OCNOS Journal of Reading Research

Ocnos
Journal of Reading Research
https://revista.uclm.es/index.php/ocnos

Open Access Full Text Article

Ocnos, 21(1), 2022. ISSN: 2254-9099
https://doi.org/10.18239/ocnos_2022.21.1.2704

Artículos

Mistakes in the writing of adolescents with high and low academic performance. A neuropsychological analysis

Errores en la escritura de adolescentes con alto y bajo rendimiento académico. Un análisis neuropsicológico

María del Rosario Bonilla-Sánchez*[1]
Marco Antonio García-Flores[2]
Ignacio Méndez-Balbuena[3]
Carolina Alvarado-Cortés[4]

[1] Benemérita Universidad Autónoma de Puebla, México
[2] Benemérita Universidad Autónoma de Puebla, México
[3] Benemérita Universidad Autónoma de Puebla, México
[4] Benemérita Universidad Autónoma de Puebla, México

* Corresponding author: maria.bonilla@correo.buap.mx

Received: 05/03/2021; Accepted: 29/11/2021

Abstract

The purpose of the work was to analyze, from the Historical-Cultural neuropsychology, the types of errors in writing in adolescents of basic secondary education with high academic performance (HAP) and low academic performance (LAP). Based on the syndromic analysis proposed by Luria, the mechanisms of regulation and control and of global spatial analysis and synthesis were identified as mechanisms underlying the types of errors presented by the participants. A descriptive cross-sectional design was applied. The sample included 8 adolescents with HAP and 8 with LAP, from each of the three grades of secondary education, with a total sample of 48 Mexican adolescents. Tasks were applied to evaluate neuropsychological mechanisms and writing. The results showed the types of writing errors characteristic of the mechanisms identified with a non-optimal development at their functional level, the errors were more significant in the LAP group. The need to correct difficulties in writing is highlighted not only from writing itself, but above all to contemplate activities that favor the functional development of deficient mechanisms, even since the level of initial basic education.

Keywords: Learning difficulty; school performance; neuropsychological evaluation; writing; Specific Learning Disorder (SLD)

Ocnos: Revista de estudios sobre lectura. Editada por CEPLI; Universidad de Castilla-La Mancha se distribuye bajo una licencia Creative Commons Atribucción-NoComercial-SinDerivar 4.0 Internacional

Resumen

El propósito del trabajo fue analizar, desde la neuropsicología Histórico-Cultural, los tipos de errores en la escritura en adolescentes de educación media básica con alto rendimiento académico (ARA) y bajo rendimiento académico (BRA). Con base en el análisis sindrómico propuesto por Luria, se identificó a los mecanismos de regulación y control y de análisis y síntesis espacial global, como mecanismos subyacentes a los tipos de errores presentados por los participantes. Método. Se aplicó un diseño transversal descriptivo. La muestra incluyó 8 adolescentes con ARA y 8 con BRA, de cada uno de los tres grados del nivel de educación secundaria, siendo una muestra total de 48 adolescentes mexicanos. Se aplicaron tareas para evaluar a los mecanismos neuropsicológicos y a la escritura. Los resultados mostraron los tipos de errores de escritura característicos a los mecanismos identificados con un desarrollo no óptimo en su nivel funcional, los errores fueron más significativos en el grupo de BRA. Se resaltan la necesidad de corregir las dificultades en la escritura no solo desde la escritura misma, sino sobre todo contemplar actividades que favorezcan el desarrollo funcional de los mecanismos deficientes, incluso desde el nivel de la educación básica inicial.

Palabras clave: Dificultad en el aprendizaje; rendimiento escolar; evaluación neuropsicológica; escritura; dificultades específicas de aprendizaje

Introduction

Since the PISA test was implemented in Mexico in 2003, it has been reported that around 50% of adolescents in Mexico have poor academic performance (level zero and one) in reading comprehension, mathematics and science (Salinas et al., 2019).

Prevalence of specific learning disabilities (SLDs) is between 5 and 15% (APA, 2014). If we consider this figure and that reported by PISA, the difference in Mexican students who do not have ASD - but who are academically underachieving - ranges between 45 and 35%.

It is important to delve into this stage of development and in a population without clear alterations. However, there are few reports of neuropsychological studies related to the level of academic performance of students in basic secondary education (Bonilla et al., 2018) and much less related to writing (Amaya, 2011). It is estimated that more than half of the cases of school failure are due to neuropsychological implications (Portellano, 1995).

In adolescence, development is characterised by major maturational changes, especially in the more complex areas of the brain. Maturation of the posterior tertiary (spatial) areas is nearing completion, while the prefrontal tertiary areas are in full development. The latter carry out executive functions such as planning, impulse control, inhibitory control, organisation, flexibility of thought, self-control of behaviour, rule following, abstract attitude, verbal fluency, reverse sequencing, working memory, among others. Maturation is not completed until early adulthood (Flores & Ostrosky-Solís, 2012; Roselli et al., 2010). These functions are essential for optimal academic learning (Best et al., 2001).

Writing is a complex process that requires both external-social aspects (López-Escribano, 2012) and neuropsychological and psycholinguistic skills (Rivas & López, 2017). Its study has been considered by various disciplines such as pedagogy, neuropsychology, psycholinguistics and neurolinguistics (Londoño-Muñoz et al., 2016). And within neuropsychology, digraphy can

Ocnos, 21(1): 1-15. 2022. ISSN: 2254-9099
https://doi.org/10.18239/ocnos_2022.21.1.2704

be approached from different perspectives such as cognitive and cultural-historical (Suárez & Quijano, 2014).

From a cognitive neuropsychological and psycholinguistic perspective, several processes have been identified.

One of the main proposals for understanding the act of writing was made by Hayes and Flower (1980), and was subsequently enriched by the former (Hayes, 1996) and with the contributions of Chenoweth in 2001. The enriched model considers two dimensions: that of the activity and that of the individual. The first dimension takes into account the external social and physical factors that impact the writer (to whom the writing is addressed, with whom it is written, the text itself, the specific means of the text, etc.). The second refers to motivational and cognitive aspects. Three aspects are identified within cognitive processes: 1) planning-reflection of writing (previous processes: objectives, generation, organisation of content, problem solving, decision making, inferences); 2) transcription-production of the text and, 3) revision of the text (which includes the monitor which is a type of executive control). Hayes also considers long-term memory, which is indispensable especially in planning; and working memory in text production and revision, which has to do with phonological, semantic and visual-spatial processing.

From the neurocognitive approach Cuetos (2009) has referred to four processes: message planning, construction of syntactic structures, word selection and motor processes. The planning process does not differ much from Hayes', so we will mainly deal with the other three. In the second process, the writer must activate the syntactic structure in which he will arrange and select the words. This is followed by the word selection stage, where the meaning of the words is first activated and then their orthographic form is chosen. There are two ways of doing this: lexical and sub-lexical. Lexical refers to the activation and availability in working memory of the orthographic form of the whole word. In the sub-lexical way, the phonological form of the word is first activated and then the sounds will be transformed into graphic signs (grapheme-phoneme conversion mechanism), which will be available in the working memory. Finally, the motor processes that produce the graphemes will be activated. The dorsal, ventral and anterior systems are required to carry out the various processes.

The formulation of a topic (spontaneous writing) will require all the processes discussed above, as it is creative writing. On the contrary, in dictation writing, written reproduction of an orally received message will require less involvement of planning, the semantic system, syntactic activation and long-term memory; it will require mainly word selection processes, working memory and motor processes. Errors in the writing will consequently be due to the alteration of one of the above-mentioned processes.

Taking up this neurocognitive model, López-Escribano (2012) calls aphasic dysgraphia to alterations in planning, central dysgraphia to those in which the lexical level is altered and peripheral dysgraphia to motor disorders. He further refers that all processes considered by Cuetos and Hayes are "interactive, recursive, potentially simultaneous, goal-driven and qualitatively different in children and adults" (p. 159).

It is therefore to be expected that, in the adolescent population without prefrontal pathology, there are as yet undeveloped functional patterns that optimally support executive

functions. Among the executive functions of non-early (middle) development are risk-benefit processing, working memory, mental flexibility, reverse sequencing, visual-spatial planning, sequential planning, whilst verb fluency, abstract category generation and figurative meaning comprehension fall within late development (Flores & Ostrosky-Shejet, 2012).

A study of adolescents with and without dysgraphia compared reading and writing skills, as well as functional characteristics of the executive functions (EFs) development, and identified that adolescents with dysgraphia had lower EF skills, which was one of the main aspects explaining the variability in the quality of written content (Hen-Herbst & Rosenblum, 2018).

Cultural-historical neuropsychology considers that all psychological activities (writing, reading, calculation, etc.) are functional systems that entail the participation of several neuropsychological factors or mechanisms. These are related to various brain areas that are functionally linked, so that one neuropsychological factor can be involved in several psychological functions (Luria, 1989; Solovieva & Quintanar, 2014). Consequently, if a factor does not show optimal functional development, errors will be observed in the various functions in which it participates (this analysis is called syndromic). Therefore, the therapeutic intervention will be factor-directed. Table one schematically shows the involvement of each of the neuropsychological factors and their systemic effect on writing in the face of sub-optimal development.

Writing emerges as a result of voluntary organised activity as well as formal teaching during primary education. Akhutina (2002) points out that the complex functional system of writing can be executed as a voluntary programme of actions, thanks to the efficient inclusion of the programming and control factor. Although every student develops writing skills differently, self-regulation of one's own writing strategies is a key process for learning and academic achievement (Shunk & Zimmerman, 2007; Zimmerman, 1990).

Previous studies have identified some neuropsychological mechanisms responsible for reading and writing difficulties in adolescents with learning difficulties in upper secondary education, such as regulatory and kinestic mechanisms (Solovieva et al., 2006, 2018) and kinesthetic disturbances in children in basic education (Sarmiento-Bolaños, et al., 2016).

Akhutina (2002) and Eslava-Cobos, et al. (2008) identified the typical errors of sub-optimal work in the regulatory block (frontal areas): application of orthographic and syntactic rules, consonant omissions, syllable omissions, anticipations, contaminations and repetitions of letters, syllables and words, failure to respect word and sentence boundaries, and block writing. Errors are due to poor control in the execution of the operations involved in writing. For example, spelling and syntax rules must be consciously and voluntarily applied in order to adequately convey a written message, which is not present in spoken language (Cuetos, 2009). This complexity could also be due to the lexical unavailability of verbs and their argument structure, since action fluency has a late development (Flores & Ostrosky-Shejet, 2012). On the other hand, the verb is considered the main element of the sentence and a central part of the syntax (Lezcano, 1995).

The findings described above contribute to the study of writing difficulties. However, they are related to the study of the school population at primary and secondary school level,

Ocnos, *21*(1): 1-15. 2022. ISSN: 2254-9099
https://doi.org/10.18239/ocnos_2022.21.1.2704

with a diagnosis of learning disabilities. This highlights the need to apply neuropsychological analysis to adolescents in lower secondary education without alterations in neuropsychological development, with tasks such as dictation and spontaneous writing, since these have been little used to study possible alterations in writing (Londoño-Muñoz et al., 2016).

The aim of the study is to identify writing errors in adolescents without pathology with low and high academic performance, as well as the comparison of errors between these populations, and to determine the link of these errors to the sub-optimal development of neuropsychological factors.

Methodology

Study design

A mixed, cross-sectional, non-experimental, qualitative-descriptive, qualitative-descriptive design was carried out in three groups of adolescents in lower secondary school.

Participants

The non-probabilistic sample was made up of a total of 48 students from the three grades of a secondary school incorporated into the Public Education System (SEP, as per its Spanish acronym) in Puebla, Mexico, located in a geographical area of medium-low socio-economic origin. The sample consisted of 8 high academic performance (HAP) and 8 low academic performance (LAP) students from each of the secondary school grades. The average age of all participants was 13 years, 4 months. The HAP and LAP groups were formed on the basis of the school average obtained by the students (Edel, 2003) at the time of the neuropsychological assessment. The parents of the participants reported no history of psychopathological or learning disabilities in their life history. The inclusion criteria for the HAP group were to have obtained a school average between scores 9-10. For the LAP group, school averages were between 6-7. In addition, both groups had no history of repeating a grade in their school career. The selection of students for group formation was carried out by the secondary school management based on the inclusion criteria.

Instruments

a) Brief Neuropsychological Assessment for adolescents, a protocol based on the theoretical and methodological principles of the historical-cultural Neuropsychological theory (Luria, 1995), including tasks that assess the functional state of the neuropsychological mechanisms proposed by A. R. Luria (Eslava-Cobos et al., 2008) (table 1); and b) activities of: 1) dictated sentence writing and 2) spontaneous writing on a given topic: “your past holidays”, from the evaluation of the verification of school success in adolescents (Solovieva & Quintanar, 2018).

Table 1.
Neuropsychological mechanisms assessed, description of their functional work and types of errors linked to writing.

Neuropsychological Mechanism	Job/role in the writing process	Errors/difficulties in handwriting
Regulation and control	Participates in the process of executing an activity in accordance with the objective set.	Difficulty in applying spelling and syntax rules. Omissions of consonants, anticipations and repetitions of letters, words and sentences. Does not respect word and sentence boundaries, block writing. Difficulties in spontaneous writing.
Sequential organisation of movements and actions	It ensures a smooth transition from one movement to another in writing.	Repetition of motor elements of writing. Asyntactic and agrammatical writing. Does not respect word boundaries, block writing.
Phonematic hearing	It enables the differentiation of verbal sounds of the language according to phonemic oppositions.	Spelling errors, omissions and consonant substitutions, according to phonemic features and lexical poverty.
Kinesthetic integration	Ensures fine tactile sensitivity, precise positions and poses. In the articulation of language, it ensures differentiation of verbal sounds according to where and how they are produced.	Severe spelling errors, consonant omissions and substitutions, according to articulatory proximity and problems in conceptual categorisation.
Audio-verbal retention	It enables the stability of memory traces in the audio-verbal modality under interference conditions.	Consonant omissions and substitutions and lexical poverty.
Visual retention	It enables the stability of memory traces in the visual modality under interference conditions.	Difficulty in understanding logical-grammatical structures in spontaneous writing.
Spatial analytical	Ensures adequate perception and production of essential features, their location and spatial links between writing elements.	Difficulties in comprehension and in the use of logical-grammatical structures in spontaneous writing.
Spatial global	Participates in the perception and appropriate production of the general shape, metric aspects and proportions of objects.	Substitutions and omissions of vowels. Difficulty in the spatial organisation of writing and in the representation and evocation of metrical aspects and proportions of writing elements. Mirror writing.
Alertness (cortical tone)	It guarantees substance and stability of writing.	Instability in executions. Macrography and/or micrography in writing.

Source: Prepared by the authors based on Eslava-Cobos et al. (2008)

Procedure

Once the relevant approvals were obtained from the educational institution, the HAP and LAP groups were formed. Informed consents were obtained from parents or guardians with the support of the social worker of the educational institution. The selected students agreed to participate voluntarily in the neuropsychological assessment.

The Brief Neuropsychological Assessment for Adolescents instrument was then applied. Analysis of the results showed functional impairment of the neuropsychological factors of regulation and control, spatial analysis and synthesis of information in its global component and alertness. The findings were the first part of the study of the characteristics of neuropsychological performance in adolescents (Bonilla et al., 2018).

The second part of the research is the present analysis of the adolescents' writing performances. The applications of the activities 1) dictated sentence writing and 2) spontaneous writing of the Adolescent School Success Assessment were carried out individually by Neuropsychology specialists in a distraction-free cubicle on the school premises. Average

Ocnos, 21(1): 1-15. 2022. ISSN: 2254-9099
https://doi.org/10.18239/ocnos_2022.21.1.2704

evaluation time with student was one hour. Research was conducted in accordance with the ethical standards expressed in the Declaration of Helsinki (WMA, 2013), and was assessed and approved by the local ethics committee of the Faculty of Psychology of the Benemérita Universidad Autónoma de Puebla, Mexico.

Data analysis techniques

Qualitative analysis

The errors in the evaluation tasks were recorded, applying the criteria of the syndromic analysis proposed by Luria (1995), which consists of identifying the neuropsychological mechanism causing the errors in the tasks of each factor and in the errors in the writing activity. Such analysis was initially termed by Vigotsky (1992) as “inter-functional or systemic”.

Quantitative analysis

For the identification of strengths and weaknesses in the functional development of neuropsychological mechanisms, Glozman’s (2002) proposal for the quantitative analysis of qualitative neuropsychological assessment data was applied. In order to know the overall performance of the participants in all the tasks assessed, a value of 1 was assigned in the case of incorrect execution; value 2 for correct execution, but with the help of the applicator; and 3 for correct execution.

In order to find out the contrast between high academic achievement (HAP) and low academic achievement (LAP), we conducted a statistical analysis between these two groups. Because the data (including ages) were not normally distributed (Kolmogorov-Smirnov normality test, $p<0.05$) we used a non-parametric test (Mann-Whitney U), under the null hypothesis that the dependent variables were the same in the two conditions (HAP and LAP). Analyses were conducted in the Statistical Package for the Social Sciences (SPSS) version 20. Statistical significance was taken as one-tailed. All effects are reported as significant if $P<0.05$.

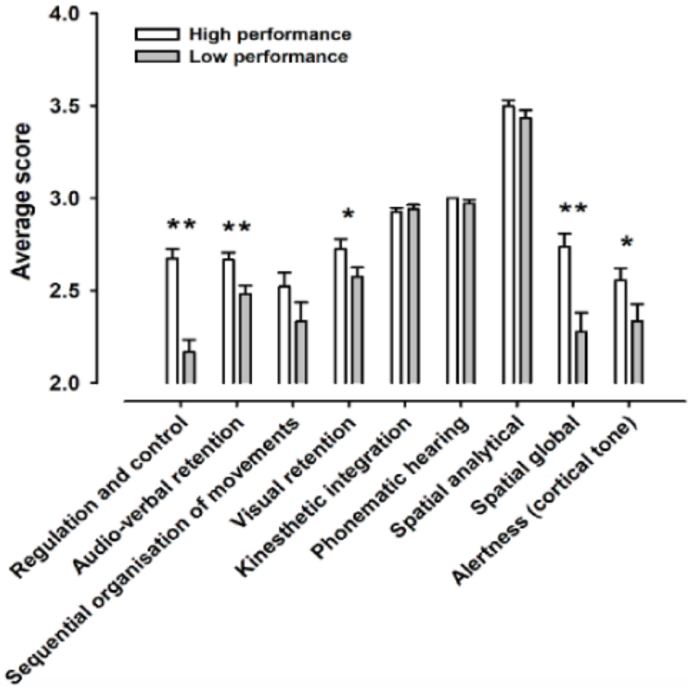
Results

Based on the assigned values, the results of the overall performance of the first-grade participants in the tasks assessed showed that the students in the LAP group reported the highest frequency of incorrect execution, and the lowest number of correct executions. The students in the HAP group achieved the highest number of correct performances, both with assistance and independently. In particular, it was the second and third grade HAP students who did not require the help of the evaluators.

In order to test that age had no effect on the dependent variables, a Mann-Whitney U-test was performed, and it was found that there was no statistically significant difference in age between the HAP group (13.21±0.83 years) and the LAP group (13.46±1.18 years), $U=253.5$, $Z=-0.74$, $p>0.05$.

On the other hand, the functional status of the adolescents' neuropsychological mechanisms showed the following significant differences in favour of the HAP group. Variable regulation and control (RC) in the HAP group (mean=2.68±0.25), differed significantly from the LAP group (mean=2.17±0.33), U=68.0, Z=-4.58, p<.0001, r=0.66. Audio-verbal retention (AVR), in the HAP group (mean=2.66±0.19), also differed significantly from the LAP group (mean=2.48±0.22), U=152.5, Z=-2.82, p<.01, r=0.40. Similarly visual retention (VR), in the HAP group (mean=2.72±0.26), also differed significantly from the LAP group (mean=2.57±0.24), U=189.5, Z=-2.10, p<.04, r=0.30. The overall spatial analysis and synthesis (ASEPG, as per its Spanish acronym) in the HAP group (mean=2.73±0.35), differed significantly from that of the LAP group (mean=2.27±0.49), U=131.0, Z=-3.35, p<.001, r=0.48. Finally, it was also found that alertness (AE) in the HAP group (mean=2.55±0.32), differed significantly from the LAP group (mean=2.33±0.46), U=213.5, Z=-1.60, p<.05, r=0.23 (figure 1).

Figure 1.
Comparison of neuropsychological assessment results in the HAP and LAP groups



Note. Comparison of the average score obtained in the neuropsychological assessment of the HAP and LAP groups. A non-parametric test (Mann-Whitney U test) was conducted Statistical significance was taken as one-tailed. * p < 0.05 (significant). ** p < 0.01 (very significant).

Syndromic analysis revealed that the neuropsychological mechanisms of regulation and control, global spatial analysis and synthesis, and alertness (figure 1) were the cause of the writing errors. Clinical features that correspond to the neuropsychological factors identified with functional deficits in the neuropsychological assessment.

The main errors in the neuropsychological assessment related to poor regulation and control in dictation writing in the LAP group are presented in table 2. In addition, during the assessment it was necessary for the assessors to repeat the instructions to the learners, who were also impulsive in their execution and did not correct their writing errors. As for systemic errors due

Ocnos, *21*(1): 1-15. 2022. ISSN: 2254-9099
https://doi.org/10.18239/ocnos_2022.21.1.2704

to the functional deficit of the mechanism of global spatial analysis and synthesis, substitutions or omissions of vowels and failures in the spatial organisation of writing were found (table 2). In addition, they presented dysmetria in the reproduction of models and drawings on the visual perceptual level.

Table 2.

Percentages and means of types of dictation writing errors by grade level in the LAP group, related to neuropsychological mechanisms: Regulation and Control and Global Spatial Analysis and Synthesis

Neuropsychological factors	Type of error	First grade		Second grade		Third grade	
		fi	$\bar{x}$	fi	$\bar{x}$	Fi	$\bar{x}$
Regulation and control	Spelling	27.517%	7.687	30.310%	8.562	25.67%	7.187
	Syntactic	3.356%	0.937	2.655%	0.75	2.455%	0.687
	Omission of consonants	0671%	0.187	0.885%	0.25	1.339%	0.37
	Word substitution	0.224%	0.062	1.106%	0.312	1.786%	0.5
	Anticipation of letters or words	3.579%	1	3.097%	0.875	6.473%	1.812
	Repetition of letters	0 %	0	0.221%	0.062	1.339%	0.375
	Repetition of words	0.671%	0.187	0.221%	0.062	0.223%	0.062
	Non respect of word boundaries	2.685%	0.75	2.434%	0.687	2.679%	0.75
	Block writing	1.342%	0.375	1.549%	0.437	1.786%	0.5
	Variation in letter ratio	0%	0	1.106%	0.312	0 %	0
	Incomplete spelling	56.6%	15.812	53.982%	15.25	53.348%	14.938
Global spatial analysis and synthesis	Substitution or omission of vowels	1.342%	0.375	1.549%	0.437	1.563%	0.437
	Failures in the spatial organisation of writing	0.224%	0.062	0%	0	0.223%	0.062

Source: Prepared by the authors.

In summary, the highest percentage of errors in dictation writing conditioned by the regulation and control mechanism in adolescents in the three secondary school grades of the LAP group were incomplete spelling, spelling errors, errors in anticipation of letters or words, syntactic errors and errors in not respecting word boundaries. The errors linked to the global perceptual mechanism were those of vowel substitution and omission and, less frequently, failures in the spatial organisation of writing.

As for spontaneous writing, the errors presented with the highest percentage by students in the three grades of the LAP group, related to the functional deficit of the regulation and control mechanism, were again: orthographic, syntactic, omission of consonants, anticipation of letters or words and repetitions of letters and words (table 3).

Table 3.
Percentages and means of types of errors in spontaneous writing by grade level in the LAP group

Neuropsychological factors	Type of error	First grade		Second grade		Third grade	
		fi	$\bar{x}$	fi	$\bar{x}$	Fi	$\bar{x}$
Regulation and control	Spelling	37.025%	28.625	39.717%	29.812	39.807%	28.312
	Syntactic	2.425%	1.875	2.082%	1.562	2.285%	1.625
	Omission of consonants	1.132%	0.875	0.999%	0.75	0.879%	0.625
	Anticipation of letters or words	3.638%	2.8125	4.413%	3.312	7.118%	5.062
	Repetition of letters	0.404%	0.3125	0.500%	0.375	0.176%	0.125
	Repetition of words	0.243%	0.187	0.167%	0.125	0.176%	0.125

Source: Prepared by the authors.

On comparing errors conditioned by regulation and control of the three school grades between the LAP and HAP groups, a significant difference was obtained in spelling error ($p<0.013$), being greater in the LAP group. Another statistically significant type of error was that of anticipation in letter and word completion ($p<0.038$), also in the LAP group. Errors were not corrected by the students, as compared to HAP students, who corrected errors independently by highlighting spelling or rewriting the word. Other regulatory errors, with no significant statistical difference, were letter or word anticipation and letter and word perseveration. In the comparison of the errors associated with the global spatial analysis and synthesis mechanism, for the three school grades between the LAP and HAP groups, no statistically significant differences were found.

It is important to mention that, although the HAP students also presented some writing errors, these were neither frequent nor systematic in the two writing modalities assessed, compared to the LAP group.

On the other hand, as for the mechanisms of audio-verbal and visual retention and alertness, mechanisms that revealed statistically significant differences (figure 1), syndromic analysis led to identify them as a result of the systemic effect of the functional deficit in regulation and control and global spatial analysis and synthesis.

Discussion

Writing is a complex process that requires the concerted work of multiple neuropsychological mechanisms. The neuropsychological assessment allowed us to identify the neuropsychological mechanisms with sub-optimal development in their functional level in the group of students with LAP, regulation and control and global spatial analysis and synthesis (Bonilla et al., 2018). The importance of the functional efficiency of these mechanisms for the successful achievement of various school actions has been emphasised (Martínez, et al., 2019; Eslava-Cobos et al., 2008). The clinical characteristics of the participants' writing errors correspond to the neuropsychological factors identified with sub-optimal development.

Writing requires the processing of visuospatial information in order to correlate sounds with letters, stabilising their visual image, their automation and their evocation. It also involves a

Ocnos, *21*(1): 1-15. 2022. ISSN: 2254-9099
https://doi.org/10.18239/ocnos_2022.21.1.2704

highly voluntary and complex process, poor learner regulation and control would lead to a variety of errors in planning, lexical selection, cognitive flexibility in identifying letters in words, construction, sequencing and constant control in writing. The basic components of written expression are related to executive functioning (Hooper et al., 2021).

The writing process involves skills to recognise, remember and handle visual information, therefore, the mechanism of spatial analysis and synthesis constitutes one of the mechanisms of the functional system of writing in its different levels of execution (Ortiz & Bustamante, 2018). In cultural-historical neuropsychology, this mechanism is analysed as a result of the work of the temporo-parieto-occipital (TPO) brain sectors in their two functional components, analytical spatial perceptive (TPO areas of the left hemisphere) and global spatial perceptive (TPO areas of the right hemisphere). The first one ensures adequate perception and production of the essential features of spelling and their location in writing. The second one favours the perception and correct production of the general forms of spelling, their metrical aspects and their proportion in writing. Previous studies show difficulties in writing performance related to functional weaknesses in some of these components in primary education (Quintanar, 2009; Akhutina & Zolotariova, 2001; Londoño-Muñoz et al., 2016).

Frequent errors were found in spontaneous writing due to deficient analysis and synthesis of global spatial perception in the LAP group, such as substitution or omission of vowels and failures in the spatial organisation of writing, which coincide with those identified by the authors referred to above.

As for the neuropsychological factor of regulation and control, Luria (1995) linked it to the functional work of the frontal lobes, whose function is to organise, programme, control and verify, in this case, the action of writing. Spelling and syntactic errors, omission of consonants, word substitution, anticipation in writing letters in words, perseveration or repetition of letters and words, failure to respect word boundaries, block writing, variation in the proportion of letters and incomplete spellings due to regulatory failure in the writing of adolescents in the LAP group are consistent with those reported in the primary school-age population (Londoño-Muñoz et al., 2016; Akhutina, 2002).

Another interesting finding in the population studied was the presence of a greater number of errors in dictation writing than in spontaneous writing, due to the fact that this type of writing requires immediate control (Martínez-Hincapié, 2013), and greater activation of working memory, while in spontaneous writing, even though it may be more complex, the adolescent has time to formulate the idea, express it and correct it. Thus, working memory is a neuropsychological variable of high predictive value for optimising writing resources and skills (Moreno, 2016; Etchepareborda, 2005).

Previous research supports the view that writing difficulties, as part of learning problems, should be addressed from the neuropsychological mechanism that causes them (Quintanar, 2009). The purpose of neuropsychological intervention would be to perfect school actions that require optimal involvement of regulation and control and visuospatial analysis and synthesis, with the possibility of reversing the systemic effect that can occur in other complex functions, such as audio-verbal and visual information retention, writing, reading and mathematics (Verdine et al., 2014). Work on the implementation of strategies to promote executive functions

in primary school reports higher levels of self-efficacy in text generation and grammar use (Barry & Wenjuan, 2018; Mason & Brady, 2021).

Both the frontal lobes and the temporal-parietal-occipital areas are related to the tertiary areas of the cerebral cortex (Luria, 1995). Their maturation, mainly of frontal areas, concludes in late stages of development, being areas susceptible to favourable or unfavourable influences of the social environment, upbringing during the course of individual development and school teaching (Vigotsky, 1992; Lacunza et al., 2010), influences that mark individual differences in psychological development and academic performance (Akhutina & Pylaeva, 2012; Rivas & López, 2017). Mastery of school skills will be achieved as learners are exposed to the conscious use of written words (Londoño-Muñoz et al., 2016). Such conditions could account for the different performances among adolescents in the HAP and LAP groups.

Application of neuropsychological analysis to learning difficulties in populations with low academic performance can contribute to the inclusion of strategies that support the functional development of the neuropsychological mechanisms involved. These strategies, from school itself and with the participation of the teacher, are a key resource for those who find it difficult to learn. Implementation of neuropsychological analyses - where applicable - to detect those adolescents with significant learning difficulties, with the purpose of conducting a specific case study where writing difficulties could be part of a particular neuropsychological syndrome.

This study's findings also highlight the need for curricular programmes to include activities that strengthen both the learning of specific school actions (reading, writing, arithmetic, etc.) and the course of children's neuropsychological development, especially the mechanisms of tertiary zones, regulation and control and spatial analysis and synthesis, from the early education stage (Venguer & Ibatullina, 2010; Sarmiento et al., 2016; Bauselas, 2010; Carrie et al., 2021; Verdine et al., 2014). The importance of working in the zone of proximal development is also highlighted, given that many students could improve their performance with the help provided by the teacher or pedagogue, depending on their particular needs in writing.

Finally, although it is of utmost importance to work on the formation of neuropsychological mechanisms with sub-optimal development, it is considered relevant to work on orthographic aspects at the secondary education stage, since the errors with the highest incidence and which characterise the population studied were spelling errors.

Conclusions

The neuropsychological mechanisms linked to dictation and spontaneous writing errors in the group of adolescents with LAP were regulation and control and spatial analysis and synthesis in their global component.

Regulatory errors occurred most frequently in the LAP adolescent group.

Writing errors made by adolescents in the LAP group were identified and corrected only with the help of the evaluator, while adolescents in the HAP group identified and corrected their errors independently.

Ocnos, *21*(1): 1-15. 2022. ISSN: 2254-9099
https://doi.org/10.18239/ocnos_2022.21.1.2704

The findings on the mechanisms underlying the writing difficulties of the population studied highlight the need to implement activities that favour the functional development of the deficient mechanisms from the initial basic education level.

References

Akhutina, T. V. (2002). Diagnóstico y corrección de la escritura. *Revista Española de Neuropsicología, 4*(2-3), 236-261.

Akhutina, T., & Pylaeva, N. (2012). *Overcoming Learning Disabilities.* Cambridge University Press. https://doi.org/10.1017/CBO9781139012799

Akhutina, T., & Zolotariova, E. V. (2001). Acerca de la disgrafia visuo-espacial: Análisis neuropsicológico y métodos de corrección. In Y. Solovieva & Quintanar (Eds.) *Métodos de intervención neuropsicológica infantil* (pp. 39-46.). Universidad Autónoma de Puebla.

Amaya, J. (2011). Escritura adolescente: una revisión basada en resultados de investigación recientes. *Colombian Applied Linguistics Journal, 13*(1), 71-83. https://doi.org/10.14483/22487085.2944

Asociación Médica Mundial, AMM (2013). *Declaración de Helsinki de la AMM: Principios éticos para las investigaciones médicas en seres humanos.* Universidad de Navarra, Centro de documentación Bioética. http://www.redsamid.net/archivos/201606/2013-declaracion-helsinki-brasil.pdf?1

Asociación Americana de Psiquiatría (2014). *Manual diagnóstico y estadístico de los trastornos de salud mental: DSM-5* (5ª ed.). American Psychiatric Publishing.

Barry B., & Wenjuan G. (2018). Influences of Self-Regulated Learning Strategy Use on Self-Efficacy in Primary School Students' English Writing in *Hong Kong, Reading and Writing Quarterly, 34*(6), 523-536. https://doi.org/10.1080/10573569.2018.1499058

Bauselas, H. E. (2010) Función ejecutiva y desarrollo en la etapa preescolar. *Bol Pediatría, 50* (214), 272-276. https://www.sccalp.org/uploads/bulletin_article/pdf_version/1216/BolPediatr2010_50_272-276.pdf

Best, J. R., Miller, P. H., & Naglien, J. A. (2001). Relations between executive function and academic achievement from ages 5 to 17 in a large, representative national sample. *Learning and Individual Differences*, 21, 327-336. https://doi.org/10.1016/j.lindif.2011.01.007

Bonilla, M., Anguiano, G., García, F., & Ramírez, E (2018). *Neuropsychological performance of adolescents with high and low school performance. Psychology 9*(12), 2768-2781. https://doi.org/10.4236/psych.2018.913159

Carrie, G., Cornu, V., & Schiltz, C. (2021). The importance of visuospatial abilities for verbal number skills in preschool: Adding spatial language to the equation. *Experimental Child Psychology*, 201, 1-9. https://doi.org/10.1016/j.jecp.2020.104971

Chenoweth, N.A., & Hayes, J.R. (2001). Fluency in writing: Generating text in L1 and L2. *Written Communication*, 18, 80-98. https://doi.org/10.1177/0741088301018001004

Cuetos, F. (2009). *Psicología de la escritura*. Wolters Kluwer España.

Edel, R. (2003). El rendimiento académico: concepto, investigación y desarrollo. *Revista Iberoamericana sobre calidad, eficacia y cambio en educación, 1*(2). https://www.redalyc.org/articulo.oa?id=55110208

Eslava-Cobos, J., Mejía, L., Quintanar, L., & Solovieva, Y. (2008). *Los trastornos del aprendizaje: perspectivas neuropsicológicas.* Editorial Magisterio.

Etchepareborda, M. C., & Abad-Mas, L. (2005). Memoria de trabajo en los procesos básicos de aprendizaje. *Revista de Neurología. 40*(1), 79-83. https://doi.org/10.33588/rn.40S01.2005078

Flores, J., & Ostrosky-Shejet, F. (2012). *Desarrollo neuropsicológico de los lóbulos frontales y funciones ejecutivas*. El Manual Moderno.

Glozman, J. (2002). La valoración cuantitativa de los datos de la evaluación neuropsicológica de Luria. *Revista Española de Neuropsicología, 4*(2-3), 179-196.

Hayes, J. R., & Flower, L. S. (1980*).* Identifying the organization of writing processes. In L. Gregg, & E. R. Stenberg (Eds.), *Cognitive processes in writing* (pp. 3-30). Erlbaum.

Hayes, J. R. (1996). A new framework for understanding cognition and affect in writing. In M. C. Levy, & S. Ransdell (Eds.), *The science of writing* (pp. 1-27). Erlbaum.

Hooper S. R., Costa, L., Fernández, E., Barker, A., Valdes, C., Stephanie, C., & Green, M. (2021). Executive functions and writing skills in children and adolescents: developmental assocations and dissociations. In T. Limpo, & T. Olive (Eds.), *Executive Functions and writing* (pp. 139-159). Oxford University Press. https://doi.org/10.1093/oso/9780198863564.003.0006

Hen-Herbst, L., & Rosenblum, S. (2018*).* Which characteristics predict writing capabilities among adolescents with dysgraphia? *Pattern Recognition Letters,* 121, 6-12. https://doi.org/10.1016/j.patrec.2018.04.021

Lacunza, A., Contini, N., & Castro, A. (2010). Las habilidades cognitivas en niños preescolares un estudio comparativo en un contexto de pobreza. *Acta Colombiana de Psicología, 13*(1), 25-34. http://www.scielo.org.co/scielo.php?script=sci_arttext&pid=S0123-91552010000100003&lng=en&nrm=iso

Leontiev, A. (1983). *El desarrollo del psiquismo*. Akal.

Lezcano, E. (1995). Una aproximación a la gramática de valencias*. Lenguaje y Textos, 6*(7), 161-173.

Londoño-Muñoz, N., Jiménez-Jiménez, S., González-Alexander, D. C., & Solovieva, Y. (2016). Análisis de los errores en la lectura y en el lenguaje escrito en niños de Educación Primaria. *Ocnos, 15*(1), 97-113. https://doi.org/10.18239/ocnos_2016.15.1.931

López-Escribano, C. (2012). Escritura. In F. Cuetos, *Neurociencia del lenguaje* (pp. 153-169). Editorial Médica Panamericana.

Luria, A. R. (1989). *El cerebro en acción* (M. Torres, trad.). Ediciones Roca.

Luria, A. R. (1995). *Las Funciones Corticales Superiores del Hombre* (C. Pérez, trad.). Fontamara.

Martínez-Hincapié, J. (2013). La investigación experimental en lingüística. *Katharsis,* 15, 215-238. https://doi.org/10.25057/25005731.246

Martínez, V. M., Suárez, R. J. M., & Valiente, B. C. (2019). Executive functioning and learning in primary school students*. Electronic Journal of Research in Educational Psychology, 17*(1), 55-80. https://doi.org/10.25115/ejrep.v17i47.2031

Mason L. H., & Brady, S. (2021). Executive functions and writing skills in children and adolescents: developmental assocations and dissociations. In T. Limpo, & T. Olive (Eds.), *Executive Functions and writing* (pp. 181-206). Oxford University Press. https://doi.org/10.1093/oso/9780198863564.003.0008

Moreno, C. (2016). Escritura de textos narrativos en niños escolares: la importancia de la memoria de trabajo y la memoria a largo plazo*. Revista de Psicología. 12*(24), 7-17. https://repositorio.uca.edu.ar/handle/123456789/6143

Ortiz, F., & Bustamante, J. (2018). Percepción visual y escritura en estudiantes de segundo a cuarto año de E.G.B. del Colegio San José la Salle. *INNOVA Research Journal, 3*(10), 59-76. https://doi.org/10.33890/innova.v3.n10.2018.657

Portellano, J. (1995). *Fracaso Escolar. Diagnóstico e intervención, una perspectiva neuropsicológica*. Editorial Ciencias de la educación preescolar y especial.

Quintanar, L. (2009). Formas de evaluación de las causas de las dificultades en la lecto-escritura. In L. Quintanar, Y. Solovieva, E. Lázaro, M. Bonilla, L. Mejía, & J. Eslava (Eds.), *Dificultades en el proceso lectoescritor* (pp. 58-93). Editorial de la Infancia.

Rivas-Torres., R. M., & López-Gómez, S. (2017). La reeducación de las disgrafias: perspectivas neuropsicológica y psicolingüística. *Pensamiento psicológico, 15*(1), 73-86. https://doi.org/10.11144/Javerianacali.PPSI15-1.RDPN.

Roselli, M., Matute, E., & Ardila, A. (2010). *Neuropsicología del desarrollo infantil.* Manual Moderno.

Salinas, D., De Moraes, C., & Schwabe, M. (2019). N*ota País. Programa para la evaluación internacional de alumnos (PISA). PISA 2018-Resultados.* OCDE. https://www.oecd.org/pisa/publications/PISA2018_CN_MEX_Spanish.pdf .

Sarmiento-Bolaños, M., Rojas, I., Moreno, C., & Gómez, A. (2016). Dificultades en el factor neuropsicológico Cinestésico predicen posibles problemas en la adquisición de la escritura. *Universitas Psychologica, 15*(5). https://doi.org/10.11144/Javeriana.upsy15-5.dfnc.

Schunk, D., & Zimmerman, B. (2007). *Influencing Children's Self-Efficacy and Self-Regulation of Reading and Writing Through Modeling, Reading & Writing Quarterly, 23*(1), 7-25. https://doi.org/10.1080/10573560600837578

Solovieva, Y., Bonilla, M., & Quintanar, L. (2006). Análisis Neuropsicológico de los problemas de aprendizaje en adolescentes*. Revista de Ciencias Clínicas, 7*(2), 55-63

Solovieva, Y., Bonilla, M., & Quintanar, L. (2014*).* Corrección neuropsicológica de problemas de aprendizaje en la adolescencia. In M. Pérez, A. Escotto, J. Arango, & L. Quintanar, *Rehabilitación neuropsicológica. Estrategias en trastornos de la infancia y del adulto* (pp. 77-96). Manual Moderno.

Solovieva, Y., Bonilla, M., & Rojas, L. (2018). Neuropsychological Assessment of Adolescents with Learning Disabilities. *Journal of Education, Society and Behavioural Science, 26*(4), https://doi.org/10.9734/JESBS/2018/43737

Solovieva. Y., & Quintanar L. (2014). *Enseñanza de la lectura. Método práctico para la formación lectora.* Trillas

Solovieva, Y., & Quintanar, L. (2018). *Evaluación de la actividad intelectual para adolescentes y adultos (Evaluación del éxito escolar)*. Benemérita Universidad Autónoma de Puebla.

Suárez, D., & Quijano M. (2014). Comprensión de las dificultades de la lectoescritura desde las escuelas neuropsicológicas cognitiva e histórico-cultural. *Enseñanza e Investigación en Psicología, 19*(1), 55-75. https://www.redalyc.org/articulo.oa?id=29232614004.

Venguer, L. A., & Ibatullina, A. A. (2010). La correlación entre la enseñanza, el desarrollo psicológico y las particularidades funcionales de la maduración cerebral. In Y. Solovieva, & L. Quintanar (Eds.), *Antología del desarrollo psicológico del niño en edad preescolar* (pp. 40-45). Trillas.

Verdine, B., Irwin, C., Michnick, R., & Hirsh-Pasek, K. (2014). Contributions of executive function and spatial skills to preschool mathematics achievement. *Journal of Experimental Child Psychology*, 126, 37-51. https://doi.org/10.1016/j.jecp.2014.02.012

Vigotsky, L. S. (1992*). Obras escogidas*. Tomo II. Visor.

Zimmerman, B. (1990). Self-Regulated Learning and Academic Achievement: An Overview. *Educational Psychologist, 25*(1), 3-17. https://doi.org/10.1207/s15326985ep2501_2