-left recognition |
| Other signs | Learning difficulties |
| | Sustained attention difficulties |
| | Cognitive processes alterations: memory and reasoning |
| | Oral or written language problems |
| | Articulated language problems |

was made for each subtest of the CUMANIN, in order to identify the subtests with the highest and lowest average centile score. It was observed that the subtest "Spatial Structuring" (M = 65.88) obtained the highest average centile score, while "Psychomotor" (M = 31.48) showed the lowest average centile score. Table 3 shows the results of the CUMANIN scores.

Table 3
*Results of the centiles obtained by 6 year- old children in the CUMANIN*

| Subtest | *M (SD)* | $M_e$ | *K-S* |
|---|---|---|---|
| Psychomotor | 31.48 (30.49) | 20 | 1.876* |
| Articulated language | 42.02 (28.54) | 40 | 1.301 |
| Expressive language | 35.60 (27.59) | 40 | 1.595* |
| Comprehensive language | 45.05 (31.30) | 35 | 1.333 |
| Spatial structuring | 65.88 (29.98) | 88 | 1.759* |
| Visual perception | 37.07 (34.54) | 22.5 | 1.546* |
| Iconic Memory | 65.21 (28.70) | 70 | 1.275 |
| Rhythm | 36.64 (29.87) | 35 | 1.205 |
| Verbal Fluency | 39.29 (27.30) | 37.5 | 0.949 |
| Attention | 39.50 (27.05) | 45 | 1.25* |
| Reading | 55.24 (24.24) | 50 | 0.865* |
| Writing | 50.33 (25.07) | 45 | 0.798* |

*Note*: $M_e$ = Medium, M = Mean, SD = Standard deviation, K-S = z from Kolmogorov-Smirnov.

* significance <.05 (non-homogeneous)

Table 4 shows the percentage of children's execution according to their performance in each of CUMANIN's subtests. These classifications were divided into *low performance* for scores below the 40th percentile, *average performance* for scores between the 40th and 60th percentile, and *high performance* for scores from the 60th to the 100th percentile (Portellano et al., 2009). With this classification it was observed that the percentage of participating children that obtained a *low performance* was: Psychomotor skills (64.3%); Rhythm (64.3%); Visual perception (57.1%); Comprehensive language (52.4%) and Verbal fluency (50.0%).

Table 4.
*Percentage of participants with low, medium and high performance in the subtests of CUMANIN (6 years old)*

| Subtest | Performance | | |
|---|---|---|---|
| | Low | Medium | High |
| Psychomotor | 64.3% | 9.5% | 26.2% |
| Articulated language | 47.6% | 33.3% | 19.0% |
| Expressive language | 47.6% | 33.3% | 19.0% |
| Comprehensive language | 52.4% | 11.9% | 35.7% |
| Spatial structuring | 23.8% | 23.8% | 52.4% |
| Visual perception | 57.1% | 9.5% | 33.3% |
| Iconic Memory | 14.3% | 35.7% | 50.0% |
| Rhythm | 64.3% | 0.0% | 35.7% |
| Verbal Fluency | 50.0% | 31.0% | 19.0% |
| Attention | 47.6% | 35.7% | 16.7% |
| Reading | 23.8% | 35.7% | 40.5% |
| Writing | 33.3% | 28.6% | 38.1% |

To identify the existence of differences between the performances in centile scores by the sex variable, the Mann-Whitney U test was used. It was observed that only in the subtest of Expressive language significant differences were found, with girls showing a better performance.

Table 5.
*Ranks of execution in the CUMANIN according to sex (6 years old)*

| Subtests | Sex (average range) | | Mann-Whitney U | *p* |
|---|---|---|---|---|
| | Boys[a] | Girls[b] | | |
| Psychomotor | 20.87 | 22.02 | 206.5 | 0.758 |
| Articulatory language | 18.97 | 23.59 | 170.5 | 0.217 |
| Expressive language | 17.29 | 24.98 | 138.5 | .037* |
| Comprehensive Language | 19.08 | 23.5 | 172.5 | 0.24 |
| Spatial structuring | 23.42 | 19.91 | 182 | 0.349 |
| Visual perception | 19.66 | 23.02 | 183.5 | 0.375 |
| Iconic Memory | 18.82 | 23.72 | 167.5 | 0.191 |
| Rhythm | 22.24 | 20.89 | 204.5 | 0.718 |
| Verbal Fluency | 22.66 | 20.54 | 196.5 | 0.575 |
| Attention | 19.18 | 23.41 | 174.5 | 0.264 |
| Reading | 19.63 | 23.04 | 183 | 0.361 |
| Writing | 18.84 | 23.7 | 168 | 0.199 |

*Note.* [a]n= 19; [b]n= 23. *$p$<.05.

It is important to present the description of the qualitative execution for the group of participants with low centile scores in the CUMANIN subscales.

*Psychomotricity*: Problems that involve the diadochokinesis and sensory disintegration affect movements at a fine or gross motor level, and are characterized by clumsy and slow movements.

*Expressive Language*: Children have articulation problems in the phoneme / r /, as well as errors of substitution of the same phoneme by another (eg. / n /; /janinero/ for "*jardinero*"). Morphology modifications were also observed (eg. /plantador/ for "*jardinero*") and using another word from the same semantic field (eg. /manzanas/ for "*peras*"). These difficulties show immaturity for the adequate construction of words, lack of stimulation in the lexical level and consolidation of the same; however, they do not indicate neuropsychological semiology.

*Verbal fluency*: Little fluency is observed, the task of mentioning animals seemed complicated and one minute seemed like a long time; the difficulties are more noticeable as the complexity of the task increases. Participants showed difficulties in syntactically structuring a single coherent sentence, congruent and with a greater number of words from the presentation of two words without a clear relationship (eg. "*Television*" and "*tiger*").

*Visual perception:* The execution of the participants was characterized by: uncoordinated trace and review of the elaborated perceptual unit. These difficulties are related to fine motor skills, due to failures in eye-hand coordination and deficiency in the grip of the pencil (clamp). When making the copy of figures: cross, circle, square and triangle they showed perseverations, drawing more than once the drawing that was requested.

*Rhythm:* In this subtest the majority of children (69.6%) showed a low performance, participants could not respond to the items correctly. However, it cannot be concluded that the participants do not have rhythm; the scores obtained were the result of factors associated with the low sensitivity of the test in this area.

*CUMANES (from 7 to 11 years old)*

For this age group, an analysis of central tendency measurements and centiles dispersion of each subtest of the instrument was made, where the sten scores of the test were taken into account. The sten score refers to the execution of the participant, where 10 represents a very high performance and 1, a very low performance-, which were obtained from the standardized scores (Portellano et al., 2012). Table 6 presents the results of the participants' performance, in which it is observed that the Visual perception subtest (M = 6.18) has the highest average score, while the Auditory-gnosic writing (M = 2.54) has the lowest average score.

Table 6.

*Results of the sten scores obtained by children from 7 to 11 years old in the CUMANES*

| Subtests | M (SD) | $M_e$ | K-S |
|---|---|---|---|
| Auditory-verbal inderstanding | 5.48 (2.46) | 5 | 1.199 |
| Understanding of images | 3.97 (1.89) | 4 | 1.522* |
| Phonological fluency | 4.44 (1.99) | 4 | 1.363* |
| Semantic fluidity | 3.86 (1.95) | 4 | 1.433* |
| Leximetry- understanding | 3.70 (1.99) | 4 | 1.18 |
| Leximetry- speed | 3.96 (2.73) | 4 | 1.289 |
| Auditoy-gnosic writig | 2.54 (1.98) | 1.5 | 2.839* |
| Visual perception | 6.18 (2.03) | 6 | 1.214 |
| Executive function - time | 4.44 (2.23) | 4 | 1.38* |
| Executive function - errors | 6.03 (3.17) | 6 | 1.659* |
| Verbal memory | 4.10 (1.85) | 4 | 1.174 |
| Visual memory | 4.49 (1.80) | 5 | 1.32 |
| Rhythm | 3.76 (1.64) | 3 | 2.108* |

*Note*: $M_e$ = Medium, M = mean, SD = standard deviation, K-S = z from Kolmogorov-Smirnov. *significance <.05 (non-homogeneous)

Table 7 shows the percentage of participants that are placed in *low performance*, because they are in sten score 4 or below; it also shows the percentage of children that according to their execution are in sten score 5 and 6 or *average performance*, and sten score 7 or *high performance*. It is observed that in most of the subtests the highest percentage of children is concentrated in low performance. The subtests with the highest concentration of participants with low performance are: Auditory-gnostic writing (80.4%), Rhythm (69.6%), Image comprehension (65.7%), Semantic fluency (63.7%), Leximetry-comprehension (67.7%) and Leximetry- speed (62.7%). In contrast, the highest percentage in high performance is concentrated in the subtests: Visual perception (44.1%), Executive functions-errors (43.1%) and Audio-verbal comprehension (37.3%).

On the other hand, in Figure 1, the distribution of difficulties, both severe (sten score 1) and moderate (sten score 2 and 3), are shown in detail. It can be observed that the presence of NSS is related to reading and writing processes, highlighting three subtests with a high percentage of severe difficulties: 1) Auditory-gnosic writing (50%), 2) Leximetry-speed (25.5%) and 3) Leximetry -comprehension (19.6%). Moderate difficulties were observed in the Rhythm subscales (46.1%), Image comprehension (38.2%) and Semantic fluency (36.3%), the last two being related to difficulties in language processes, both expressive and comprehensive.

Regarding the differences by the sex variable, each CUMANES subscale was compared using Mann Whitney

Table 7.

*Percentage of participants with low, medium and high performance in the CUMANES subtests (7 to 11 years old)*

| Subtests | Performance | | |
|---|---|---|---|
| | Low | Medium | High |
| Auditory-verbal understanding | 32.4% | 30.4% | 37.3% |
| Understanding of images | 65.7% | 24.5% | 9.8% |
| Phonological fluency | 53.1% | 29.4% | 16.7% |
| Semantic fluidity | 63.7% | 27.5% | 8.8% |
| Leximetry- understanding | 67.7% | 27.5% | 9.8% |
| Leximetry- speed | 62.7% | 19.6% | 17.6% |
| Auditoy-gnosic writing | 80.4% | 15.7% | 3.9% |
| Visual perception | 18.6% | 37.3% | 44.1% |
| Executive function – time | 53.9% | 31.4% | 14.7% |
| Executive function - errors | 35.3% | 21.6% | 43.1% |
| Verbal memory | 58.8% | 30.4% | 10.8% |
| Visual memory | 48.0% | 39.2% | 12.7% |
| Rhythm | 69.6% | 21.6% | 8.8% |

U test, because in the Kolmogorov-Smirnov normality test it is observed that the distribution of normality in the scores is not homogeneous (Pérez-López, 2004). Each task presented a non-normal data distribution, where there were no significant differences in the children's performance. However, it should be noted that the group of girls obtained average scores, higher in the Visual perception (M = 7.00) and Executive Functions-errors (M = 7.00) subtests (See Table 8).

In order to compare the sten scores associated with the various CUMANES subtests between the different age groups, the Kruskal-Wallis *H* test was used (See Table 9), given that in the Kolmogorov-Smirnov normality test (age subgroups), data were distributed in a non-normal way, presenting significant differences in the scores of four subtests: Leximetry-understanding ($X^2 = 10.201$, $p < 0.05$); Executive function-errors ($X^2 = 16.412$, $p < 0.05$); Verbal memory ($X^2 = 11.283$, $p < 0.05$) and Rhythm ($X^2 = 14.168$, $p < 0.05$).

Table 8

*Ranks of performance in the CUMANES according to sex*

| Subtests | Age (average range) | | Mann-Whitney U | *p* |
|---|---|---|---|---|
| | Boys[a] | Girls[b] | | |
| Auditory-verbal inder-standing | 5.0 | 5.0 | 1158.5 | 0.379 |
| Understanding of images | 4.0 | 4.0 | 1255.5 | 0.824 |
| Phonological fluency | 4.0 | 4.5 | 1021 | 0.069 |
| Semantic fluidity | 4.0 | 3.0 | 1031.5 | 0.081 |
| Leximetry- understanding | 4.0 | 4.0 | 1245 | 0.770 |
| Leximetry- speed | 3.0 | 4.0 | 1081.5 | 0.160 |
| Auditoy-gnosic writig | 1.0 | 2.0 | 1169.5 | 0.395 |
| Visual perception | 5.5 | 7.0 | 1067 | 0.133 |
| Executive function - time | 4.5 | 4.0 | 1270.5 | 0.905 |
| Executive function - errors | 5.0 | 7.0 | 1114 | 0.238 |
| Verbal memory | 4.0 | 4.0 | 1253.5 | 0.814 |
| Visual memory | 5.0 | 5.0 | 1204.5 | 0.569 |
| Rhythm | 3.0 | 3.0 | 1166 | 0.398 |

*Note.* [a] n= 56; [b] n= 46.

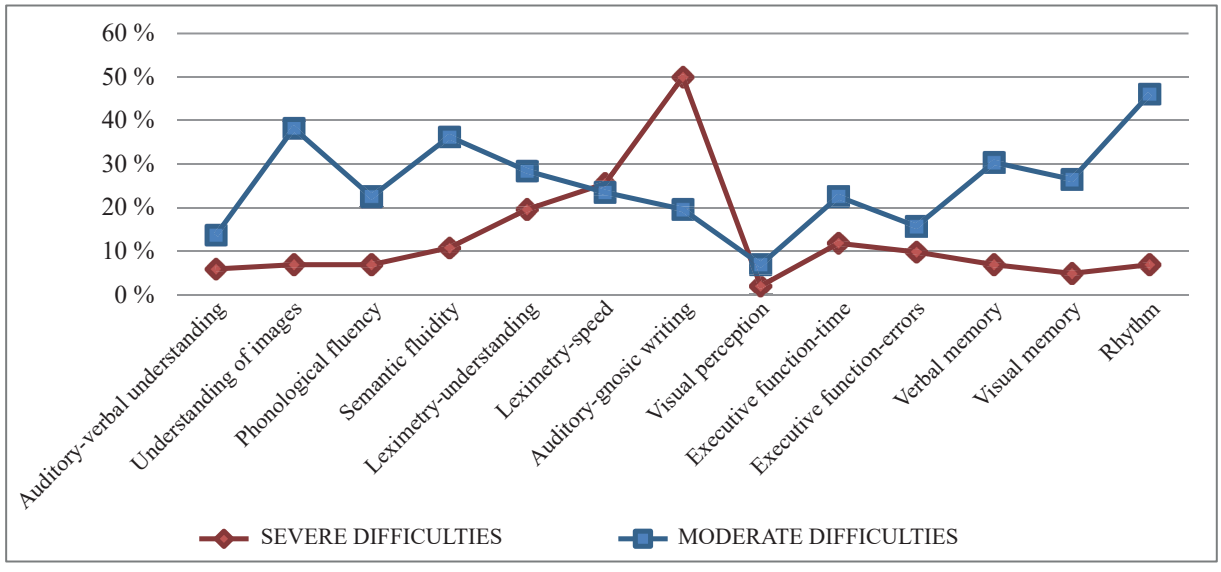


*Figure 1.*

Percentage of children with moderate difficulties (sten score 2 and 3) and severe difficulties (sten score 1) in the CUMANES

Table 9

*Average performance in the CUMANES subtests according to age.*

| Subtests | Age | | | | | $X^2(4)$ | *p* |
|---|---|---|---|---|---|---|---|
| | 7 years[a] | 8 years[b] | 9 years[c] | 10 years[d] | 11 years[e] | | |
| Auditory-verbal understanding | 4.0 | 5.0 | 6.5 | 6.0 | 6.5 | 8.384 | 0.078 |
| Understanding of images | 4.0 | 4.0 | 3.0 | 4.0 | 4.0 | 2.403 | 0.662 |
| Phonological fluency | 4.0 | 4.0 | 4.0 | 5.0 | 4.5 | 2.082 | 0.721 |
| Semantic fluidity | 4.0 | 3.0 | 4.0 | 3.0 | 4.0 | 1.198 | 0.878 |
| Leximetry- understanding | 2.5 | 4.0 | 4.0 | 3.0 | 5.5 | 10.201 | 0.037* |
| Leximetry- speed | 2.5 | 4.0 | 4.0 | 4.0 | 3.0 | 2.301 | 0.681 |
| Auditoy-gnosic writig | 1.0 | 2.0 | 4.0 | 2.0 | 1.0 | 6.461 | 0.167 |
| Visual perception | 5.5 | 6.0 | 6.0 | 7.0 | 5.5 | 9.118 | 0.058 |
| Executive function - time | 5.0 | 5.0 | 4.0 | 4.0 | 4.0 | 1.331 | 0.856 |
| Executive function - errors | 8.0 | 9.0 | 4.0 | 5.0 | 4.5 | 16.412 | 0.003* |
| Verbal memory | 5.0 | 4.0 | 4.0 | 3.0 | 2.0 | 11.283 | 0.024* |
| Visual memory | 4.0 | 5.0 | 4.0 | 5.0 | 5.0 | 1.725 | 0.786 |
| Rhythm | 4.0 | 4.0 | 3.0 | 2.0 | 2.5 | 14.168 | 0.007* |

*Note.* [a]n= 26; [b]n= 35; [c]n= 14; [d]n= 15; [e]n= 12. *p<.05.

The qualitative analysis of the participants who showed difficulties during the execution in the subtests allowed to characterize the main problems of this age group.

*Leximetry:* In this test, children show alterations in reading comprehension, due to difficulties of phonological maturity, poor lexicon according to age and morphology modifications. Reading out loud is characterized by associated failures in punctuation marks and reading speed.

*Visual perception*: In general, execution of the participants presented an age-appropriate development. However, at 11 years of age, there is a performance decrease, probably because stimuli processing strategies at this age change or are adapting to the demands of cognitive processes.

*Executive functions*: Regardless of age, children perform a disorganized tracking, reflected in the number of errors committed, either due to lack of organization and / or planning. Children aged 9, 10 and 11 years tend to make mistakes more frequently, and it is at these ages where tests such as Executive functions-errors, Verbal memory and Rhythm-show a decrease in their execution.

## Discussion

The purpose of this research was to evaluate the presence of NSS and higher cognitive processes in Mexican schoolchildren from a medium-low socioeconomic stratum, without neurological and / or psychiatric history. The findings show the presence of psychomotor development signs like disorder in sensory integration, dysdiadochokinesis, coordination disorder, and perceptive signs such as spatial orientation disorder and difficulty in right-left recognition.

Additionally, there are signs related to processes such as attention, memory, reasoning, language (oral, comprehensive and written) and learning difficulties. Some of these NSS should have to disappear in the early stages of development, to give way to more complex behaviors that are required in the school and social environment. In this way, when going through a neuropsychological examination, the 6-years-old children assessed in the present study showed difficulties in specific areas, such as psychomotor skills, where children at this age improve their gross motor ability, can make short jumps, and launch a ball with a certain weight and size. At the fine motor level, they can take a pencil to draw and even button up a shirt (Feldamn, 2007).

Similar to these results, Ozkan, Kara, Mahmoud, and Congologu (2018) observed that their sample of participants, classified as having borderline intellectual functioning, unlike patients with a diagnosis of specific learning disorder, presented a greater number of soft neurological signs, mainly in sensory integration, motor coordination and in the total assessment of the instrument that these researchers used.

In the same way, a dysrhythmia was observed, defined as an incorrect time and / or rhythm of movement. According to Pitizianti, *et al.* (2017) the alteration of the motor responses rhythm and the poor motor coordination seem to be the most prominent motor abnormalities in children with alterations in the development of the nervous system and ADHD.

The above mentioned coincides with what was pointed out by Ávila (2012), and Parra-Pulido, *et al.* (2016), whose research results indicate the presence of NSS, which can be indicators of immaturity of the Central Nervous System,

affecting the intellectual, behavioral and emotional development of children.

On the other hand, a poor performance on the Visual perception test was observed in the 6-year-old group of the current study, where at this age the development of occipital- parietal cortical areas shows a greater integration with visual stimuli. As Capellini, Giaconi and Germano (2017) point out, visomotor activity is defined as a fluid integration between visual perception capacity and motor skills, which requires the ability to translate visual perception into motor function, or the ability to coordinate hand and eye; therefore, it has an important role in the future academic development of the child.

In terms of cognitive processes, impairments were observed at the level of expressive / articulated and comprehensive language. According to Narbona and Chevrie-Muller (2003), at the age of 6 years, all phonemes are consolidated, except for the phoneme / r /. In relation to comprehension, the infant can understand more than twice as much vocabulary as it expresses, and shows increased ability in understanding complex syntactic structures. On the other side, deficits in verbal fluency were found, where the child at this age must be able to generate between 10 and 16 words within a semantic field (García et al., 2012). In the same way, poor attention ability was observed, since children at this age can concentrate for longer periods of time, focusing on the necessary information and filtering the unnecessary one (Anderson, Jacobs & Anderson, 2010).

The findings of this study agree with the data published by Mateos and López (2011), regarding the fact that the presence of psychomotor, sensory and cognitive disorders in school-age children are a risk factor for the presence of expressive language disorders (spoken and written); disorders in semantic fluency; reading problems, poor pace and speed; little or even no understanding of the text read, and visual perceptive difficulties that can influence an abnormal development of writing and calculation.

Moreover, when analyzing the performance of CUMANIN subtests and the participant's sex variable, significant differences were found in expressive language associated with better performance of girls, in contrast with the results obtained by Ávila (2012), Parra-Pulido *et al*. (2016), Portellano *et al*. (2009) and Urzúa *et al*. (2010), which indicate that the presence of NSS is not associated with this variable during this stage of development.

The performance of children from 7 to 11 years old in CUMANES shows the presence of NSS associated with auditory-gnostic writing, leximetry-speed and leximetry-language comprehension. The results observed in the comparisons by age indicated significant differences in areas of language, executive functions, verbal memory and rhythm. This may be due to the cognitive strategies developed, which change depending on some critical points in development. Battro, Fischer and Lena (2016) point out the importance of these critical stages during which the processes of cerebral maturation are activated and the nervous connections develop more intensely; these periods occur around the age of 4, 8 and 12 years. In addition to this, the demands of the environment in which children develop and the cognitive demand at school, play an important role in the adaptation and development of new strategies. Chadwik (1988) points out that these changes in cognitive strategy can occur at two levels: processing and execution. The first level, processing, includes the strategies that the person normally uses automatically to improve their chances of entering and storing information, impressions, specific data, general ideas, etc. The second level, execution, includes everything the person does to recover and solve problems, and generate creative responses. It is concluded that the difference between the two levels can be seen as income strategies and outcome strategies.

Regarding the auditory-gnostic writing in the CUMANES test, the child is required to write a text that is dictated by the evaluator, a cognitive task that allows knowing whether the child has an adequate verbal auditory recognition and provides relevant information in the early development of the functioning of working memory, which plays an important role in the ability to process and perform complex cognitive tasks, of verbal auditory type, such as reading and writing (Tindle & Longstaff, 2015). In relation to leximetry, comprehension and speed, children in this study showed a deficit in the execution of this task, which cognitively speaking is a relevant function associated with reading ability and, therefore, with learning, which requires that the reader's attention will focus on understanding, while the mechanics of word recognition should operate with speed and in an automatic way (Abu-Leil, Share, & Ibrahim, 2014).

Concerning the association of sociodemographic factors, the sample was homogeneous in this variable, which could not be matched at a statistical level in the present study. Urzúa, *et al.* (2010) point out that the socioeconomic level determines the differences in the performance of the CUMANIN subtests. Likewise, UNESCO (2015) states that students with better academic performance come from a high socioeconomic level. In the same way, a low educational level of parents is related to poor school performance of their descendants (Matute, Sanz, Gumá, Roselli & Ardila, 2009), including other factors such as poverty, lifestyle habits, family interaction models, linguistic communication within the home, and expectations of education towards the children.

The limitation of this study lies in the origin of the participants and their socioeconomic level, as mentioned above, since a sample of heterogeneous type (urban and rural areas) derived from the Mexican population, would have enriched the results that were obtained.

The justification of this study is related to the scarce research in which the CUMANES battery has been used, which does not take up the observation and evaluation of NSS (Becerra-Garrido, 2016); thus, an emphasis on deepening the development thereof would be relevant. It should take into account the ecological validity implied in the results of the present research, given the context in which the behavior of the individual has multiple levels of influence, highlighting the intrapersonal one (biological and psychological), the interpersonal (social and cultural), the organizations and communities, as well as the physical and political environment (Salvador-Cruz et al., 2016).

Finally, school failure has multiple factors, among which the socioeconomic level and the presence of NSS stand out. The identification and diagnosis of NSS in the early stages of development will allow to anticipate the academic performance of the child, enabling the promotion of secondary intervention lines or early stimulation strategies, which prevent the future damage of the cognitive activity during the development of the child, thus improving their quality of life.

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