The published version can be found in: Limpo, T., Alves, R. A., & Fidalgo, R. (2014). Children's high-level writing skills: Development of planning and revising and their contribution to writing quality. *British Journal of Educational Psychology, 84,* 177-193. doi:10.1111/bjep.12020

Children's high-level writing skills: Development of planning and revising and their contribution to writing quality

Teresa Limpo, Rui A. Alves

University of Porto

and

Raquel Fidalgo

University of León

Author Note

Teresa Limpo, and Rui A. Alves, Faculty of Psychology and Educational Sciences, University of Porto; Raquel Fidalgo, Department of Psychology, Sociology, and Philosophy, Faculty of Education, University of León.

This research was made possible by funds from the COST Action IS0703 – The European Research Network on Learning to Write Effectively (STSM-IS0703-9392) and from the Portuguese Foundation for Science and Technology (grants SFRH/BD/68548/2010 and PTDC/PSI-PCO/110708/2009).

Correspondence concerning this article should be addressed to Teresa Limpo, Faculdade de Psicologia e de Ciências da Educação, Universidade do Porto, Rua Alfredo Allen, 4200-392 Porto, PORTUGAL. E-mail: tlimpo@fpce.up.pt

Abstract

Background. It is well established that the activity of producing a text is a complex one involving three main cognitive processes: planning, translating, and revising. Although these processes are crucial in skilled writing, beginning and developing writers seem to struggle with them, mainly, with planning and revising.

Aims. To trace the development of the high-level writing processes of planning and revising, from Grade 4 to 9; and to examine whether these skills predict writing quality in younger and older students (Grades 4-6 vs. 7-9), after controlling for gender, school achievement, age, handwriting fluency, spelling, and text structure.

Sample. Participants were 381 students from Grade 4 to 9 (age 9 to 15).

Method. Students were asked to plan and write a story, and to revise another story by detecting and correcting mechanical and substantive errors.

Results. From Grade 4 to 9, we found a growing trend in students' ability to plan and revise despite the observed decreases and stationary periods from Grade 4 to 5, and 6 to 7. Moreover, whereas younger students' planning and revising skills made no contribution to the quality of their writing, in older students, these high-level skills contributed to writing quality above and beyond control predictors.

Conclusion. The findings of the present study seem to indicate that, besides the increase of planning and revising, these skills are not fully operational in school age children. Indeed, given the contribution of these high-level skills to older students' writing, supplementary instruction and practice should be provided from early on.

Keywords: planning, revising, high-level writing skills, writing development

Children's high-level writing skills: Development of planning and revising and their contribution to writing quality

Thirty years ago, Hayes and Flower (1980) introduced the first cognitive model of written composition. Still today, this is one of the most prominent models within the cognitive approach to writing. One of the reasons for its longstanding impact was the identification of the cognitive processes involved in writing a text (Alves & Haas, 2012). From thinking-aloud protocols analysis, Hayes and Flower (1980) inferred three writing processes, namely, planning, translating, and revising, which recursively interact during skilled writing. Although these processes were subsequently elaborated, they continue to represent the core cognitive component in more recent cognitive writing models (Berninger & Winn, 2006; Hayes, 1996, 2012; Kellogg, 1996).

The present study investigated the development of planning and revising skills in Grades 4-9, and analysed the contribution of these high-level skills to writing quality. In what follows, we define planning, translating, and revising processes, and outline how students' planning and revising skills contribute to the quality of their texts.

High-Level Writing Processes

The planning process involves generating and organizing ideas, and setting goals (Hayes & Flower, 1980). As planning can occur before or during translating, a distinction was made between advanced and online planning (Berninger & Swanson, 1994). The central function of planning, even in adults, is generating content (Torrance, Thomas, & Robinson, 1999). Writers plan their text by extracting information from the task environment and by searching for content in their long-term memory. When necessary, this generated material is (re-)organized in a writing plan that guides text production. During planning, writers also formulate goals for their texts, and delineate conceptual plans to achieve them (Hayes & Flower, 1986).

Based on research on developing writing, Berninger et al. (1992) proposed two components of the translating process: text generation and transcription. Text generation is the transformation of ideas into language representations in the working memory. Transcription is the transformation of those representations into written language, which includes the low-level skills of spelling and handwriting.

The revision process can be activated at any point during writing to evaluate and introduce changes at the word, sentence, or text level (Chanquoy, 2009; Fitzgerald, 1987). The timing of revision in relation to translation allowed the distinction between online and posttranslation revision (Berninger & Swanson, 1994). Revision involves two sub-processes: problem detection, which includes schema-guided reading and text evaluation, and problem correction, which involves the selection of a revising strategy and its implementation (Butterfield, Hacker, & Albertson, 1996; Hayes, 2004).

Berninger and colleagues conducted cross-sectional studies from Grade 1 to 9 (age 6 to 15) and found that planning, translating, and revising had different rates of development (Berninger, Cartwright, Yates, Swanson, & Abbott, 1994; Berninger, Whitaker, Feng, Swanson, & Abbott, 1996; Berninger et al., 1992). Transcription and text generation were the first to emerge, followed by online planning and online revision (Grades 1-3). The last processes to develop were advanced planning and posttranslation revision (Grades 4-6), which were only fully operational by Grades 7-9.

Planning Skills and Writing Quality

Several correlational studies have analysed how students' preplanning skills are related to their compositional quality. In the studies reviewed below, preplanning skills were assessed through the complexity of students' written plans (see Hayes & Nash, 1996 for a review on planning measures). Outlines and graphic organizers were considered as the most advanced form of preplanning.

In Grades 2 and 4, it was found that students' plans did not predict writing quality (Olinghouse & Graham, 2009). Likewise, in Grades 4-6, preplanning skills were not related to writing performance (Whitaker, Berninger, Johnston, & Swanson, 1994). Only in Grades 7-9, the plan generated before writing were positively correlated with compositional quality (Berninger et al., 1996). Thus, while younger students were able to make written plans, only older students seemed to use them to guide text production (Limpo & Alves, 2013). This might have happened because younger students' written plans tended to be very similar to their texts, which means that they are not differentiating planning from translating (Bereiter & Scardamalia, 1987).

There is strong evidence that planning instruction is a way to promote students' writing performance (for meta-analyses see Graham, McKeown, Kiuhara, & Harris, 2012; Graham & Perin, 2007). Harris, Graham, and Mason (2006) demonstrated that children as young as 7-years-old can beneficiate from interventions targeting planning skills. Second-graders with difficulties in learning to write were taught a general planning strategy, and genre-specific strategies for narrative and expository writing in tandem with self-regulation procedures. By using these strategies, students were able to write longer and better texts than controls. The advanced plan might have functioned as an external memory where children stored their ideas. Moreover, it might have freed up cognitive resources for the other higher level writing processes by reducing children's need to plan during writing (cf. Kellogg, 1988).

Revising Skills and Writing Quality

Among other factors, the influence of students' revising skills on writing quality depends on writers' developmental level and the nature of the revision (mechanical vs. substantive). It seems that young writers' revisions have a limited impact on text quality (Fitzgerald & Markham, 1987; MacArthur, 2012). Indeed, only in Grades 7-9, text revision led to an improvement at the word, sentence, and text levels (Berninger et al., 1996). A

possible reason for this is that younger students focused on mechanical and local problems, while older writers also considered meaning and global problems (Graham, Schwartz, & MacArthur, 1993; MacArthur, Graham, & Harris, 2004). Nonetheless, a robust result about revision is that meaning errors are harder to detect and correct than surface errors for school-age children, as well as for adults (Butterfield, Hacker, & Plumb, 1994). Several explanations have been proposed (for a review see MacArthur, 2012). Writers may lack the knowledge of appropriate evaluation criteria or may have a limited conception of revision as proofreading (Graham et al., 1993). It might also be that they have deficient reading strategies (McCutchen, Francis, & Kerr, 1997), or that substantive revisions place large demands on working memory (Hacker, 1994). Regarding revision sub-processes, it was suggested that younger students struggle more with detecting errors than correcting them. Indeed, Beal (1990) showed that students in Grade 4 detected less meaning errors than children in Grade 6. Even though fourth graders were as likely as sixth graders to correct the errors adequately once they were detected.

Several studies have analysed the impact of revision instruction on writing performance, and results are generally positive (for meta-analyses see Graham, McKeown, et al., 2012; Graham & Perin, 2007; but see Torrance, Fidalgo, & García, 2007). De La Paz, Swanson, and Graham (1998) taught a modified version of the *Compare*, *Diagnose*, and *Operate* strategy (CDO strategy; developed by Scardamalia & Bereiter, 1983) to eight-graders with learning disabilities. This revision routine prompted students to deal first with global problems and then with local ones. Students using the CDO strategy improved not only their revising behaviour but also the quality of their texts. The authors suggested that the strategy encouraged them to consider the whole text and provide them an executive support to manage the revision process.

The Present Study

Covering a large developmental window (Grades 4-9, with about 60 students per grade), this study examined the development of planning and revising, and the contribution of these skills to writing quality. Compared to previous studies also focused on the development of high-level writing skills (e.g., Berninger et al., 1996; Whitaker et al., 1994), the main contribution of our work is twofold. Firstly, we used more controlled and comprehensive measures of planning, revising, and text quality. Planning skills were studied in narrative writing, whose underlying schema is expected to be already acquired by Grade 4 (Berman & Slobin, 1994). Given the wide range of grades assessed, the use of this genre minimized potential differences across grades due to declarative knowledge, which could impact students' planning behaviour. Students' revising skills were analysed considering the nature of revision (viz., mechanical vs. substantive) and the underlying sub-processes (viz., detection vs. correction). Students were also asked to revise a provided text and not their own texts (for a methodological discussion on the study of revision see Butterfield et al., 1994). This enabled us to remove the effect that differences among writers' texts would have on revision. To control for the influence of topic knowledge on substantive revision (McCutchen et al., 1997), the provided text was a fictional narrative requiring no prior topic knowledge to be understandable. Regarding writing quality, all texts were evaluated by means of a holistic scale considering ideas quality, organization, sentence structure, and vocabulary.

Secondly, we examined the incremental validity of planning and revising in predicting writing quality in Grades 4-6 and 7-9, which, to the best of our knowledge, had not been tested. This kind of analysis provides additional evidence of the contribution of high-level skills to writing because it tests their unique contribution over well-known predictors. Given the complexity of writing, demonstrating the incremental validity of these skills is a way to highlight their importance to educational researchers and practitioners. Indeed, this study's

findings may be relevant to guide writing instruction by informing about appropriate periods to target a particular writing process.

In this study, students from Grade 4 to 9 were asked to plan and write a narrative. Also, they were asked to detect and correct mechanical and substantive errors in the same genre. Our first aim was to trace the development of planning and revising. Due to instruction and maturation, we expected that planning would increase from grade to grade (Hypothesis 1; Alamargot & Fayol, 2009). Similarly, we expected that mechanical and substantive revision would increase throughout schooling (Hypothesis 2). Furthermore, according to the literature on revision, we predicted that student's ability to correct errors would be higher than students' ability to detect them (Hypothesis 3).

Our second aim was to examine the contribution of high-level writing skills to writing quality in Grades 4-6 (age 9 to 12) vs. Grades 7-9 (age 12 to 15). Separate regression analyses were conducted to predict writing quality for the two grade groups. Six control variables and five high-level writing variables were included in the regression model. Three control variables were non-writing: gender, school achievement, and age. Several studies have found that girls surpass boys with respect to writing performance (for a review see Gelati, 2012). Because writing plays a key role in students' assessments at school, those with better grades would probably write qualitatively better texts. Age was introduced as a control variable because, to obtain more reliable and powerful regression models, students in Grades 4-6 and 7-9 were grouped. This split was also based on the fact that, from Grade 6 to 7, children change from the second to the third Stage of Basic Education. The writing-related control variables were: handwriting fluency, spelling, and text structure. It has been demonstrated that transcription skills are largely associated with writing quality (Berninger & Swanson, 1994; Graham, Berninger, Abbott, Abbott, & Whitaker, 1997). The text structure variable was included as a measure of students' knowledge about the characteristic elements of narrative

texts. It was found that genre knowledge predicted writing performance (Olinghouse & Graham, 2009). The high-level writing variables included story planning and four revision variables: mechanical detection, mechanical correction, substantive detection, and substantive correction. We expected that high-level skills would predict compositional quality above and beyond control variables in Grades 7-9, but not in Grades 4-6 (Hypothesis 4). This hypothesis was based on the previously surveyed research, which supported a larger contribution of high-level writing skills in older than younger students.

Method

Participants

The participants were 419 Portuguese native speakers in Grades 4-9. Five students with special education needs, 14 students who missed one of the two administration sessions, and 19 students who did not follow task instructions were excluded from the analyses. Demographic data from the remaining 381 students is presented in Table 1.

Table 1 about here

Setting

Basic Education in Portugal lasts 9 years and comprises three stages: Grades 1-4 (age 6 to 10), Grades 5-6 (age 10 to 12), and Grades 7-9 (age 12 to 15). Crucial differences between stages are as follows: Stage 1 is provided in primary schools and only one teacher is responsible for teaching the four main courses; Stage 2 is provided in basic schools and children have one teacher for each of the nine courses; finally, Stage 3 is provided in basic or secondary schools and students have eleven courses.

Regarding the teaching of writing in Portugal, a gradual shift from a product- to a process-oriented approach has been occurring (Álvares Pereira, Aleixo, Cardoso, & Graça, 2010). For instance, in a recent reform of the Portuguese Language curriculum (Reis et al.,

2009), the explicit teaching in planning, translating, and revising processes is deemed as a critical component of writing instruction. Although writing is the preferred learning and assessment tool across courses and schooling, explicit writing instruction only occurs in Portuguese Language classes.

Procedure

The present study is part of a larger research project investigating writing development. Students performed several tasks, but only those relevant to the present study are described next. Data collection occurred in classroom groups with 20-25 students during two 45-min sessions in the month of May. Students started each session by planning and writing a story about the following topic: "Tell a story about a child who lost his/her pet". The experimenter gave students 3 min to plan the text, that is, to write down everything that could help them to write the text (for a similar procedure see Berninger et al., 1996). Then, students had 8 min to write it. Anytime a student stopped writing he or she was prompted to continue. Given the wide range of participants' grade level, the duration of the planning and writing tasks was chosen to allow all students to generate and develop their ideas without fatiguing the younger ones. After the writing task, in the first session, participants performed the alphabet task (Berninger et al., 1992). They were asked to write the lowercase letters of the alphabet during 15 s, legibly and as quickly as possible. In the second session, participants were asked to revise a story, in which we implanted six mechanical errors (two errors of three kinds: spelling, punctuation, and syntax errors), and six substantive errors (two errors of three kinds: missing, inconsistent, and out-of-sequence sentences). This task was completed in two phases. Firstly, students marked everything they thought was not right (detection phase). Secondly, the experimenter gave them the text with all target errors marked and students corrected them (correction phase). In both sessions two adults were always present in the

room to guarantee that experimental procedures were carried out as intended and that students did not look at their peer's sheets, particularly, in the revision task.

Measures

Handwriting fluency. To assess students' handwriting fluency we counted the total number of legible letters of the alphabet written in the right sequence during 15 s.

Spelling. The percentage of words spelled correctly in the story was used as a measure of spelling skills.

Text structure. Texts were scored to determine if they included the characteristic elements of a story. Eight narrative elements were considered: characters, time, space, initiating event, attempt, internal response, consequence, and reaction (based on Stein & Trabasso, 1982). For each element, one point was awarded if it was present.

Planning. A rating scale ranging from 1 (*low*) to 6 (*high*) was used to assess students' planning skills. The scores 1 and 2 were attributed to plans that represent no preplanning and minimal preplanning, respectively. Plans summarizing the text received a score of 3, and plans with topics slightly elaborated in the text received a score of 4. The scores 5 and 6 were attributed to plans with emergent subordination (i.e., rudimentary macrostructure) and structural relationships (e.g., graphic organizers), respectively. This scoring scale was based on those developed by Whitaker et al. (1994), and Olinghouse and Graham (2009).

Revision. Four measures were extracted from the revision task. The number of mechanical errors accurately detected or corrected was used as a measure of mechanical detection and mechanical correction, respectively. The number of substantive errors accurately detected or corrected was used as a measure of substantive detection and substantive correction, respectively (maximum of 6 points per score).

Writing quality. Two pairs of graduate students, blind to study purposes, rated writing quality by means of a scale ranging from 1 (*low*) to 7 (*high*). Raters were told to

consider ideas quality, organization, sentence structure, and vocabulary, and to give the same weight to these factors. To control for expected differences between grade levels, one pair of judges rated all texts from Grades 4-6, and the other pair rated all texts from Grades 7-9. To avoid biased judgments all texts were previously typed and corrected for spelling, punctuation, and capitalization errors (Berninger & Swanson, 1994). Inter-rater reliability using Cohen's weighed Kappa for writing quality was .78 and .84, respectively, in Grades 4-6 and 7-9. Thus, the final score was the average for the two judges.

Measures Reliability

At each grade, a second judge rescored the tasks for 20% of the students. Inter-rater reliability, using Cohen's weighed Kappa, for text structure, planning, and revision was .98, .88, and 1.00, respectively. Inter-rater reliability for the alphabet task and spelling, using Intraclass Correlation Coefficient, was .991 and .997, respectively.

Results

Data analyses encompassed two phases. In the first one, analyses of variance (ANOVAs) were conducted to analyse the development of planning, as well as mechanical and substantive detection and correction across schooling. In the second phase, regression analyses were performed to examine the contribution of planning and revising skills to writing quality.

Development of Planning and Revising Skills

To examine the development of planning skills throughout school years, we conducted a one-way ANOVA (see Table 2 for descriptive statistics). As predicted, we found significant effect of grade, $F(5, 375) = 18.33$, $p < .001$, $\eta^2_p = 0.20$. Planned contrasts revealed a decrease from Grade 4 to 5 ($p = .002$, $d = -0.62$), an increase from Grade 5 to 6 ($p = .001$, $d = 0.72$), a stationary period from Grade 6 to 7 ($p = .33$, $d = -0.16$), and increases from Grade 7 to 8 ($p = .01$, $d = 0.42$) and 8 to 9 ($p < .001$, $d = 0.68$).

The development of mechanical and substantive revising skills throughout school years was analysed by means of two 2 (revision sub-process) x 6 (grade) ANOVAs, with repeated measures on the first factor (see Table 2 for descriptive statistics). Regarding mechanical revision, we found a main effect of revision sub-process, $\Lambda = .66$, $F(1, 375) = 192.53$, $p < .001$, $\eta^2_p = 0.34$, and a main effect of grade, $F(5, 375) = 37.61$, $p < .001$, $\eta^2_p = 0.33$. The interaction between these two variables was also significant, $\Lambda = .97$, $F(5, 375) = 2.46$, $p = .03$, $\eta^2_p = 0.03$, and was examined with tests of simple main effects. We found that for all grade levels, students were better at correcting mechanical errors than detecting them, $\Lambda < .97$, Fs$(1, 375) > 10.29$, ps $< .001$, $\eta^2_p > 0.03$. Furthermore, tests of simple main effects revealed significant differences across grades for mechanical detection, $F(5, 375) = 21.19$, $p < .001$, $\eta^2_p = 0.22$, as well as for mechanical correction, $F(5, 375) = 29.58$, $p < .001$, $\eta^2_p = 0.28$. These significant effects were followed-up by planned contrasts. For mechanical detection, these tests showed a decrease from Grade 4 to 5 ($p = .02$, $d = -0.55$), which was followed by increases from Grade 5 to 6 ($p = .03$, $d = 0.45$) and 6 to 7 ($p = .007$, $d = 0.45$). Although these skills remained stable from Grade 7 to 8 ($p = .02$, $d = 0.01$), they clearly levelled up from Grade 8 to 9 ($p < .001$, $d = 0.70$). Similar tests showed that mechanical correction levelled off from Grades 4 to 5 ($p = .54$, $d = -0.12$), increased from Grade 5 to 6 ($p = .01$, $d = 0.45$), and levelled off again from Grade 6 to 7 ($p = .09$, $d = 0.45$). A growing trend was found throughout the next grades, with robust increases from Grade 7 to 8 ($p = .004$, $d = 0.51$), and 8 to 9 ($p = .009$, $d = 0.47$).

Concerning substantive revision, we found a main effect of revision sub-process, $\Lambda = .97$, $F(1, 375) = 12.86$, $p < .001$, $\eta^2_p = 0.03$. Similarly to mechanical revision, students were better at correcting substantive errors than detecting them. We also found a main effect of grade, $F(5, 375) = 9.41$, $p < .001$, $\eta^2_p = 0.11$. Planned contrasts revealed that substantive revision remained stable from Grade 4 to 5 ($p = .76$, $d = -0.06$), increased from Grade 5 to 6

(p = .01, d = 0.41), and levelled off again from Grade 6 to 7 (p = .84, d = -0.03). Although there was a growing trend from Grade 7 to 8 (p = .06, d = 0.25) and 8 to 9 (p = .18, d = 0.17), the differences between these grades were not larger enough to be statistically significant. The interaction between revision sub-process and grade was not reliable, $F < 1$.

Table 2 about here

Contribution of High-Level Writing Skills to Writing Quality

Table 3 shows means and standard deviations for the regression variables, along with their intercorrelations, for Grades 4-6 and 7-9. Regarding control variables, achievement was positively correlated with almost all variables in both groups. Age was also correlated with almost all other variables, but only in the older group. Transcription variables had higher correlations with each other than with other control variables. Revision variables were moderately correlated in both groups, but they were only correlated with planning in the older group.

Table 3 about here

To examine whether students' high-level writing skills made a unique contribution to writing quality, we conducted hierarchical regression analyses. Separate analyses by grade groups were conducted to predict writing quality (see Table 4). For both analyses, Step 1 included the six control variables, and on Step 2 the five high-level variables were added.

In Grades 4-6, the control variables significantly predicted writing quality, R^2 = .27, $F(6, 169) = 10.30$, $p < .001$. However, when the high-level variables were entered, there was no increase in the prediction of writing quality, R^2 = .30, $F_{change}(5, 164) = 1.25$, p = .29. Only age, achievement, handwriting fluency, and text structure significantly contributed to writing quality. In Grades 7-9, Step 1 of the analysis was significant, R^2 = .32, $F(6, 198) = 15.37$, $p <$

.001. Moreover, there was a significant increase in the prediction of writing quality on Step 2, $R^2 = .38$, $F_{change}(5, 193) = 3.54$, $p = .004$. This means that 6% of the variance associated with writing quality was uniquely explained by high-level writing skills. Planning and substantive correction, along with gender, achievement, and text structure, significantly explained writing quality variability.

Table 4 about here

Discussion

The first aim of the present study was to analyse the development of planning and revising from Grade 4 to 9. We examined whether grade affected planning, and whether grade and revision sub-process (detection vs. correction) affected mechanical and substantive revision. The second aim of the present study was to analyse the contribution of students' high-level skills to writing quality, after controlling a set of variables writing and non-writing related.

The predicted growth tendency of the planning skills across schooling was found (Hypothesis 1). From Grade 4 to 9, there was an increase of 1.2 in story planning. Agreeing with Berninger and collaborators (Berninger & Swanson, 1994; Berninger et al., 1996; Whitaker et al., 1994), this finding suggests that preplanning has already emerged in Grade 4 and continues to develop throughout the next school years. Nonetheless, it is worth mentioning that in Berninger and colleagues' studies and ours the experimental procedure forced students to preplan. Hence, we cannot assume that they would do it in the absence of such instruction. Indeed, in the latter situation, 85% of sixth graders and 67% of eight graders did not show explicit planning processes (Fidalgo, Torrance, & García, 2008; Torrance et al., 2007).

Confirming Hypothesis 2, students' ability to revise increased from one grade to the next. Still, the pace of development was more pronounced for mechanical than substantive revision. Respectively, there was a growth of 3.5 and 1.6 points, from Grade 4 to 9, even though the performance of older students in revising substantive errors was poor. This result might be explained by a biased conception of revision toward surface features (Graham et al., 1993), or it might have been the by-product of indicating errors' location. It has been shown that this procedure lead seventh graders to focus on mechanical problems, at the expense of meaning problems (McCutchen et al., 1997).

The finding that students were better at correcting than detecting either mechanical or substantive errors corroborated Hypothesis 3. At all grade levels, students were able to correct more errors than those they were able to detect. In line with the findings of Hacker, Plumb, Butterfield, Quathamer, and Heineken (1994), this result suggests that writers may have difficulties in detecting an error if they are not able to recognize the correct version of it. With a sample of high school students, they showed that the majority of detected errors were corrected. However, especially in the case of meaning errors, students' were able to correct several errors that had not been previously detected. This difference might have been magnified because in the correction task students were cued by the indication of error location, but in the detection task they were not. Probably, if this latter have been cued (e.g., by providing the number of errors or delimiting their location) the difference between the two revision sub-processes would be reduced. Nevertheless, the superiority of correction over detection is a consistent finding in the literature. Despite that, students' ability to detect errors can be improved by several means, such as instruction in the revision process (Fitzgerald & Markham, 1987), promotion of comprehension monitoring (Beal, Garrod, & Bonitatibus, 1990), or postponement of the revision process (Chanquoy, 2001).

It is noticeable that besides the growth pattern of planning and revising skills some decreases and stationary periods were found from Grade 4 to 5, and from Grade 6 to 7. This might be the consequence of the transitions between the Basic Education Stages of the Portuguese school system (see method's section). These transitions are usually accompanied by increases in teachers' expectations and learning demands (Reis et al., 2009), which can possibly defeat and weaken students' confidence on their academic skills. In the specific case of writing, it is likely that this lower sense of self-efficacy could negatively impact their performance. Indeed, it was shown that students' self-perceptions of their own writing competence is a strong predictor of various writing outcomes, above and beyond other motivational variables (Pajares & Valiante, 1997, 1999).

The regression analyses used to test if students' high-level writing skills had an incremental effect on their writing quality verified Hypothesis 4. As expected, high-level writing skills did not predict writing quality in Grades 4-6, but they did in Grades 7-9. Given the poorly developed planning and revising skills of younger students, they might have adopted a knowledge-telling strategy to write the story. With this strategy, text production is guided by topic and genre cues with little influence of high-level processes (Bereiter & Scardamalia, 1987). The early acquisition of the narrative schema enables students to write by retrieving content, filling it within the narrative schema, and translating it into text (Olive, Favart, Beauvais, & Beauvais, 2009). Regarding older students, differences in writing quality were accounted for by their planning and revising skills, above and beyond other well-known predictors. This finding indicates that older students might have adopted a knowledge-transforming strategy to write the story, which involves the articulation of translation with planning and revising (Bereiter & Scardamalia, 1987). Older students' writing called for their planning and revising skills, respectively, to generate and organize ideas in a coherent way, and to change these ideas in an attempt to clarify them to the audience.

It is noteworthy that, with respect to revision, only substantive correction contributed to writing quality. On the one hand, it seems that writing quality is dependent upon writers' ability to focus on overall concerns at the text-meaning level, rather than on local concerns at the sentence and word levels. Indeed, it was shown that an increase in the amount of meaning, global revisions resulted in gains in compositional quality (De La Paz et al., 1998), but an increase in the amount of surface, local revisions did not (Graham, 1997). On the other hand, the finding that substantive correction, rather than substantive detection, influenced the quality of students' texts might be explained by their poor ability to detect meaning errors. Yet, this is not to say that one of the sub-processes is more important than the other. Actually, writers must be able to detect not only flaws in the text but also elements that can be enhanced through rereading. Without this recognition, writers will not be able to introduce modifications that improve the text.

The presented findings should be considered in view of at least four limitations. First, the development of planning and revising skills was analysed cross-sectionally. Future research should explore the development of these skills longitudinally. Second, students in Grades 4-6 were grouped as well as students in Grades 7-9. Besides age was introduced as a control predictor, larger samples should be collected to analyse the contribution of high-level writing skills to writing at each grade level. Third, we did not analyse the online management of planning or revision. This analysis could deepen our understanding about students' use of these skills during text production as writing performance is also influenced by the interaction and temporal distribution of planning and revision in a writing session (Rijlaarsdam & Van den Bergh, 2006).

Educational Implications

With respect to the teaching and learning of writing, the current study agrees with the position of many writing researchers that more needs to be done to support and foster the

writing skills of school-aged children (e.g., Connelly & Barnett, 2009; Graham, Gillespie, & McKeown, 2012; Rijlaarsdam et al., 2005). In particular, our results complement a large body of research (see Graham & Harris, 2009), by emphasizing the importance of fostering students' high-level writing skills throughout schooling.

We found that planning and revising progressively increased across schooling, which seems to indicate that school instruction supports their development. Even so, our findings suggest that there is room for improvement. Signalling the need to develop and test instructional programs to supplement writing instruction in the general education classroom, we found that students' ability to plan before writing and to revise for meaning was not fully operational. This is problematic because these skills are critical in writing. Actually, planning and revising contributed to writing quality above and beyond a set of writing- and non-writing-related variables (viz., gender, school achievement, age, handwriting fluency, spelling, and text structure). The incremental validity of these high-level writing skills points out to the need of boosting them as a key way to improve developing writers' text production effectively and efficiently. The finding that these skills are predictive of writing quality in Grades 7-9 but not in Grades 4-6 makes us argue that they should be targeted in the initial stages of learning to writing. The lack of sufficient planning and revising abilities may, perhaps, explain why younger students are not using them in a manner that would aid text production. Nevertheless, the poorly developed high-level writing skills of novice writers do not seem to be only a question of maturation of executive functions. They might also sign that younger students are not benefiting from appropriate instruction. Consequently, efforts should be made to develop and provide teachers with evidence-based practices that they can use to support very young writers' planning and revising skills. Research has been providing evidences that not only older but also younger students can be successfully taught to employ their high-level writing skills to write qualitatively better texts. In a meta-analysis of writing

instruction for students in Grades 1-6, Graham, McKeown, et al. (2012) found that the teaching of planning and revising strategies is among the most effective writing interventions. A similar result was found in another meta-analysis with students in Grades 4-12 (Graham & Perin, 2007). Collectively, these findings and those of the present study highlight that, among the plethora of skills involved in writing, those of planning and revision deserve a prominent place in writing instruction from early on.

References

Alamargot, D., & Fayol, M. (2009). Modeling the development of written composition. In R. Beard, D. Myhill, J. Riley & M. Nystrand (Eds.), *The Sage handbook of writing development* (pp. 23-47). London: Sage.

Álvares Pereira, L., Aleixo, C., Cardoso, I., & Graça, L. (2010). The teaching and learning of writing in Portugal: The case of a research group. In C. Bazerman, R. Krut, K. Lunsford, S. Mcleod, S. Null, P. Rogers & A. Stansell (Eds.), *Traditions of writing research* (pp. 58-70). New York, NY: Routledge.

Alves, R. A., & Haas, C. (2012). Special issue: Writing and cognition, in Honer of John R. Hayes: Editors' Introduction. *Written Communication, 29*, 239-243. doi: 10.1177/0741088312451110

Beal, C. R. (1990). The development of text evaluation and revision skills. *Child Development, 61*, 247-258. doi: 10.2307/1131063

Beal, C. R., Garrod, A. C., & Bonitatibus, G. J. (1990). Fostering children's revision skills through training in compregension monitoring. *Journal of Educational Psychology, 82*, 275-280. doi: 10.1037/0022-0663.82.2.275

Bereiter, C., & Scardamalia, M. (1987). *The psychology of written composition*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Berman, R. A., & Slobin, D. I. (Eds.). (1994). *Relating events in narrative: A crosslinguistic developmental study*. New Jersey: Lawrence Erlbaum Associates.

Berninger, V. W., Cartwright, A. C., Yates, C. M., Swanson, H. L., & Abbott, R. D. (1994). Developmental skills related to writing and reading acquisition in the intermediate grades: Shared and unique functional systems. *Reading and Writing: An Interdisciplinary Journal, 6*, 161-196. doi: 10.1007/BF01026911

Berninger, V. W., & Swanson, H. L. (1994). Modifying Hayes and Flower's model of skilled writing to explain beginning and developing writing. In E. C. Butterfield (Ed.), *Children's writing: Toward a process theory of the development of skilled writing* (Vol. 2, pp. 57-81). Greenwich, Connecticut: JAI Press.

Berninger, V. W., Whitaker, D., Feng, Y., Swanson, H. L., & Abbott, R. D. (1996). Assessment of planning, translating, and revising in junior high writers. *Journal of School Psychology, 34*, 23-52. doi: 10.1016/0022-4405(95)00024-0

Berninger, V. W., & Winn, W. (2006). Implications of advancements in brain research and technology for writing development, writing instruction, and educational evolution. In C. A. MacArthur, S. Graham & J. Fitzgerald (Eds.), *Handbook of writing research* (pp. 96-114). New York, NY: Guilford Press.

Berninger, V. W., Yates, C. M., Cartwright, A. C., Rutberg, J., Remy, E., & Abbott, R. D. (1992). Lower-level developmental skills in beginning writing. *Reading and Writing: An Interdisciplinary Journal, 4*, 257-280. doi: 10.1007/BF01027151

Butterfield, E. C., Hacker, D. J., & Albertson, L. R. (1996). Environmental, cognitive, and metacognitive influences on text revision: Assessing the evidence. *Educational Psychology Review, 8*, 239-297. doi: 10.1007/BF01464075

Butterfield, E. C., Hacker, D. J., & Plumb, C. (1994). Topic knowledge, linguistic knowledge, and revision skill as determinants of text revision. In E. C. Butterfield (Ed.),

Children's writing: Toward a process theory of the development of skilled writing (Vol. 2, pp. 83-141). Greenwhich, Connecticut: JAI Press.

Chanquoy, L. (2001). How to make it easier for children to revise their writing: A study of text revision from 3rd to 5th grades. *British Journal of Educational Psychology, 71*, 15-41. doi: 10.1348/000709901158370

Chanquoy, L. (2009). Revision processes. In R. Beard, D. Myhill, J. Riley & M. Nystrand (Eds.), *The Sage handbook of writing development* (pp. 80-97). London: Sage.

Connelly, V., & Barnett, A. L. (2009). Introduction: Teaching and learning writing. *British Journal of Educational Psychology Monograph Series, II*(6), 1-4. doi: 10.1348/978185409X421110

De La Paz, S., Swanson, H. L., & Graham, S. (1998). The contribution of executive control to the revising by students with writing and learning difficulties. *Journal of Educational Psychology, 90,* 448-460. doi: 10.1037/0022-0663.90.3.448

Fidalgo, R., Torrance, M., & García, J.-N. (2008). The long-term effects of strategy-focussed writing instruction for grade six students. *Contemporary Educational Psychology, 33*, 672-693. doi: 10.1016/j.cedpsych.2007.09.001

Fitzgerald, J. (1987). Research on revision in writing. *Review of Educational Research, 57*, 481-506. doi: 10.3102/00346543057004481

Fitzgerald, J., & Markham, L. R. (1987). Teaching children about revision in writing. *Cognition and Instruction, 4*, 3-24. doi: 10.1207/s1532690xci0401_1

Gelati, C. (2012). Female superiority and gender similarity effects and interest factors in writing. In V. W. Berninger (Ed.), *Past, present, and future contributions of cognitive writing research to cognitive psychology* (pp. 153-174). New York, NY: Psychology Press.

Graham, S. (1997). Executive control in the revising of students with learning and writing difficulties. *Journal of Educational Psychology, 89*, 223-234. doi: 10.1037/0022-0663.89.2.223

Graham, S., Berninger, V. W., Abbott, R. D., Abbott, S. P., & Whitaker, D. (1997). Role of mechanics in composing of elementary school students: A new methodological approach. *Journal of Educational Psychology, 89*, 170-182. doi: 10.1037/0022-0663.89.1.170

Graham, S., Gillespie, A., & McKeown, D. (2012). Writing: Importance, development, and instruction. *Reading and Writing: An Interdisciplinary Journal*(Advanced online publication). doi: 10.1007/s11145-012-9395-2

Graham, S., & Harris, K. R. (2009). Evidence-based writing practices: Drawing recommendations from multiple sources. *British Journal of Educational Psychology Monograph Series, II*(6), 95-111. doi: 10.1348/000709909X421928

Graham, S., McKeown, D., Kiuhara, S., & Harris, K. R. (2012). A meta-analysis of writing instruction for students in the elementary grades. *Journal of Educational Psychology, 104*, 879-896. doi: 10.1037/a0029185

Graham, S., & Perin, D. (2007). A meta-analysis of writing instruction for adolescent students. *Journal of Educational Psychology, 99*, 445-476. doi: 10.1037/0022-0663.99.3.445

Graham, S., Schwartz, S. S., & MacArthur, C. A. (1993). Knowledge of writing and the composition process, attitude toward writing, and self-efficacy for students with and without learning disabilities. *Journal of Learning Disabilities, 26*, 237-249. doi: 10.1177/002221949302600404

Hacker, D. J. (1994). Comprehension monitoring as a writing process. In E. C. Butterfield (Ed.), *Children's writing: Toward a process theory of the development of skilled writing* (Vol. 2, pp. 143-172). Greenwhich, Connecticut: JAI Press.

Hacker, D. J., Plumb, C., Butterfield, E. C., Quathamer, D., & Heineken, E. (1994). Text revision: Detection and correction of errors. *Journal of Educational Psychology, 86*, 65-78. doi: 10.1037//0022-0663.86.1.65

Harris, K. R., Graham, S., & Mason, L. H. (2006). Improving the writing, knowledge, and motivation of struggling young writers: Effects of self-regulated strategy development with and without peer support. *American Educational Research Journal, 43*, 295-340. doi: 10.3102/00028312043002295

Hayes, J. R. (1996). A new framework for understanding cognition and affect in writing. In C. M. Levy & S. Ransdell (Eds.), *The science of writing: Theories, methods, individual differences, and applications* (pp. 1-27). Mahwah, NJ: Lawrence Erlbaum Associates.

Hayes, J. R. (2004). What triggers revision? In L. Allal, L. Chanquoy & P. Largy (Eds.), *Revision: Cognitive and instructional processes*. Dordrecht: Kluwer Academic Publishers.

Hayes, J. R. (2012). Evidence from language bursts, revision, and transcription for translation and its relation to other writing processes. In M. Fayol, D. Alamargot & V. W. Berninger (Eds.), *Translation of thought to written text while composing: Advancing theory, knowledge, research, methods, tools, and applications* (pp. 15-25). New York, NY: Psychology Press.

Hayes, J. R., & Flower, L. (1980). Identifying the organization of writing processes. In L. W. Gregg & E. R. Steinberg (Eds.), *Cognitive processes in writing* (pp. 3-29). Hillsdale, NJ: Lawrence Erlbaum Associates.

Hayes, J. R., & Flower, L. (1986). Writing research and the writer. *American Psychologist, 41*, 1106-1113. doi: 10.1037/0003-066X.41.10.1106

Hayes, J. R., & Nash, J. G. (1996). On the nature of planning in writing. In C. M. Levy & S. Ransdell (Eds.), *The science of writing: Theories, methods, individual differences, and applications* (pp. 29-55). Mahwah, NJ: Lawrence Erlbaum Associates.

Kellogg, R. T. (1988). Attentional overload and writing performance: Effects of rough draft and outline strategies. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 14*, 355-365. doi: 10.1037/0278-7393.14.2.355

Kellogg, R. T. (1996). A model of working memory in writing. In C. M. Levy & S. Ransdell (Eds.), *The science of writing* (pp. 57-71). Mahwah, NJ: Lawrence Erlbaum Associates.

Limpo, T., & Alves, R. A. (2013). Modeling writing development: Contribution of transcription and self-regulation to Portuguese students' text generation quality. *Journal of Educational Psychology*. doi: 10.1037/a0031391

MacArthur, C. A. (2012). Evaluation and revision. In V. W. Berninger (Ed.), *Past, present, and future contributions of cognitive writig research to cognitive psychology* (pp. 461-483). New York, NY: Psychology Press.

MacArthur, C. A., Graham, S., & Harris, K. R. (2004). Insights from instructional research on revision with struggling writers. In L. Allal, L. Chanquoy & P. Largy (Eds.), *Revision: Cognitive and instructional processes* (pp. 125-137). Amsterdam: Kluwer.

McCutchen, D., Francis, M., & Kerr, S. (1997). Revising for meaning: Effects of knowledge and strategy. *Journal of Educational Psychology, 89*, 667-676. doi: 10.1037/0022-0663.89.4.667

Olinghouse, N. G., & Graham, S. (2009). The relationship between the discourse knowledge and the writing performance of elementary-grade students. *Journal of Educational Psychology, 101*, 37-50. doi: 10.1037/a0013248

Olive, T., Favart, M., Beauvais, C., & Beauvais, L. (2009). Children's cognitive effort and fluency in writing: Effects of genre and of handwriting automatisation. *Learning and Instruction, 19*, 299-308. doi: 10.1016/j.learninstruc.2008.05.005

Pajares, F., & Valiante, G. (1997). Influence of self-efficacy on elementary students' writing. *The Journal of Educational Research, 90*, 353-360. doi: 10.1080/00220671.1997.10544593

Pajares, F., & Valiante, G. (1999). Grade level and gender differences in the writing self-beliefs of middle school students. *Contemporary Educational Psychology, 24*, 390-405. doi: 10.1006/ceps.1998.0995

Reis, C., Dias, A. P., Cabral, A. T., Silva, E., Viegas, F., Bastos, G., . . . Pinto, M. O. (2009). *Programas de português do ensino básico*. Lisboa: Ministério da Educação.

Rijlaarsdam, G., Braaksma, M., Couzijn, M., Janssen, T., Kieft, M., Broekkamp, H., & Van den Bergh, H. (2005). Psychology and the teaching of writing in 8000 and some words. *British Journal of Educational Psychology Monograph Series, II*(3), 127-153. doi: 10.1348/000709905X62156

Rijlaarsdam, G., & Van den Bergh, H. (2006). Writing process theory: A functional dynamic approach. In C. A. MacArthur, S. Graham & J. Fitzgerald (Eds.), *Handbook of writing research* (pp. 41-53). New York, NY: The Guilford Press.

Scardamalia, M., & Bereiter, C. (1983). The development of evaluative, diagnostic and remedial capabilities in children's composing. In M. Martlew (Ed.), *The psychology of written language: Development and educational perspectives* (pp. 67-95). New York, NY: Wiley.

Stein, N. L., & Trabasso, T. (1982). What's in a story? An approach to comprehension and instruction. In R. Glaser (Ed.), *Advances in instructional psychology* (Vol. 2, pp. 213-267). Hillsdale, NJ: Laurence Erlbaum Associates.

Torrance, M., Fidalgo, R., & García, J.-N. (2007). The teachability and effectiveness of cognitive self-regulation in sixth-grade writers. *Learning and Instruction, 17*, 265-285. doi: 10.1016/j.learninstruc.2007.02.003

Torrance, M., Thomas, G. V., & Robinson, E. J. (1999). Individual differences in the writing behaviour of undergraduate students. *British Journal of Educational Psychology, 69*, 189-199. doi: 10.1348/000709999157662

Whitaker, D., Berninger, V. W., Johnston, J., & Swanson, H. L. (1994). Intraindividual differences in levels of language in intermediate grade writers: Implications for the translating process. *Learning and Individual Differences, 6*, 107-130. doi: 10.1016/1041-6080(94)90016-7

Table 1

Demographic data for the participating students by grade

	Grade					
Measure	4	5	6	7	8	9
Gender (*N*s)						
Girl	26	23	45	28	30	39
Boy	32	30	20	41	31	36
Age (in years)						
M (*SD*)	10.0 (0.4)	11.0 (0.6)	12.1 (0.5)	13.0 (0.4)	14.0 (0.4)	15.0 (0.5)
Range	9.4–11.0	10.4–13.0	11.4–12.1	11.9–14.4	12.7–15.3	14.4–16.8
Mother's educational level (%)						
Grade 4 or below	25.9	9.4	18.5	14.5	9.8	14.7
Grade 9 or below	34.5	52.8	46.2	46.4	34.4	52.0
High school	19.0	22.6	16.9	20.3	26.2	14.7
College or above	20.7	7.5	16.9	17.4	27.9	16.0
Unknown	0.0	7.5	1.5	1.4	1.6	2.7
School marks[a] (1-5)						
$M_{\text{Portuguese}}$ (*SD*)	3.83 (0.96)	2.96 (0.68)	3.37 (0.74)	2.96 (0.63)	3.34 (0.91)	3.11 (0.80)
$M_{\text{Mathematics}}$ (*SD*)	3.67 (0.98)	3.02 (0.67)	3.12 (0.84)	2.91 (0.68)	3.18 (0.79)	2.95 (0.79)
M_{History} (*SD*)	4.03 (1.03)	2.91 (0.69)	3.68 (0.85)	3.30 (0.67)	3.69 (0.85)	3.25 (0.70)

Note. [a] The average mark of these courses was used as a measure of students' school achievement.

Table 2

Descriptive Statistics for Planning and Revision Measures by Grade

Measure	Grade					
	4	5	6	7	8	9
Planning (1-6)						
M	2.57	1.83	2.63	2.42	2.98	3.81
SD	1.42	0.91	1.28	1.38	1.28	1.14
Me	2.5	2	2	2	3	4
Min-Max	1-4	1-4	1-4	1-5	1-6	1-6
Mechanical detection (0-6)						
M	1.64	1.08	1.58	2.17	2.18	3.15
SD	1.00	1.04	1.18	1.41	1.50	1.25
Me	2	1	1	2	2	3
Min-Max	0-3	0-4	0-5	0-5	0-5	0-6
Mechanical correction (0-6)						
M	2.26	2.11	2.71	3.07	3.70	4.27
SD	1.09	1.35	1.32	1.26	1.20	1.20
Me	2	2	3	3	4	4
Min-Max	0-5	0-5	0.5	0.5	0-6	0-6
Substantive detection (0-6)						
M	1.02	0.89	1.23	1.26	1.57	1.79
SD	1.00	0.91	1.13	1.02	1.44	1.18
Me	1	1	1	1	1	2
Min-Max	0-3	0-3	0-5	0-4	0-5	0-5
Substantive correction (0-6)						
M	1.10	1.13	1.60	1.51	1.77	1.96
SD	0.83	0.86	1.04	0.95	1.16	0.94
Me	1	1	2	2	2	2
Min-Max	0-2	0-3	0-5	0-4	0-4	0-5

Table 3

Correlations, means, and standard deviations for regression variables by grade group

	1	2	3	4	5	6	7	8	9	10	11	*M*	*SD*
1. Age		-0.06	0.18	0.22	-0.001	0.35	0.22	0.31	0.14	0.15	0.17	14.00	0.95
2. Achievement	-0.27		0.29	0.29	-0.12	0.11	0.20	0.18	0.26	0.25	0.40	3.18	0.67
3. Handwriting Fluency	0.34	0.15		0.32	0.06	0.13	0.25	0.13	0.14	0.21	0.31	20.93	5.43
4. Spelling	-0.04	0.25	0.26		-0.10	0.12	0.42	0.30	0.11	0.18	0.20	98.03	2.13
5. Text Structure	0.21	0.06	0.23	-0.02		0.08	0.09	0.09	-0.01	-0.01	0.21	6.60	1.30
6. Planning	-0.02	0.27	0.15	-0.01	0.13		0.05	0.19	0.15	0.16	0.28	3.10	1.39
7. Mechanical Detection	-0.07	0.34	0.13	0.20	0.03	0.10		0.37	0.12	0.36	0.20	2.53	1.45
8. Mechanical Correction	0.09	0.34	0.15	0.27	0.06	0.09	0.32		0.06	0.25	0.18	3.70	1.32
9. Substantive Detection	0.05	0.25	0.12	0.19	0.07	0.13	0.23	0.14		0.36	0.19	1.55	1.23
10. Substantive Correction	0.18	0.25	0.28	0.16	0.12	0.11	0.14	0.24	0.43		0.32	1.75	1.03
11. Writing Quality	0.28	0.24	0.34	0.11	0.31	0.06	0.03	0.23	0.22	0.24		3.84	1.44
M	11.07	3.41	14.64	95.72	6.50	2.37	1.45	2.38	1.06	1.30	4.35		
SD	1.02	0.83	5.09	4.13	1.35	1.28	1.11	1.28	1.03	0.95	1.20		

Note. Values below the diagonal are Grades 4-6 (n = 176) and correlations equal or above .15 are statistically significant (α = .05). Values above the diagonal are for Grades 7-9 (*n* = 205) and correlations equal or above .14 are statistically significant (α = .05).

Table 4

Regression Model Predicting Writing Quality by Grade Group

Predictor	Grades 4-6 (n = 146)			Grades 7-9 (n = 205)		
	B	*SE*	*t*	*B*	*SE*	*t*
Step 1						
Gender	-0.31	0.17	-1.86	-0.59	0.18	-3.34***
Age	0.28	0.09	3.16**	0.24	0.09	2.58*
Achievement	0.37	0.11	3.44***	0.76	0.14	5.39***
Handwriting fluency	0.03	0.02	1.77	0.03	0.02	1.84
Spelling	0.001	0.02	0.05	0.00	0.04	0.06
Text structure	0.19	0.06	3.11**	0.26	0.07	3.96***
Step 2						
Gender	-0.21	0.18	-1.20	-0.63	0.17	-3.64***
Age	0.24	0.09	2.65**	0.15	0.10	1.44
Achievement	0.35	0.12	2.92**	0.65	0.14	4.54***
Handwriting fluency	0.04	0.02	1.97*	0.03	0.02	1.50
Spelling	-0.01	0.02	-0.27	0.01	0.05	0.13
Text structure	0.19	0.06	3.06**	0.25	0.07	3.85***
Planning	-0.05	0.07	-0.70	0.16	0.07	2.43*
Mechanical detection	-0.13	0.08	-1.67	-0.03	0.07	-0.48
Mechanical correction	0.09	0.07	1.18	-0.04	0.07	-0.52
Substantive detection	0.14	0.09	1.52	-0.05	0.07	-0.61
Substantive correction	0.03	0.10	0.28	0.30	0.09	3.17**

Note. The gender variable was dummy codded (0 = boy; 1 = girl).

*p < .05. **p < .01. ***p < .001.