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# Identification and characterization of dysgraphia in students with learning difficulties and learning disorders

## Identificação e caracterização da disgrafia em escolares com dificuldades e transtornos de aprendizagem

## Identificación y caracterización de disgrafía en estudiantes con dificultades y trastornos de aprendizaje

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### Abstract

**Objective:** <sup>1</sup> identify the presence of dysgraphia in students with learning difficulties and learning disorders; <sup>2</sup> describe the calligraphic amendments in each group and <sup>3</sup> compare the groups in order to verify differences from each other. **Methods:** 57 students participated, both genders, aged from 08 to 11 years, from 2nd to 6th school year, divided into three groups (19 students each), as follows: (GI) learning difficulties; (GII) learning disorders; (GIII) good academic performance. As procedure, we requested a copy of a message and the writing was analyzed by Dysgraphia Scale, being considered as dysgraphic all the students who obtained a grade equal to, or greater than 8.5 points. **Results:** The results revealed the presence of dysgraphia in 63.2% of GI, 47.4% of GII and 26.3% of GIII; GI presented high scores in Floating Lines, the GII in Floating Lines and Retouched Letters and GIII showed similar performance among the 10 items evaluated; When comparing the groups together it was noted that the performance of GI and GII are similar, differing only when you compare them with GIII, because those have high scores on items Floating lines and Curvatures and Angulation of the arcades of the M, N, V and U. **Conclusion:** calligraphic alterations were evidenced in all three groups, and the students with learning difficulties and learning disorders should be given more attention to items Floating Lines, Retouched Letters and Curvatures and Angulation of the arcades of the M, N, V and U.

**Keywords:** Handwriting; Learning Disorders; Evaluation; Learning; Teaching.

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**Authors' contributions:** MHC lead researcher, development schedule and research, literature review, data collection and analysis, article writing, submission and procedures of the article. SAC advisor, development schedule and research, data analysis, article writing correction, approval of the final version.

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## Resumo

**Objetivos:** <sup>1</sup> Identificar a presença de disgrafia em escolares com dificuldades e transtornos de aprendizagem; <sup>2</sup> descrever as alterações caligráficas presentes em cada grupo e <sup>3</sup> compará-los a fim de verificar se os grupos se diferenciam entre si. **Métodos:** participaram 57 escolares, ambos os gêneros, com idade entre 08 e 11 anos, do 2º ao 6º ano escolar, divididos em três grupos (19 escolares em cada), sendo: (GI) dificuldades de aprendizagem; (GII) transtornos de aprendizagem; (GIII) bom desempenho acadêmico. Como procedimento foi solicitada a cópia de um bilhete, e a escrita foi analisada por meio da Escala de Disgrafia, sendo considerados disgráficos todos os escolares que obtiveram nota igual ou superior a 8,5 pontos. **Resultados:** Os resultados revelaram presença de disgrafia em 63,2% de GI, 47,4% de GII e 26,3% do GIII; o GI apresentou altas pontuações em Linhas Flutuantes, o GII em Linhas Flutuantes e Letras Retocadas e o GIII apresentou desempenho semelhante entre os 10 itens avaliados; ao comparar os grupos notou-se que o desempenho de GI e GII é semelhante, diferenciando-se apenas quando comparados com GIII, pois aqueles apresentam altas pontuações nos itens Linhas Flutuantes e Curvaturas e Angulações das arcadas dos M, N, V e U. **Conclusão:** as alterações caligráficas foram evidenciadas nos três grupos estudados, sendo que nos escolares com dificuldades de aprendizagem e transtornos de aprendizagem devem-se dar mais atenção aos itens Linhas Flutuantes, Letras Retocadas e Curvaturas e Angulações das arcadas dos M, N, V e U.

**Palavras-chave:** Escrita Manual; Transtornos de Aprendizagem; Avaliação; Aprendizagem; Ensino.

## Resumen

**Objetivos:** <sup>1</sup> identificar la presencia de digrafía en estudiantes con dificultades y trastornos de aprendizaje; <sup>2</sup> describir alteraciones caligráficas presentes en cada grupo; <sup>3</sup> comparar los grupos para determinar diferencias entre ellos. **Métodos:** Participaron 57 estudiantes, ambos sexos, con edades comprendidas entre 08 a 11 años, del segundo al sexto año de la Educación Primaria, divididos en tres grupos (compuestos por 19 estudiantes), de esta manera: (GI) dificultades de aprendizaje; (GII) Trastornos de aprendizaje; (GIII) estudiantes con buen rendimiento académico. Como procedimiento se solicitó una copia de un billete, y se analizó la escritura por medio de la Escala de Disgrafía, siendo considerados disgráficos todos estudiantes que hayan obtenido una puntuación igual o superior a 8,5 puntos. **Resultados:** Los resultados revelaron presencia de disgrafía en 63,2% de los estudiantes de GI, 47,4% de GII y 26,3% de GIII; GI presentó puntuaciones más altas en líneas flotantes, GII en líneas flotantes y letras retocadas y GIII rendimiento similar entre los 10 ítems evaluados; Al comparar los grupos hubo indicación de que el desempeño de GI y GII es similar, difiriendo sólo en comparación con GIII, debido a que estos grupos tienen puntuación altas en líneas flotantes y curvas y angulación de los arcos de M, N, V y U. **Conclusión:** Se observaron alteraciones en caligrafía en los tres grupos, y en estudiantes con dificultades y trastornos de aprendizaje se debe dar más atención a líneas flotantes, letras retocadas y curvas y angulación de los arcos de M, N, V y U.

**Palabras claves:** Escritura Manual; Trastornos del Aprendizaje; Evaluación; Aprendizaje; Enseñanza.

## Introduction

Writing skill is directly related to most school activities, and according to the literature<sup>1</sup>, 30 to 60% of the school's daily period fine motor tasks are performed, mainly consisting of handwriting activities / calligraphy. It is a sophisticated skill, used to the highest level of human communication, i.e., it plays the role of spreading culture and concepts of humanity<sup>2</sup>. It is characterized as complex<sup>1</sup>, because it simultaneously involves perceptuo-motor skills (planning and implementation of motor action), cognitive and linguistic processes<sup>3</sup>, so writing is therefore, a single context which refines language, literacy and motor skills<sup>4</sup>.

Literature reports that good handwriting requires mainly fine motor control, visual-motor integration, motor planning, proprioception, visual perception, sustained attention and sensory awareness of the fingers<sup>5</sup>, and alterations in one or more of these functions, may cause impairments to the development of writing skills<sup>6-7</sup>.

According to the literature<sup>7</sup>, 10 to 30% of the children have difficulty in developing calligraphy properly, which may cause an academic and psychosocial impact, interfering on personal relationships and self-esteem, and also predictive of learning difficulties<sup>6-9</sup>.

However, when an individual with appropriate intellectual level receives the necessary instructions for learning calligraphy, he/she is subjected to a practicing process during the schooling course and is still unable to produce a legible writing, this difficulty is called dysgraphia<sup>10</sup>.

According to the DSM-5, dysgraphia is defined as a "specific learning disorder with impairment in written expression." This diagnosis requires the presence of a difficulty in relation to writing, persistently at least for six months, at minimum, despite the intervention sessions. These difficulties may impair the individual, resulting into lower written performance than expected for the chronological age, difficulties in school performance or at work and daily life activities, possible to be confirmed by complete clinical evaluation and standardized performance measures<sup>11</sup>.

According to an international study<sup>12</sup>, dysgraphia constitutes a written expression disorder, which results into writing skills lower than expected for the age, related to legibility letter training quality, alignment and spacing of letters

and words, dimensioning of letters) and low speed (production rate)<sup>6-8</sup>.

International<sup>13</sup> and national<sup>6</sup> studies have reported that dysgraphia may be present in school children with and without learning disabilities, learning disorders and dyslexia.

In cases of learning disorders, the school children present the following skills systematically and recurrently altered, such as: identification or decoding of words, pseudowords reading, fluency and reading comprehension, listening comprehension, calculation, mathematical reasoning, spelling, additional vocabulary and oral and written expression<sup>14</sup>, and may present dysgraphia, due to fine motor function alterations, that is, for having difficulties in bimanual coordination, manual dexterity and fine motor skills<sup>15</sup>. Unlike the cases of learning difficulties, which may present these same skills transiently altered and at any period of the teaching-learning process<sup>16</sup>.

Accordingly, either children with disorders as with learning disabilities may present dysgraphia, since it may exist due to intrinsic factors related to the child, such as motor function alteration<sup>6</sup> and extrinsic factors such as, e.g., non-effective calligraphic writing teaching method, rigid instructions at literacy period (involving requirements regarding the quality and writing speed), limited time to writing teaching practice<sup>3,5</sup>, or still, the interaction between these factors<sup>17</sup>.

However, there are not national studies investigating the occurrence of dysgraphia in different learning problems in order to compare whether the calligraphy alterations in students with learning disabilities are similar, or not, to calligraphic alterations in students with learning disorders.

Therefore, the hypothesis of this study is guided regarding the fact that investigating dysgraphia in different learning problems will enable calligraphic alterations knowledge of these school children, providing markers evidence in writing, which may assist on the diagnosis and treatment of handwriting acquisition alterations.

Based on the above, this study aimed the following objectives: <sup>1</sup> identify the presence of dysgraphia in students with difficulties and learning disabilities; <sup>2</sup> describe the calligraphic amendments in each group and <sup>3</sup> compare them to determine whether the groups differ from each other.

## Methods

### Subjects

The study included 57 students of both genders, 40 males (70.2%) and 17 females (29.8%), aged eight years and two months to 11 years and ten months, between from the second to the sixth grades level of public schools in the city of Marília, São Paulo, Brazil. The students were divided into three groups:

- Group I (GI): composed by 19 students with learning disabilities, from municipal public school in Marília-SP, 13 (68.4%) males and 06 (31.6%) females.
- Group II (GII): composed by 19 students with interdisciplinary diagnosis of learning disorders, 14 (73.7%) males and 05 (26.3%) females.
- Group III (GIII): composed by 19 students with good academic performance, 13 (68.4%) males and six (31.6%) females.

The GI and GII consisted of students nominated by the teachers, according to their academic performance in the first two quarters of the school year. They considered students with learning difficulties with poor performance in two consecutive quarters, with score below five in Portuguese and math tests. As for students with good academic performance, those with satisfactory performance in two consecutive quarters, i.e. with grades higher or equal to six. Moreover, these students did not have in their school records, any notes related to hearing, visual, motor or intellectual impairments.

The students of GII performed interdisciplinary diagnosis, consisting of child neurology, neuropsychology<sup>18</sup>, and speech language pathologist assessment, according to criteria defined by the DSM-V<sup>11</sup>, at the Investigation Learning Disabilities Laboratory at the Speech and Hearing Sciences Department – Faculty of Philosophy and Sciences, São Paulo State University - FFC – UNESP –

Marília - São Paulo – Brazil. These students did not present history of previous speech language pathology or educational therapies, and were on the waiting list for speech language therapy at the original institution.

### Methodological procedures

As procedure, the Dysgraphia Scale<sup>19</sup> was employed. The students were instructed to make the copy of a specific message (which was given to each student, individually) in a non-lined sheet, using black pencil n° 2, with enough time for doing it (therefore, writing speed is not assessed).

This instrument, enables in its analysis, verifying ten handwriting aspects, as follows: <sup>1</sup> floating lines, <sup>2</sup> ascending/descending lines, <sup>3</sup> irregular space between words, <sup>4</sup> retouched letters, (5) curvatures and angles of the arches of the letters “m”, “n”, “u” and “v”, <sup>6</sup> junction points <sup>7</sup> collisions and adherences, <sup>8</sup> jerky movements, <sup>9</sup> dimension irregularities <sup>10</sup> bad forms.

Each item of this Scale is scored from 0 to 2 point, when the sum of points is equal or greater than eight and a half points, equivalent to 50% of the total score, writing is considered as dysgraphic<sup>19</sup>.

The results of this study were statistically analyzed using SPSS (Statistical Package for Social Sciences), version 20.0, and the significance level was 5% ( $p = 0.050$ ) indicated by an asterisk (\*).

## Results

From the score obtained by Dysgraphia Scale, it was observed in Table 1, presence of dysgraphia in all three groups comprising this study; however, with the implementation of the Likelihood Ratio Test, there was no statistically significant difference between the groups.

**Table 1.** Distribution of dysgraphia frequency for students of GI, GII and GIII

Group	Frequency		Total
	Dysgraphia	Non-Dysgraphia	
GI	12 63,20%	7 36,80%	19 100,00%
GII	9 47,40%	10 52,60%	19 100,00%
GIII	5 26,30%	14 73,70%	19 100,00%
Total	26 45,60%	31 54,40%	57 100,00%

p = 0,068

Legend: GI: School Difficulty; GII: learning disorder; GIII: good academic performance; (p): significance.

In order to describe the calligraphic amendments in each group of this study, the Friedman Test was applied to check the performance of the groups in the ten items of the Dysgraphia Scale and

it was observed a statistically significant difference when comparing items to one another, on the three groups (table 2).

**Table 2.** Mean distribution and standard deviation regarding the performance of students of GI, GII and GIII in 10 items of the Dysgraphia Scale.

Items of the Dysgraphia Scale	GI			GII			GIII		
	Mean	Standard deviation	Value of p	Mean	Standard deviation	Value of p	Mean	Standard deviation	Value of p
LF	1,37	0,6		1,26	0,73		0,63	0,68	
LD/A	0,63	0,23		0,74	0,35		0,63	0,33	
EI	0,42	0,34		0,58	0,38		0,32	0,3	
LR	1,21	0,79		1,47	0,77		0,89	0,88	
C/A	0,71	0,38	0,001*	0,82	0,34	< 0,001*	0,39	0,39	0,029*
PJ	0,63	0,76		0,74	0,87		0,63	0,83	
CA	1,34	1,11		0,87	1,04		1,45	1,24	
MB	1,05	1,18		0,95	0,91		0,53	0,7	
ID	0,89	0,81		0,47	0,7		0,53	0,77	
MF	0,82	0,3		0,76	0,39		0,71	0,45	

Legend: LF: Floating lines; LDA: Ascending/descending lines; EI: Irregular spaces between words; LR: Retouched Letters; C / A: angles of the arches of the letters "m", "n", "u" and "v"; PJ: Junction points; CA: Collisions and adherences; MB: jerky movements; ID: Dimension irregularities; MF: Bad forms; GI: School Difficulty; GII: learning disorder; GIII: good academic performance. (P = 0.050)

In order to identify which items of Dysgraphia Scale differ when compared one by one, the Wilcoxon Signed Posts Test was apply, adjusted by Bonferroni correction (Table 3).

As shown in Table 3, the students of GI showed statistically significant differences when compared the item *Floating lines* (LF) with items *Ascending/descending lines* (LD / A), *Irregular spaces between words* (EI), *Curvatures and angles of the*

**Table 3.** Distribution of the value of p related to the comparison of the items assessed by the Dysgraphia scale for students, of GI GII and GIII.

Items of the Dysgraphia Scale	GI	GII	GIII	Items of the Dysgraphia Scale	GI	GII	GIII	Items of the Dysgraphia Scale	GI	GII	GIII
LD/A - LF	0,001*	0,006	0,915	ID - LD/A	0,244	0,138	0,436	PJ - C/A	0,681	0,88	0,103
EI - LF	< 0,001*	0,001*	0,048	MF-LD/A	0,02	0,915	0,38	CA - C/A	0,02	0,864	0,004
LR - LF	0,439	0,248	0,259	LR - EI	0,004	< 0,001*	0,018	MB - C/A	0,179	0,513	0,728
C/A - LF	0,001*	0,037	0,21	C/A - EI	0,022	0,038	0,475	ID - C/A	0,336	0,075	0,388
PJ - LF	0,006	0,057	0,963	PJ - EI	0,26	0,271	0,145	MF - C/A	0,206	0,516	0,003
CA - LF	0,87	0,098	0,036	CA - EI	0,005	0,183	0,002	CA - PJ	0,042	0,39	0,048
MB - LF	0,301	0,21	0,72	MB - EI	0,04	0,073	0,28	MB - PJ	0,163	0,248	0,691
ID - LF	0,068	0,004	0,71	ID - EI	0,048	0,56	0,437	ID - PJ	0,369	0,132	0,577
MF - LF	0,001*	0,013	0,522	MF - EI	0,005	0,035	0,007	MF - PJ	0,312	0,952	0,662
EI - LD/A	0,023	0,083	0,005	C/A - LR	0,015	0,007	0,022	MB - CA	0,252	0,924	0,009
LR - LD/A	0,013	0,003	0,26	PJ - LR	0,052	0,01	0,363	ID - CA	0,124	0,06	0,019
C/A - LD/A	0,317	0,47	0,029	CA - LR	0,562	0,014	0,11	MF - CA	0,072	0,937	0,03
PJ - LD/A	0,912	0,852	0,903	MB - LR	0,548	0,032	0,182	ID - MB	0,571	0,021	0,951
CA - LD/A	0,022	> 0,999	0,015	ID - LR	0,163	0,002	0,169	MF - MB	0,352	0,359	0,281
MB - LD/A	0,145	0,385	0,436	MF - LR	0,021	0,002	0,288	MF - ID	0,659	0,083	0,396

(Alpha Bonferroni = 0.001139). **Legend:** LF: Floating lines; LDA: Ascending/descending lines; EI: Irregular spaces between words; LR: Retouched Letters; C / A: *Curvatures and angles of the arches of the letters "m", "n", "u" and "v"*; PJ: Junction points; CA: Collisions and adherences; MB: jerky movements; ID: Dimension irregularities; MF: Bad forms; GI: School Difficulty; GII: learning disorder; GIII: good academic performance.

arches of the letters "m", "n", "u" and "v" (C / A) and Bad Forms (MF) of handwriting, featuring larger number of LF and fewer LD / A, EI, C / A and MF.

GII students showed statistically significant differences when compared the item *Irregular spaces between words* (EI) with items *Floating Lines* (LF) and *Letters Retouched* (LR), featuring more occurrence of items LF and LR, and fewer occurrence of item EI.

As for GIII students, there were no statistically significant differences when compared the items

evaluated one by one, featuring these students performance as similar in the ten items evaluated in the Dysgraphia Scale.

Finally, it was checked the performance of students of GI, GII and GIII, compared to each other on each item evaluated of the Dysgraphia Scale (Table 4). With the Kruskal-Wallis test, it was found statistically significant differences in items *Floating lines* (LF) and *Curvatures and angles of the arches of the letters "m", "n", "u" and "v"* (C / A). For the remaining items, the performances of the students were similar for each group.

**Table 4.** Distribution of the value of p related to the performance comparison of the students of GI, GII and GIII, on each item evaluated of the Dysgraphia Scale.

Items of the Dysgraphia Scale	G	Mean	Dp	Value of p	Items of the Dysgraphia Scale	G	Mean	Dp	Value of p	Items of the Dysgraphia Scale	G	Mean	Dp	Value of p
LF	GI	1,37	0,6	0,004*	C/A	GI	0,71	0,38	0,003*	ID	GI	0,89	0,81	0,17
	GII	1,26	0,73			GII	0,82	0,34			GII	0,47	0,7	
	GIII	0,63	0,68			GIII	0,39	0,39			GIII	0,53	0,77	
LD/A	GI	0,63	0,23	0,333	PJ	GI	0,63	0,76	0,924	MF	GI	0,82	0,3	0,373
	GII	0,74	0,35			GII	0,74	0,87			GII	0,76	0,39	
	GIII	0,63	0,33			GIII	0,63	0,83			GIII	0,71	0,45	
EI	GI	0,42	0,34	0,082	CA	GI	1,34	1,11	0,283	Total	GI	9,03	3,16	0,09
	GII	0,58	0,38			GII	0,87	1,04			GII	8,68	4,12	
	GIII	0,32	0,3			GIII	1,45	1,24			GIII	6,71	2,53	
LR	GI	1,21	0,79	0,102	MB	GI	1,05	1,18	0,269		GI	0,95	0,91	
	GII	1,47	0,77			GII	0,95	0,91			GII	0,95	0,91	
	GIII	0,89	0,88			GIII	0,53	0,7			GIII	0,53	0,7	

**Legend:** LF: Floating lines; LDA: Ascending/descending lines; EI: Irregular spaces between words; LR: Retouched Letters; C / A: *Curvatures and angles of the arches of the letters "m", "n", "u" and "v"*; PJ: Junction points; CA: Collisions and adherences; MB: jerky movements; ID: Dimension irregularities; MF: Bad forms. GI: School Difficulty; GII: learning disorder; GIII: good academic performance. (p = 0.050)

Given these findings, the Mann-Whitney Test was applied, and adjusted by Bonferroni correction, in order to identify which groups distinguished from each other when compared one by one, on the items *Floating Lines* (LF) and *Curvatures and*

*Angulations* of the arcs of M, N, V and U (C / A). It was observed that GI and GII performed similarly, only presenting differences when compared with GIII (Table 5).

**Table 5.** Distribution of the value of p related to one by one comparison, of the students of GI, GII and GIII, on items *Floating Lines* (LF) and *Curvatures and angles of the arches of the letters "m", "n", "u" and "v" (C / A)* of the Dysgraphia scale.

Item	Groups		
	GI X GII	GI X GIII	GII X GIII
LF	0,723	0,002*	0,012*
C/A	0,33	0,018	0,002*

(alpha de Bonferroni = 0,016952).

**Legend:** LF: *Floating Lines*; C / A: *Curvatures and angles of the arches of the letters "m", "n", "u" and "v"*; GI: School Difficulty; GII: learning disorder; GIII: good academic performance.

These findings demonstrated that, during the handwriting assessment, students with learning difficulties presented higher occurrences on item LF, while students with learning disorders had higher occurrence on item LF in relation to C / A, when compared with good academic performance students.

## Discussion

In response to the first objective of this study (identify the presence of dysgraphia in different groups, it was observed that 63.2% of the GI students (learning difficulties), 47.4% of GII (learning disorder) and 26, 3% of GIII (good academic performance) presented dysgraphia.

The literature<sup>6</sup> showed that high incidence of dysgraphia in students with difficulties and learning disorders can be justified by fine motor function, sensory and perceptual alterations, present in these situations, since they are abilities directly responsible for alterations in writing skills. Alterations at any level of motor function, sensory from sensorial information capture, processing and sequencing, to the motor act itself, lead to bad forms of writing, known as dysgraphia<sup>6</sup>.

However, when comparing the groups with one another, there was no statistically significant difference, which is a possible limitation of this study. Thus, it becomes necessary to associate the investigation concerning difficulty in writing with fine motor function, sensory and perceptual

checkings of these students, in order to establish a comparison based on the source of dysgraphia.

With 26.3% of students from GIII presenting dysgraphia, it was observed that this information is in accordance with the national<sup>6</sup> and international<sup>20</sup>, literature which reported that ten to 34% of school children fail to develop and efficient writing performance. This finding is justified by the lack of investment in school activities involving fine motor function, perceptual visual and written activities<sup>21</sup>. When the school does not employ the perceptual-visuomotor skills related to writing, writing quality will be impaired. Thus, dysgraphia diagnosis is difficult to be recognized, since the origin of the manifestations presented by the student may not be evidenced by the deficit in perceptual and visual-motor integration, but for not dominating the delicate visual muscular control, necessary for writing production.

As the presence of dysgraphia was found in the three groups, it enabled responding the second objective (describe calligraphic amendments present in each group), and, in this study, the students of GI showed high scores for the item *Floating Lines* (LF) compared to the low score on items *Ascending/descending lines* (LD / A), *Irregular spaces between words* (EI), *Curvatures and angles of the arches of the letters "m", "n", "u" and "v" (C/A)* and *Bad forms* (MF) of handwriting. GII students presented high scores for items *Floating Lines* (LF) and *Retouched Letters* (LR) compared to low scores on the item *Irregular spaces between*

words (EI). Yet, students from GIII showed similar performance during the comparison of the ten items evaluated in the Dysgraphia Scale.

Based on these findings, in general, it becomes possible to state that the students of GI and GII showed higher occurrence of the items *Floating Lines* (LF) and *Retouched Letters* (LR), which can be justified by the difficulty these students presented, not being able to follow the space restrictions and the inconsistency of their writing<sup>22</sup>, i.e., due to the difficulty in understanding the differences, to coordinate the parties as a whole, spatial movement and distinguish sizes of the letters<sup>23</sup>.

Answering the third objective (comparing groups to check if they differ from one another), it was observed that the students from GI and GII presented occurrence close to the items evaluated by the Dysgraphia Scale. This performance may be related to the increased vulnerability of neural work (responsible for information sensorimotor integration), found in students who presented disorder in motor coordination development and learning difficulty<sup>6</sup>.

Fine motor function, i.e., the ability to control a group motion activities of certain segments of the body, with minimal force use, in order to achieve a precise answer to the task, constitutes one of the motor actions which require higher integration level and proper functioning of the central nervous system, muscles, joints and tendons<sup>(24,9)</sup>. The literature suggests that alterations related to this motor function, can cause failures in writing skills development<sup>7</sup>, and may influence both the quality and quantity of learning in the classroom, affecting motivation and self-esteem of the student<sup>9</sup>.

Comparing performance between GI and GII, it was observed a higher occurrence of the item *Floating Lines* (LF) in students with learning disabilities in opposition to lower occurrence of this item for those with good performance. Among GII and GIII it was observed greater occurrence of items *Floating Lines* (LF) and *Curvatures and angles of the arches of the letters "m", "n", "u" and "v" (C/A)* for students with learning disorder, as opposed to the lower occurrence of these items for those with good academic performance.

According to the international literature<sup>(25,26)</sup>, performance in visuospatial abilities of children with learning disabilities is inferior to the students with good academic performance. The alterations of these skills, associated with organizational skills

and difficulties in executive functions, impair writing skills<sup>27</sup>.

By realizing this study, it was possible to identify markers in the participants' handwriting. Students with learning difficulties presented a higher occurrence of *Floating Lines* (LF) and lower incidence of *Ascending/descending lines* (LD/A), *Irregular spaces between words* (EI), *Curvatures and angles of the arches of the letters "m", "n", "u" and "v" (C/A)* and *Bad Forms* (MF) of letter. In turn, those with learning disorders had higher occurrence of *Floating Lines* (LF), *Curvatures and angles of the arches of the letters "m", "n", "u" and "v" (C/A)* and *Retouched Letters* (LR) and low occurrence for *Irregular Spaces* between words (EI);

However, lack of investments of schools for working with handwriting can not only hinder early identification, but also provide a false diagnosis, because the assessment of writing quality is an important criterion for diagnosing of dysgraphia<sup>3</sup>.

Therefore, it becomes necessary, since preschool, the performance of activities encouraging the habit of writing, also learning the mechanical meaning of writing<sup>28</sup>, for example: how to hold the pencil, the formation of the individual letter, how to gather the letters gently and and fluently<sup>29</sup>, jointly with activities covering fine motor movements and visual processing<sup>30</sup>. In that sense, the school environment will play a preventive and active role in the classroom, in order to minimize the negative impacts which the perceptual-visuomotor alterations may result to the student academic life.

## Conclusion

With the findings of this study it was concluded that dysgraphia may be present in students with learning disabilities and with learning disorders, as in students with good academic performance, since it was found that 63.2% of the students with learning difficulties presented dysgraphia, with highest occurrence for *Floating Lines* (LF) in handwriting; 47.4% of the students with learning disorders presented dysgraphia, showing higher incidence of *Floating Lines* (LF) and *Retouched Letters* (LR) in handwriting; and 26.3% of the students with good academic performance presented dysgraphia, though the performance of these students was similar in the ten items evaluated on the Dysgraphia Scale, that is, none of them excelled.



Comparing the groups of this study, it was observed that the students of GI (learning difficulties) and GII (learning disorders) showed similarities in occurrence of all the items of the Dysgraphia Scale. GI students showed higher occurrence of the items *Floating Lines* (LF) when compared to GIII. The GII students presented higher occurrence of items *Floating Lines* (LF) and *Curvatures and angles of the arches of the letters “m”, “n”, “u” and “v”* (C/A) when compared to GIII.

In general, the hypothesis of this study was confirmed, and the data obtained confirm the efficacy of the employment of the Dysgraphia Scale for identifying markers which characterize writing dysgraphia in students with difficulties and learning disorders.

## References

1. Chang S-H, Yu N-Y. The effect of computer-assisted therapeutic practice for children with handwriting deficit: A comparison with the effect of the traditional sensorimotor approach. *Res Dev Disabil.* 2014; 357: 1648-57.
2. Planton S, Jucla M, Roux F-E, Demonet J-F. The “handwriting brain”: A meta-analysis of neuroimaging studies of motor versus orthographic processes. *Cortex.* 2013; 4910: 2772-87. doi: <http://dx.doi.org/10.1016/j.cortex.2013.05.011>
3. Overvelde A, Hulstijn W. Handwriting development in grade 2 and grade 3 primary school children with normal, at risk, or dysgraphic characteristics. *Res Dev Disabil.* 2011; 32: 540-8.
4. Bindman SW, Skibbe LE, Hindman AH, Aram D, Morrison FJ. Parental writing support and preschoolers' early literacy, language, and fine motor skills. *Early Child Res Q* 2014; 294: 614-24.
5. Martins MRI, Bastos JA, Cecato AT, Araujo MLS, Magro RR, Alaminos V. Screening for motor dysgraphia in public schools. *J. Pediatr. (Rio J).* 2013; 89:70-4.
6. Okuda PMM, Pinheiro FH, Germano GD, Padula NAMR, Lourencetti MD, Santos LCA, Capellini S A. Função motora fina, sensorial e perceptiva de escolares com transtorno do déficit de atenção com hiperatividade. *J. Soc. Bras. Fonoaudiol.* 2011; 234: 351-7.
7. Feder KP, Majnemer A. Handwriting development, competency, and intervention. *Dev Med Child Neurol.* 2007; 494: 312-7.
8. Shen I-H, Lee T-Y, Chen C-L. Handwriting performance and underlying factors in children with Attention Deficit Hyperactivity Disorder. *Res Dev Disabil.* 2012; 33: 1301-9.
9. Fukuda MT, Okuda PM. Avaliação e intervenção na disgrafia. In: Capellini SA, Germano GD, Cunha VL. (Orgs). *Transtornos de aprendizagem e transtornos da atenção: da avaliação à intervenção.* São José dos Campos: Pulso Editorial; 2010. p. 91-103.
10. Rosenblum S, Aloni T, Josman EN. Relationships between handwriting performance and organizational abilities among children with and without dysgraphia: A preliminary study. *Res Dev Disabil.* 2010; 31: 502-9.
11. American Psychiatric Association. *Manual Diagnóstico e Estatístico de Transtornos Mentais.* 5ª Edição. Porto Alegre, RS: Artmed; 2014.
12. Nicolson RI, Fawcett AJ. Dyslexia, dysgraphia, procedural learning and the cerebellum. *Cortex.* 2011; 47: 117-27.
13. Sumner E, Connelly V, Barnett A. Children with dyslexia are slow writers because they pause more often and not because they are slow at handwriting execution. *Read Writ.* 2012; 266: 991-1008. doi: <http://dx.doi.org/10.1007/s11145-012-9403-6>
14. Oliveira AM, Cardoso MH, Capellini S A. Caracterização dos processos de leitura em escolares com dislexia e distúrbio de aprendizagem. *J. Soc. Bras. Fonoaudiol.* 2012; 172: 201-7.
15. Crawford SG, Dewey D. Co-occurring disorders: a possible key to visual perceptual deficits in children with developmental coordination disorder? *Hum Movement Sci.* 2008; 271: 154-69.
16. Capellini SA, Butarelli AP, Germano GD. Dificuldades de aprendizagem da escrita em escolares de 1ª a 4ª séries do ensino público. *Rev. Educ. Quest.* 2010; 3723: 146-64.
17. Vinter A, Chartrel, E. Effects of different types of learning on handwriting movements in young children. *Learn Instr.* 2010; 20: 476-86.
18. Raven JC, Raven J, Court JH. *Matrizes Progressivas Coloridas de Raven.* Manual. São Paulo: Casa do Psicólogo. 1988.
19. Lorenzini MV. Uma escala para detectar a disgrafia baseada na escala de Ajuriaguerra. [Dissertação de mestrado não publicada]. São Carlos: Universidade Federal de São Carlos; 2003.
20. Rosenblum S, Weiss PL, Parush S. Handwriting evaluation for developmental dysgraphia: Process versus product. *Read Writ: An interdisciplinary J.* 2004; 17: 433-58.
21. Conlon EG, Sanders MA, Wright CM. Relationships between global motion and global form processing, practice, cognitive and visual processing in adults with dyslexia or visual discomfort. *Neuropsychologia.* 2009; 473: 907-15.
22. Smits-Engelsman BCM, Van Galen GP. Dysgraphia in children: Lasting psychomotor deficiency or transient developmental delay? *J Exp Child Psychol.* 1997; 672: 164-84.
23. Galli M, Vimercati SL, Stella G, Caiazzo G, Norveti F, Onnis F, et al. A new approach for the quantitative evaluation of drawings in children with learning disabilities. *Res Dev Disabil.* 2011; 32: 1004-10.
24. Danna J, Enderli F, Athènes S, Zanone PG. Motor coordination dynamics underlying graphic motion in 7- to 11-year-old children. *J Exp Child Psychol.* 2012; 111: 37-51.
25. Cermak S, Murray EA. The Validity of constructional subtests of the Sensory Integration and Praxis Tests. *Am J Occup Ther.* 1991; 45: 539-43.
26. Hamlet-Mundlak G. The effect of Rey program on constructional abilities in children with and without learning disabilities. [Unpublished master's thesis]. Boston: Boston University; 1994.
27. Tseng MH, Cermak SH. The influence of ergonomic factors and perceptual-motor abilities on handwriting performance. *Am J Occup Ther.* 1993; 47: 919-26.



28. Erdogan T, Erdogan O. An analysis of the legibility of cursive handwriting of prospective primary school teachers. *Procedia Soc. Behav. Sci.* 2012; 46: 5214 – 8.
29. Mccarney D, Peters L, Jackson S, Thomas M, Kirby A. Does Poor Handwriting Conceal Literacy Potential in Primary School Children?. *Int J Disabil Dev Educ.* 2013; 602: 105-18. Doi:10.1080/1034912X.2013.786561
30. Neumann MM, Hyde MB, Neumann DL, Hood MH, Ford RM. Multisensory methods for early literacy learning. In: Andrews G, Neumann DL. (Eds.). *Beyond the lab: Applications of cognitive research in memory and learning.* Nova Science, Hauppauge: New York; 2012. P. 197–216.