https://doi.org/10.23925/2176-2724.2021v33i2p315-321

Speed and legibility of manual writing among dyslexic children in copy tasks

A velocidade e legibilidade da escrita manual de disléxicos em tarefas de cópia

La velocidad y legibilidad de la escritura manual de disléxicos en tareas de copia

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Abstract

Objective: to compare speed and legibility of handwriting in two copy tasks of a group of dyslexic children against students with good academic performance. **Methods:** 64 children participated, and of these, 7 were dyslexic (GI) from a specialized rehabilitation center, aged between 9 years and 13 years and 1 month. The remaining 57 students presented good academic performance (GII). These were paired with GI. For the procedure, two copy tasks were used from the Detailed Assessment of Speed of Handwriting (DASH), denominated Best copy and Quick copy of a sentence. Both tasks consist of writing a sentence in the best handwriting for two minutes. Parameters considered were the number of words written, the number of legible words written and the number of illegible words. **Results:** The dyslexic children performed less well than schoolchildren with good academic performance in both tasks. In Task 1, they presented a lower number of readable words / minute (GI - 7.79; GII - 12.72) and a higher number of illegible words / minute (GI - 1.64; GII - 0.04). In Task 3, GI presented 7.64 rwmp and 4.29 iwpm, while GII presented 16.39 rwpm and 0.07 iwpm. It is possible to add that the dyslexic children lost the quality of writing, presenting higher rates of IWPM in Task 03, when compared to Task 01. **Conclusion:** Through this study it was possible to confirm the hypothesis that the performance in speed and legibility of the writing of dyslexic children is inferior to that of students with good academic performance.

Keywords: Dyslexia; Handwriting; Child Development; Learning; Students.

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Authors'contributions
NLS: Study design; Data collection.
MHC: Guidance; Article outline.
SAC: Guidance; Methodology; Critical review.

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Received: 12/10/2020
Accepted: 03/05/2021

Resumo

Objetivo: comparar a velocidade e a legibilidade da escrita manual de escolares disléxicos e com bom desempenho acadêmico em duas tarefas de cópia. **Métodos:** Participaram 64 sujeitos, sendo 7 disléxicos provenientes de um centro especializado em reabilitação, com idade entre 9 anos e 13 anos e 1 mês (GI), e 57 sujeitos com bom desempenho acadêmico (GII), pareados com GI. Como procedimento, foram utilizadas duas tarefas de cópia do Detailed Assessment of Speed of Handwriting (DASH), denominadas de Melhor Cópia e Cópia Rápida de uma frase. Ambas as tarefas consistem em escrever uma frase com a melhor caligrafia durante dois minutos. Foram consideradas a quantidade de palavras escritas, quantidade de palavras legíveis escritas e quantidade de palavras ilegíveis escritas. **Resultados:** Os resultados revelaram que os disléxicos apresentaram desempenho inferior aos escolares com bom desempenho acadêmico nas duas tarefas solicitadas. Na Tarefa 1 apresentaram uma quantidade inferior de palavras legíveis/minuto (GI – 7,79; GII – 12,72) e quantidade superior de palavras ilegíveis/minuto (GI – 1,64; GII – 0,04). Já na Tarefa 3, GI apresentou 7,64 PLPM e 4,29 PIPM, enquanto GII apresentou 16,39 PLPM e 0,07 PIPM. É possível acrescentar que os disléxicos perderam a qualidade da escrita, apresentando índices maiores de PIPM na Tarefa 3, quando comparados na Tarefa 1. **Conclusão:** Por meio deste estudo foi possível confirmar a hipótese de que o desempenho em velocidade e legibilidade da escrita de disléxicos é inferior ao dos escolares com bom desempenho acadêmico.

Palavras-chave: Dislexia; Escrita Manual; Desenvolvimento Infantil; Aprendizagem; Estudantes.

Resumen

Objetivo: comparar la velocidad y la legibilidad de la escritura manual de estudiantes disléxicos y con buen desempeño académico en dos tareas de copia. **Métodos:** Han participado 64 sujetos, siendo 07 disléxicos provenientes de un centro especializado en rehabilitación, con edad entre 9 años y 13 años y 1 mes (GI), y 57 sujetos con buen desempeño académico (GII), emparejados con GI. Como procedimiento, han sido utilizadas dos tareas de copia del Detailed Assessment of Speed of Handwriting (DASH), denominadas de Mejor copia y Copia rápida de una oración. Ambas tareas consisten en escribir una oración con la mejor caligrafía durante dos minutos. Ha sido considerado la cantidad de palabras escritas, cantidad de palabras legibles escritas y cantidad de palabras ilegibles escritas. **Resultados:** Los resultados mostraron que los disléxicos han presentado desempeño inferior a los estudiantes con buen desempeño académico en las dos tareas solicitadas. En la Tarea 1 han presentado una cantidad inferior de palabras legibles/minuto (GI- 7,79; GII - 12,72) y cantidad superior de palabras ilegibles/minuto (GI- 1,64; GII - 0,04). En la Tarea 3, GI ha presentado 7,64plmp y 4,29pipm, mientras GII ha presentado 16,39plpm y 0,07pipm. Es posible añadir que los disléxicos han perdido la calidad de la escritura, presentando índices mayores de PIPM en la Tarea 03, cuando se compara en la Tarea 01. **Conclusión:** A través de este estudio ha sido posible confirmar la hipótesis de que el desempeño en velocidad y legibilidad de la escritura de disléxicos es inferior al de los estudiantes con buen desempeño académico.

Palabras clave: Dislexia; Escritura Manual; Desarrollo Infantil; Aprendizaje; Estudiantes.

Introduction

Handwriting is considered a functional task used for the communication and recoding of thoughts and experiences[1]. It is not an isolated motor act; on the contrary, it is a complex skill that requires formal training beginning in the early school years[2]. To be developed properly, continuous interactions between the perceptual-visual-motor processes and the cognitive processes are necessary [3]. The former consists of visual perception, coordination fine motor and visual-motor integration; while the latter can be divided into more generic processes, such as cognitive planning, working memory processes, and more specific linguistic processes, such as phonological and orthographic coding [4].

From the moment a child starts to read, he or she begins to recognize the letters in isolation and understands that these letters register content and is

then, able to learn to register the forms of the letter [5]. However, for the student to be able to produce the shapes of the letters precisely, fine motor control, visual-motor integration, motor planning, proprioception, visual perception, sustained attention and sensory awareness of the fingers are necessary [6, 7].

Difficulties regarding handwriting competence at school have far-reaching negative effects on children's academic success and self-esteem[8], which causes them to avoid writing-related activities, and this attitude, is considered, in the eyes of parents and teachers, to be an oppositional behavior, thus generating conflicts at home and at school [9]. It is estimated that the prevalence of difficulties in handwriting varies between 10% and 30% [8, 10, 11], these being manifested as illegible handwriting, slow writing speed, reports of pain or discomfort during the activity and without any intellectual or somatic pathology [12].

Although difficulties in handwriting skills are not yet considered to be a diagnostic criterion for a neurodevelopmental disorder [13], there is a prevalence of impairments relating to this ability in dyslexia when compared to other learning disorders [6].

Dyslexia is characterized as difficulties in decoding isolated words, usually reflecting insufficient phonological processing, unexpected in relation to age and other cognitive and academic skills, being able to interpret a heard text [14]. According to Lyon, Shaywitz, Shaywitz [15], it is manifested by varied linguistic difficulties, including reading impairment, problems with the acquisition of writing proficiency and poor spelling.

According to DSM-5[16] the term Dyslexia is used to refer to a pattern of learning difficulties characterized by problems with accuracy or fluency in recognizing words, together with poor decoding and spelling skills.

Studies suggest that reading and writing may be indirectly interrelated [17, 18], and may have underlying links with other cognitive skills, such as orthographic perception and motor planning. However, research with dyslexic persons focused more on reading problems[19] and associated the difficulties of writing with phonological deficits [20, 21], while neglecting their handwriting problems [22].

Although studies can be found in the international literature [6, 19, 23] that investigate the handwriting and writing speed of dyslexic people, in Brazil there are no publications on this theme. With this in mind, this study aims to compare the handwriting speed and legibility of dyslexic students compared to their peers with good academic performance in two copy tasks.

This study proposes to be based on the hypothesis that the performance in speed and legibility of the handwriting of dyslexic students could be lower than that of students with good academic performance.

Method

Characterization of the subjects

Students diagnosed with dyslexia were selected by convenience, that is, they were recruited from the Specialized Center for Rehabilitation – CER II / UNESP / FFC, located in a city in the countryside of the State of São Paulo, and who underwent the multidisciplinary diagnostic process (including speech, neurological and neuropsychological evaluation) in the first semester of 2017. These students were not submitted to any speech therapy or psychoeducational intervention session.

During the period, 7 dyslexic schoolchildren, of both genders and aged between 9 years and 13 years and 1 month old, participated in the research, which comprised group I (GI) of this study. Group II (GII) was selected from a bank of writing samples from 57 students with good academic performance, of both genders and aged between 9 years and 13 years and 1 month. The selected students were paired according to gender and age group with the students of GI, so that the distribution was 11% of the studied population with dyslexia, that is, neither the minimum nor the maximum prevalence of dyslexia, but an intermediate prevalence for diagnosis. Thus, the study population comprised a total of 64 students.

As criteria for inclusion in the research, students should not have annotations in their school records regarding hearing, visual, motor and / or intellectual disabilities and they could not present any intervention (clinical and / or pedagogical) in their history with a focus on calligraphy. In accordance with the resolution of the National Health Council CNS 196/96, prior to beginning the activities to be carried out, the parents or guardians of the selected students signed the Term of Informed Consent to authorize the study and those students who were aged 12 years or older also signed the consent form. Failure to meet at least one of the

above criteria automatically excluded the student from the study sample.

Description of the procedure used

To carry out this study, we used the instrument Detailed Assessment of Speed of Handwriting (DASH) [24], in the version translated and adapted to Brazilian Portuguese [25, 26].

The procedure consists of five tasks to be administered during a period of 30 minutes, four of which are written tasks and one is a measure of perceptual-motor competence. However, to answer the objective of this study, in the present work, only the data related to the two copying tasks of the instrument will be presented.

Data collection with students was performed individually and in a single session, in which two copy tasks proposed by DASH were applied, as described below:

- **Task 1 – Best copy**: copy a sentence (classified as pangram) with your best handwriting, for two minutes;
- **Task 3 – Fast copy of a sentence**: copy the same sentence from the first task, as quickly as possible, but legibly, for two minutes.

Data analysis regarding legibility

The researchers read each word written by the student only once and should categorize them as LEGIBLE or ILLEGIBLE. It is worth mentioning that, in the original version of DASH, both in the translation and in the adaptation to Brazilian Portuguese, there are no criteria for considering readability beyond what has already been described in this work. If the researchers understood the written word during the first reading, they should classify it as "legible"; if they didn't understand, they shouldn't insist on re-reading or, even, they shouldn't "try" to understand by the context of the sentence, classifying the word as "illegible". At the end of the trial, the number of legible words and illegible words written by each student in the proposed tasks were counted.

Calculation of handwriting speed

The handwriting speed was calculated by taking into account the quantity of legible and illegible words written per minute, which will be presented hereafter as LWPM (legible words per minute) and IWPM (illegible words per minute). For example, a student that presented a total of 100 words written in task 1 (Best copy), judged his writing sample and evidenced 70 legible words and 30 illegible words. As the task lasts two minutes, the calculations performed are described in Chart 1.

Chart 1. Example of how to calculate the writing speed

LWPM	IWPM
$= \frac{70}{2}$	$= \frac{30}{2}$
= 35 legible words per minute	= 15 illegible words per minute

(ANOVA test = 0.05). LWPM: Legible words per minute; IWPM: Illegible words per minute

Data analysis

The data were analyzed statistically by the SPSS software, version 20, using the ANOVA test (Analysis of variance), which consists of a parametric test that compares means using the variance. A significance level of 0.05 (5%) was defined, that is, all confidence intervals constructed over the course of the work were calculated with 95% statistical confidence.

Results

The results showed statistically significant differences in the comparison between dyslexic and typical students, demonstrating that dyslexic students, when asked to perform their best handwriting during a copy task, Task 01 of DASH, underperform those of students with good academic performance; in that they presented a lower number of LWPM and a higher number of IWPM (Table 1).

Table 1. Comparison between the dyslexic and typical school children in Task 1 of the DASH.

Task 1		Mean	Median	SD	n	CI	p Value
LWPM	Dyslexic	7.79	8	3.57	7	2.64	0.023*
	Typical	12.72	11.5	5.43	57	1.41	
IWPM	Dyslexic	1.64	1.5	1.77	7	1.31	<0.001*
	Typical	0.04	0	0.26	57	0.07	

(ANOVA test = 0.05). LWPM = Legible words per minute; IWPM = Illegible words per minute; n = number of students; CI = Confidence interval

By asking students to write as quickly as possible, but not to lose the quality of handwriting, Task 03 of DASH, it was possible to verify that, once again, the performance of dyslexic students differed from typical students, since they presented lower LWPM and higher IWPM (Table 2).

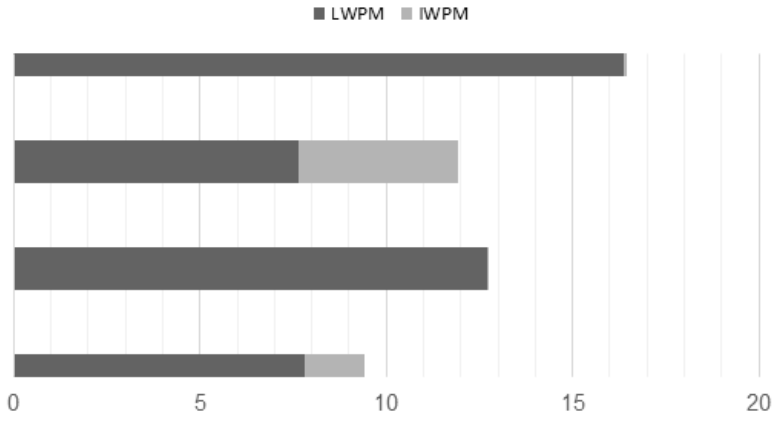
Table 2. Comparison between the dyslexic and typical school children in Task 3 of the DASH.

Task 3		Mean	Median	SD	n	CI	p Value
LWPM	Dyslexic	7.64	7.5	2.14	7	1.58	<0.001*
	Typical	16.39	16	5.47	57	1.42	
IWPM	Dyslexic	4.29	2.5	3.47	7	2.57	<0.001*
	Typical	0.07	0	0.31	57	0.08	

(ANOVA test = 0.05). LWPM = Legible words per minute; IWPM = Illegible words per minute; n = number of students; CI = Confidence interval

Graph 1 shows that, in the two proposed tasks, the writing speed of typical students was higher than that of dyslexic students and both were able to increase their writing speed when comparing their performance in Task 01 against Task 03. However, the dyslexic students showed a loss in the quality of handwriting, presenting higher IWPM rates in the Fast copy of a sentence, Task 03 of DASH, when compared to the Best copy, Task 01 of DASH.

Graph 1. Comparison between the dyslexic and typical schoolchildren in Tasks 1 and 3 of the DASH.



(ANOVA test = 0.05). LWPM = Legible words per minute; IWPM = Illegible words per minute; n = number of students; CI = Confidence interval

Discussion

From the objective of this study, to compare the speed and legibility of handwriting of dyslexic students against students with good academic performance, in two copy tasks, it can be observed that dyslexic students present slower and inferior writing quality than students with good academic performance. These findings corroborate the literature [13, 27], which reports that Chinese children showed inferior performance in their speed and precision of handwriting when compared to typical Chinese students.

When asked that students write faster, but without losing quality, it was possible to verify that students with good academic performance successfully accomplished the proposal. Dyslexic students, on the other hand, presented more illegible words, denoting loss in the quality of handwriting. According to international studies [2, 22, 28], the rate of production of writing by dyslexic students is slower than that of students without learning difficulties, that is, dyslexic students produce fewer words per minute.

These differences in performance between schoolchildren in the two groups can be justified by difficulties in fine motor control, motor coordination, balance, visual perception, visuospatial orientation, visual memory and visual-motor integration that dyslexic children may present [8, 13, 29], since such difficulties can affect the readability and variation in the writing speed of these students. According to Nicolson, Fawcett [30] ,the neuropsychological dysfunction present in dyslexic individuals would be a hypothesis to justify motor deficits and, therefore, would be an explanation for the co-occurrence between dysgraphia and dyslexia.

However, it should be noted here that students presenting dysgraphia are commonly identified, either by the school system or by health professionals, and should therefore receive strategies for rehabilitation of handwriting, while dyslexic children do not undergo any type of practical intervention with calligraphy [22], since the professionals focus on the other difficulties of these students, such as reading and spelling, leaving aside research and intervention directed to the handwriting of dyslexic students.

Conclusion

Through this study it was possible to confirm the hypothesis that the performance in speed and legibility of the writing of Brazilian dyslexic children is inferior to that of students with good academic performance.

Justifications regarding motor skills, visual, perceptual, attentional, memory and access to linguistic codes were raised; however, further studies are needed to investigate the correlation of these skills with handwriting in order to achieve a better understanding of how these underlying factors can interfere and reflect on the quality of handwriting.

It is considered that performing these new studies may contribute to the understanding of health and education professionals regarding the individual differences in the processes related to the learning of calligraphy in each group, thus making it possible to better define intervention programs and thereby reduce the difficulties experienced by dyslexic students in the classroom.

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