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Influence of the chosen handwriting style on reading and writing skills of second graders

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Título: El impacto del estilo de escritura manual utilizada en habilidades de lectura y escritura en niños de segundo grado de primaria.

Resumen: En la actualidad la literatura no es conclusiva con respecto al rol del estilo de escritura a mano en el desempeño en lecto-escritura de estudiantes de educación primaria. El objetivo de este trabajo fue estudiar el impacto del estilo utilizado por el alumno (letra o grafía imprenta mayúscula, script, o cursiva) en los procesos de transcripción, composición escrita y lectura. Participaron 152 niños de segundo grado de escuelas de nivel socioeconómico medio de la provincia de Buenos Aires, Argentina. Los participantes completaron tareas de dictado de palabras y pseudopalabras, redacción, fluidez en la escritura, grafomotricidad y fluidez lectora. Los resultados mostraron que los estudiantes que utilizaron grafía script escribían mayor cantidad de palabras y oraciones correctas, cometían menor cantidad de errores ortográficos, escribían más letras por minuto y leyeron con mayor fluidez en comparación a quienes utilizaron imprenta mayúscula o cursiva, todos los $p < .045$. La precisión en la escritura de pseudopalabras y los errores fonológicos fueron explicados por el nivel de desarrollo grafomotor, ambos $p < .007$. Los resultados aportan evidencia al debate de qué estilo de escritura a mano es más conveniente utilizar y se discuten en función de su aplicación al ámbito escolar.
Palabras clave: Escritura a mano. Cursiva. Script. Mayúscula. Escritura.

Abstract: Current literature is inconclusive regarding the role of handwriting style in reading and writing performance of primary school students. This study aimed to investigate the impact of the handwriting style used by students (uppercase print, script, cursive) on spelling, use of punctuation and capital letters, richness of composition, and writing and reading fluency. A total of 152 second-grade students from middle socioeconomic level schools in Buenos Aires, Argentina, participated. The students completed word and pseudoword dictation tasks, writing composition, writing fluency, graphomotor skills and reading fluency tasks. Results showed that students who used handwritten script (lowercase print) wrote a greater number of correct words and sentences, made fewer spelling errors, wrote more letters per minute, and read with greater fluency compared to those who used handwriting uppercase print or cursive, all with $p < .045$. Accuracy in pseudowords and phonological errors were explained by graphomotor development, both with $p < .007$. The results provide evidence to the debate on which handwriting style is better to use and are discussed in relation to their application in the school context.
Keywords: Handwriting. Uppercase print. Cursive. Script. Writing.

Introduction

Traditionally, the teaching of writing focused on the practice of transcription, such as calligraphy and spelling (Graham et al., 2008). Over time, teaching approaches with a global focus in Latin America began to emphasize meaningful writing and composition according to textual type, relegating the practice of transcription skills and minimizing the impact that the mastery of handwriting has on the quality of texts (Alves et al., 2016; Graham et al., 2000; Berninger & Amtmann, 2003; Berninger & Swanson, 1994; Jiménez & Barrientos, 2024; Jiménez & Hernández-Cabrera, 2019; Morin et al., 2017; Santangelo & Graham, 2016). However, multiple studies highlight the benefits of practicing transcription skills on writing and reading performance. Transcription is crucial in the productivity and quality of texts, mainly in the first grades where its automation frees up cognitive resources to be assigned to other processes involved in writing (Jiménez & Barrientos, 2024), resulting in improvements in the quality of written productions (Alves et al., 2016; Berninger et al., 1992; Graham, 1990; Graham et al., 2000; Jiménez & Barrientos, 2024; Jiménez & Hernández Cabrera, 2019).

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Currently, in many Latin American countries (e.g., Argentina, Mexico, Peru, Uruguay), writing begins in preschool in uppercase print exclusively and is often maintained until second grade. Then cursive is introduced in a poorly structured way, which generates incorrect motor patterns that are resistant to correction (Simner, 1981) and affects the fluency and consolidation of spelling (Borzone & Yausaz, 2004). The decline in transcription practices has had a negative impact on tracing accuracy and spelling quality, exacerbated by the abandonment of the systematic use of cursive and its replacement by uppercase print (Borzone & Yausaz, 2004; Morin et al., 2017). In addition, the lack of systematic practice has a greater impact on the textual quality of those who have difficulties in graphomotor skills (Pontart et al., 2013).

Although transcription can be trained based on any style of handwriting, since the pioneering work of Gates and Brown (1929) the debate has focused on which facilitates greater fluency, with findings suggesting that *script* (i.e., lowercase print) promotes greater fluency (Bara & Morin., 2013; Berninger et al., 2006; Gates & Brown, 1929; Graham et al., 1998; Morales et al., 2014; Morin et al., 2012), although later studies show opposite results (Borzone & Yasauz, 2004; Semeraro et al., 2019) or null in terms of handwriting styles and instead report greater fluency with mixed styles (Graham et al., 1998). Therefore, it is not clear which handwriting style) would most facilitate the development of writing fluency.

The Writing Process

Writing is a complex skill that requires multiple cognitive factors and processes. Berninger and Swanson (1994) adapted Hayes and Flower's (1980) model of written composition based on adult experts, highlighting the role of transcription in the generation of texts in children who are learning to write. The greater the automation of transcription, the more cognitive resources become available for planning and organizing ideas (Graham et al., 1997). This is also seen in studies that found that in the first grades the length of the essays is shorter and a very slight progress is observed from grade to grade, while a growth curve in writing fluency emerges, indicating that, at first, cognitive resources are primarily devoted to transcription (Alves et al., 2016; Berninger et al., 1992; Graham, 1990; Jiménez & Barrientos, 2024; Jiménez & Hernández Cabrera, 2019; Santangelo & Graham, 2016).

Motor, phonological and orthographic processes are involved in the transcription process. Sánchez Abchi et al. (2009) longitudinally studied a group of children between first and second grade and detected that in initial writing phonological mechanisms are predominant until the end of first grade and persist in second grade where they begin to interact with lexical mechanisms. Similarly, Jiménez et al. (2008) studied the evolution of spelling skills in Spanish children from second to sixth grade and found that up to third grade a greater use of phonological coding is detected. It is only in fourth grade that the incorporation of regulated spelling is observed, both in dictation tasks and in written composition. Unlike what is observed in the upper grades of primary school, in the first grades there is usually a greater association between graphomotor development, writing fluency and spelling accuracy (Jiménez et al., 2008; Jiménez & Hernández Cabrera, 2019).

Handwriting Style and Fluency

Despite the relevance of automating the transcription process at an early age for achieving text writing quality, there are few studies focused on evaluating which style of handwriting facilitates the development of transcription and, consequently, accurate and fluent writing.

Cursive handwriting is characterized by the connected stroke of letters to form words, which theoretically could develop continuity and fluency in writing; while script handwriting, simpler and easier to learn, could facilitate the recognition and reproduction of letters (Morin et al., 2017). Bonneton-Botté et al., (2018) found that, although the concept of trace continuity appears early, the concept of directionality develops progressively and begins to be more efficient only in second grade, although it continues to evolve until fifth grade. Consequently, cursive handwriting places a greater cognitive load than script handwriting, as the strokes are more complex and require greater motor control (Duval, 1985; Thomassen & van Galen, 1992). In addition, it is a challenge in cases of graphomotor difficulty, where maintaining continuity of connections and achieving fluency and readability may take longer or not be adequately achieved (Jolly et al., 2014).

S*cript handwriting* (as a version of the lowercase print) on the other hand, is composed of simple straight and curved lines, in addition to the fact that each letter is written separately which makes it easier to learn (Duval, 1985). This facilitates their recognition and reproduction, particularly in younger children or those with fine motor difficulties (Schwellnus et al., 2012). Furthermore, the fact that the letters are separated (i.e., not linked) allows the child to take time to better plan the next letter and its corresponding phoneme (Meulenbroek & van Galen, 1986).

Both styles of handwriting, cursive and script, have distinct letterforms that vary in size and placement, with nasi ascenders, descenders, and midline letters that allow easier recognition of words in relation to uppercase letters, where the paths are of the same height. On the other hand, *uppercase print* incorporates the same strokes as script, but without differentiating the height of the letters or the rotation (as in the case of b-d-p-q), which may be easier for young children (Morin, et al., 2017) and therefore suggested to be used exclusively (without the lowercase letters).

Research shows that script handwriting facilitates fluency and legibility in the early stages (Gates & Brown 1929). Morales et al. (2014) compared the accuracy and fluency in transcribing the alphabet in cursive and script in children from first to third grade. They found that when using script handwriting, children made fewer omissions of strokes and wrote more fluently as they advanced in grade compared to those who wrote in cursive, where no significant changes were observed. In line with the previous study, Morin et al. (2012), explored the relationship between different handwriting styles and the development of writing skills in second-grade students exposed to cursive-only, script-only, or both simultaneously. They found that writing speed was associated with script handwriting, but cursive handwriting was associated with greater mastery of syntax, although not to the length of what was written. Berninger et al. (2006) in a study comparing cursive, script, and keyboard writing found that script handwriting and keyboard writing were faster than cursive writing in third and fifth graders and that, although fluency increased with age, the difference between handwriting styles remained. In contrast to these authors, Semeraro et al. (2019) studied the impact of explicit and systematic teaching of cursive-only in first-grade children compared to others who learned script and cursive simultaneously and found that those who learned in a single writing style achieved greater writing and reading fluency than those exposed to the simultaneous learning of various handwriting styles. On the other hand, Graham et al. (1998) found no significant differences in speed and legibility between the two pure writing styles (cursive or script). Instead, they found that those who mixed handwriting styles and wrote mostly in script or mostly in cursive were faster than those who used a single

style. However, there is no conclusive evidence to demonstrate that the use of a style guarantees greater fluency, accuracy, and written productivity (Schwellnus et al., 2012).

Impact of Handwriting Style on Reading Performance

The question of what handwriting style should be taught to facilitate the automation of transcription processes could not only impact writing but also indirectly favor reading fluency. The literature shows that handwriting tasks activate specific brain areas that are also involved in reading, suggesting that handwriting practice facilitates the identification of characters for reading (Longcamp et al., 2005). This finding highlights the intrinsic link between writing and reading, although it remains to be investigated whether the use of different handwriting styles in writing leads to an effect of greater fluency in reading. Bara et al. (2016) compared reading efficiency in children exposed to different styles of handwriting and found that those who learned script only or script and cursive simultaneously were more efficient in reading than those exposed to cursive alone, supporting and old finding showing that script is easier to process (Tinker, 1965). Borzone and Yausaz (2004) found that first-grade children who received instruction in reading and writing exclusively in uppercase print, achieved lower reading fluency at the end of the year than those who were taught to read in script and write in cursive.

There is no conclusive evidence on which handwriting style is better to teach and on its impact on writing fluency and composition. Based on the above, it is considered necessary to provide knowledge on whether there is a handwriting style or code (uppercase print vs. script vs. cursive) more convenient for teaching writing.

Based on what has been described, there seems to be a link, although still unclear, between handwriting style and reading and writing. However, research results vary and leave open the debate of whether one handwriting style should be adopted over another. The aim of this study was to explore how the style of handwriting selected freely (i.e., spontaneously) impacted the performance of second-grade students in writing and reading tasks. In particular, the students evaluated were exposed during their literacy instruction to cursive, script and uppercase print and individually chose which style to use in their school activities, which could represent a natural context in which to observe the contrast between those who decide to use one style over another.

The specific goals of this study were to explore the impact of the different styles chosen on: a) orthographic consolidation; b) phonological precision; c) fluency in writing; (d) composition quality; e) reading fluency. Additionally, as a control, the impact of graphomotor skills and gender on the investigated variables was taken into account.

Method

Participants

An incidental sample of 152 second-grade children (58.6% female; mean age = 7.1 years, *SD* = .44) from middle socioeconomic background, attending two private schools in Buenos Aires Province, was included. The participating schools introduced lowercase print (script) at the beginning of first grade in English classes, while using exclusively uppercase print in Spanish. Midway through first grade, lowercase print was informally introduced in Spanish, and cursive handwriting was taught in second grade. A total of 13.6% of the participants exhibited a mixed handwriting style (a combination of script, uppercase print, and cursive); however, they were excluded from the analyses due to the heterogeneity of this category.

Parents provided informed consent, and students were given the opportunity to assent to participation with the option to withdraw from the study. All procedures complied with the provisions of the Comprehensive Protection of the Rights of Children and Adolescents Law No. 2606 (2014).

Study Design

The present study employed a non-experimental cross-sectional design. Data were collected in classrooms settings over a two-week period, primarily in group sessions; the reading task, was administered individually. Writing was assessed through dictation, composition, and fluency tasks, from which the following variables were obtained: phonological accuracy (pseudoword dictation), spelling accuracy (word dictation), writing fluency (letters per minute), and richness of written composition (adherence to a writing prompt). Based on their productions, students were grouped according to the **handwriting style** they chose for each task. Handwriting style was coded as uppercase print (exclusively uppercase), cursive, script (lowercase print), or mixed (a combination of two or more styles). Reading was assessed using a text from the Reading and Writing Analysis (TALE) test, measuring the number of words read per minute as an indicator of fluency. The instruments are described in detail in the corresponding section.

Instruments

Dictation

An ad hoc word and pseudowords dictation task was administered (Pearson, 2012). It consisted of 10 words exploring orthographic groups and accentuation (e.g., *hombre*, *árbol*, *balcón*, *clavel*, *cocina*) and 10 nonwords or pseudowords (e.g., *cueno*, *elredor*, *enmorar*, *bordel*, *conmerusable*, *sortenidamente*). The following variables were coded: number of correct words, phonological errors (failure to respect the phoneme–grapheme correspondence, e.g., *brodel* or *borbel*), spelling er-

rors (where the phoneme–grapheme correspondence is preserved but the orthographic rule is violated, e.g., *ombre instead of hombre*, *árvol instead of árbol*), and accentuation errors (e.g., *arbol instead of árbol*).

Writing Composition

The "Writing Samples" subtest from the Woodcock-Muñoz Achievement Battery III (Muñoz-Sandoval et al., 2005) was administered to assess the quality of written composition. In this task, participants were asked to produce simple sentences based on a prompt that could include either a visual or a verbal stimulus (e.g., "Write a sentence that describes three things you like to do on weekends. They must be three things"). The analysis focused on the use of capitalization at the beginning of the sentence and the use of a period at the end. This subtest has shown adequate reliability indices, with internal consistency coefficients ranging from .80 to .90 and test–retest reliability around .85 (Muñoz-Sandoval et al., 2005).

Writing fluency

The "Writing Fluency" subtest from the Woodcock-Muñoz Achievement Battery III (Muñoz-Sandoval et al., 2005) was administered. This task requires students to write simple sentences based on visual stimuli and key words within a seven-minute time limit (e.g., a picture of a girl with an ice cream on the floor accompanied by the words *girl–sad–is*; the student must add a word and write a syntactically correct sentence. The student continues generating sentences in this manner until the time expires). The number of letters written was counted to calculate the letters-per-minute score. This subtest has shown high reliability, with internal consistency coefficients ranging from .88 to .92 and test–retest reliability coefficients around .90 (Muñoz-Sandoval et al., 2005).

Graphomotor Skills

To assess this area, the Bender Visual-Motor Gestalt Test (2010) was administered to evaluate graphomotor skills. Students were asked to copy nine drawings of increasing geometric complexity as accurately as possible. The number of errors (e.g., omission of angles, substitution of dots with circles, figure rotations) was recorded as an index of graphomotor ability. This system has demonstrated adequate reliability: internal consistency ranges from .80 to .89, test–retest reliability is around .85 – .90, and inter-rater reliability exceeds .90 in studies with trained judges (Koppitz, 1975).

Reading fluency

A Spanish text in script from the *Reading and Writing Analysis Test* (TALE; Cervera & Toro, 2002) for second grade was used. Each child was individually asked to read the text aloud. The passage was narrative in type and consisted of 68 words. Reading fluency was calculated as the number of words read per minute, obtained by multiplying the total number of words in the passage by 60 (seconds) and dividing by the time in seconds the child took to complete the reading. This subtest has demonstrated adequate reliability, with internal consistency coefficients ranging from .85 to .90 and test–retest reliability around .88 (Cervera & Toro, 2002).

Procedure

Data collection was conducted in the school setting during regular class hours, using two modalities: group and individual. In both instances, additional tests not included in the present study were also administered.

For the group assessment, half of the class (approximately 15 students) was assessed at a time to ensure better control of testing conditions and data quality. The assessment took place in a classroom prepared by the institution, under the supervision of the first author and two previously trained examiners. In this session, students completed the fluency, dictation, and composition tasks. Before each activity, instructions were read aloud and illustrated with concrete examples to ensure understanding of the task. The group session lasted approximately 50 minutes.

While the group session was being conducted, the remaining half of the class was assessed individually in a quiet space within the school. A team of trained professionals individually administered the oral reading and graphomotor tasks. These tasks were also preceded by the reading of instructions and clarification of any questions. The individual assessment lasted an average of 10 minutes per student.

All examiners were professionals in educational psychology and received specific training to ensure standardized administration across both modalities. Tasks were administered in the same order for all participants. Data collection was completed within two days during the same week at each school. On the second day, students who had been assessed individually completed the group activities, and vice versa.

Data Analysis

Statistical analyses were conducted using Jamovi 2.3 (The jamovi Project, 2023) with the addition of the GAMLj module (Gallucci, 2019). First, descriptive analyses of the indices derived from the tests were presented, segmented according to the handwriting style used.

Second, linear models (LM) and generalized linear models (GLM, with Poisson distribution) were fitted to evaluate the impact of handwriting style on writing and reading indices. In every model, handwriting style was included as a multinomial factor, gender as a binary factor, and the graphomotor index as a continuous covariate. The latter two were entered as control variables.

Continuous variables were analyzed with LM (e.g., number of letters per minute in writing and reading tasks, and the

total score on the composition task), whereas count variables (i.e., whole, discrete, non-negative events; Hilbe, 2014) were analyzed with GLM (e.g., correct words, phonological errors, spelling errors, correct pseudowords, and pseudoword errors in the dictation task; number of correct sentences, use of capital letters, and use of periods in the fluency task; use of capital letters and periods in the composition task). A Poisson distribution was specified for modeling count data, as recommended for this type of variable (Hilbe, 2014).

Assumptions of residual normality and homoscedasticity were evaluated for the LM, and the equidispersion assumption was evaluated for the GLM. The equidispersion assumption (i.e., that the dispersion of the data approximates that expected under a Poisson distribution) was verified using the Pearson chi-square statistic divided by the model degrees of freedom (X^2/df). When this ratio deviated by more than 0.20 points from 1, overdispersion or underdispersion was assumed (i.e., greater or lesser dispersion than expected under the model, respectively). In such cases, a Quasi-Poisson distribution was used, an alternative that corrects for distortions caused by over- or underdispersion (Harris et al., 2012; Hilbe, 2017).

Effect sizes were reported as estimated beta coefficients in the LM and exponentiated beta coefficients in the GLM. Finally, the Mixed handwriting style category was not analyzed due to its internal heterogeneity.

For each explanatory variable in the models, the corresponding significance statistics are reported (i.e., t for LM and z for GLM). In the absence of significance, only the p value is reported.

Results

Table 1 shows the frequencies of use of the three handwriting styles analyzed, broken down by task and by participants' gender. Chi-square tests indicated that the handwriting style used in each task varied as a function of student gender (all $p < .006$) and task type (all $p < .001$). Girls and boys differed in the handwriting styles they used, and all students tended to switch handwriting style across tasks.

Table 1
Handwriting style frequency by task and gender.

Style	Gender	Dictation		Fluency		Composition	
		n	%	*N*	%	*n*	%
Uppercase Print	Male	36	26.3%	21	18.3%	26	19.1%
	Female	17	12.4%	18	15.7%	13	9.6%
	Total		38.7%		34%		28.7%
Cursive	Male	14	10.2%	16	13.9%	22	16.2%
	Female	34	24.8%	23	20%	36	26.5%
	Total		35%		34%		42.7%
Script	Male	31	22.6%	29	25.2%	34	25%
	Female	5	3.6%	8	7%	5	3.7%
	Total		26.2%		32.2%		28.7%

Note. Differences in totals are due to the exclusion of participants who had extreme scores or mixed handwriting.

Dictation

Performance on the dictation task was evaluated using five measures: number of correct words, number of phonological errors in words, number of spelling errors in words, number of correct pseudowords, and number of pseudoword errors. Table 2 presents performance broken down by handwriting style. The best performances were observed in tasks completed in script, except for correct pseudowords and pseudoword errors, where scores were similar to those obtained with uppercase print.

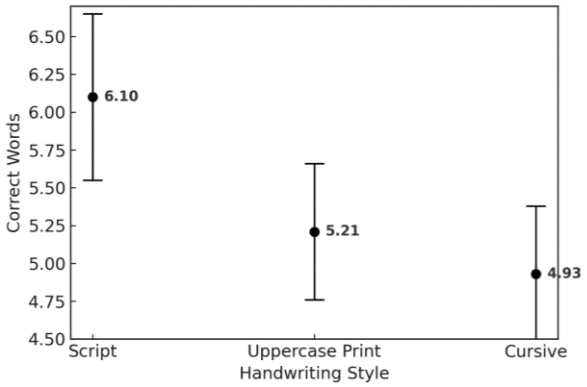
Table 2
Descriptive statistics for the Dictation Task by handwriting style.

	M	*SD*
Correct words	5.31	1.74
Uppercase print	5.13	1.91
Cursive	4.94	1.66
Script	6.06	1.35
Phonological errors (words)	0.97	1.17
Uppercase print	1.10	1.19
Cursive	.92	1.21
Script	.86	1.07
Spelling errors (words)	2.44	1.47
Uppercase print	2.68	1.60
Cursive	2.69	1.21
Script	1.75	1.40
Correct pseudowords	7.18	1.82
Uppercase print	7.48	1.86
Cursive	6.50	1.89
Script	7.67	1.39
Phonological errors (pseudowords)	2.24	1.63
Uppercase print	1.98	1.73
Cursive	2.69	1.68
Script	2.03	1.29

Correct Words

For the number of correct words, the dispersion index indicated underdispersion, $X^2/df = 0.53$. Consequently, a Quasi-Poisson distribution was specified for the inferential model. The analysis showed that the number of correct words written during the dictation task was explained by handwriting style (see Figure 1). Students who used script wrote 24% more correct words than those who used cursive, exp(B) = 1.24, 95% CI [1.06 – 1.45], $z = 2.67$, $p = .023$, and 17% more than those who used uppercase print, exp(B) = 1.17, 95% CI [1.02 – 1.34], $z = 2.28$, $p = .045$. Additionally, a significant effect of graphomotor skills was observed: each one-point increase in the graphomotor index decreased the number of correct words written by 2.9%, exp(B) = .97, 95% CI [.94 – .99], $z = –1.99$, $p = .049$. Participant gender showed no significant effects, $p = .77$.

Figure 1
Number of correct words by handwriting style.



Phonological errors

The frequency of phonological errors during dictation was analyzed using Quasi-Poisson models due to evidence of overdispersion, X^2/df = 1.30. This variable was not explained by handwriting style or by participants' gender (all p > .29). However, an effect of graphomotor skills was observed: for each one-point increase in the graphomotor index, participants were 13% more likely to make phonological errors, exp(B) = 1.13, 95% CI [1.03 – 1.24], z = 2.77, p = .007.

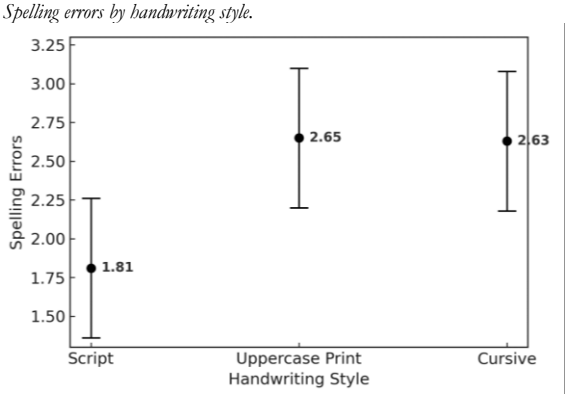
Spelling errors

The variable of spelling errors was analyzed using a generalized linear model with a Poisson distribution. The dispersion analysis did not indicate considerable deviations, X^2/df = 0.845. A significant main effect of handwriting style was found: script vs. uppercase print, z = 2.38, p = .017; script vs. cursive, z = 2.16, p = .034; and uppercase print vs. cursive, z = .07, p = .94 (see Figure 2). Students who used script made fewer errors than those who used uppercase print, exp(B) = 1.46, 95% CI [1.08 – 2.02], and those who used cursive, exp(B) = 1.45, 95% CI [1.03 – 2.06]. No differences were observed between uppercase print and cursive, exp(B) = 1.01, 95% CI [0.76 – 1.29]. Graphomotor scores and gender did not explain performance (both p > .19).

Correct Pseudowords

When evaluating the dispersion of the data, evidence of underdispersion was found, X^2/df = 0.37; consequently, a Quasi-Poisson model was specified. In the dictation of pseudowords, the number of correct responses was not explained by handwriting style. However, significant effects were detected for the graphomotor index and participants' gender. For each one-point increase in the graphomotor index, participants produced 3.7% fewer correct pseudowords, exp(B) = .96, 95% CI [0.94 – 0.98], z = –3.51, p < .001. With respect to gender, boys produced 16% more correct pseudowords than girls, exp(B) = 1.16, 95% CI [1.05 – 1.27], z = 3.09, p = .003.

Figure 2
Spelling errors by handwriting style.



Pseudowords errors

No predictor showed significant effects in explaining pseudoword writing errors (all p > .13). No evidence of overdispersion or underdispersion was observed, X^2/df = 1.13.

Fluency

Number of Correct Sentences

The number of correct sentences in the sentence-writing task was explained by the selected handwriting style (see Table 3, Figure 3). Students who used script wrote 43% more sentences than those who used cursive, exp(B) = 1.43, 95% CI [1.21 – 1.64], z = 4.52, p < .001, and 30% more than those who used uppercase print, exp(B) = 1.30, 95% CI [1.12 – 1.49], z = 3.59, p < .001. A main effect of gender was also observed: girls wrote 19% more sentences than boys, exp(B) = 1.22, 95% CI [1.05 – 1.35], z = 2.73, p = .006. Graphomotor skills did not show significant effects, z = 0.18, p = .85. Dispersion analyses showed slight indications of overdispersion, but these did not exceed the pre-established cut-off point, X^2/df = 1.16.

Figure 3
Number of correct sentences by writing style.

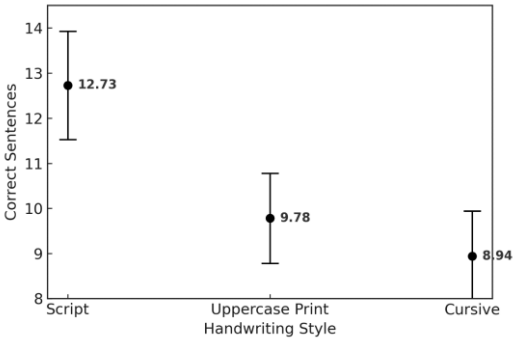


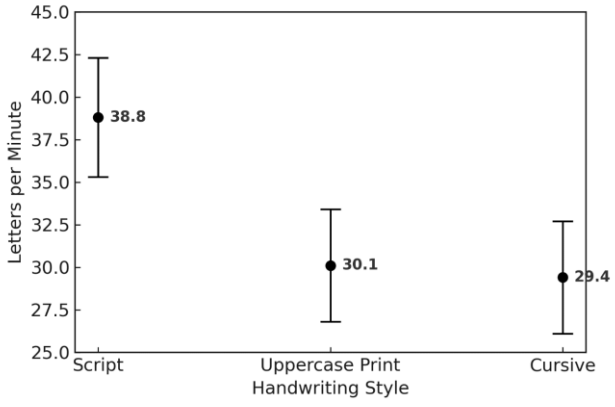
Table 3
Descriptive statistics for the Fluency and Composition tasks by handwriting style.

	Fluency		Composition	
	M	*SD*	*M*	*SD*
Correct Sentences	10.1	3.71	11.6	2.93
Uppercase print	9.72	3.7	11.7	2.60
Cursive	8.95	3.74	12.1	2.83
Script	11.8	3.15	10.6	3.19
Letters per minute	32	10.6		
Uppercase print	29.7	9.59		
Cursive	29.7	10.7		
Script	36.8	10.1		
Capitalization	4.61	5.48	4.23	4.35
Uppercase print	3.51	5.47	4.69	4.87
Cursive	4.23	5.17	3.34	4.08
Script	6.16	5.61	5.08	4,05
Punctuation	3.65	4.62	4.47	3.88
Uppercase print	2.62	3.72	3.92	3.82
Cursive	2.64	4.33	4.02	3.89
Script	5.86	5.12	5.67	3.75

Letters Per Minute

The number of letters written per minute was explained by handwriting style (see Figure 4). Students who used script wrote 9.41 more letters than those who used cursive, 95% CI [4.38 – 14.44], $t(104) = 3.67$, $p < .001$, and 8.68 more letters than those who used uppercase print, 95% CI [3.79 – 13.57], $t(104) = 3.52$, $p < .001$. Participant gender and graphomotor skills did not show significant effects (both $p > .13$). Tests of homogeneity of variances and normality of residuals indicated no significant deviations from the assumptions of the model (both $p > .516$).

Figure 4
Letters per minute by writing style.



Use of Capitalization and Periods

For both capitalization and periods, the dispersion analyses indicated considerable overdispersion, $X^2/df = 6.66$ and $X^2/df = 5.77$, respectively. Handwriting style did not explain the use of capitalization or the use of periods ($p > .06$), although a trend favoring script was observed. In the case of capitalization, a main effect of gender was found: boys produced 82% more capital letters than girls, 95% CI [1.09 – 3.16], $z = 2.22$, $p = .03$. Graphomotor scores and gender (for the use of periods) did not show significant effects (all $p > .074$).

Composition

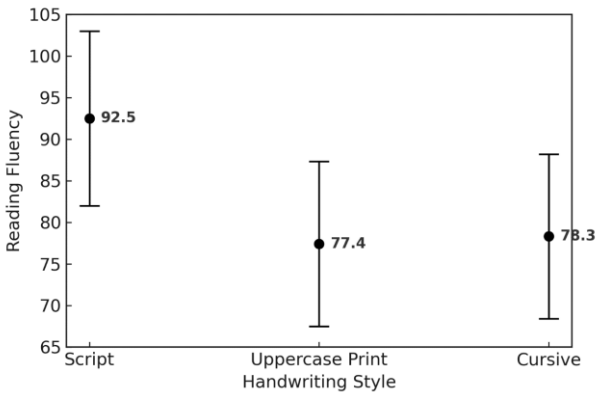
Both capitalization and period use were analyzed using Quasi-Poisson models due to the presence of overdispersion in both indices, $X^2/df = 3.52$ and $X^2/df = 4.54$, respectively. For the analysis of the total score, generalized linear models were fitted, and the evaluation of model assumptions did not reveal significant deviations for homoscedasticity ($p = .143$) or residual normality ($p = .923$).

The results showed that handwriting style did not explain the use of capitalization or periods ($p > .17$). In the case of period use, a main effect of gender was found: boys used sentence-final periods 52% more frequently than girls, 95% CI [1.05 – 2.22], $z = 2.19$, $p = .03$. Graphomotor scores and gender, in the case of capitalization, did not show significant effects ($p > .114$). Regarding the total score on the composition task, which indicates the ability to compose a text in response to a prompt, no significant effects of the proposed variables were found ($p > .100$).

Handwriting Style and Reading Fluency

Finally, differences in reading fluency were examined according to the handwriting style selected for writing, measured through the number of words per minute in reading a paragraph presented in script. Children who used script in their writing showed greater reading fluency than those who used uppercase print, $t(108) = 2.26$, $p = .027$, or cursive, $t(108) = 2.01$, $p = .047$. Additionally, a main effect of gender was observed: boys obtained higher scores than girls, $t(108) = 4.31$, $p < .001$. Graphomotor skills were not a significant predictor ($p = .64$). The assumptions of homoscedasticity ($p = .745$) and residual normality ($p = .822$) were adequately met. Estimated means are shown in Figure 5.

Figure 5
Reading fluency achieved according to writing style.



Discussion

The aim of this study was to evaluate the impact of the handwriting style chosen by second-grade students on different writing tasks, analyzing variables of speed, spelling, punctuation use, and quality of composition, as well as on a reading task by examining reading fluency.

Participants alternated between handwriting styles across tasks, showing limited consolidation of a single style. This alternation at such an early age may result from a lack of systematic practice or from unclear exposure to two handwriting styles. Previous literature shows that at this age, children tend to write in the style in which they are taught, and later, around fourth or fifth grade, they begin to personalize it by mixing styles to achieve greater fluency (Graham & Weintraub, 1996; Hamstra-Bletz & Blöte, 1990; Tarnopol & Feldman, 1987). Bara and Morin (2013) examined handwriting choices in fourth and fifth grade and compared them as a function of first-grade instruction. They found that children exposed to both styles tended to prefer script, whereas those who had been taught exclusively in cursive maintained the latter to a greater extent.

In addition, 13.6% of the participants in this study presented mixed handwriting styles (a combination of two styles), a phenomenon previously observed in middle-grade students (Graham & Weintraub, 1996; Hamstra-Bletz & Blöte, 1990; Tarnopol & Feldman, 1987). Since all participants shared the same literacy instruction, handwriting style selection may be attributed to the influence of the personal environment (family or teachers) or to instructional factors (Bara & Morin, 2013; Schwellnus et al., 2012).

Handwriting Style and Spelling Accuracy

The first objective was to explore differences in orthographic consolidation according to handwriting style in the dictation task. Although no studies have examined this aspect in depth, evidence shows that in the early grades there is a higher prevalence of spelling errors (Jiménez et al., 2008; Sánchez Abchi et al., 2009), since transcription is initially dominated by motor and phonological mechanisms (Berninger et al., 1992). In this study, the use of script was associated with fewer spelling and phonological errors and with greater accuracy in word writing, though not in pseudowords, where arbitrary rules do not apply and phonological rules prevail.

These results are consistent with previous research (Gates & Brown, 1929; Morin et al., 2012; Morales et al., 2014), but no differences were found between cursive and uppercase print, at least in second grade. This contrasts with prior regional studies in contexts where uppercase print is used, which did report such differences (Borzone & Yausaz, 2004). This finding suggests a differential effect of handwriting styles on the automatization not only of graphemic processes but also of lexical knowledge, which in turn impacts writing fluency and frees up cognitive resources for written composition and spelling correction.

According to the present findings, in second grade there appears to be a relationship between the use of script and more accurate spelling compared to cursive and uppercase print. This is consistent with the idea that cursive requires more demanding motor control due to changes in directionality and the continuity of strokes, which may leave fewer cognitive resources available for orthographic consolidation (Bonneton-Botté et al., 2018).

Handwriting Style and Phonological Accuracy

The second objective was to examine phonological accuracy according to the handwriting style used. Phonological accuracy refers to the ability to correctly assign the grapheme that represents the spoken phoneme, and since Spanish is a transparent language, reading and writing can be approached primarily through phonological mechanisms (Sánchez Abchi et al., 2009).

The absence of a clear association between the selected handwriting style and phonological errors suggests that variability in these errors may be linked to processes not addressed in this study. Written accuracy is typically affected in children with difficulties in phonological processing (dyslexia), whereas in typically developing children phonological encoding mechanisms tend to become rapidly automatized in Spanish (Suárez-Coalla et al., 2016). Consequently, by second grade, the challenge already interacts with orthographic encoding mechanisms (Jiménez et al., 2008), which may explain the significant findings for orthographic but not phonological accuracy.

Handwriting Style and Writing Fluency

Another objective of this study was to assess the fluency achieved by second-grade children in sentence writing according to the handwriting style used. Greater fluency was found in script handwriting, consistent with previous research showing that children write more fluently in script than in cursive and omit fewer strokes. They demonstrate greater accuracy, legibility, and fluency (Bara & Morin, 2013; Gates & Brown, 1929; Morales et al., 2014; Morin et al., 2012).

This finding may be explained by the relative simplicity of script, which requires straight and curved strokes, whereas cursive demands greater control of directionality and continuity in tracing (Bara & Morin, 2013). The complexity of cursive has led to the adoption of literacy programs based on script, with cursive introduced in second or third grade (Duval, 1985; Morin et al., 2012; Morin et al., 2017; Schwellnus et al., 2012). Despite these differences in the complexity of the strokes required by different styles, the literature shows no consensus on which style should be preferred.

Nevertheless, there is agreement on the importance of systematic instruction and practice of handwriting forms to

promote fluency and legibility (Bara & Morin, 2013; Bonneton-Botté et al., 2018; Graham et al., 2018; Schwellnus et al., 2012; Zachry et al., 2016). When children are systematically trained in handwriting strokes, they achieve greater writing fluency and improve the quality of their written work (Alves et al., 2016), reinforcing the importance of practice and explicit instruction.

Handwriting Style and Composition

This study also examine the impact of the chosen handwriting style on the quality of composition; however, no significant differences were found. The evidence is not conclusive regarding the superiority of one handwriting style over another for composition quality (Morin et al., 2012). What has been observed is that children who demonstrate greater automatization of handwriting, regardless of the style, produce longer and higher-quality texts (Alves et al., 2016; Berninger et al., 1992; Graham, 1990; Jiménez & Hernández Cabrera, 2019; Olinghouse & Graham, 2009).

Another relevant aspect for producing a coherent text is the appropriate use of punctuation. In this study, the frequency of correct use of capitalization and sentence-final periods was examined according to handwriting style. Although no significant results were found, a trend was observed among students who used script, as they tended to use more capital letters and periods in the writing fluency task. The literature has not specifically examined this variable.

Impact of Handwriting Style on Reading Fluency

Finally, it was found that children who used script for writing also read more fluently. This finding is consistent with Borzone and Yausaz (2004), who reported that the typography in which children are taught to read has an impact: those instructed in script for reading and cursive for writing showed greater reading fluency than those instructed exclusively in uppercase print. In the present study, children who chose script for writing read more fluently than those who chose uppercase print or cursive.

These results reinforce previous findings on the close relationship between writing and reading systems (Berninger et al., 2002; Linnemann et al., 2022; Longcamp et al., 2005). In terms of instructional differences, Bara et al. (2016) found that children exposed in first grade to writing in script or in a mixed style (cursive and script) showed better letter recognition and word reading than those exposed exclusively to cursive.

Impact of Graphomotor Skills and Gender

In the present study, participants' levels of graphomotor skills and their gender were included in the adjusted models as control variables, given the evidence supporting their influence on writing and reading tasks.

With respect to graphomotor ability, no effect was found on the handwriting style chosen. However, effects were observed for phonological and orthographic accuracy. The effect of graphomotor skills on phonological accuracy suggests that children with lower graphomotor development allocate cognitive resources to this task, thereby diverting attention not only from orthographic accuracy but also from phoneme–grapheme correspondence (Chung et al., 2020; Graham et al., 2018; Jolly et al., 2014). Findings showing an effect of graphomotor skills on orthographic accuracy are consistent with reports from other studies using graphonomic measures. Pontart et al. (2013) examined graphomotor ability and its relation to orthographic accuracy in dictation, writing, and copying tasks through a digital writing environment. The authors found a positive correlation between graphomotor skills and orthographic accuracy. They also reported that orthographic knowledge develops progressively: in the early grades, cognitive resources are focused on motor, phonological, and orthographic processes, which are not yet automatized, whereas in later grades the focus shifts more strongly to orthographic processes.

Regarding gender, boys were more likely to use script, whereas girls tended to prefer cursive. To account for this variation, the models were adjusted for gender differences. A main effect of gender was found for fluency: girls wrote 22% more sentences than boys across all handwriting styles. This result aligns with Zachry et al. (2016), who found that girls not only wrote faster than boys but also tended to prefer cursive, whereas boys were less consistent in their choice of handwriting style. Studies examining gender differences without considering handwriting style also show that girls tend to write more fluently, with greater orthographic accuracy, and produce longer texts than boys, with this difference becoming more pronounced as grade level increases (Al-Saadi, 2020; Berninger & Fuller, 1992; Graham et al., 1998). In the present study, however, no significant effects of gender were found on spelling or composition.

Conclusions

The present study shows that the handwriting style used is not neutral in terms of fluency and the quality of written productions. Even when students were free to use the style they preferred—whether chosen out of habit or comfort—significant differences were observed in writing and reading depending on handwriting style, with script showing greater efficiency. This finding challenges the assumed benefits of cursive, at least in contexts of limited practice, for achieving orthographic accuracy and reading fluency, and suggests potential drawbacks of relying exclusively on uppercase print, given its association with lower levels of orthographic accuracy and reading fluency.

This study capitalized on the fact that students' literacy instruction was not focused on a single handwriting style. However, standardizing instructional methods could provide an opportunity to establish clearer causal relationships. Additionally, future research could control for handwriting in-

struction methods and examine more precisely the extent to which handwriting style impacts text quality.

The results of this study highlight the relevance of graphomotor skills in writing and the challenges posed by different handwriting styles. The finding that a simpler style, such as script, enhances fluency suggests that its implementation could facilitate not only initial literacy acquisition in typically developing students but also, and particularly, in cases of dysgraphia.

Complementary information

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