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Tailoring Multicomponent Writing Interventions: Effects of Coupling Self-Regulation and Transcription Training

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Abstract

Writing proficiency is heavily based on acquisition and development of self-regulation and transcription skills. The present study examined the effects of combining transcription training with a self-regulation intervention (self-regulated strategy development [SRSD]) in Grade 2 (ages 7–8). Forty-three students receiving self-regulation plus transcription (SRSD+TR) intervention were compared with 37 students receiving a self-regulation only (SRSD only) intervention and 39 students receiving the standard language arts curriculum. Compared with control instruction, SRSD instruction—with or without transcription training—resulted in more complex plans; longer, better, and more complete stories; and the effects transferred to story written recall. Transcription training produced an incremental effect on students' composing skills. In particular, the SRSD+TR intervention increased handwriting fluency, spelling accuracy for inconsistent words, planning and story completeness, writing fluency, clause length, and burst length. Compared with the SRSD-only intervention, the SRSD+TR intervention was particularly effective in raising the writing quality of poorer writers. This pattern of findings suggests that students benefit from writing instruction coupling self-regulation and transcription training from very early on. This seems to be a promising instructional approach not only to ameliorate all students' writing ability and prevent future writing problems but also to minimize struggling writers' difficulties and support them in mastering writing.

Keywords

writing, self-regulation, transcription, strategy instruction

One of the truisms of the cognitive approach to written composition is that writing is a complex and cognitively demanding activity. This is mostly due to the plethora of processes involved in writing (Hayes, 1996) and seems to be one of the reasons why it is so difficult to master it (Harris & Graham, 2013). Fortunately, research has progressed in developing evidence-based practices to teach writing and support its development (Graham, McKeown, Kiuhara, & Harris, 2012; Graham & Perin, 2007). An effective way to boost the writing competence of beginning and developing writers is by promoting either self-regulated strategic writing or efficient automatic transcription. High levels of self-regulation allow the effective management of writing processes. Automatic transcription enables the effortless transformation of linguistic representations into written text. Therefore, the road to writing proficiency relies on the development of increasingly sophisticated self-regulation capabilities supported by the progressive automatization of transcription (Limpo & Alves, 2013a). Nevertheless, self-regulation and transcription have been studied independently. Thus, it is important to study the benefits of promoting transcription and self-regulation together. This was the aim of the present study, in which we compared the results from a self-regulation + transcription training group with a self-regulation-only training group and with a practice control group in Grade 2. The self-regulation training followed the self-regulated strategy development (SRSD) instructional model (Harris & Graham, 2009).

To the best of our knowledge, this is the first study testing the added value of promoting transcription with SRSD instruction in 7-year-olds. The findings will deepen our understanding of the interplay between transcription and self-regulation in beginning, normally achieving writers. This is the starting point to understand and support writing among struggling writers. Although the current study explicitly tested practices for the general education classroom, the findings are important for special education as well. The interventions developed and tested in this study are aligned with the first tier of response to intervention (RTI), which is a framework for supporting students'

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learning needs. A basilar piece of this framework is the development and implementation of Tier 1 interventions for preventing writing problems for all learners (National Center on Response to Intervention, 2010). Still, there is a paucity of evidence-based practices to implement effective Tier 1 instruction before students start struggling with writing (Baker, Chard, Ketterlin-Geller, Apichatabutra, & Doabler, 2009). This is problematic because difficulties with writing in early schooling may create a downward spiral that compromises writing development (Berninger, 1999). Interventions such as those tested here—aimed to foster the early acquisition of core writing processes—may therefore be used to prevent future writing-related problems. Moreover, the interventions provide relevant information to identify children not progressing as expected, who may need more intensive interventions, delivered at the second and third instructional tiers.

Current findings may also directly support the teaching of writing to struggling writers, since a great part of their writing instruction occurs in the general classroom (Graham, Olinghouse, & Harris, 2009). Struggling writers tend to have severe difficulties with basic writing skills, such as handwriting and spelling, as well as with strategic behaviors, such as planning and self-regulation (Berninger, 2009; Graham & Harris, 2002; Harris & Graham, 2013; Santangelo, Harris, & Graham, 2008). Targeting these skills and behaviors in early schooling, prior to the increase of writing demands in elementary grades (Reis et al., 2009), may lessen the severity of their difficulties. SRSD seems to be particularly appropriate to this aim because many of its characteristics are aligned with the needs of students challenged by writing, including those with learning disabilities (Graham & Harris, 2003; Harris & Graham, 2009). Finally, this study scrutinized instructional effects on a comprehensive set of writing measures, including measures specific to the interventions, general measures of the writing process and product, and a generalization measure. Findings may inform teachers about how best to teach students, considering their specific writing needs. This may maximize the effectiveness of the instructional practices and ultimately reduce the gap between students struggling with writing and their normally achieving peers.

Self-Regulated Strategic Writing

Hayes (1996) proposed a comprehensive writing model that illustrates the need for high levels of self-regulation in writing. This model includes an individual dimension (including cognitive processes, motivation/affect, long-term memory, and working memory) along with an environmental dimension (including task characteristics). Skilled writing is characterized by the dynamic articulation of these components, whose effective and sustained management requires "multifaceted self-regulation" (Zimmerman & Risemberg, 1997, p. 76). This means that, to attain their goals, writers need to monitor and strategically adjust all components involved in writing—namely, the cognitive processes and motivational beliefs related to writing (covert self-regulation), the writing-related motoric activities (behavioral self-regulation), and the social and physical setting where writing takes place (environmental self-regulation).

These three forms of self-regulation occur in a cyclic process made up of forethought, performance, and self-reflection phases (Zimmerman, 2000). The forethought phase sets the stage for the writing task through the implementation of task analysis strategies (i.e., goal setting and planning) and supportive self-motivation beliefs (e.g., self-efficacy, outcome expectancies, interest, and goal orientation). High-quality forethought processes are critical for the selection of strategies that will guide the writing process during the performance phase. Some strategies regulate performance (e.g., self-instructions), whereas others facilitate the observation of one's progress (e.g., self-monitoring). In the subsequent self-reflection phase, writers use self-judgment processes to compare performance against goals and to make causal attributions. These processes may result in satisfaction/dissatisfaction, positive/negative affect, and adaptive/defensive inferences. Closing the cycle, writers' reactions to outcomes influence forethought processes and exert motivational effects that will constrain future efforts and performance.

The extent to which writers engage in these self-sustaining cycles is a distinctive difference between skilled and less skilled writers. Self-regulated writers pursue their self-set goals in a flexible and knowledgeable way, employ general and writing-specific self-regulation strategies, and rely on adaptive personal beliefs stemming from goals' attainment. The characteristics of less skilled writers, including those with learning disabilities, are quite different from those of less skilled writers (Bereiter & Scardamalia, 1987; Graham & Harris, 2000; McCutchen, 2006). Less skilled writers rarely display a proactive and systematic use of strategies to regulate cognition, affect, behavior, and contexts. This poor strategic competence might be associated with difficulties in setting goals and action plans to orient writing, a limited repertoire of strategies and scant knowledge about their instrumentality, and emerging negative beliefs about writing and themselves as writers. Importantly, there is now substantial evidence that self-regulation in writing can be boosted through explicit instruction. Strategy-focused interventions, such as SRSD, are particularly suitable to that purpose by enhancing conscious, goal-directed, and effortful processing in writing (Pressley & Harris, 2006).

SRSD facilitates students' cognitive, motivational, and behavioral functioning in writing by combining systematic explicit teaching with extensive deliberate practice (for greater detail on SRSD, see Harris & Graham, 2009). SRSD

teaches students strategies to accomplish writing-specific processes, such as planning. Moreover, it teaches general self-regulation strategies (e.g., goal setting, self-monitoring, and self-instructions) to optimize forethought, performance, and self-reflection phases. Instruction involves six stages: develop background knowledge, discuss it, model it, memorize it, support it, and independent performance. Progressively across these stages, there is a reduction in teachers' support, which is paralleled by an increase in students' roles. Meta-analyses indicated that SRSD is one the best approaches to writing instruction in Grades 2 through 12, since its average effect size doubles that of other strategy instruction approaches (Graham & Perin, 2007; Graham et al., 2012; Rogers & Graham, 2008). In a meta-analytic review, Harris, Graham, Brindle, and Sandmel (2009; see also Graham, 2006; Graham & Harris, 2003) reported strong effects of SRSD on writing quality for taught genres (*ES* = 1.20 and *ES* = 1.23, respectively, at posttest and maintenance) as well as for untaught genres (*ES* = 1.20). Meaningful and lasting effects of SRSD had also been reported for other aspects of writing, such as schematic structure (e.g., inclusion of genre-specific elements), approach to writing (e.g., time spent planning and writing), discourse knowledge, and self-efficacy beliefs. These improvements were observed across achievement level, grade level, cognitive process taught, target genre, and type of instructor (teacher or researcher).

Efficient Automatic Transcription

Transcription is responsible for externalizing language held in working memory in the form of written text. This low-level writing process draws on the integration of the orthographic codes of letters and written spellings with the sequential finger movements required by the writing tool used to produce them (Abbott & Berninger, 1993). Therefore, transcription includes spelling and handwriting (or typing). An important condition for skilled writing is to have these processes operating automatically—that is, with minimal attentional requirements. Automatizing transcription is crucial because it promotes the concurrent activation of high-level writing processes, such as idea generation, language formulation, or purposeful self-regulation. Evidence of such parallel processing was found for adults but not for child writers (Olive & Kellogg, 2002).

For beginning and developing writers as well as for children with learning disabilities, such those with dyslexia (Sumner, Connelly, & Barnett, 2013) or developmental coordination disorder (Prunty, Barnett, Wilmut, & Plumb, 2013), transcription is not completely automatic. The act of putting words onto paper imposes heavy demands on the limited capacity of working memory, thereby depleting available attentional resources and preventing the concurrent activation of other processes (Bourdin & Fayol, 1994, 2000; Kellogg, 1996; McCutchen, 1996; Olive & Kellogg, 2002). A great amount of studies indicated that the nonautomatic transcription of either novice or struggling writers is a major constraint to their ability to produce texts (for a review, see Graham & Harris, 2000). Graham, Berninger, Abbott, Abbott, and Whitaker (1997) tested the contribution of handwriting and spelling to writing fluency and quality at two developmental points (Grades 1–3 vs. 4–6). This study showed that among younger and older students, transcription skills accounted for 41% and 66% of the variance in fluency and 25% and 42% of the variance in quality, respectively. Despite the importance of these results, they informed little about the mediating processes through which transcription interferes with writing.

Limpo and Alves (2013a) contributed to clarification of the link between transcription and writing. They tested the direct effects of transcription on writing quality as well as its indirect effects via self-regulation (i.e., planning, revising, and self-efficacy) at two developmental points (Grades 4–6 vs. 7–9). Together, transcription and self-regulation accounted for 76% and 82% of the variance in writing quality in Grades 4–6 and 7–9, respectively, suggesting that these variables were core ingredients to good writing. In the younger sample, transcription contributed directly to writing quality, indicating a lack of automaticity in handwriting and spelling. Transcription also contributed directly to planning, revision, and self-efficacy, showing that higher transcription skills were associated to better self-regulation processes. However, there was no contribution of planning, revision, and self-efficacy to writing quality. This might be related to novice writers' aforementioned difficulties in using self-regulation strategies and supportive motivation in writing. A different pattern was found in the older sample in which transcription influenced writing quality indirectly via planning and self-efficacy. This result substantiated the authors' claim that self-regulation plays a mediating role in the relationship between transcription and writing in older students. The reduced cognitive cost of efficient automatic transcription may facilitate the enactment of self-regulated strategic behaviors, which are fundamental to produce high-quality texts.

Given the key role played by transcription in children and adolescents' writing, these skills should be promoted very early. Explicit and systematic transcription instruction seems to be particularly effective, as reported by two recent meta-analyses on handwriting and spelling intervention research. Santangelo and Graham (2015) found that handwriting instruction had strong and consistent effects not only on handwriting fluency (*ES* = 0.63) but also on the amount (*ES* = 1.33), quality (*ES* = 0.84), and fluency (*ES* = 0.48) of students' writing. Regarding spelling, Graham and Santangelo (2014) found that, compared with no or informal instruction, explicit spelling instruction enhanced spelling performance (*ES* = 0.54 and *ES* = 0.43, respectively),

including that in the context of writing (*ES* = 0.94). Even though no further gains were observed in writing—which should be read cautiously given the small number of studies (*n* = 6)—reliable gains were found on reading skills (*ES* = 0.44). Importantly, both meta-analyses revealed the need for more research testing the effectiveness of transcription interventions and their effects on writing.

The Present Study

The main purpose of this study was to test whether transcription training would increase the effectiveness of a self-regulation intervention in Grade 2 (ages 7–8 years). For that, we developed a self-regulation program and a transcription program, which were implemented in parallel. Students receiving the two programs were compared with students receiving the self-regulation program only and with students receiving the regular Portuguese language arts curriculum. The self-regulation program followed the SRSD model to teach a writing-specific strategy for planning stories in tandem with self-regulation strategies (i.e., goal setting, self-monitoring, and self-instructions). The transcription program provided students with explicit instruction and intensive practice in writing letters, words, and sentences fluently and accurately. To strengthen students' knowledge about the Portuguese spelling system, transcription activities included carefully selected words containing alternations (i.e., different ways to represent a single phoneme). The effects of the interventions were assessed with a comprehensive set of writing measures, including planning, handwriting, spelling, writing performance, levels of written language, and online measures. In addition, the generalization effects of the intervention to story written recall were examined.

Research Questions and Hypotheses

Stemming from the research previously surveyed, our study was driven by two major research questions:

> *Research Question 1*: Does SRSD instruction, with or without transcription training, increase students' composing skills?
> *Research Question 2*: Is the effectiveness of the SRSD program enhanced when it is combined with transcription training?

Effects of SRSD instruction. Due to the teaching of a story-specific planning strategy, we expected extensive improvements in the complexity of students' plans. As previously discussed, the teaching of a planning strategy with self-regulation procedures is among the most effective practices to raise writing performance (Graham, 2006; Graham & Harris, 2003; Graham et al., 2012; Harris et al., 2009). Still, only a paucity of studies has shown this for 7-year-olds (Harris, Graham, & Mason, 2006; Zumbrunn & Bruning, 2013). We thus predicted that the SRSD program, with or without transcription training, would promote writing performance, measured through text length, writing fluency, and story quality.

To examine these overall effects in detail, stories were evaluated at three levels of language—namely, discourse, sentence, and word levels (Wagner et al., 2011; Whitaker, Berninger, Johnston, & Swanson, 1994). These levels were respectively measured through story completeness, clause length, and vocabulary diversity. We predicted that the SRSD program would promote story completeness, since it taught a story grammar with strategies to use it when generating ideas and producing text. There is compelling evidence that SRSD instruction targeting planning increases the number of genre-specific elements included in texts (Graham, 2006; Graham & Harris, 2003; Harris et al., 2009). Because preplanning should reduce students' need to generate ideas during writing, allowing them to focus on the conversion of ideas into language (Graham & Harris, 2007; Kellogg, 1988; Limpo & Alves, 2013b), we additionally expected positive effects of the SRSD program on story writing at the sentence and word levels.

Ancillary analyses of writing as it unfolds in real time allowed for an in-depth analysis of instructional effects on online measures of the writing process—namely, burst length and pause duration. Because this is the first study examining the effects of SRSD interventions on these measures, no specific hypotheses were formulated. Bursts and pauses are important developmental markers of writing efficiency (Alves & Limpo, 2015), and self-regulation training could either increase this efficiency by reducing children's need to plan during writing or decrease it by prompting deliberate and conscious processing.

The positive effects of the SRSD program were hypothesized to generalize to an untrained task: the written recall of a story orally presented. This hypothesis was grounded on the findings of a meta-analysis showing that teaching writing processes and text structures enhances reading comprehension (Graham & Hebert, 2011). In particular, transfer from story writing to story recall should be facilitated in two ways. First, the learning of a story-specific strategy should guide the encoding and retrieval of story information (Glaser & Brunstein, 2007; Johnson, Graham, & Harris, 1997). Second, the development of self-regulation skills should support the flexible application of knowledge and strategies to new tasks (Harris & Graham, 2009).

Incremental effects of transcription training. We anticipated that transcription training would raise students' handwriting fluency and spelling accuracy, as supported by recent meta-analyses' results (Graham & Santangelo, 2014; Santangelo & Graham, 2015). This increase in transcription

automatization was hypothesized to free up students' attentional resources (Bourdin & Fayol, 1994, 2000; Kellogg, 1996; McCutchen, 1996; Olive & Kellogg, 2002), which could be allocated to the newly acquired self-regulation skills. On this ground, we predicted that, compared with students receiving SRSD-only training, those receiving SRSD and transcription training would produce more complex plans; write longer, more fluent, and better stories; and produce more complete texts with longer clauses and more diverse vocabulary. Numerous studies have already found that promoting transcription has positive effects on students' composing skills (Alves et al., 2016; Berninger et al., 1997; Berninger et al., 1998; Berninger et al., 2002; Graham, Harris, & Fink-Chorzempa, 2000, 2002; Jones & Christensen, 1999; for meta-analyses see, Graham & Santangelo, 2014; and Santangelo & Graham, 2015). Given a growing body of research showing that transcription skills affect online writing measures (Alves, Branco, Castro, & Olive, 2012; Alves et al., 2016; Alves & Limpo, 2015; Connelly, Dockrell, Walter, & Critten, 2012), we further expected that transcription training would increase writing efficiency, manifested by longer bursts and shorter pauses. A similar effect was recently shown by Alves et al. (2016). Keeping our argument that transcription training should potentiate SRSD effects, we anticipated that students receiving both programs would also surpass their counterparts receiving only the SRSD program on the generalization measure.

Method

Participants and Design

In this study, 135 native Portuguese speakers in Grade 2 (six classes) participated. All participants were Caucasian and without diagnosed writing difficulties. The study involved a pretest-posttest quasi-experimental design. Classes were randomly assigned to one of three conditions, with two classes per condition: self-regulation + transcription (SRSD+TR), self-regulation only (SRSD only), and control. Due to the small number of classes per condition, students rather than classes were used as the unit of analyses. Four students with two or more retentions and 12 students who did not complete all pretest/posttest tasks were dropped from data analyses. Subsequent analyses were based on the data from 119 students (see Table 1 for demographic information).

Table 1. Demographic Data for the Participating Students by Condition.

Measure	Condition		
	SRSD+TR (n = 43)	SRSD only (n = 37)	Control (n = 39)
Gender, *n*			
Girls	25	19	23
Boys	18	18	16
Age, years			
M (*SD*)	7.2 (0.3)	7.4 (0.6)	7.4 (0.4)
Min-Max	6.8–7.7	5.9–9.6	6.8–8.7
Mother's educational level, %			
Grade ≤4	0	8	5
Grade ≤9	29	46	35
High school	44	22	41
College or above	27	24	19
Achievement,[a] *M* (*SD*)	4.3 (0.5)	3.9 (1.0)	4.1 (1.0)

Note. The three conditions did not differ on gender distribution (p = .76), students' chronological age (p = .09), mother's educational level (p = .24), and achievement (p = .12). SRSD+TR = self-regulation + transcription condition; SRSD-only = self-regulation-only condition.
[a]Achievement was measured by averaging students' marks on language arts, mathematics, and social sciences (1 = *lowest score*, 5 = *highest score*).

Intervention Conditions

The self-regulation program was delivered during ten 60-min lessons that occurred once a week, and it was equally implemented in the SRSD+TR and SRSD-only conditions. The transcription program was delivered during 10 units composed of three 20-min lessons that occurred once a week. Transcription lessons were implemented on different days, after the self-regulation lesson. The interventions were delivered by two graduate research assistants in psychology who taught one classroom of both conditions. Interventions were implemented during classes, partially replacing the regular instruction delivered by teachers.

SRSD program. This program taught a planning strategy that helped students generate and organize ideas following the narrative structure. The strategy was taught through the Portuguese mnemonic CASA (*house*), which helped students to remember the major story parts. To prompt the generation of ideas, these parts were formulated as questions: How does the story start: who, where, when? What happened and how? What was the solution? What happened next? How did they feel? How does the story end? In line with SRSD, this genre-specific strategy was coupled with general self-regulation strategies. Goal setting helped students guide their behavior and set the basis for self-monitoring. The students' goal was to write a complete story. Self-monitoring helped students obtain concrete evidence of their progress and link performance to strategy use. After writing each story, students counted the number of included story parts and registered the number on a "progress sheet." Self-instructions helped students manage the taught strategies. Using a "writing flowchart," they developed self-instructions to set goals, use the planning strategy, write the

story following the plan, and self-monitor. Instruction relied on the following SRSD practices: development of background knowledge; explicit instruction, discussion, and modeling of the self-regulation strategies; strategy memorization; collaborative practice supported by instructors that was gradually faded; and independent practice with minimal support (Harris & Graham, 2009). See Appendix for instructional procedures by lesson.

Transcription program. The main purpose of this program was to explicitly promote automaticity in handwriting. It also provided spelling practice aimed to facilitate students' automatic access to the correct spelling of words. Each of the 10 weekly units of this program were composed of three lessons: Lesson 1 was implemented in the classroom; Lesson 2 was implemented as homework; and Lesson 3 was implemented in the classroom under time constraints. These three lessons had a similar structure composed of two parts: alphabet warm-up (5 min), followed by single-word or sentence copying (15 min). Alphabet and copying activities are among the best practices to promote transcription skills (Graham, 2009).

The alphabet warm-up aimed to promote fast access to representations of letter forms in an ordered set in memory, as well as to automatize their retrieval and production in writing. There was a different activity in each lesson. In the first lesson of each unit, students wrote the lowercase alphabet starting from different letters. In the second lesson, they wrote the letter coming before and/or after other letters in the alphabet. In the last lesson, they wrote the lowercase alphabet during 60 s and self-monitored the number of letters correctly written.

The copying activities aimed to increase students' handwriting accuracy and speed. There was a different copying activity in each lesson. In the first lesson of each unit, students made a written sort of 20 words into two groups according to superficial features of the words (e.g., color, font). In the second lesson, students were given 10 incomplete sentences and a list of the words missing (one per sentence). After filling in the blank, students copied the whole sentence. In the last lesson, they copied a set of 10 sentences under time constraints (60 s per sentence) and self-monitored the number of words correctly copied in the last sentence.

By including carefully selected words, the copying activities provided students with implicit spelling practice. During the three lessons of each unit, students were exposed to and copied 20 target words containing alternations (i.e., different ways to represent a single phoneme) that are a struggle for children leaning the Portuguese spelling system (see Table 2 for a description). In Lesson 1, students were told to sort the words according to a superficial characteristic; however, they were actually sorting the words based on the two forms of representing a single phoneme. In Lesson 2, the 10 missing words corresponded to half of the 20 words targeted that week. In Lesson 3, the 10 sentences to copy included the other half of the 20 target words (one word per sentence). The copying activities of Weeks 5 and 10 included the target words presented in the previous 4 weeks. Importantly, spelling was practiced only through sorting and copying activities without any kind of explicit instruction. Instructors never discussed spelling, and any error was characterized as a copying mistake rather than a spelling mistake.

Table 2. Description of the Alternations (Different Forms of Representing the Same Phoneme) in Each Weekly Unit.

Unit	Alternation	Example
1	Alternative spelling units *r* and *rr* for the phoneme [R]	relva vs. jarra
2	Alternative spelling units *c* and *qu* for the phoneme [k]	caneta vs. tanque
3	Use of *m* before *p* or *b* and use of *n* before *t* or *d*	tampa vs. tinta
4	Alternative spelling units *g* and *gu* for the phoneme [g]	lago vs. figueira
5	Revision of the four previous alternations	
6	Alternative spelling units *ch* and *x* for the phoneme [S]	ficha vs. lixo
7	Alternative spelling units *s* and *z* for the phoneme [z]	desejo vs. amizade
8	Alternative spelling units *ss* and *ç* for the phoneme [s]	pessoa vs. pescoço
9	Alternative spelling units *j* and *g* for the phoneme [Z]	objeto vs. gigante
10	Revision of the four previous alternations	

Treatment fidelity. Six procedures guaranteed that the self-regulation and transcription programs were implemented as intended. First, instructors participated in an 8-hr preintervention workshop aimed to introduce the theoretical and empirical bases of the programs, to deliver the instructional manuals, and to discuss lesson procedures. Second, instructors had weekly meetings with the first author to practice the next lesson and discuss the previous one. There were rare deviations from instructional plans that usually involved missed steps and did not affect the planned duration of the lessons. Third, instructors were provided with a checklist with all lesson steps, and they were asked to check them off when each step was completed. Instructors reported to have completed an average of 97% and 96% of the proposed steps in the self-regulation and transcription programs, respectively. Whenever possible, missed steps were addressed in the next lesson. Fourth, the first author observed 30% of the lessons and filled out the same checklist as the instructors. In both programs, the author reported that instructors completed an average of 95% of the proposed steps. Fifth, the

quality of the observed lessons was evaluated on (a) level of students' engagement, (b) students' responses to questions and participation in discussion, (c) teachers' responses to students' questions, (d) efficiency of instruction, and (e) pacing of instruction (based on Saddler & Graham, 2005). The average quality of the self-regulation and transcription programs was 3.8 and 3.9, respectively (0 = *very low*, 4 = *very high*). Finally, students' notebooks were examined to assess whether the instructional activities were completed. With the exception of activities or part of activities whose nonaccomplishment was mentioned on instructors' checklists, the main activities of both programs (including homework activities) were successfully understood and completed by the majority of students.

Control Condition

Writing instruction of control students followed the standard writing curriculum and was delivered by their teachers. Although control classes were not observed, after the interventions, teachers were asked about how they taught handwriting, spelling, and text production in the previous 10 weeks (i.e., average time allotted, specific contents addressed, and main activities used). Teachers estimated that they dedicated 1, 2, and 3 hr per week to handwriting, spelling, and writing, respectively. Handwriting instruction was focused on fine motor skills and capitalization rules, trained through letter writing and text copying with "careful handwriting." The teaching of spelling involved explicit instruction of orthographic rules, trained through dictation and error-finding activities. Regarding text production, teachers reported to ask their students to write stories, invitations, and descriptions. Importantly, no references were made to key features of the intervention programs, such as promotion of handwriting automaticity through fast-paced exercises, implicit training of spelling, or teaching of writing and self-regulation strategies. Control students had the same amount of writing practice as interventions students. During story-writing instruction, control students were asked to write the same number of stories and on the same topics as their peers. Similarly, schoolteachers of intervention students provided them with writing practice in invitations and descriptions during regular instruction.

Testing Sessions

All students were evaluated 1 week before and after instruction. Testing sessions occurred in regular classroom groups and lasted 60 min. First, the experimenter presented the story topic (pretest: "Tell a story about a child who broke his/her brother's toy?" and posttest: "Tell a story about a child who lost his/her pet"). Then, the experimenter gave students a blank sheet to register everything that could help them to write the story (for a similar procedure, see Limpo & Alves, 2013b). Students had 5 min to plan the text and 10 min to write it. Afterward, students did the alphabet and copy tasks. In the former, they wrote the lowercase letters of the alphabet during 60 s, as quickly and legibly as possible (Berninger, Mizokawa, & Bragg, 1991). In the latter, they copied a sentence containing all letters of the alphabet during 90 s, as quickly and legibly as possible. Last, students spelled 16 dictated words. Only at posttest, students made a written recall of a story orally presented.

Materials: HandSpy

To collect temporal handwriting data, we used a new logging system called HandSpy. To write their texts, each student was provided with a regular-appearance digital pen (LiveScribe Pulse) and a paper sheet. The pen contained an infrared camera pointed at its nib and was running a penlet for logging handwriting data. The paper had a special microdotted pattern printed on it. Jointly, the pen and the paper enabled the recording of spatial and temporal coordinates about the pen trace. These data were then uploaded to the HandSpy application for online analyses.

Measures

Except for writing quality and measures calculated with software, the written products of one third of the students in each condition were rescored by a second judge. Interrater reliability was calculated separately for pre- and posttest based on the intraclass correlation coefficient (ICC).

Planning. Planning complexity was measured with a 6-point scale (Limpo & Alves, 2013a; $ICC_{pretest}$ = .95, $ICC_{posttest}$ = .99). The scores 1 and 2 were attributed to plans representing no 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. To examine posttest differences between the two intervention groups, we also scored posttest plans for completeness, by counting the number of strategy parts included in the plans (maximum = 8).

Handwriting. The alphabet and copy tasks were used to measure handwriting fluency. For the alphabet task, the final score was the number of correct letters written ($ICC_{pretest}$ = .99, $ICC_{posttest}$ = .97). A letter was counted when it was legible out of context and in the right alphabetical order. For the copy task, the final score was the number of correct words copied ($ICC_{pretest}$ = .98, $ICC_{posttest}$ = .98). A word was considered correct when its letters were copied without any mistakes.

Spelling. To assess spelling accuracy, we relied on students' performance on a dictation task composed of 16 words that were targeted in the transcription program (two of each unit). The test included eight consistent words, whose correct spelling could be determined by applying phoneme-to-grapheme correspondences and orthographic conventions, and eight inconsistent words, whose correct spelling could be resolved only through rote learning. For both sets of words, we counted the number of words correctly spelled (consistent set: $ICC_{pretest}$ = .97, $ICC_{posttest}$ = .98; inconsistent set: $ICC_{pretest}$ = .98, $ICC_{posttest}$ = .98).

Writing performance. Three measures of writing performance were obtained from students' stories: text length, writing fluency, and writing quality. Text length, measured in words, was calculated with the Computerized Language Analysis software (CLAN; MacWhinney, 2000). Writing fluency was measured by the number of words written per minute, which was calculated by dividing text length by composing time. Two research assistants, blind to study purposes, assessed writing quality. Using a scale ranging from 1 (*low quality*) to 7 (*high quality*), judges considered and gave the same weight to four factors: creativity (i.e., originality and relevance of the ideas), coherence (i.e., clarity and organization of the text), syntax (i.e., syntactic correctness and diversity of the sentences), and vocabulary (i.e., diversity, interest, and proper use of the words). To remove transcription biases from quality assessments, all texts were typed and corrected for spelling errors (Berninger & Swanson, 1994). The final score was the average across judges ($ICC_{pretest}$ = .91, $ICC_{posttest}$ = .92).

Levels of written language. At the discourse level, we measured story completeness by examining the presence and elaboration of eight story elements: characters, time, space, initiating event, attempt, internal response, consequence, and reaction (Stein & Trabasso, 1982). For each element, it was awarded 1 point if it was present and 2 points if it was present and elaborated (maximum = 16; $ICC_{pretest}$ = .95, $ICC_{posttest}$ = .94). At the sentence level, we measured clause length. We first divided texts into clauses (i.e., unit with a unified predicate and expressing a single situation; Berman & Slobin, 1994; $ICC_{pretest}$ = .97, $ICC_{posttest}$ = .95). Then, we calculated the average number of words per clause with CLAN. At the word level, we measured vocabulary diversity with a corrected type:token ratio (Carroll, 1964), which was calculated by dividing different words by the square root of two times the total words (word counts were provided by CLAN).

Online measures. Three measures were obtained from students' stories: burst length, short pauses duration, and long pauses duration. Burst length was calculated by averaging the number of words per burst, which was defined as a period of transcription activity between two consecutive pauses >2 s ($ICC_{pretest}$ = .97, $ICC_{posttest}$ = .98). Periods of transcription inactivity between 30 ms and 2 s were considered short pauses, and those >2 s were considered long pauses. The average duration of pauses was provided by HandSpy.

Story recall. The story orally presented and to be recalled included the eight story parts that students were taught: characters, time, space, initiating event, attempt, internal response, consequence, and reaction (Stein & Trabasso, 1982). The written recalls were scored for the presence and elaboration of each element. It was awarded 1 point if it was present but incomplete and 2 points if it was present and elaborated. We also counted the number of ideas that were misinterpretations of the original story. The final score was the total points awarded for the eight story elements minus the number of misinterpretations (maximum = 16; $ICC_{posttest}$ = .93).

Results

In a set of preliminary analyses, we tested if our data met the normality assumption of parametric procedures. The inspection of skewness and kurtosis of all pre- and posttest scores revealed no distributional problems, as the absolute values of these indexes did not exceed 3.0 and 10.0, respectively (Kline, 2005). Additionally, we examined if there were differences among conditions for all dependent measures at pretest. One-way analyses of variance with condition as a between-subjects factor revealed no condition effects at pretest (p's > .13), except for inconsistent words (p = .01) and vocabulary diversity (p = .03). Therefore, interventions' effects in posttest measures were examined with analyses of covariance (ANCOVAs) for all variables, introducing the respective pretest score as a covariate (see Table 3 for descriptive statistics). There were two exceptions to this—namely, the writing quality variable, in which there was a significant interaction between pretest scores and condition (p = .02), and the story recall variable, which was analyzed with a one-way analysis of variance since data were collected only at posttest. Significant condition effects were followed up through pairwise comparisons, the Cohen's d (Cohen, 1988) of which is reported in Table 4. Adjustments for multiple comparisons were not made, as these would be very conservative, particularly given the large number of comparisons computed (Perneger, 1998).

Because the data files extracted from the digital pens of 16 students were damaged, analyses involving measures dependent on HandSpy (i.e., writing fluency, burst length, short pauses duration, and long pauses duration) were based on the data of 103 students. Except for vocabulary diversity (p = .05), the excluded students did not significantly differ from the rest of the sample on any other measure (p's > .07).

Table 3. Means and *SD*s for All Measures in Each Condition by Testing Time.

	Pretest			Posttest			Posttest (adjusted *M*)		
Measure	SRSD+TR	SRSD only	Control	SRSD+TR	SRSD only	Control	SRSD+TR	SRSD only	Control
Planning	1.26 (0.44)	1.22 (0.42)	1.18 (0.39)	5.26 (0.49)	5.16 (0.44)	1.36 (0.54)	5.26	5.16	1.36
Handwriting									
Alphabet task	16.21 (7.52)	15.84 (7.09)	14.33 (6.31)	53.72 (11.61)	29.11 (11.74)	29.03 (13.22)	53.17	28.84	29.9
Copy task	7.86 (2.69)	7.32 (2.21)	7.28 (3.61)	17.93 (4.44)	14.30 (4.74)	14.41 (3.95)	17.6	14.47	14.62
Spelling									
Consistent words	5.37 (1.88)	4.73 (1.94)	4.74 (2.17)	6.81 (1.52)	6.14 (1.62)	6.72 (1.47)	6.59	6.27	6.84
Inconsistent words	3.26 (1.60)	2.19 (1.61)	2.38 (1.70)	5.77 (1.43)	4.11 (1.74)	4.36 (1.71)	5.48	4.34	4.49
Writing performance									
Text length	30.00 (14.60)	29.38 (13.54)	27.08 (15.69)	62.12 (13.99)	61.51 (19.23)	50.33 (18.91)	61.54	61.25	51.22
Writing fluency	4.39 (1.69)	3.83 (1.57)	4.44 (2.23)	8.98 (2.55)	7.20 (2.40)	7.96 (1.95)	8.87	7.44	7.82
Writing quality	2.76 (1.03)	2.54 (0.88)	2.49 (1.04)	4.80 (0.96)	4.61 (1.24)	3.99 (1.09)	4.76	4.59	4.03, 4.00[a]
Levels of written language									
Discourse: Story completeness	3.51 (1.53)	3.59 (1.88)	3.31 (1.63)	8.63 (2.05)	7.54 (2.33)	6.03 (1.69)	8.62	7.5	6.07
Sentence: Clause length	5.45 (0.79)	5.61 (0.83)	5.80 (1.00)	6.12 (0.97)	5.77 (0.84)	5.56 (1.00)	6.14	5.77	5.54
Word: Vocabulary diversity	2.79 (0.48)	2.84 (0.57)	2.55 (0.50)	3.40 (0.37)	3.49 (0.44)	3.33 (0.56)	3.37	3.45	3.39
Online measures									
Burst length	1.49 (0.47)	1.32 (0.30)	1.53 (0.54)	2.80 (1.12)	2.07 (0.65)	2.07 (0.70)	2.77	2.16	2.00
Short pause duration, ms	636.49 (168.15)	628.57 (125.54)	575.75 (102.71)	528.09 (145.04)	573.03 (173.26)	553.21 (140.47)	516.94	566.78	579.63
Long pause duration, s	7.56 (2.84)	8.31 (2.50)	8.94 (4.23)	6.45 (2.66)	7.15 (3.18)	5.62 (1.61)	6.54	7.13	5.45
Story recall[b]	—	—	—	5.88 (2.49)	6.57 (2.48)	4.51 (2.53)	—	—	—

Note. SRSD+TR = self-regulation plus transcription condition; SRSD-only = self-regulation-only condition.
[a]First and second values refer to adjusted means for the comparison between control students and, respectively, SRSD+TR and SRSD-only students. [b]Measure collected only at posttest.

Table 4. Effect Sizes (Cohen's *d*) Computed for All Pairwise Comparisons Among Conditions at Posttest.

Measure	SRSD+TR vs. SRSD only	SRSD+TR vs. Control	SRSD only vs. Control
Planning	0.21	**7.56**	**7.72**
Handwriting			
Alphabet task	**2.08**	**1.87**	−0.09
Copy task	**0.68**	**0.71**	−0.03
Spelling: Inconsistent words	**0.72**	**0.63**	−0.09
Writing performance			
Text length	0.02	**0.62**	**0.53**
Writing fluency	**0.58**	**0.46**	−0.17
Writing quality	—[a]	**0.71**	**0.51**
Levels of written language			
Discourse: Story completeness	**0.52**	**1.36**	**0.71**
Sentence: Clause length	0.41	**0.61**	0.25
Online measures			
Burst length	**0.67**	**0.82**	0.24
Story recall	−0.28	**0.55**	**0.82**

Note. Significant effects in bold. Effect sizes for short pauses, long pauses, and vocabulary diversity are not presented, because there were no differences among conditions at posttest. SRSD only = self-regulation only condition; SRSD+TR = self-regulation + transcription condition.
[a]Effect size was not calculated, as intervention effects were moderated by pretest scores.

Planning

After adjusting for initial pretest differences, there was a significant difference among conditions on planning complexity, $F(2, 115) = 790.78$, $p < .001$, $\eta_p^2 = 0.93$. Follow-up analyses showed that SRSD+TR students and SRSD-only students (p's < .001) wrote more complex plans than control students. To further investigate differences between intervention groups, we compared the number of strategy parts included in the plans. SRSD+TR students ($M = 4.93$, $SD = 1.67$) had more complete plans than SRSD-only students ($M = 3.76$, $SD = 2.14$), $t(78) = 2.75$, $p = .007$, $d = 0.61$.

Handwriting

With the respective pretest score introduced as a covariate, there were significant effects of condition on the alphabet task, $F(2, 115) = 63.65$, $p < .001$, $\eta_p^2 = 0.53$, and on the copy task, $F(2, 115) = 10.57$, $p < .001$, $\eta_p^2 = 0.16$. Post hoc analyses showed that SRSD+TR students surpassed SRSD-only and control students in both these tasks (all p's < .001).

Spelling

ANCOVAs revealed no differences among conditions for trained consistent words, $F(2, 115) = 2.71$, $p = .07$, $\eta_p^2 = 0.04$. There was, however, a significant condition effect for trained inconsistent words, after adjusting for pretest differences, $F(2, 115) = 7.03$, $p = .001$, $\eta_p^2 = 0.11$. Pairwise comparisons showed that SRSD+TR students correctly spelled more inconsistent words than SRSD-only students ($p = .001$) and control students ($p = .003$).

Writing Performance

After controlling for variations in pretest scores, there was a significant difference among conditions on text length, $F(2, 115) = 5.37$, $p = .01$, $\eta_p^2 = 0.09$. Follow-up analyses showed that SRSD+TR students ($p = .004$) and SRSD-only students ($p = .01$) wrote longer stories than control students. After adjusting for initial pretest differences, there was also a significant effect of condition on writing fluency, $F(2, 99) = 4.83$, $p = .01$, $\eta_p^2 = 0.09$. Post hoc analyses showed that SRSD+TR students wrote more words per minute than SRSD-only students ($p = .004$) and control students ($p = .05$).

Concerning writing quality, the violation of the homogeneity of regression slopes assumption precluded the use of ANCOVA to compare the three conditions simultaneously. Therefore, we conducted separate ANCOVAs for each pair of conditions to determine whether the Covariate × Condition interaction would be significant for all comparisons. Analyses revealed no interactions for the ANCOVAs comparing SRSD+TR and control conditions as well as SRSD-only and control conditions (p's > .09). Separate ANCOVAs without the interaction term were thus conducted. Results showed that SRSD+TR and SRSD-only wrote better stories than control students, $F(1, 79) = 11.26$, $p = .001$, $\eta_p^2 = 0.13$ and $F(1, 73) = 6.63$, $p = .01$, $\eta_p^2 = 0.08$, respectively. Regarding the model comparing SRSD+TR and SRSD-only conditions, we found a significant interaction between pretest scores and condition ($p = .01$). Thus, the Johnson-Neyman technique was used to determine the regions in the range of pretest scores where the condition effect on posttest scores was statistically significant (Aiken & West, 1991). Regression lines for SRSD+TR ($Y = 4.34 + 0.17X$) and SRSD only ($Y = 2.54 + 0.82X$) were determined separately and compared. Results showed that the region of significance included all pretest scores ≤1.93, $b = 0.55$, $p = .05$, as well as all pretest scores ≥4.00, $b = -0.79$, $p = .05$. Among students who received a writing quality score <2 at pretest (14% of students), SRSD+TR students wrote better posttest stories than SRSD-only students. Additionally, among students who received a writing quality score ≥4 at pretest (14% of students), SRSD-only students wrote better posttest stories than SRSD+TR students.

Levels of Written Language

After adjusting for initial pretest differences, results showed a significant difference among conditions on story completeness (discourse level), $F(2, 115) = 16.80$, $p < .001$,

$\eta_p^2 = 0.23$. Pairwise comparisons revealed that SRSD+TR students ($p < .001$) and SRSD-only students ($p = .002$) surpassed control students. SRSD+TR students also wrote more complete stories than SRSD-only students ($p = .01$). After controlling for variations in pretest scores, we found a significant effect of condition on clause length (sentence level), $F(2, 115) = 4.19$, $p = .02$, $\eta_p^2 = 0.07$. Follow-up analyses showed that SRSD+TR students wrote longer clauses than control students ($p = .01$). Concerning vocabulary diversity (word level), the ANCOVA revealed no differences among conditions, $F < 1$.

Online Measures

After controlling variations in pretest scores, there was a significant difference among conditions on burst length, $F(2, 99) = 8.52$, $p < .001$, $\eta^2_p = 0.15$. Post hoc analyses showed that SRSD+TR students wrote longer bursts than SRSD-only students ($p = .002$) and control students ($p < .001$). ANCOVAs revealed no significant condition effects on duration of short pauses, $F(2, 99) = 2.35$, $p = .10$, $\eta_p^2 = 0.05$, and long pauses, $F(2, 99) = 2.91$, $p = .06$, $\eta_p^2 = 0.06$.

Story Recall

At posttest, there was a significant condition effect on story recall, $F(2, 116) = 6.71$, $p = .002$, $\eta_p^2 = 0.10$. Pairwise comparisons revealed that SRSD+TR students ($p = .04$) and SRSD-only students ($p = .002$) produced more complete written recalls than control students.

Discussion

This study evaluated the effects of a multicomponent intervention addressing self-regulation and transcription in Grade 2. To that end, students receiving SRSD instruction coupled with transcription training were compared with students receiving SRSD-only instruction and with students in a practice control group. Our main research questions were as follows: (1) Does SRSD instruction, with or without transcription training, increase students' composing skills? (2) Is the effectiveness of the SRSD program enhanced when it is combined with transcription training? To provide fine-grained answers to these questions, instructional effects were assessed on a comprehensive set of writing measures, including planning, handwriting, spelling, writing performance, levels of written language, online measures, and story recall.

Confirming the effectiveness of self-regulation instruction and in line with previous findings (Graham, 2006; Graham & Harris, 2003; Harris et al., 2009), we found that the SRSD intervention, with or without transcription training, increased students' composing skills. These positive effects occurred in measures aligned with the self-regulation program (i.e., planning complexity and story completeness), in measures of overall writing performance (i.e., writing length and quality), and in a generalization measure (i.e., written recall). Also as predicted, we found that promoting self-regulation with transcription yielded several effects above and beyond promoting self-regulation alone. The combined intervention increased the transcription skills that were directly targeted by the transcription program (i.e., handwriting and spelling). It seems likely that due to an increase in transcription automaticity, SRSD+TR students produced their texts more efficiently—with greater writing fluency and longer bursts—than their peers. Notably, the added value of the transcription program was not limited to transcription- and fluency-related variables but extended to content-related variables. Incorporating transcription training into SRSD instruction allowed students to register more ideas in their written plans, to write more complete and elaborated stories, and to produce more syntactically complex sentences in writing. It seems that promoting automaticity in low-level processes resulted in spare attentional resources that were devoted to high-level processes, such as generating ideas and putting them into sentences (Bourdin & Fayol, 1994, 2000; Kellogg, 1996; McCutchen, 1996; Olive & Kellogg, 2002).

Together, these findings add to prior research highlighting the pivotal role of transcription and self-regulation in writing (Berninger & Winn, 2006; Graham & Harris, 2000). Furthermore, they provide a strong argument to couple SRSD and transcription training in instructional programs for primary-grade students. In what follows, we provide a thorough discussion on the effects of SRSD and SRSD+TR on each outcome measure.

Planning

The strongest effect of the SRSD program was on the complexity of students' written plans. This was not surprising, since students were explicitly taught the necessary knowledge and skills to plan their stories ahead of writing. Furthermore, as suggested by pretest scores and confirmed by teachers, students had not received planning instruction before. Even though planning complexity has been barely assessed in similar SRSD studies (e.g., Harris et al., 2006; Zumbrunn & Bruning, 2013; but see Limpo & Alves, 2013b), this is an important result. It shows that children as young as 7 years can be successfully taught how to carry out this forethought process in writing. Indeed, after the intervention, almost all students were able to produce outlines and graphic organizers, which are deemed the most sophisticated form of planning (Hayes & Nash, 1996). Although the transcription training did not influence planning complexity, it did have a facilitative effect on planning completeness. SRSD+TR students produced plans with more story elements than SRSD-only students. This result

indicates that promoting transcription automaticity not only freed up attentional resources to generate more story elements but also enabled students to register them quickly.

Handwriting

As hypothesized, the intervention providing self-regulation and transcription training had a strong and consistent effect on students' handwriting skills. After 10 weeks of instruction, SRSD+TR students were able to produce more letters in the alphabet task and copy more words in the copy task than SRSD-only and control students. This increased automaticity in handwriting might have been largely due to transcription training, which included explicit instruction and extensive practice in writing letters, words, and sentences. These results are similar to those reported in prior research (Alves et al., 2016; Berninger et al., 1997; Graham et al., 2000; Jones & Christensen, 1999) and support the results of a meta-analysis that found impressive gains in handwriting fluency due to handwriting instruction (Santangelo & Graham, 2015).

Spelling

Instructional effects on spelling accuracy partially confirmed our hypotheses. Concerning consistent words, there were no effects of the interventions. Probably, the majority of students had already acquired the phoneme-to-grapheme correspondences and orthographic conventions needed to spell consistent words correctly. Indeed, at posttest, all groups were able to correctly spell about 6 to 7 consistent words out of 8. Regarding inconsistent words, we found a positive effect of the SRSD+TR intervention, with SRSD+TR students surpassing their counterparts in the SRSD-only and control conditions. This is an interesting result since students were not provided with explicit spelling instruction in any of the target alternations. However, this finding should be read carefully, as it does not mean that explicit instruction is unnecessary. Actually, meta-analytic findings showed a clear superiority of formal spelling instruction over informal or incidental approaches (Graham & Santangelo, 2014). On the contrary, our result adds to previous studies by stressing the usefulness of sorting and copying activities to raise students' ability to correctly spell words, whose correct form can be learned only through rote learning. When carefully designed, these activities can aid students in grasping the correct form of inconsistent words, at least for Portuguese full-range second graders. Further research is needed to explore whether similar effects might occur for students struggling with spelling, such as those with dyslexia.

Writing Performance

In line with the well-documented positive effects of SRSD on overall writing performance (Graham et al., 2012; Graham & Perin, 2007; Rogers & Graham, 2008), we found that SRSD students, with or without transcription training, wrote longer and better stories than control students. This finding was likely due to the explicit teaching of and guided practice in writing-specific and general self-regulation strategies. This set of strategies might have supported students' strategic competence to activate and manage key writing processes, thereby increasing text length and quality (Glaser & Brunstein, 2007). Although the comparison between SRSD+TR and SRSD-only students did not yield a significant effect for text length, an important result emerged for writing quality. Specifically, we found that writing quality at pretest moderated interventions' effects on writing quality at posttest.

On one hand, we found that among writers who produced the best pretest stories, SRSD-only instruction resulted in better posttest stories than SRSD+TR instruction. This result suggests that intensive transcription training may not be needed for better writers to benefit from SRSD interventions and that such training may inclusively limit SRSD effects. Orienting better writers' attention to low-level aspects of writing might have had a detrimental effect on their motivation for writing and to be engaged in the SRSD program. On the other hand, we found that among writers who produced the lowest pretest stories, SRSD+TR instruction resulted in better posttest stories than the SRSD-only instruction. This finding is important as it may hint at the possibility that multicomponent interventions, focusing on core writing processes as self-regulation and transcription, might be particularly beneficial for students who struggle with writing. This makes sense to the extent that this kind of intervention addresses key cognitive, motivational, and behavioral processes that typically underlie the difficulties faced by struggling writers (Berninger, 2009; Harris & Graham, 2013). As noted in the introduction, struggling writers experience problems with multiple aspects of the composing process, such generating and organizing ideas ahead of writing, putting those ideas into words, executing the fine motor movements for forming letters, or enacting self-regulatory mechanisms to manage the writing process (Graham & Harris, 2002; Santangelo, Harris, & Graham, 2008). In line with this profile, there is strong evidence that the best evidence-based recommendations for struggling writers, including those with learning disabilities, are the explicit teaching of writing strategies with the SRSD model and the explicit teaching of handwriting and spelling (Graham et al., 2009; Olinghouse, Graham, & Harris, 2010). Notably, the present study suggests that both recommendations can be effectively implemented together, with improved gains for poorer writers. Further research should expand current findings by exploring the potential of multicomponent interventions to boost writing in children with diagnosed writing difficulties.

Although transcription training did not augment the SRSD effect on the number of words written in the story

(text length), it did increase the number of words written per minute (writing fluency). SRSD+TR and SRSD-only students produced texts virtually of the same length, but the former were able to produce them more fluently than the latter. This finding indicates that the incorporation of transcription training into the SRSD intervention allowed students to finish their texts earlier. This has important implications for the promotion of strategic behaviors in writing. It means that, through explicit instruction, students may be taught to allocate this spare time to key writing processes, such as revision.

Levels of Written Language

Instructional effects on writing at the discourse level supported our hypotheses. On one hand, we found that students receiving SRSD instruction, alone or with transcription, wrote more complete stories than control students. This effect seemed to result from the explicit teaching of a story-specific planning strategy including the major story parts, combined with self-regulated-based instruction in how to use this strategy to produce complete stories. On the other hand, we found that SRSD+TR students surpassed SRSD-only students on story completeness. This superiority might be explained by the more complete plans that guided writing as well as by the more automatic transcription that facilitated strategy use during composition.

Based on the idea that preplanning should reduce the need to generate content during writing, thereby allowing students to devote more attention to language formulation (Graham & Harris, 2007; Kellogg, 1988; Limpo & Alves, 2013b), we hypothesized that SRSD instruction would promote writing at the sentence and word levels (as measured through clause length and vocabulary diversity, respectively). This was not, however, verified. We envision at least three reasons for this unexpected result: (a) Students still need to generate content during writing, given the reduced time for planning; (b) students might have been able to focus on sentence- and word-level aspects of writing but lacked knowledge and skills to improve them; and (c) any spare attention resulting from preplanning was not devoted to translating, but it was depleted by the costly process of transcription. The finding that transcription training improved sentence-level writing seems to support this latter hypothesis. Indeed, SRSD+TR students were found to produce longer clauses than control students. It seems that reducing the demands of planning and transcription during writing enabled students to focus on sentence-level aspects of composition.

Online Measures

Overall, only SRSD + transcription instruction affected online writing measures. Concerning burst length, we found no posttest differences between students receiving SRSD-only training and control students. This indicates that, for very young children, self-regulation instruction may have a limited impact on the ease at which ideas are transformed into written language. This was already implied in our finding that SRSD alone had no impact at the sentence and word levels of composition. Nonetheless, the combination of self-regulation and transcription training did increase burst length. SRSD+TR students produced longer bursts than SRSD-only and control students. These results align with a growing body of research showing a strong and direct link between transcription and bursts (Alves & Limpo, 2015; Alves et al., 2012; Alves et al., 2016; Connelly et al., 2012). It seems that fast and accurate transcription processes allow writers to transcribe their ideas more efficiently, which is reflected in the production of longer bursts. This growth in burst length might have greatly contributed to the aforementioned increase in writing fluency observed in SRSD+TR students.

The SRSD intervention, with or without transcription training, had no effects on pauses. As short pauses are presumably devoted to transcription processes, they were expected to be greatly reduced by transcription training. This was not observed, probably due to the small amount of practice provided (i.e., 10 hr). Indeed, Alves et al. (2016) reported a decrease in duration of short pauses after an intervention that provided the double amount of transcription training. Long pauses, which are thought to reflect high-level processes, were also unaffected by SRSD instruction, with or without transcription training. Yet, we wonder whether students receiving the interventions were using these pauses to carry out the same processes as students in the control group. Further research should examine how writing instruction, especially through self-regulatory training, may affect child writers' cognitive processing during pauses.

It is worth highlighting that the online measures were collected with HandSpy, which is a new tool to study handwriting in real time. Contrary to other logging tools requiring several technological artifacts (e.g., computers, digitizing tablets), HandSpy allows children to compose using apparently normal pens and paper sheets. Although the smartpen is slightly larger, no child complained about having difficulties using it. Moreover, except asking students to handle the pens properly, no further details were given about their characteristics. Thus, for participating children, writing with digital pens was not very different from writing with normal pens.

Story Recall

As predicted, students provided with SRSD instruction were able to apply their newly acquired skills during a written recall of a story orally presented. This result is consistent with the findings from a meta-analysis showing that writing instruction improves students' reading skills (Graham & Hebert, 2011). The generalization effect observed here might

be explained by the teaching of a planning strategy that included the main story parts. Probably, students used this schema as a guide to encode story information and organize its subsequent recall. Nevertheless, Glaser and Brunstein (2007) suggested that this might not be enough to prompt knowledge and skills transfer. They found that teaching a story-specific strategy without supplementary self-regulation training raised strategy-related knowledge and stories' schematic structure but did not generalize to story recall. Transfer was found only for students who were taught procedures to self-regulate strategy usage. Accordingly, the general self-regulation strategies learned by students in the current study might have been crucial to support the flexible use of the planning strategy. Transcription training did not enhance this effect, probably because of the few opportunities to apply the trained transcription skills in writing.

Limitations and Future Directions

The presented findings need to be considered in view of at least five limitations that might guide future research. First, while students in the SRSD+TR condition were receiving transcription training, SRSD-only students were receiving the regular Portuguese language arts curriculum from their teachers. Although it could be argued that the incremental effects of transcription training could be explained by the different amount of contact time, we do not think that this was the case. If contact hours, rather than type of training, had played a role in the results, SRSD+TR students should have surpassed SRSD-only students in all variables. This was not observed. Actually, the added value of the SRSD+TR intervention over the SRSD-only intervention occurred in specific measures (e.g., handwriting fluency, burst length, writing fluency) that previous research has identified to be closely linked to transcription (e.g., Alves et al., 2016). Additionally, there are neither theoretical nor empirical bases suggesting that such fine-grained measures can be enhanced in the absence of systematic and explicit instruction. Nonetheless, to completely rule out alternative explanations of the current findings, future studies should compare time-equated interventions targeting self-regulation with and without transcription training.

Second, our design did not include a transcription-only intervention group. This means that no strong claims can be made about the isolated effects of the transcription program implemented in the current study. However, the effects of transcription interventions are well documented in the literature (for reviews, see Graham & Santangelo, 2014; Santangelo & Graham, 2015). Still, to isolate the unique impact of transcription training, researchers would need to conduct direct comparisons of the isolated and combined effects of transcription and self-regulation interventions.

Third, although each intervention was administered by two instructors, allowing us to control for teacher effects, this study is a small quasi-experiment with two intact classes per treatment. Additionally, students were used as the unit of analysis given the reduced number of classrooms involved (n = 6). Further intervention studies with larger samples and, eventually, randomized controlled trials are warranted to detect intervention effects more reliably, as well as to enable the use of powerful statistical techniques that adjust for and model nested data (e.g., hierarchical linear modeling).

Fourth, as standardized writing tests in Portuguese are lacking, we used only researcher-constructed measures. The use of standardized measures would have been important to assess instructional effects more comprehensively and to examine whether students' normative standing changed as a result of instruction. Nevertheless, we do not think that the measures used in the present study compromise the validity of the findings. Indeed, all measures have been extensively used in writing research with proven validity, including that in second-grade Portuguese samples (Alves et al., 2016).

Finally, we assessed students' strategic behavior via only preplanning. Future research should delve into the effects of SRSD on a larger array of strategic processes taking place before, during, and after writing, as well as on motivational processes, which represent a key component of self-regulated behaviors (Zimmerman, 2000). For instance, similar to the work of Limpo and Alves (2014), it would be worthwhile to examine the role of preintervention beliefs in shaping students' response to writing instruction.

Conclusion

In summary, this study showed that SRSD instruction, with or without transcription training, resulted in improvements on measures directly related to the program (i.e., planning complexity and story completeness), measures of overall writing performance (i.e., writing length and quality), and a generalization measure (i.e., written recall). Notably, findings revealed that combining SRSD instruction with transcription training produced an incremental effect on students' composing skills. Compared with SRSD students, SRSD+TR students showed improvements not only in intervention-specific measures (i.e., handwriting and spelling) but also on measures of planning and story completeness as well as on overall writing measures focused on the process (i.e., burst length and writing fluency). This incremental effect of the SRSD+TR intervention was also observed for writing quality, particularly for the poorest writers. Together, these findings confirm the widespread gains of SRSD+TR students in critical skills to produce high-quality texts. Given its effectiveness, we deem this multicomponent intervention a promising tool to support writing development for all learners, including those experiencing writing problems (for the importance of Tier 1

interventions to special education see Graham & Harris, 2002; Graham et al., 2009). The intervention may not only attenuate the writing difficulties of struggling writers, frequently taught in the regular classroom, but also reduce the severity of difficulties that these students face due to ineffective instruction. It is worth reiterating that typically developing and struggling writers face similar writing difficulties, and some of the most critical ones are targeted by the SRSD+TR intervention (i.e., transcription, planning, self-regulation). Future research should extend the testing of this program from the first tier of writing instruction (i.e., primary prevention) to the second tier (i.e., secondary prevention). This may include adaptations such as providing students with additional guided practice in applying the strategies and with more individual attention. Intense SRSD+TR interventions delivered to small groups might assist educators in addressing the writing challenges faced by at-risk students in the initial years of learning to write.

Appendix. Overview of the Instructional Procedures of the Self-Regulated Strategy Development Program by Lesson.

Lesson	Instructional Procedures
1	• Students set the goal for the program (i.e., write good stories) and discussed the importance of planning ahead of writing to achieve it. • Instructors told them that they were going to learn a strategy to make good plans. • Students committed to try hard to learn the strategy by signing a learning contract.
2	• Instructors presented the CASA strategy and discussed the meaning of each letter. • Students learned how to self-monitor by finding and registering the story parts included in their own pretest stories. • Students registered their preintervention performance by filling out their progress sheet (from this session on, they filled it in anytime they worked individually).
3	• Instructors modeled how to write a story with the CASA strategy using the self-instructions to set goals, to use the strategy, to write the story following the plan, and to check goals attainment. • The whole class discussed what instructors had said to themselves and came up with their own self-instructions.
4	• The whole class emulated instructors' modeling to write a story with CASA under intensive guidance and questioning.
5	• Students wrote a story with CASA individually under instructors' guidance and support.
6	• Instructors grouped students facing similar difficulties and gave them individualized feedback. • Students were helped to generate a special self-instruction to overcome their main difficulty. • For homework, they wrote a story, paying particular attention to the special self-instruction.
7–9	• Students wrote a story with CASA individually under instructors' guidance and support, which was gradually faded as students showed competence to work autonomously.
10	• Students examined their progress sheet and discussed how the strategy and their effort helped them to write good stories. • Teachers gave students "quality certificates" to stick on their learning contracts.

Note. CASA is a Portuguese mnemonic for a set of questions related to the critical parts of a story: How does the story start: who, where, when? What happened and how? What was the solution? What happened next? How did they feel? How does the story end?

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