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## Linking Executive Functions and Written Language: Intervention for Students with Language Learning Disorders

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### Abstract

**Purpose:** School based speech-language pathologists (SLPs) has an important role in the identification and intervention of problems in oral and written language. In collaboration with classroom teachers, they often are asked to develop intervention plans that include evidence-based practices for those students with language learning disabilities (LLD) who have language deficits. The purpose of this article is to bridge theory to practice by explaining an evidence-based instructional model, the self-regulated strategy development model (SRSD), for SLPs to consider as they deliver instruction to support the written language deficits of students with LLD.

**Method:** The authors examine critically the relationship between executive functions (EFs) and written expression. They discuss the EFs researchers have identified as important to students' development of written expression and the difficulties students with LLD encounter in completing written expression tasks. The authors outline a model of EFs in relationship to the "Not-So-Simple view of writing" model which provides a framework for viewing the multiple components of the writing system.

**Conclusion:** Based on the review of the literature, the SRSD is an effective evidence-based teaching model for instructing students with LLD that integrates and scaffolds the EFs essential for developing written expression skills.

**Keywords:** Written communication disorder; Specific learning disorder; Executive functions; School-age children; Treatment; Strategies

### Introduction

The ability to effectively communicate in writing is essential for success not only in school, but also in the workplace [1,2]. In school, students complete spelling tests, essay exams, write reports, and otherwise engage in the writing process. Once students leave school, they complete college and/or job applications and writing continues to be part of their daily lives. The successful use of written expression depends on many factors (e.g. phonological awareness, orthography, metacognition skills). For example, a student must be able to read and spell words, know the meaning of the words, and the syntax of the language to be able to compose a written product. Further, writing represents a complex task that not only requires a range of linguistic skills, but also several important cognitive processes (e.g. working memory) [3,4].

Writing is an especially difficult task for many students with language learning disabilities (LLD). Often, their written assignments lack clarity and coherence [5,6]. For some students, written expression is challenging even when decoding skills do not pose a problem. Other students with LLD evidence problems with handwriting, spelling, grammar, content generation, and revising written products. Any one of these difficulties will negatively affect the student's ability to generate quality written messages [7,8]. However, obstacles to written expression go beyond low-level skills, such as spelling and punctuation. In fact, the American Psychiatric Association's diagnostic and statistical manual of mental disorders (DSM-5) uses the term

"impairment in written expression" to describe "Specific Learning Disorders" that include deficits not only in spelling, grammar, and punctuation accuracy, but also in clarity and organization of written expression. Speech-language pathologists (SLPs), especially those who work in school settings, play an important role in supporting students who are struggling with written language. In collaboration with classroom teachers, they often are asked to develop intervention plans for those students with LLD, designed to treat language deficits in both oral and written modalities [9].

In this article, we examine critically the relationship between executive functions (EFs) and written expression. We outline a model of executive functions in relationship to a "simple view of writing" [10] and, more recently, to the not-so-simple view of writing" model [11] which provides a framework for viewing the multiple components of the writing system. We bridge theory to practice by explaining an evidence-based instructional model, the self-regulated strategy development model (SRSD) which integrates and scaffolds those aspects of EFs essential to the "not-so-simple view of writing" [11-13].

### Understanding Executive Functions

EFs is an umbrella term that refers to a number of cognitive processes and skills that facilitate learning. EFs are the processes that control our ability to pay attention, to hold, manipulate, retrieve, and process information which guide our behaviour. Together, these core cognitive processes build and coordinate other higher-order skills or functions, such as problem solving and planning [14,15]. The functions encompassed within the EFs are task dependent and interact to give rise to observable, goal directed behaviour. Packwood et al. outlined five domains that together represent a multidisciplinary conceptual

definition of EFs: 1) planning (e.g. goal management), 2) working memory (e.g. efficient word retrieval), 3) inhibition (e.g. control of response), 4) set shifting (e.g. selective attention), and 5) fluency (e.g. response modulation). The behavioural manifestation of these subcomponents during academic activities is closely related to the nature of the assignment demands and reflects a convergence of multiple processes.

In the classroom, EFs allow students to regulate their emotions, sustain attention, manage time, plan what they are going to do, monitor their thoughts, and manipulate and store information across situations and for various activities [16,17]. EFs enable most students to be mentally and behaviourally flexible as well as effectively solve problems to achieve successful completion of academic tasks such as writing assignments. The task of generating ideas and write quality text depends largely upon EFs. Experienced writers approach a writing assignment as a problem they must solve. EFs are the control processes that together guide the self-initiation of thoughts, affect, and behaviours required to achieve writing goals [18-22].

## Understanding Written Language

Hayes and Flower conceptualized writing as a problem-solving process that is goal directed and guided by the writer's EFs. Writing also is described as a developmental skill that includes transcription (i.e., handwriting, keyboarding, and spelling) and text generation (i.e. translation of ideas into written text). In this conceptualization of writing, the Simple View of Writing model [10], EFs play a limited role in beginning writers due to the immature transcription skills of young writers and the limited capacity of working memory. As the demands of transcription decreases and writing development progresses, EFs (i.e. conscious attention, planning, reviewing, revising, and strategies for self-regulation) play an increasing role [10].

More recently, Berninger and Winn [9] offered a modification of the Simple View of Writing model, a Not-So-Simple View of Writing model. The changes made reflect a deeper understanding of the role of working memory and attention within the EFs domain (i.e. from conscious attention in the previous model to supervisory attention in the new one). Supervisory attention, which accounts for low-level of EFs in the executive control of the writing process, helps the writer attend to the metalinguistic and metacognitive subtasks associated with effective writing performance. According to Berninger and Richards, low-level EFs underlie and support the high-level EFs. This means that not only high-level EFs, but also low-level EFs affect the performance of developing writers [23].

The Not-So-Simple View of Writing is a theoretical model that explains the components of written expression [11]. The components of written expression can be visualized as three intersecting vertices of a triangle. At the bottom left is transcription; at the top vertex is text generation, and at the bottom right is EFs (i.e. supervisory attention, goal setting, planning, reviewing, revising, strategies for self-monitoring, and regulation). In the center is working memory which activates long-term memory during planning, composing, reviewing, and revising written tasks. Short-term memory is activated only during reviewing and revising stages. The Not-So-Simple View of Writing model supports the importance of EFs to successful completion of writing tasks.

## Understanding the Relationship between Executive Functions and Written Expression

The different descriptive domains of EFs contribute uniquely to written expression [19]. For example, supervisory attention, working memory, and self-monitoring (i.e. inhibition) are required for revising and editing. The acquisition of such multifaceted skill requires the coordination of many functional components that combined comprise written language [24]. Accordingly, writing involves the application of various cognitive processes at different levels (e.g. semantic and planning levels). These cognitive processes (e.g. supervisory attention) are included in the umbrella term EFs [25,26]. All of the steps good writers follow when completing a writing assignment depend on EFs. The ability to inhibit irrelevant responses, apply strategies, maintain those strategies and shift them, as needed, are all EF skills [27].

The EF which is the most critical and contributes the most to successful writing is working memory [28]. Working memory (WM) often is described as a "mental scrapbook" where information is manipulated and temporarily stored and processed during cognitive activities [29-31]. The framework of WM includes the central executive (the attention-controlling system), the phonological loop (language acquisition), the visuospatial sketchpad (visual/spatial representations), and the episodic buffer (integration of information for storage [29]. Kellogg suggested that the visuospatial component supports the planning stage of writing and the phonological loop supports the translations of ideas into written sentences. The work of Kellogg, Ransdell, et al., and Vanderberg and Swanson among others, has demonstrated the important role WM plays in the writing process.

When composing written text, working memory becomes critically important to recall spelling rules, sentence structures, use of punctuation, and syntax, at the same time the student is trying to organize his/her thoughts to write about a specific topic. During the writing process, planning, translating, and reviewing/revising draw upon a student's WM capacity and efficiency, regardless of age or the writing task (i.e. analytical or creative writing) [28,32]. Writing requires students to shift among and concurrently activate several pieces of information, cognitive skills (e.g. planning), and processes (e.g. WM) [33]. For example, when composing a written product, a student must constantly integrate the visual feedback she/he receives from the current text with the 'internal language' (i.e. the thoughts they have about a topic and the words that best express those thoughts). At the same time, the student is generating ideas to add to the composition. Accordingly, the student must quickly and accurately replace and refresh ideas and vocabulary from their long-term memory, while simultaneously integrating various pieces of orthographic information and putting them into written form [34].

Vanderberg and Swanson [27] asserted that writing is largely dependent on the central executive component of WM; that is, the system with which students regulates and control attention in WM [33]. The central executive of WM allows individuals to regulate their behaviour according to the current task, maintain goals, and appropriately manipulate information without getting distracted. The central executive, also known as executive attention supports and facilitates WM [35-37]. Although complicated, executive attention is what allows a student to selectively process environmental stimuli and is considered a critical component of WM by some researchers [38,39]. It is important to understand that composing text requires a student to select ideas to translate into sentences and to hold those ideas in mind, while ignoring distractions and retrieving information from long-term

memory regarding the particular subject area. In all, along with various EFs (e.g. planning, set shifting, inhibition), WM plays an essential role in written expression. It is WM that enables a student to shift and focus attention between the current task and their prior knowledge of a particular topic in order to compose written text.

## **Understanding the Relationship between Executive Functions, Written Expression, and Language Learning Disability**

Written expression often is an area of weakness for many students with LLD because it involves the coordination of many EFs [40], especially WM. Text generation requires a student to draw upon WM to maintain an awareness of the topic while retrieving information from long-term memory in order to record it. The Not-So-Simple View of Writing conceptualizes writing in a WM environment in which transcription skills (i.e. handwriting/typing and spelling) and EFs (e.g. supervisory attention and planning) enable text generation [11]. Text production requires the writer to filter one's thoughts, inhibit distractions, sustain attention, plan what to write, organize the ideas, and have cognitive flexibility to switch gears and adapt to changed perspectives and demands of the writing task. Written expression combines the demands of several EFs because the writer not only has to generate and organize ideas, but also translates them into print while keeping in mind those ideas to be recorded. Language facilitates this interaction and serves as a mediator for EFs [41]. Not surprisingly, students with LLD who have deficits in one or more areas of the language system (e.g. semantic and syntax) are at risk of writing difficulties because writing includes a range of linguistic factors and the coordination of several cognitive processes and skills that make up EFs [42].

Researchers looking at the written compositions of students with LLD describe their written expression as having deficits in productivity, complexity of sentences, spelling, grammar, and poor lexical diversity [43,44]. Usually, students with LLD use their limited WM capacity (i.e. executive attention) on lower-level skills (e.g. handwriting, spelling), leaving little room for the generation of ideas or the writing process itself [45]. Students who have LLD generally do not plan (set goals, generate and organize ideas) before starting to write. Their compositions usually are short, disorganized, and contain little elaboration which suggest students with LLD have deficits in EFs. They struggle to initiate written tasks and have difficulty devoting the attention and effort necessary to complete a written assignment. They seldom evaluate and revise their work and, when they are asked to make revisions, they usually focus on grammatical and spelling errors and/or making word substitutions, rather than on content clarification [46-48]. All these behaviours depend on EFs. Besides being a self-directed activity, written composition requires the writing skills, content knowledge, organizational strategies, attention, working memory, planning ability, and other executive functions that are difficult for many students with LLD [35]. Not surprisingly, the complex nature of the task makes writing especially difficult for students with LLD.

Students with LLD who have written expression difficulties usually have comorbid oral language and/or reading disorders [49,50]. A number of studies [51-53] have demonstrated the relationship of spoken to written language and reading to written language. Oral language, lexical growth, knowledge of language structure, reading decoding, and reading comprehension skills are related to the development of expressive language development [25,44]. Students

who have deficits in those areas (e.g. reading comprehension) often have EF impairments [27]. Additionally, students with LLD have problems planning what to write, organizing their ideas, monitoring their performance, and revising what they have written which are dependent on EFs [27,54,55].

Ardila and Surloff [3] proposed the term *dysexecutive agraphia* to refer to written expression disorder. Based on their findings, Ardila and Surloff suggested that the complex aspects of writing (e.g. planning, coherence) are disturbed by executive dysfunctions. Indeed, the performance level of elementary school age students with written expression difficulties is substantially lower on EF tests than students without written expression problems [24,56]. These findings underscore the importance of executive functions as a critical component of the writing process. For example, skilled writers are highly goal directed, generate more ideas, and routinely plan the next sentence or paragraph they are going to write; whereas, poor writers have few if any specific strategies when attempting to produce written text.

Because of the complexity involved in composing written text, a student's *dysexecutive agraphia* usually is manifested by ineffective ways to plan, monitor their own learning, and/or detect and correct their errors [54,57]. Students with LLD often evidence significant problems accessing, organizing, prioritizing information in simultaneous mental activities (e.g. writing). They struggle with self-regulatory behaviour, are unaware of effective strategies to solve problems, and have little flexibility in their thinking [58-60]. Writing tasks usually are complex and require EF skills and unfortunately, many students with LLD have various EF difficulties [27,55,61]. Students who are deficient in one or more EFs are likely to experience problems in written expression. In light of these findings, we draw on the extant literature on EFs to offer SLPs elements of effective writing intervention and a research-based strategic model to address written language deficits.

## **Intervention Framework for Written Language for Students with Language Learning Disabilities**

The development of a student's skills in written expression poses special challenges to educators and SLPs. While reading is one of the most widely researched academic skills, there has been far less research on the cognitive components of writing and on strategies with which to intervene on behalf of students with LLD. Furthermore, writing requires a coordination of EFs, numerous cognitive processes and physical capabilities; for these reasons, it is inherently challenging to teach writing to students with LLD.

Knowing that composing written tasks requires several cognitive processes and skills (e.g. WM and planning) and that student with LLD have deficits in those areas, SLPs should consider using instructional methods and strategies that specifically address those problems [54]. Gersten and Baker have identified three instructional components for writing interventions that can produce positive effects in the writing tasks of students with LLD: (1) explicit instruction in the steps of the writing process (e.g. revising), (2) explicit instruction of text structure (e.g. narratives), and (3) guided feedback from a clinician, teacher or peers. These components are important because students with LLD lack knowledge of the steps that comprise the writing process and of the different writing genres. Explicit instruction in those areas may minimize overload of students' WM capacity and help them to better focus on the writing task itself. Researchers have

successfully used explicit instruction to teach students with LLD planning and revising strategies specifically for story writing and expository texts (e.g. persuasive, compare/contrast) [62-66]. Several studies have shown positive effect sizes, varying from medium to high, for the explicit teaching of specific text structure strategies that include planning and revising instruction [67,68]. The explicit teaching of those skills is needed because the difficulties students with LLD encounter in the writing process are partially due to executive control issues [20,69].

Writing involves many cognitive processes and skills. In fact, in their report to the Carnegie Corporation of New York, Graham and Perin [35] identified 11 elements of effective writing instruction for students in grades 4 through 12. The use of these elements has produced positive results in teaching students how to write well and to use writing as a learning tool. The 11 elements are presented in the order of their average effect sizes, which reflect the magnitude of a treatment effect.

1. Writing strategies for planning, revising, and editing compositions.
2. Summarization of text skills taught explicitly and systematically.
3. Collaborative writing in which students work together.
4. Specific product goals for writing assigned to students specifically as attainable goals.
5. Word processing used as instructional support for writing
6. Sentence combining which involves teaching students how to write compound and complex sentences.
7. Prewriting skills in which students generate and organize their ideas for compositions (e.g. outlines, brainstorming).
8. Inquiry activities in which students analyze information to develop ideas to write about a particular topic.
9. Process writing approach which stresses extended opportunities for writing, writing for authentic audiences; personalize instruction, and cycles of writing.
10. Study of models in which students read, analyze, and imitate a model of good writing.
11. Writing for content learning in which writing is used to learn content material.

Authorities argue that a combination of these approaches is more likely to produce positive results than the use of a single approach [40,67], because students with LLD lack knowledge of the writing process, writing strategies, and they often overestimate their writing abilities [13,48]. Thus, writing instruction for students with LLD should include not only the combination of those approaches and explicit instruction, but also specific components to effectively address the cognitive, linguistic, and other skill deficits of students with LLD [55]. In the next section, we place special emphasis on the self-regulated strategy development model (SRSD) because it exemplifies several important elements that facilitate improved writing by targeting strategies which incorporate scaffold planning, WM, and inhibition for students with LLD.

## Understanding the Self-Regulated Strategy Development Model (SRSD)

One well researched evidence-based teaching model that incorporates many of the components essential to written expression is the SRSD model [70-72]. SRSD is a model for teaching strategies that are designed to improve a student's cognitive skills facilitated by key aspects of working memory (i.e. controlled attention, inhibition, and self-regulation) [1,71]. This teaching model uses explicit instruction to scaffold the acquisition and application of strategies, thus reducing demands in WM. SRSD has mostly been used to teach writing strategies. It considers writing as a problem-solving task that includes: planning, knowledge, and skills. Self-regulation training is embedded in the stages of instruction to help students eventually to become independent writers. Self-regulation strategies address the EF deficits of students with LLD. For example, students set goals, monitor their performance, and learn to be self-instructors. Teaching students with LLD strategies using the SRSD model not only addresses the students' EF deficits, but also is likely to improve their writing skills.

When composing or generating written text, students depend on different cognitive processes, depending on the task and grade level [19,28]. WM, especially the central executive component, is one of those cognitive processes linked to composing written text [32]. When generating ideas, students must retrieve information about the topic, possess word knowledge and know punctuation rules, as well as skills to edit and revise what they have written, and other skills needed to produce written text. All those skills require WM involvement. Accordingly, writing intervention should target lessening the demands on WM in the writing process. The teaching steps of SRSD for writing strategies seem to support students' WM and diminish the possibility of WM capacity overload. Strategies are taught to a level of automaticity and the use of mnemonics, cues, and graphic organizers reduce student demands on WM [73]. The scaffolding process embedded in SRSD and the explicit instruction of writing strategies (e.g. WWW, What=2, How=2 for narratives) simplify the writing task and reduce the students' cognitive load. In summary, students learn to be strategic learners by developing strategic writing behaviours.

Research on the SRSD teaching model has yielded large effect sizes for several components of the writing process with different age groups. The SRSD model uses explicit instruction and mastery learning to teach students how to plan what they are going to write, draft the written text, and revise and edit a written product [74,75]. By teaching students those writing skills, students' metacognitive skills improve, and thereby, further develop self-regulation and learn how to monitor their own progress. The SRSD teaching model can be modified and structured according to individual student's learning and educational needs [76]. The ultimate goal of the SRSD model is to provide students with the tools required to be independent, effective, and flexible writers. Accordingly, maintenance and generalization of target skills are an integral part of SRSD.

Harris and Graham outlined six stages for teaching learning strategies using the SRSD model. Those stages include: 1) developing background knowledge; 2) discussing it; 3) modelling it; 4) memorizing it; 5) supporting it; and 6) practicing writing independently. The first stage, build background knowledge, is intended to increase the student's insight regarding his/her writing abilities, what skills are necessary to become more an efficient writer, a rationale for the instructional strategy, and the reasons writing is important. This can be accomplished through brainstorming ideas and

the use of semantic webbing [13]. During the second stage, discuss it, students set goals and review the steps needed to achieve those goals. Students are introduced to the strategic mnemonic (e.g. POW Strategy: Pick my idea, organize my notes, write and say more). They are told the value and purpose of the strategy--how and when it can be used to achieve their goals. The third stage, model it, is when the teacher demonstrates how to use the selected strategy, while using "talk aloud" to model the thought process. During the fourth stage, memorize it, students use motivating and engaging activities to help them memorize the strategy and all of the steps that comprise the strategy. The fifth stage, support it, provides scaffolding for the mastery of the strategy through mini-lessons, additional teacher modelling, and practice or collaboration with peers. At stage five, scaffolding is faded over time as student confidence grows and, with more independence performance, the maintenance of generalization of the strategy. Finally, during the sixth stage, independent performance, students practice applying the strategy independently in order to complete a writing assignment. Students also are taught to silently engage in self-talk to self-instruct and to give themselves encouragement (e.g. "I can do this.").

Self-instruction teaches students to stop and think about what they are going to write and addresses some of their executive function deficits (e.g. self-regulation). As part of the overall instruction, students create writing journals where they can reflect on their writing experience. If a teacher notices that a student continues to struggle with written expression, the teacher can provide 'booster teaching' sessions to improve student performance [77,78].

There is compelling empirical evidence to support the use of SRSD as an effective teaching model that incorporates cognitive strategy to teach students written expression [54,79-82]. Furthermore, there is reason to believe that teaching students with LLD self-regulation strategies can make a positive impact on the development of organized and strategic behaviours [73]. SRSD has been successfully used for writing instruction not only with students with LLD, but also with students with other disabilities (e.g. emotional disabilities). The results of multiple studies have shown that students improved their writing skills after being taught a strategy (e.g. TREE=Topic sentence, reasons, examples, ending) using the SRSD model [54,68,79,82]. In fact, in their meta-analysis on writing instruction, Gillespie and Graham reported that studies involving strategy instruction using SRSD had higher effect sizes than those that did not use SRSD. One explanation for this difference may be that SRSD targets underlying cognitive processes important to the writing process such as self-regulation and WM. Thus, writing strategy instruction using the SRSD model addresses some of the EF deficits evidenced by many students with LLD and has the potential to improve their writing skills [73,83,84].

## Conclusion

Written language may be the most difficult academic skill for students to master. Not surprisingly, it is a major problem area for students with LLD [85]. Many students with LLD have difficulty organizing and composing textual material and using strategies that may help them become more successful writers. They have difficulty with pre-writing activities, composing, revising, and editing [19,86,87], skills that are related to executive functions deficits [19,24,27]. For that reason, an important goal for writing instruction is to provide students with LLD support to develop those EF skills that are important for writing (e.g. planning, inhibition, working memory). Closely monitoring student performance is critical as well. The empirical evidence supports the use of SRSD as a cognitive teaching strategy

model for improving written language because the strategies included in this instructional model help support underlying, foundational executive processes such as WM. Students with LLD need accommodations and explicit, scaffolded instruction to avoid overload of WM. Teaching students with LLD writing strategies using the SSRD model may promote the development of skills that are essential to quality writing and at the same time decrease cognitive load. SLPs must continue to understand and employ empirically based techniques designed to teach written language to students with LLD. Intervention needs to be based on what is understood about human cognition and learning to better address the written language deficits of students with LLD.

In addition to addressing the EF involved in composing, both classroom teachers and speech-language pathologists must keep in mind that composing is linked to low-level skills such as handwriting and spelling. Students with LLD also struggle with those skills which make writing physically and mentally exhausting to those students. Some researchers [7,87-89] have attempted to address the barriers of low-level skills by using dictation as an intervention to improve the writing quality of students with LLD. As we have discussed, intervention in support of students with LLD writing problems using the SSRD model may promote the development of skills that are essential to quality writing.

## Implications for Practice

Writing is an important skill for success in life. Writing is a multifaceted process that includes lower level (e.g. spelling) and higher level (e.g. planning) skills. Students with LLD often struggle with both levels of these skills. School personnel tend mostly to focus on the lower level skills and often neglect the skills involved in the writing process of composing such as planning, organizing, and revising. In that, written expression is a very cognitive demanding and challenging task, the cognitive (e.g. self-regulation, memory) and linguistic deficits of students with LLD make writing an arduous learning task [59]. Thus, effective writing instruction for students with LD should be based on diagnostic information that identifies students' strengths and weaknesses and focuses on individual student needs.

Students with LLD frequently need explicit, individualized, and intensive instructional interventions. Explicitly teaching strategies using the SRSD model to students with LLD on different genres, text organization and how to generate, organize, and revise their written ideas, can improve their knowledge about writing, strategic writing process, self-regulation, and motivation [55,32]. Through the teaching steps of the SRSD, speech-language pathologists 'think aloud' to model the use of the strategy and self-regulation procedures, and they provide corrective feedback to students to support their learning. Criterion for mastery learning is emphasized which helps students set goals and monitor their own progress.

Teaching written expression to students with LLD requires a combination of approaches that includes explicit strategy instruction [40,76]. Writing instruction must address students' cognitive deficits (e.g. WM, self-regulation) and those EF skills that are essential to being a successful writer, such as planning, organizing, and problem solving. Fortunately, accumulated research on writing instruction indicates that, although writing is a complex process, the use of evidence-based practices can improve the written expression skills LLD [7,48,68]. As we have asserted, along with their classroom counterparts, speech and

language pathologists, play an important role in accomplishing that outcome.

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