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Pascual, Mariona; Salas, Naymé. «The cognitive profile and text-based traits of struggling writers». *Journal for the Study of Education and Development. Infancia y aprendizaje*, Vol. 44, Num. 1 (2021), p. 219-253

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The cognitive profile and text-based traits of struggling writers

Abstract

Writing difficulties have typically been investigated as the consequence of learning disabilities. However, several characteristics of texts and the underlying cognitive skills are often shared across these populations. Our aim was to investigate the writing and cognitive profile of children at-risk of writing difficulties, regardless of whether they have concomitant diagnoses. Drawing from a sample of 357 primary school children, we identified children who showed low levels on a single writing component, such as handwriting (15), spelling (39), or text generation (17), and 11 children who showed difficulties across two or more components. We compared them to a typically-developing group (50) on a series of writing features (e.g., spelling, vocabulary), and cognitive and linguistic skills (e.g., working memory, morphosyntax). Children who struggled with a single writing component showed difficulties also in other components. Children with multiple writing difficulties struggled with most writing features. All children displayed similar levels in key cognitive and linguistic skills. Our data thus presents compelling evidence of children who struggle with writing, despite no obvious cognitive or linguistic impairments.

Keywords

writing, learning disabilities, writing difficulties, struggling writers

Writing is essential to succeed professionally and academically, so difficulties with writing may turn into a major obstacle for self-realization (Clegg, Hollis, Mawhood & Rutter, 2005). Writing difficulties have usually been considered a secondary outcome of other, more general or primary disability. Several studies have pointed out that people with a history of learning disabilities, such as dyslexia, autistic spectrum disorder (ASD), specific language impairment (SLI), or attention-deficit/hyperactivity disorder (ADHD), experience sustained difficulties with writing even until adulthood (De Bono et al., 2012; Hatcher, Snowling, & Griffiths, 2002; Hellendoorn & Ruijssenaars, 2000; Tops, Callens, Lammertyn, Van Hees, Brysbaert, 2012). More recently, however, a new line of research has emerged that intends to raise the status of writing difficulties and start considering them as a potentially primary impairment (Coker, Ritchey, Uribe-Zarain, & Jennings, 2017; Dockrell, Connelly & Arfé, 2019; Graham & Harris, 2005). There are three main advantages of bringing writing difficulties to the forefront: first, it facilitates an in-depth understanding of writing and writing processes by focusing on examples where writing develops atypically; second, it allows for specific remediation strategies that target writing behavior that needs improvement; third, it might uncover children who do not suffer from any learning disabilities but who, nevertheless, experience serious difficulties with writing. In this study we thus focused on building the writing and cognitive profile of children potentially at risk of writing difficulties, with or without comorbidities.

Affected Text Features

A number of studies have found that there are specific text features affected in the writing of learning-disabled (LD) children. These include measures of lexical diversity and grammar (e.g., verb or noun agreement), which have been reported as affected in children with ADHD (Re, Pedron, & Cornoldi, 2007), ASD (Myles, et al., 2003), dyslexia (Puranik, Lombardino &

Altmann, 2007), and SLI (e.g., Dockrell, Lindsay, Connelly, & Mackie, 2007; Dockrell, Ricketts, Charman, & Lindsay, 2014).

Most importantly, several studies have converged in pointing out that LD children often show impaired text generation skills, across various LDs including dyslexia, SLI, ASD, or ADHD (e.g., Connelly, Campbell, MacLean & Barnes, 2006; Connelly, Dockrell, Barnett & Lane, 2012; Dockrell et al., 2007, 2014; Mackie & Dockrell, 2004; Myles et al., 2003; Sumner, Connelly & Barnett, 2013; Zajic et al., 2016). Text generation is a writing-specific process (Berninger & Winn, 2006) responsible for the production of written text (measured in words, sentences, or ideas), and it is considered to be one of the best proxies for the overall quality of a text and one of the first dimensions of writing to emerge (Berman & Verhoeven, 2002; Salas & Caravolas, 2019; Salas, Llauradó, Castillo, Casas, & Martí, 2016).

Most models of writing consider that text generation is affected by a writer's transcription skills (i.e., spelling and handwriting), such that low levels of transcription are assumed to be at the root of poor text generation skills (e.g., Berninger & Winn, 2006; Juel, Griffith, & Gough, 1986). Accordingly, both spelling and handwriting have been reported to be affected in the writing of SLI (e.g., Dockrell et al., 2014), ADHD (e.g., Graham, Fishman, Reid & Hebert, 2016), dyslexic children (e.g., Arfé, Dockrell, & Berninger, 2014), and ASD (Dockrell et al., 2014; Kushki, Chau & Anagnostou, 2011).

Affected Cognitive Processes

Writing is a cognitively demanding task and, as such, it involves the recruitment of several cognitive processes and resources (e.g., Hayes & Flower, 1980). Given that most learning disabilities involve some kind of processing or cognitive impairment, it is not surprising that a number of cognitive skills linked to writing have been found to be affected in LD populations. For example, working memory, that is, the ability to withhold information, while performing some kind of manipulation or operation (Baddeley, 1992) has

been found to be impaired and to affect the writing skills of people who suffer from ADHD, ASD, SLI, and dyslexia (e.g., Capodieci et al., 2018, Nyeden, Gillberg, Hjelmquist, & Heiman, 1999; Vugs, Hendriks, Cuperus, & Verhoeven, 2014; Connelly et al., 2006). Moreover, inhibition, a core, low-level executive function (Diamond, 2013), which is instrumental to writing (e.g., Salas & Silvente, 2019), has also been found to abe affected in ADHD (Craig et al., 2016), ASD (Robinson, Goddard, Dritschel, Wisley, & Howlin, 2009), SLI (Cuperus et al., 2014), and dyslexia (Helland, & Asbjørnsen, 2000). In addition, short-term memory is also affected in SLI (Conti-Ramsden, Ullman, & Lum, 2015; Conti-Ramsden, Botting & Faragher, 2001; Mackie, Dockrell, & Lindsay, 2013) and dyslexic children (Varvara, Varuzza, Padovano-Sorrentino, Vicari, & Menghini, 2014).

This Study

We have established that a few developmental disabilities, despite having different aetiologies, result in children experiencing some common writing difficulties and similar cognitive impairments. We argue that there may be a developmental disorder that affects writing, which affects LD populations as well as children without other developmental or learning disabilities. In line with previous studies (e.g., Coker et al., 2017; Dockrell et al., 2019), we aim to investigate the writing features and cognitive profile of children at risk of writing difficulties, whether they belong to an LD population or not.

To identify potential at-risk writers, we used data from a larger project on writing development and proceeded to identify children with marked difficulties on one or more aspects of written composition. Afterwards, we compared them to a group of age-matched controls on a number of text-based features and cognitive skills. Following Coker et al. (2017), we identified children based on their performance on three domains: handwriting, spelling, and text generation (number of words). Given that our study deals with children who are schooled in a minority language in Spain, Catalan, no standardized tests were available to

measure writing skills. We identified children who scored below -1SD from the mean for their age group (Grade 2 or 4) on key writing features and skills. A criteria of -1SD has been typically used as a threshold for children to be considered as potentially at-risk group (Berninger et al., 2008; Conti-Ramsden et al., 2001; Williams, Larkin & Blaggan, 2013). Children who performed below -1SD from the mean for their age group across two tasks of handwriting fluency constituted the **Low Handwriting** (LowHw) group. We reasoned that having a deviant score across two tasks that estimate the same skill provided consistency to our identification criteria. Children who scored below -1SD from the mean for their age group in phonological spelling accuracy constituted the **Low Spelling** (LowSpell) group. Children completed a bespoke test designed to analyze their ability to represent each phoneme in the target word with a plausible letter. Catalan has a shallow orthography, similar to Spanish, Portuguese, and students are expected to represent the phonological structure of words by the end of Grade 1 (Generalitat de Catalunya, 2017). Therefore, difficulties to represent the phonology of the word at 2nd or 4th grade should be a sensitive indicator of difficulties with spelling. Children who consistently scored below -1SD inthe number of words across two separate writing tasks, a narrative text and an opinion essay, constituted the **Low Text Generation** (LowTG) group. In sum, we opted for consistency across multiple measurements (i.e., in handwriting and text generation) or for the severity of the impairment (i.e., spelling). During our classification process, we identified a group of children who showed difficulties across two or more of the above-mentioned domains (e.g., spelling and text generation). These children constituted the **Multiple Writing Difficulties** (MWD) group. Finally, we randomly selected a **Reference group** of typically-developing peers (TD) out of the rest of the children in the sample.

Our study had three main goals. First, we aimed to examine the text-based features of the at-risk groups. We expected that the MWD group would show lower levels of achievement across all text-based measures, in comparison with the TD group. We also expected the single-

deficit groups (i.e., LowTG, LowSpell, LowHw) to be impaired for specific text features, although their problems would not be as pervasive as the MWD group's. However, given the codependency of the various writing skills and processes (Connelly et al., 2006; Cruz-Rodrígues et al., 2014; Mackie et al., 2013), their lower achievement might not be confined to the feature that led to their identification, but could affect other, related features as well. For example, the Low TG group could also show lower levels of handwriting fluency (Jones & Christensen, 1999). Second, we aimed to examine the cognitive profile of all at-risk groups, in comparison to the TD group. We expected that the children in the MWD group would be impaired in most cognitive measures, when compared to the TD group. For this reason, we administered a number of tasks and obtained measures of non-verbal IQ, short-term memory, and low-level executive functions (inhibition and updating). We also collected measures of children's levels of vocabulary and morphosyntax, in order to examine whether there were any language issues, a likely cause of writing difficulties (Dockrell & Connelly, 2009). A third goal was to determine the specificity of the writing difficulties observed. To pursue this goal, we obtained measures of word reading and reading comprehension, to determine whether children's struggles with writing were specific to the writing domain or if they were literacy-general.

Method

Participants

Potentially at-risk students were drawn from a sample of 357 2nd and 4th graders (188 male, 169 female) from a larger project. Students came from 5 public schools in districts with an average/high socioeconomic status in Barcelona, Catalonia (Spain). Information of parents' level of education was available for 315 children. Fifty-eight percent of mothers and 48.7% of fathers had completed university level education, 16.8% and 19.9% of mothers and fathers, respectively, had completed high-school education; and 4.5% and 3.1% of mothers

and fathers, respectively, had only completed primary education studies. Catalan is a minority language which coexists with Spanish in Catalonia (IDESCAT, 2015). It is the main language of instruction at schools from preschool to college, ensuring the bilingual ability both for speaking and writing of all children in the region. While it is safe to assume that the children in our sample are speakers of both Spanish and Catalan --the language of interest for this study--, they vary in their exposure to it. Use of Catalan in the family context was determined by means of a questionnaire that asked children the language(s) in which they talked to their mother, father, siblings, etc. Of the children in our sample, 16.5% did not have a regular exposure to Catalan outside of school, while the rest did.

The final, post-identification sample consisted of 132 children (77 boys; 55 girls) from 2nd and 4th grade, with a mean age of 101.11 months (*SD* = 12.73, Table 1). Of the 132 students, only 24 had been previously diagnosed with ADHD (5 children), ASD (1 child), dyslexia (2 children), SLI (5 children), and 2 children had curricular adaptations at school. In addition, 8 children in the sample had been identified as requiring special needs. In this final sample, the percentage of children with no Catalan support outside of school was 35%, but a comparison of the rate of Catalan support outside of school indicated that it was similar across at-risk and reference groups, X^2 (5, 132) = 3.90, p = .420.

INSERT TABLE 1 AROUND HERE

Tasks and Measures

Written expression. Students elaborated two texts: a narrative and an opinion essay. In the narrative, children from three schools replied to one of two prompts “A boy/girl loses his/her pet” or “A boy/girl gets angry with his/her best friend”. In the opinion essay, they answered to the prompt “Do you think that every boy and girl your age should go to school?” or “Do you think that children at school need recess?”. Prompts counterbalanced across classrooms. Children were given 10 minutes to produce a draft and 20 minutes to complete

their opinion essay or their story. The first author and a trained research assistant transcribed all texts. We obtained the following measures from each text:

Number of words. This measured assessed text generation at the word level and was the feature that served as the basis of identification of the LowTG group. The number of words in both texts was automatically counted in CLAN (MacWhinney, 2000). Reliability (ICC) between the first author and a research assistant on 100 randomly chosen texts was .996.

Spelling mistakes. This measure assessed accuracy at the word level. Spelling mistakes were identified and then counted automatically in CLAN. Morphosyntactic errors, invented words, typical colloquialisms, and interferences from Spanish were not penalized. Reliability (ICC) between the first author and a research assistant on 100 randomly chosen texts was .856.

Lexical diversity. To assess this word-level text feature, we calculated the Mass Ratio, which provides a measure of different word use that is not sensitive to text length. The formula for this measure is $M = (\log n - \log t) / \log^2 n$ (Torruella & Capsada, 2013).

Number of clauses. This measure assessed text generation at the sentence level by segmenting texts into clauses, following Berman and Slobin's (1994) criteria. Clauses were counted automatically using the FREQ command in CLAN. Reliability (ICC) between the first author and a research assistant on 100 randomly chosen texts was .958.

Word per Clause. This measure assessed syntactic complexity at the sentence level. It involved a calculation of the ratio of words per clause.

Grammatical mistakes. Accuracy at sentence level was assessed by identifying grammatical mistakes, such as morphosyntactic errors, inadequate use or absence of pronouns, incorrect noun or verb agreement, or grammatical replicas of Spanish

constructions. The number of grammatical mistakes was counted automatically in CLAN and then divided by the total number of clauses in the text.

Alphabet task (Berninger et al., 1994). To assess handwriting skills, students were asked to write the alphabet from memory as fast and as many times as they could during one minute. Given that some schools in Spain do not teach the alphabet, the task was evaluated in two ways: one which penalized alphabetical order errors (strict) and one that did not (lenient). Correlation between the strict and lenient scoring was very high, r = .996. We proceeded to use the lenient score, as it allowed us to include all the participants in the sample. The score was the number of legible letters, regardless of the order, written within the first 15 seconds. Reliability with a second scorer on 20% of the sample was ICC = .984. A result below -1SD in this task, as well on the Days task (below) was used to identify children form the LowHw group.

Days task. This task aimed to measure handwriting fluency when writing highly known words. Students were asked to write the days of the week from memory, as fast and as many times as they could for one minute.The score was the number of legible letters written within the first 15 seconds. Spelling mistakes were not penalized. Reliability with a second scorer on 20% of the sample was .995. A result below -1SD in this task, as well on the Alphabet task (above) was used to identify children form the LowHw group.

Spelling. Children were administered a bespoke dictation task. Children were dictated 34 words, which were counterbalanced for frequency, length in syllables, and syllabic complexity. The administrator said each word out loud in isolation, then contextualized it with a sentence, and repeated it one last time, again in isolation. Words were presented in pseudo-randomized order and administered in two different sequences which were counterbalanced. All words in the task were scored for phonological plausibility. Words were counted as correct if the phonographic structure of the word was represented with a letter that

has the intended phonological value, even if conventionally inaccurate. For example, for *hivern*, ‘winter’, the <h> is silent, and the <v> stands for phoneme /b/, which can be represented also by letter <b>. Therefore, *<ivern>, *<ibern>, or *<hibern>, although conventionally incorrect, were scored as phonologically plausible representations of the target word and afforded 1 point. The final score was the sum of all phonologically plausible representations. A trained RA scored a random 20% of the cases, and inter-rater reliability (ICC) was .989. Internal consistency of the task was also assessed; Cronbach's alpha = .919. Scores - 1SD in this task were used to identify children to form the LowSpell group.

IQ Raven Matrices (BAS II; Raven, 1999). Non-verbal intelligence was assessed with the Spanish adaptation of Raven’s Progressive Matrices test. Reliability for this task is reported in the manual to have a Cronbach’s □ of .86.

Rapid Automatized Naming (RAN; Lervåg & Hulme, 2009). To assess rapid retrieval of well-known letters and produce a verbal output, children were asked to name a set of 5 letters out loud (a, s, d, p, o) from a stimulus sheet as fast as they could. The letters were displayed on an A4 sheet in 5 rows of 8 letters randomly distributed. There were two trials with a different ordering of the letters. The administrator noted the time that it took to complete each trial. The final score was the mean time in seconds between both trials. Reliability was the correlation between the trials, r = .834.

Word Span. This task assessed verbal short-term memory (after Caravolas et al. 2012). Students were asked to recall lists of short, high-frequency words. The length of the lists increased progressively, starting with two-word lists and up to eight-word lists. There were four lists per length. The test was discontinued when children failed to recall correctly three consecutive lists of the same length. Each correct list was scored with 0.25, so that a completely correct length scored 1 point. The total score was the sum correct (range: 0-8). Split-half reliability for this task was .739.

Digit Span (WISC-IV; Wechsler, 2004). To assess updating of working memory we administered the *Digits* subtest of the Spanish adaptation of the WISC-IV test battery (Wechsler, 2007). This test involves a baseline digit recall subtask in which children have to repeat lists of digits that increase in length, starting with 2 and of up to 8 digits. There are two lists (i.e., items) per list length. The test includes a second subtask, in which children need to repeat lists of numbers but in reverse order. Each correct item was scored with 1 point and the overall score was the sum of both subtasks. The manual reports a reliability of .74, but because the test is standardized to be administered in Spanish, not Catalan, we calculated reliability for our sample; Cronbach's was .74.

Opposite Worlds (TEA-Ch; Manly et al., 2001). To assess verbal inhibition, children were shown a path made of blocks with the numbers “1” or “2”. In the baseline, “same world” trial, they were asked to say the numbers ‘1’ or ‘2’ printed on the path, as fast as they could. Two other trials ensued, in which children were asked to say the opposite of the number they saw (“opposite world” trials). The administrator wrote down the time (in seconds) to complete each trial. The final score was the mean time of the two “opposite world” trials. Test reliability was the correlation between the opposite-world trials, r = .823.

Morphosyntax. Because there are no standardized measures of morphological or syntactic development of Catalan, we adapted a sentence reading test (PROLEC-R, Grammatical Structure test; Cuetos, Rodríguez, Ruano & Arribas, 2007) and used it to estimate a receptive morphosyntax measure. The administrator read a sentence to the children and asked them to point to one of four pictures, choosing the one that best matches the sentence. A virtually identical procedure can be found in the TROG-II test (Bishop, 2003). The task was discontinued if the children failed five consecutive answers. There were 16 items in total and one point was given for each correct answer. The final score was the sum correct (range: 0-16). Cronbach's was .83.

Vocabulary (WISC-IV; Wechsler, 2004). Because there are no standardized tests of Catalan vocabulary, we adapted the Vocabulary subtest of the WISC-IV Spanish test battery. A group of expert researchers in the field of language teaching in Catalan, as well as primary teachers were consulted to find words that were similar to the Spanish items in terms of frequency of use, register/tone, age of acquisition, and overall difficulty. The final instrument consisted of 26 items of increasing order. Children were asked to provide a definition for each word. For example, the administrator asked "What is a *clock*?" or "What does *emigrate* mean?"). The first 6 items were awarded 1 or 2 points depending on depth and specificity of the definition, whilst the next 20 items were awarded a maximum of 1 point. Answers defining the term in Spanish were accepted, given that we evaluated the knowledge of the Catalan term, yet only the translation of the word was not awarded any points. The final score was the sum of all points obtained across items. Six well-trained research assistants collected and scored 16% of the sample each, and a seventh research assistant scored the entire sample. The average *r* for each 16th percent of the sample was .958 (range .940 - .984). In addition, we estimated the internal consistency of the task; Cronbach's □ = .887.

Word Reading. This subtest of the PROLEC-R reading test battery (Cuetos et al., 2007) was used to assess children's word reading ability. Students were asked to read aloud 40 words. One point was given for each correctly read word and the total score was the sum of all correct answers. The manual reports a Cronbach's □ of .79.

ACL (Català, Català, Molina & Monclús, 2004; 2008). To assess reading comprehension, we adapted the standardized test *Avaluació de la Comprensió Lectora* (ACL, Català et al. 2004; 2008). The test requires children to read brief texts of various genres and then answer multiple-choice questions. There are different versions of the test according to the school year the children have last completed. Therefore, the 2nd and 4th grade children completed the Grade 1 and Grade 3 version (as per the test instructions), respectively, and we

added the first two texts of the Grade 2 and Grade 4 instrument, respectively. This procedure was followed to ensure that the test would be able to capture children whose skill level is above grade level. The final instrument administered to 2nd graders included 9 texts with 31 questions, while the 4th graders answered 33 questions from 9 texts. Children had 45 minutes to complete the test. One point was awarded to each correct answer and the final score was the proportion of correct responses. The manual reports a reliability (KR-20) of 0.80 for the Grade 1 subtest and 0.72 for the Grade 3 subscale.

Procedure

Children were assessed on all measures in individual sessions in quiet rooms, with the exception of the Raven, Spelling, ACL, and Written Expression tasks, which were administered to the entire class in their classroom. All tests instructions, items, and administration were in Catalan. Testing took place during the first trimester (October-December) of the school year, except for the Written Expression task which took place in the second trimester (February-March). The order of administration of the tests was counterbalanced to avoid conditioning between tests.

Results

Descriptive statistics can be found in Table 2. Children were off-ceiling in all measures, but differences between groups were apparent. Data were generally normally distributed, with skewness values within -1.27 and 1.61, and kurtosis values ranging between -2.26 and 2.16. To address our goals, namely, which text-based measures and cognitive skills distinguish typical from at-risk writers, we ran a series of one-way ANCOVAs[1], controlling for the effect of age, on each text-based measure and cognitive skill. We included planned comparisons (Simple method), where the four at-risk groups (LowHw, LowSpell, LowTG,

[1] Note that, in addition to controlling for age in all ANOVAs, they were carried out with values that had been standardized to the mean for either 2nd or 4th grade.

and MWD) were compared against our reference group of TD children. We used the Benjamini-Hochberg (BH) correction for false discovery rate (FDR), in which p-values are adjusted to the number of repeats and weighted by their order (Benjamini & Hochberg, 1995). This correction method reduces the probability of type I errors that may occur due to multiple comparisons. Unlike other known methods, the BH correction integrates the number of repeats and amount of significant results.

Identification tests

We first tested whether groups were statistically significantly different from the reference group in the key aspects of writing that led to their classification into each of the at-risk groups. There was a significant main effect of Group in both measures of handwriting fluency, the alphabet task, $F(4, 119) = 16.51$, $p < .001$, $\eta_p^2 = .04$, and the days task, $F(4,82) = 12.25$, $p < .001$, $\eta_p^2 = .037$. Planned comparisons revealed that the LowHw group scored significantly below the reference group in both tasks ($p <.001$ in both the alphabet and days tasks). The MWD group obtained lower scores in both tasks ($p < .001$), while the LowTG group obtained significantly lower scores in the alphabet task ($p = .008$). For phonological spelling accuracy, there was a significant effect of Group, $F(4, 125) = 67.04$, $p < .001$, $\eta_p^2 = .68$. Planned comparisons reflected a significantly poorer performance of the LowSpell ($p < .001$) and MWD groups ($p < .001$). With regards to number of words, there was a significant Group effect in the narrative texts, $F(4, 117) = 14.75$, $p < .001$, $\eta_p^2 = .33$, and in the opinion essays, $F(4, 116) = 11.10$, $p < .001$, $\eta_p^2 = .28$). Planned comparisons revealed that the reference group wrote significantly more words than the LowTG group (ps $< .001$). In addition, the MWD group performed significantly below the reference group in both text types ($p < .001$ for both texts). Finally, the LowSpell group produced significantly less words than the reference group in the opinion essay ($p = .004$).

These results confirmed the selection criteria for all at-risk groups. In addition, some groups showed difficulty with traits for which they had not been identified, while the MWD group scored significantly poorer than the reference group across all traits.

TABLE 2 GOES AROUND HERE

Writing Profile of Each At-risk Group

Word-level writing features were assessed in terms of spelling accuracy and lexical diversity (Mass Ratio). Results showed a significant main effect of Group for the proportion of spelling errors, but only in the opinion essays, $F(4, 116) = 3.74$, $p = .007$, $\eta_p^2 = .114$. Planned comparisons showed significant results for the LowTG group ($p = .009$) and for the MWD group ($p = .007$) but not for the LowSpell group ($p > .05$). For lexical diversity, no significant main effect of Group was found in the narratives, $F(4,112) = 1.83$, $p = .128$, $\eta_p^2 = .06$, or in the opinion essays, $F(4,89) = 0.60$, $p = .660$, $\eta_p^2 = .03$.

Sentence-level writing features were assessed by the total number of clauses, the average number of words per clause, and the proportion of grammatical mistakes. For the number of clauses, there was a main effect of Group in the narrative texts, $F(4,115) = 10.74$, $p < .001$, $\eta_p^2 = .27$, as well as in the opinion essays, $F(4,116) = 7.77$, $p < .001$, $\eta_p^2 = .21$. Planned comparisons indicated that the LowTG group scored significantly below the reference group in both text types (ps <.001). The MWD group also produced significantly fewer clauses on average in the narrative texts ($p = .002$) and in the opinion essays ($p = .022$). A measure of words per clause showed no significant main effect of Group in the narrative texts, $F(4, 115) = 0.49$, $p = .740$, $\eta_p^2 = .17$. Words per clause in the opinion essays did show a main effect of Group, $F(4, 116) = 5.03$, $p = .001$, $\eta_p^2 = .15$. Planned comparisons revealed that the MWD group scored significantly below the reference group ($p < .001$). Finally, for grammatical accuracy, there was a significant effect of Group in the average proportion of grammatical errors in the narrative text, $F(4, 116) = 3.60$, $p = .008$, $\eta_p^2 = .110$.

The reference group significantly outscored the LowHw (p = .001). This means that children with low handwriting fluency had difficulty with text generation at the sentence level.

TABLE 3 GOES AROUND HERE

Underlying Cognitive-linguistic Profile

In order to compare groups on a number of key cognitive and linguistic skills, as well as in their reading skills, we ran another series of one-way ANCOVAs, controlling for age (Table 4). Children in all at-risk groups did not differ from the reference group on a measure of non-verbal intelligence (Raven test), $F(4,118) = 1.83$, $p = .128$, $\eta_p^2 = .06$). No significant Group effect was found either for verbal short-term memory (word-span task), $F(4,119) = 1.15$, $p = .335$, $\eta_p^2 = .04$). The core executive functions of inhibition (Opposite-worlds task) and updating of WM (Digit-span task) did not show a significant Group effect, $F(4,118) = 2.10$, $p = .085$, $\eta_p^2 = .07$, and $F(4,119) = 2.27$, $p = .065$, $\eta_p^2 = .07$, for inhibition and WM, respectively. Finally, there was no significant effect of Group in the RAN task, $F(4,118) = 2.08$, $p = .088$, $\eta_p^2 = .07$). These results indicate that at-risk children had similar levels in key cognitive skills in comparison with the reference group.

To obtain the linguistic profile of the at-risk children, we compared them with the reference group in terms of their morphosyntactic skills and vocabulary knowledge. Results showed that there was no significant effect of Group in morphosyntax, $F(4, 119) = 0.30$, $p = .878$, $\eta_p^2 = .01$, or in vocabulary, $F(4, 118) = 1.48$, $p = .214$, $\eta_p^2 = .05$.

We finally compared children's reading skills, in order to ascertain whether their writing difficulties were specific or literacy-general. There was a significant main effect of Group in word reading, $F(4, 112) = 3.15$, $p = .017$, $\eta_p^2 = .10$). Planned comparisons showed that the MWD group performed significantly below the reference group (p = .006). In contrast, we found that the main effect of Group was non-significant for reading comprehension, $F(4, 115) = 1.77$, $p = .139$, $\eta_p^2 = .06$).

INSERT TABLE 4 AROUND HERE

Discussion

This study aimed to build a profile of the struggling writer, independently of whether there were comorbidities with other learning disorders. We started by following the composition of at-risk groups proposed by Coker et al. (2017) and found 71 children who showed consistent or severe struggles with handwriting (*n* = 15), spelling (*n* = 39), or text generation (*n* = 17). Moreover, in line with Dockrell et al. (2019) and Connelly, Dockrell and Barnett (2005), we were able to identify a group of children who presented difficulties with several aspects of writing (*n* = 11). Notably, only a few (3) of these children had been diagnosed or identified with a learning disability. A first outcome of this study is, thus, that there are children who struggle with writing despite not having been diagnosed. In our data, the prevalence of struggling writers was around 3%, but epidemiological studies are needed to add precision to our findings. Nevertheless, this figure is comparable to other learning disabilities like dyslexia, whose prevalence has been reported to be around 5% (e.g., Lagae, 2008), ADHD with 4.3% of prevalence in populations under 15 years old (Coll & Pons, 2017) or ASD, whose prevalence in Catalonia is around 1.23% (Pérez- Crespo et al., 2019).

Our first goal was to examine the nature of the texts of the at-risk groups and to determine the extent to which they differed from their TD peers. For this reason, we compared them on a series of text-based measures. Children in the LowHw group had difficulties with the mechanics of letter-writing fluency. However, this defining trait did not limit most aspects of their writing performance: these children showed no marked difficulties with spelling, lexical diversity, syntactic complexity or, crucially, the amount of text generated (measured either in words or clauses). Nevertheless, they made more grammatical mistakes in the narratives, indicating that the extra effort of handwriting could be limiting their ability to keep track of grammatical agreement. The LowSpell group was unable to

comply in an age-appropriate manner with the basic phonographic requirements of writing. Nonetheless, these children seemed to have found a way around this difficulty that prevented them from affecting other features of their texts. The exception was the amount of text produced in an opinion essay. This is well aligned with the abundant evidence of the constraining role of spelling in text generation (e.g., Abbott, Berninger, & Fayol, 2010; Juel et al. 1986). In addition, it has been suggested that children may develop an early awareness of their difficulties with spelling, which could also be motivating them to write less (Hayes, 2012). The LowTG group was identified because they produced substantially fewer words across two texts. Their difficulties were confirmed when measured in number of clauses, meaning that children in the LowTG group struggled to generate text at the word and sentence levels. They also scored significantly below their TD peers on handwriting fluency. This seems to indicate that, while not severely impaired on handwriting as the LowHw group, at least part of the difficulties to generate text of the LowTG group may stem from disfluent handwriting skills, again in accordance with a robust line of research pointing to the key role of handwriting in writing development (Limpo & Alves, 2013; Jones & Christensen, 1999; Salas & Silvente, 2019). To sum up, it appears that struggling even with one process of writing composition is likely to have repercussions on other processes. Over time, children with problems on a single aspect of written composition could suffer from a more pervasive problem with written expression. We would like to suggest that these children should receive tailored treatment for their writing difficulties, in order to guarantee that they will be able to cope with the ever-increasing demands of writing tasks.

Finally, the MWD group provided the profile of the struggling writer. Of the 11 children identified in this group, only 2 had been previously diagnosed with SLI, and 1 student was receiving a curricular adaptation. Their texts, as we expected originally, were shorter, contained a larger proportion of spelling mistakes, and less syntactic complexity.

Notably, the affected writing features were strikingly similar to reports of the writing difficulties experienced by children with learning disabilities (e.g., Connelly et al., 2006; Dockrell et al., 2014; Re et al., 2010).

Our second goal was to investigate the cognitive profile of all groups of writers. A critical finding of this study is that all groups of children at-risk of writing difficulties showed a similar cognitive profile to the reference group, at least in terms of non-verbal intelligence, short-term and working memory, inhibition, and RAN. This means that children's struggles with writing cannot be explained on the basis of cognitive impairments.

Our third goal was to determine whether the writing difficulties we observed were due to poor language skills, and whether children's difficulties were writing-specific or if they affected literacy in general. Our data revealed that our struggling writers showed similar levels of vocabulary and of receptive morphosyntactic skills, as well as normal levels of reading comprehension. However, the MWD group had difficulties with word reading. Therefore, we claim that there is a profile of student who struggles with writing quite specifically, and in the absence of language issues, although issues with reading deserve further exploration.

To conclude, we found that around 3% of children attending early and middle elementary school may suffer from a developmental disorder that targets writing specifically, without the necessary existence of comorbid developmental disorders, abnormal IQ, or poor language skills. In line with previous findings by Dockrell et al. (2019) and Connelly, Dockrell, Walter & Critten (2012), these children produce short texts, make more spelling mistakes, and have disfluent handwriting. We found compelling evidence that, at the root of their writing profile, there are no affected cognitive processes; critically, executive functions, RAN, and short-term or working memory were unaffected across the board. These children arguably require a timely identification, so that an intervention program can be put in place

early on. Future studies should strive to explore further its causes and its relationship with other learning disorders, as well as to determine effective remediation strategies.

Limitations

A major obstacle in the development of the present study was the practical absence of standardized psycholinguistic tests in Catalan, which made the identification of the at-risk groups much harder. It would be interesting to compare our findings with future studies in languages that can resort to standardized test batteries.

This study was limited by the lack of resources to have an exhaustive screening of possible diagnoses. We cannot rule out underlying disorders that have not yet been detected by specialized practitioners. In addition, it was out of the scope of this study to be able to go into further detail into the causes of the discrepancies across studies. Finally, another limitation with this and several studies on writing, is that writing performance should be explored not only with writing products but also looking at the online writing processes. A study is underway of a subsample of the children in this paper that explores online writing processes in TD vs. at-risk children.

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Table 1. Number of participants, distribution by grades and percentage of Catalan at home by group

	Low Handwriting	Low Spelling	Low Productivity	Multiple Writing Difficulties (MWD)	Reference group
N	15	39	17	11	50
2nd Grade	20	10	4	7	20
4th Grade	19	5	13	4	30
Catalan at Home	53%	56%	64%	63%	74%

Table 2. Means and SDs of all identification tasks per group

Identification measures	Groups				
	Low Handwriting *Mean (SD)*	Low Spelling *Mean (SD)*	Low Productivity *Mean (SD)*	Multiple Writing Difficulties (MWD) *Mean (SD)*	Reference group *Mean (SD)*
Mean Age	96.20 (12.23)	100.00 (11.78)	107.29 (12.76)	95.90 (11.83)	102.40 (13.11)
Mean SES	52.00 (14.87)	52.42 (12.18)	58.48 (10.46)	59.63 (15.36)	59.21 (12.57)
Spelling Phonog.	23.67 (5.09)	5.59 (5.94)	26.12 (3.95)	12.27 (12.22)	25.28 (5.53)
Hndw Alph	2.93 (1.49)	7.03 (3.05)	6.88 (2.55)	3.45 (0.82)	8.06 (2.50)
Hndw Days	5.67 (1.92)	12.83 (4.45)	13.73 (5.51)	5.56 (2.24)	15.18 (4.30)
Words OP	31.87 (22.54)	33.03 (19.09)	16.00 (7.98)	10.64 (6.68)	44.17 (31.31)
Words NA	86.60 (37.72)	104.25 (67.91)	42.94 (24.05)	38.70 (45.52)	101.43 (50.57)

Note. NA = narrative text; OP = opinion essay; Hndw Alph = handwriting fluency *Alphabet* task; Hndw Days = handwriting fluency *Days* task.

Table 3. Mean and SDs of text-based measures by group

Writing measures	Groups				
	Low Handwriting Mean (SD)	Low Spelling Mean (SD)	Low Productivity Mean (SD)	Multiple Writing Difficulties Mean (SD)	Reference Group Mean (SD)
No. Words NA	86.60 (37.92)	104.25 (67.91)	42.94 (24.05)	27.11 (28.64)	101.43 (50.57)
No. Words OP	31.87 (22.54)	33.03 (19.09)	16.00 (7.98)	9.30 (5.27)	44.17 (31.31)
Spelling errors NA	24.68% (12.44)	18.92% (11.17)	15.73% (8.72)	21.83% (10.79)	15.95% (12.58)
Spelling errors OP	37.52% (20.33)	28.20% (16.99)	35.56% (18.98)	45.72% (13.56)	27.01% (16.02)
Mass NA	0.05 (0.02)	0.05 (0.02)	0.04 (0.01)	0.05 (0.02)	0.05 (0.01)
Mass OP	0.05 (0.03)	0.04 (0.02)	0.04 (0.03)	0.07 (0.06)	0.05 (0.03)
No. Clausules NA	16.07 (8.62)	20.03 (13.43)	9.00 (4.90)	5.25 (4.65)	19.49 (9.22)
No. Clausules OP	8.27 (5.40)	8.42 (5.41)	4.41 (2.06)	5.10 (4.23)	10.62 (6.96)
Word per Clause NA	5.69 (0.93)	5.49 (1.30)	5.57 (2.42)	5.51 (1.84)	5.28 (0.90)

Word per Clause OP	3.76 (1.11)	4.14 (1.30)	3.60 (0.89)	2.34 (1.03)	4.10 (1.24)
Grammatical Errors NA	2.27 (1.75)	1.18 (1.17)	1.41 (1.46)	1.80 (1.48)	0.93 (1.14)
Grammatical Errors OP	0.87 (1.41)	0.57 (0.88)	0.69 (1.14)	1.11 (0.93)	0.61 (0.94)

Note. NA = narrative text; OP = opinion essay.

Table 4. Means and SDs of cognitive skills by group

Cognitive measures	Groups				
	Low Handwriting Mean (SD)	Low Spelling Mean (SD)	Low Productivity Mean (SD)	Multiple Writing Difficulties Mean (SD)	Reference Mean (SD)
Hndw Alph	2.93 (1.49)	7.03 (3.05)	6.88 (2.54)	3.40 (0.84)	8.06 (2.50)
Hndw Days	5.67 (1.92)	12.83 (4.45)	13.73 (5.51)	5.56 (2.24)	15.18 (4.30)
Spelling Phonog.	23.67 (5.09)	5.59 (5.94)	26.12 (3.95)	13.50 (12.15)	25.28 (5.53)
Raven	27.27 (9.71)	34.33 (10.86)	32.94 (10.61)	29.70 (11.93)	35.00 (10.41)
RAN	29.40 (9.36)	27.73 (10.40)	24.64 (7.10)	35.29 (11.03)	24.83 (8.16)
Word Span	2.57 (0.50)	2.79 (0.53)	2.72 (0.49)	2.67 (0.58)	2.91 (0.65)
Digit Span	11.53 (1.96)	11.77 (2.04)	12.82 (2.38)	10.50 (1.90)	12.69 (2.14)
Opposite Worlds	48.87 (12.10)	45.62 (11.74)	46.18 (12.66)	56.40 (9.65)	44.20 (11.62)
Morphosyntax	11.27 (2.46)	11.26 (2.39)	12.12 (2.15)	11.10 (2.92)	11.85 (2.59)

Vocabulary	15.64 (5.27)	17.37 (5.28)	18.59 (4.66)	14.10 (6.76)	18.69 (4.42)
Reading Comprehension	19.39 (8.49)	22.67 (5.55)	21.33 (6.43)	23.56 (4.93)	27.67 (2.08)
Single Word Reading	32.20 (5.12)	36.00 (4.43)	36.06 (9.15)	29.00 (8.20)	36.06 (5.50)

Note. NA = narrative text; OP = opinion essay; Hndw Alph = handwriting fluency *Alphabet* task; Hndw Days = handwriting fluency *Days* task.