

**Working memory and L2 writing: Implications for SLA individual differences research.  
Introduction to the Special Issue.**

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**Abstract**

This Introduction to the special issue first elaborates on the rationale for advocating the inclusion of L2 writing in SLA IDs research, and subsequently provides an overview of empirical work on IDs in the domain of writing with a focus on cognitive IDs and specifically working memory. Against this background, we synthesize the focus, structure, and contents of the special issue. We finish with substantive and methodological suggestions for moving forward in research agendas on IDs and L2 writing.

The study of learner individual differences (IDs) has been a central concern in second language acquisition (SLA) studies. Yet, SLA-oriented second language (L2) writing research has made its way into IDs research agendas just in the last 15 years. This SLA-oriented L2 writing scholarly interest on IDs was sparked by Kormos's (2012) seminal piece in one of the earliest publications intended to establish intellectual bridges between SLA and L2 writing studies, namely, a special

issue published in the *Journal of Second Language Writing* in 2012 on “Exploring L2 Writing-SLA Interfaces” (*JSLW*, 21, 4). In this pioneering analysis, Kormos (2012) acknowledged the neglect of research on IDs as related to L2 writing products and processes, theorized the role of IDs in learning through writing for the first time, and outlined a research agenda for future empirical work in the domain. Since then, theory and research on the way in which learning through writing itself and through feedback processing may be moderated by learner IDs has grown exponentially.

Theoretically, a telling example of these developments are Leow’s (2020) and Bitchener’s (2019) recent models of feedback processing and language learning. The latter makes predictions about the moderating effects of a range of cognitive (especially working memory) and affective IDs (especially motivation, which is also central in Leow’s 2020 Feedback Processing Framework) on L2 writers’ engagement with the feedback provided on their writing, primarily in connection with the processing stages of understanding and analyzing the feedback received, as well as when formulating and testing hypotheses about the L2 on the basis of such feedback processing.

Empirically, the SLA-oriented inquiry into IDs and writing has also gradually gained momentum, as attested by the inclusion of comprehensive syntheses of the available research in two recent SLA handbooks: Manchón and Polio’s (2021) *Routledge Handbook of SLA and writing* (contributions by Ahmadian & Vasylets, 2021, and Papi, 2021), and Papi and Li’s (2022) *Routledge Handbook of SLA and Individual Differences* (contribution by Papi et al., 2021). Yet, it is also the case that these empirical advancements have not always been sufficiently acknowledged or at least accounted for in previous SLA syntheses of IDs research. A telling example is the absence of writing in the L2 “learning” and “processing” dimensions in focus in

Granena et al.'s (2016) collective volume on IDs in SLA. Relevant in the present context is also the conspicuous omission of research on working memory (WM) in L2 writing in the recent *Cambridge Handbook of Working Memory and Language* (Schwieter & Wen, 2022). The handbook does include one chapter on WM and writing (Olive, 2022), but the discussion focuses just on L1 writing. Similarly, Li (2023) decided not to include writing (alongside listening) in his synthesis of empirical research of WM in SLA due to “a lack of research” and, in effect, he suggested that one of the key questions to be addressed in future research agendas would be how L2 writing is affected by WM. Some of these omissions are in part explained by the recency of studies on WM effects in L2 writing, given that, with minor exceptions (Adams & Guillot, 2008; Kormos & Sáfár, 2008), most studies have been published in the last 8 years and, of these, the majority have seen the light between 2018 and 2022 (see Table 1. See also review of this body of work in contributions by Kormos and Li to this special issue).

Given this state of affairs in overall SLA IDs disciplinary discussions, as well as the emergent nature of research on IDs and L2 writing, this special issue *Working memory and L2 writing: Implications for SLA individual differences research* aims not only to expand theory and research on IDs and L2 writing, but also to position L2 writing more centrally in SLA debates on IDs in general, and WM studies in particular. To this end, the special issue features theoretical reflections on the development of L2 writing IDs research and its connection with global SLA IDs theoretical, methodological, and empirical preoccupations, together with a set of novel empirical studies on the role of WM in L2 writing processes and products, as more fully discussed in a later section.

In this Introduction to the special issue we first elaborate on the rationale for advocating the inclusion of L2 writing in SLA IDs research, and subsequently provide an overview of

empirical work on IDs in the domain of writing with a focus on cognitive IDs and specifically working memory. This overview will be brief as other papers in the volume (by Granena, Kormos, and Li) contribute comprehensive, critical analyses of this body of work. Against this background, we synthesize the focus, structure, and contents of the special issue. We finish with substantive and methodological suggestions for moving forward in research agendas on IDs and L2 writing.

### **Writing and SLA IDs research. The relevance of working memory**

The rationale for making L2 writing more central in SLA discussions of the role and effects of IDs is theoretical, empirical, and applied (pedagogical).

**Theoretically**, the relevance of adding writing as a central concern in IDs research agendas rests on two previous assumptions. The first would be that both input processing and output production push L2 development. As a consequence, the second assumption would be that written output production constitutes a site for language learning. Accordingly, approaching the role and effects of IDs in language learning as implicated primarily or exclusively in input processing might lead to a somewhat distorted, and surely limited, vision. In this respect, it is important to note that, as Vasylets and Manchón (2023) observe, writing often involves a most intriguing combination of input processing --e.g. when reading from sources or when processing feedback on one's writing-- and output production, a crucial issue "that has not been accounted for in current models of IDs in SLA" (p. 88). This combination of input (feedback) processing and output explains the scholarly interest in ascertaining how and why IDs may be implicated both in the act of writing itself, and in processing and using the feedback received on one's own writing (see Table 1 and its analysis below).

Focusing just on the output dimension of writing, as emphasized in all contributions to the special issue, producing a written text is a complex process, even more so in a second language. It requires *inter alia* lexical access and the incorporation of morphosyntactic cues. Additionally, unlike writing at the word or sentence level, extensive writing requires planning ideas, translating them into text, transcribing, and revising. Writing is thus a complex activity consisting of multiple processes which happen simultaneously and recursively, and this makes text production a cognitively taxing task. As such, success at writing is characterized by an enormous amount of variability; enhancing or preventing writing success is heavily dependent on the interaction among external factors linked to education, genre and task-related considerations (crucially including task complexity), and cognitive individual internal differences (such as aptitude or working memory). This explains why in her pioneering account of IDs in writing, Kormos (2012) discussed the implication of WM capacity in all stages of composing alluding to the cognitively-demanding nature of the act of writing itself, and the potential additional cognitive demands that writing in an L2 may entail (see also her expanded analysis in her contribution to this special issue). Along the same lines, Li (this volume) succinctly describes the central implication of WM capacities in writing as follows:

Writing involves the incremental, dynamic, and recursive interaction between information generation, linguistic (phonological, morphosyntactic, and orthographic) encoding, transcription, and editing, which pose a heavy processing demand for writers' working memory resources. The importance of working memory is supposedly more evident in second language (L2) writing than first language (L1) writing due to the extra cognitive burden caused by L2 writers' incomplete and unautomatized linguistic system and their lack of genre and discursal knowledge about writing in the L2.

Additionally, as repeatedly discussed in the literature on writing as a site for language learning (e.g. Manchón, 2023; Manchón & Williams, 2016; Williams, 2012), it is relevant to be mindful of the time-distributed/extended nature of many forms of literacy practices and of the

invisible text production processes behind such practices, an issue of crucial implications for the learning and processing dimensions that are so central in discussions of IDs in SLA. Therefore, how writing may lead to language learning in these diverse conditions, and how IDs may be implicated in bringing about L2 learning through writing is theoretically and pedagogically pertinent. This justifies Granena's claim that research on IDs in writing is necessary for drawing "conclusions about the role of cognitive IDs in SLA that take into account literacy practices" (p. xxx).

In short, it should not be too controversial to assume that adding writing to IDs agendas would put research on safer grounds towards theorizing more fully the role of IDs in L2 learning and processing. Unless it is assumed that L2 learning through L2 writing is not theoretically or empirically pertinent in central SLA preoccupations, and unless it is also mistakenly assumed that literacy practices do not take a central position in instructed SLA.

**Empirically**, certain assumptions in SLA IDs research need to be further validated empirically in their application to written production. For instance, recent SLA postulations of working memory as part of language aptitude (e.g. Wen, 2019, 2022; Wen et al, 2017) ought to be tested across language modalities, at a minimum on account for the problem-solving nature and extended time conditions of writing, two characteristics of written production that in principle should result in a differential involvement and demands of attentional resources for linguistic processing in oral and written communication (Manchón, 2023; Manchón & Williams, 2016; Williams, 2012). Additionally, postulations about working memory as part of aptitude, as well as the nature and effects of WM and aptitude individually considered, require additional empirical evidence given (i) the idiosyncratic nature of writing processes that has been posited to be linked to aptitude components other than working memory capacity and executive functions

(Ahmadian & Vasylets, 2021); (ii) the limited research on aptitude effects on writing itself (see Table 1 below. See also Granena, this special issue); and (iii) the divergent findings on the links between different WM functions and writing processes, on the one hand (e.g. Michel et al., 2019; Révész et al., 2017. See also Révész et al. and Torres, this volume), and WM functions and text characteristics, on the other (e.g. Adams & Guillot, 2008; Cho, 2018; Kormos & Sáfar, 2008; Lu, 2015; Mavrou, 2020; Michel et al, 2019; Mutjaba et al, 2021; Vasylets & Marín, 2021; Zalbidea, 2017. See also Manchón et al., this volume). As regards aptitude, in his review of language aptitude in SLA, Li (2019) concludes that the “predictive research shows that overall aptitude is a strong predictor of learning success but seems less predictive of L2 writing” (p. 93), a position that requires additional empirical evidence given the already mentioned limited number of L2 writing aptitude studies, of which most have focused on effects of aptitude on feedback processing and use (see Table 1. See Kormos’s and Granena’s contributions). Additionally, as Li (2016) himself acknowledged in his meta-analysis of the relationship between aptitude and language skills, the absence of evidence of a connection between aptitude and L2 writing in the studies he reviewed needs further scrutiny on account of methodological considerations related to how L2 writing was measured in the studies under review (see also Li’s detailed methodological analysis of past research in this special issue), a key methodological concern we shall come back to in the final part of this Introduction.

In short, and regarding cognitive IDs, previous work evidences contradictory findings on how WM is implicated in L2 writing, and scant research exists on potential correlations between components of aptitude and L2 writing. Therefore, as Granena (this special issue) notes:

The addition of writing research to previous work on WM and other cognitive IDs in SLA will refine and broaden our current understanding of the role of cognitive abilities in SLA

by showing similarities and differences in whether and how cognitive capacity underlies the development of different types of L2 knowledge and skills.

**Pedagogically**, and echoing Vasylets and Manchón's (2023) claims, disregarding writing in SLA IDs research would be an important oversight given the forcefully defended pedagogical relevance of matching instructional interventions to learners' abilities (e.g. Robinson, 2012), and given also the ubiquity of literacy practices in instructed SLA contexts, which is central in theorizing on L2 writing as a potential site of language learning (Harklau, 2002; Leow & Manchón, 2021; Manchón, 2011, 2023; Manchón & Williams, 2016). As for the former, Granena (this volume) reminds us that not only research on interactions between cognitive abilities and learning conditions is scant, but also that writing has not featured in this body of work. Also worthy of comment is that aptitude has been predicted to be fully implicated in communicative practice, in monitoring output, and in learning from producing comprehensible output, which would surely include comprehensible written output. Equally relevant from a pedagogical angle would be a consideration of the attested effects of IDs (including L2 proficiency and working memory) in learning and task performance across modalities (e.g. Zalbidea, 2021; Zalbidea & Sanz, 2020. See review in Johnson, 2021; Manchón & Vasylets, 2019; Vasylets & Gilabert, 2021).

These arguments, and very especially the recognition of writing as integral in instructed SLA, justify Granena's and Kormos's (this volume) suggested directions for future L2 writing pedagogically-oriented IDs research agendas. In Kormos's words:

it is important to investigate how L2 writing pedagogy can cater for the needs of students with different cognitive abilities so that those who might be disadvantaged by their lower WM capacity or language aptitude can be successfully supported to develop the required



level of L2 writing expertise Furthermore, it is also important to consider WM and aptitude in order to find instructional conditions that are beneficial for all L2 learners, regardless of their cognitive abilities. The potential effect of cognitive individual differences in interaction with task characteristics and task administration conditions can also create an unfair bias in assessment contexts. For this reason, it is also important to consider how the interference of cognitive abilities with writing test scores can be avoided in order to ensure that assessment tasks give a fair chance to everyone to demonstrate their abilities (p. xxx).

In short, there are sound theoretical, empirical, and applied reasons to make L2 writing a much more central concern in SLA IDs disciplinary discussions and empirical research agendas, and this justifies the collective efforts in this special issue.

As advanced earlier, in what follows we provide a synthetic overview of research on IDs and L2 writing, with special attention to WM studies, the main focus of the special issue.

### **The role of IDs in writing: Working memory and writing**

Table 1 summarizes empirical research on L2 writing and IDs. It shows the range of IDs investigated, from cognitive (aptitude and working memory) to motivational and affective variables (anxiety, beliefs, motivation, and self-efficacy). As advanced above, we shall briefly describe the content of Table 1. Readers are referred to Granena's, Kormos's, and Li's pieces for expanded discussions of research on cognitive IDs and writing.

As seen in Table 1, a considerable part of research efforts has been devoted to the effects of cognitive, motivational, and affective variables on L2 writers' processing and use of the feedback provided on their writing. A notable difference with the writing strand is that ID research on feedback has prioritized the study of aptitude, whereas WM has been the central concern in research on IDs and text production. Regarding writing itself, three main research directions can be distinguished. One group of studies has investigated the effects of IDs on writing performance, at times adding proficiency or task-related considerations as moderators. A

second research direction has looked into the effects of WM on writing processes. Finally, a third line of research has focused on the effects of WM across language modalities, i.e. studies have compared WM effects on speaking and writing.

Also shown in Table 1, WM has been the ID that has attracted the most scholarly attention, a research interest that is perfectly understandable if we consider the important role of WM in current models of L1 writing adopted by L2 scholars. Working memory refers to the cognitive system responsible for maintaining and processing information in service of complex cognition (Baddeley, 2000, 2007). Since the early 90s, SLA models have placed a heavy emphasis on the role of attention and assumed that limited WM resources support successful development, processing, and use of the second language (Schmidt, 1993; VanPatten, 2004). Indeed, empirical evidence suggests that individual differences in WM capacity predict grammar development (e.g., Lado, 2017; Serafini & Sanz, 2016. For a comprehensive review, see McCormick & Sanz, 2022), and comprehension (e.g., Sagarra, 2017), for example. The contribution that WM capacity makes to production, including writing, has received less attention, but recent studies (see Figure 1) show that individual differences in WM impact second language written texts (but see Manchón et al, this volume) and writing processes (especially regarding pausing behavior. See Révész et al, Torres, this volume); that task demands and different modes of production -oral or written- differentially tax second language processes that involve WM; and that, regardless of individual WM skills, writing tasks afford better opportunities for effective grammar learning compared to oral tasks, as evidenced in Zalbidea (2017) and Zalbidea and Sanz (2020).

These insights are more fully discussed in Granena's, Kormos's, and Li's contributions to the special issue. For now, let us simply note that past research has relied mostly on correlational

designs, where writers perform separate writing and WM tasks and the researchers observe their relationship. Less common are experimental and dual task designs, where writers perform both writing and working memory tasks. Some of these studies have looked at the effects of WM on writing quality, as thoroughly reviewed in Kormos's contribution. A key variable in this strand is writing genre: seven studies in Li's review in this special issue focused on argumentative writing, five used narrative tasks, and three expository; they also follow varied procedures: with or without pre-planning, time limits, or word limits. The constructs measured are also very different: overall writing performance in seven studies; complexity, accuracy and fluency (CAF) in six.

Another strand corresponds to process-based research that investigates WM effects on writing processes, where studies are growing in number, especially concerning correlations between WM components and fluency and pausing behavior. These process-oriented studies have relied on keystroke logging using InputLog ([www.inputlog.net](http://www.inputlog.net). Leijten & Van Waes, 2013), concurrent verbalizations, stimulated recall, questionnaires, and eye-tracking technologies, at times triangulating research instruments and resulting data. Regarding WM components investigated, of the 14 studies examined in Li's review, five investigate verbal working memory (operation span); five, phonological working memory; and four, visual-spatial working memory. Of the executive functions, three looked at inhibition, two at switching, and one at updating.

The existing body of SLA-oriented L2 writing studies on WM effects has built on the abundant research on WM in L1 writing, including theoretical postulations. The most influential writing models (see Olive, 2022 for a full analysis. See also contributions by Granena and Kormos, this volume) have emphasized WM as an explanation for differential success in L1

writing, although they differ on the emphasis placed on the implication of different WM subcomponents, namely, verbal working memory (simultaneous information processing and manipulation in the verbal domain); phonological short-term memory (ability to store and rehearse auditory information); visual-spatial working memory (ability to simultaneously store and process visual-spatial information); and executive functions (inhibition, shifting, and updating). For Hayes (1996), phonological memory, visuospatial memory, and semantic memory are fully involved in all writing processes, whereas Kellogg (1996) proposed precise hypotheses regarding the involvement of specific WM subcomponents in the different writing processes. Researchers are working to empirically validate the predictions the models have made (Kellogg et al., 2013). The situation changes in part when we consider L2 writing. Native speakers vary in their vocabulary range, their ability to build complex sentences, and their command of devices to build cohesive texts, for example; this variability however cannot be compared with differences in language proficiency among L2 writers. To explain variability in success at L2 writing, scholars carry a double weight: to adapt models developed to account for L1 writing to explain L2 writing, and to factor in language-related (especially language proficiency) and task-related considerations, as done in the empirical studies in this special volume (see analysis by Granena).

**Table 1. Overview of research on IDs and writing**

**[Insert Table 1 here]**

In short, WM is heavily implicated in written text production. Available empirical insights provide evidence of its effects, which Li (this volume) synthesizes as follows:

The results of the synthesized studies demonstrate that (1) working memory is largely unrelated to overall writing proficiency; (2) it is predictive of specific aspects of L2 composition such as complexity, accuracy, and fluency; (3) the role of working memory

varies as a function of genre, proficiency, target structure, instruction type, and task demands; and (4) verbal working memory, phonological short-term memory, visual-spatial working memory, and executive functions (inhibiting, shifting, and updating) have differential associations with the process and product aspects of L2 writing.

Despite this preliminary evidence, many open questions remain regarding WM effects in L2 writing processes and performance, as discussed more fully in the three theoretical contributions to the special issue (see also final section in this Introduction). Yet, as Li concludes, “despite the small amount of research and heterogeneous methods, the findings are suggestive of theoretically meaningful patterns, promising perspectives, and inspirational directions” (p. xxx).

## **The Special Issue. Aims, Structure, and Contents**

### *Aims*

On account of the above considerations, the special issue pursues three main aims:

1) *Provide a state of the art of research on WM and L2 writing.*

The literature on WM and writing is not extensive but it is highly heterogeneous. One of the aims of this volume is to make available a scoping review of the current literature in WM and writing. To achieve this global aim, Granena’s, Kormos’s, and Li’s articles comprehensively dissect the research in terms of methods, findings, and remaining empirical questions.

2) *Contribute new empirical findings.*

A second aim set for the volume is to contribute new findings on the nature and effects of WM in L2 writing. The three empirical studies in the volume differ, however, in the dimension of writing potentially affected by WM: The study by Révész, Michel, and Lee, together with the

one by Torres looked into WM effects on writing processes (in both cases focusing on pausing and revision behavior), whereas Manchón, McBride, Mellado, and Vasylets' paper investigated WM effects on written performance (in terms of CAF indices).

### *3) Suggest future avenues*

The final aim of the volume is to look ahead with suggestions for worthy avenues to explore in future research agendas. As readers will see in contributions to the volume (and the synthesis in the last part of this Introduction), these suggestions are both substantive and methodological in nature. The former include not only a critical analysis of pending empirical questions, but also a theoretically- and empirically-informed SLA-oriented future research agenda with the invitation the field to test empirically Kormos's "Task-Mediated Cognitive Model of L2 Writing and Writing to Learn", a comprehensive description of the role of cognitive factors in L2 writing processes and in learning through writing.

## ***Structure and Contents***

### *Structure*

The special issue is divided into three parts. Part I, which includes the studies by Kormos and Li, provides the overall picture of current theorizing and empirical research on cognitive IDs in L2 writing (Kormos) and WM studies in particular (Li). Together, these two pieces offer the necessary background for studies in Part II, which contribute the new empirical evidence on WM effects in writing processes and products. Finally, in the final Coda section, Granena synthesizes and discusses the insights reported in the three empirical studies and looks into the future with suggestions for needed substantive and methodological developments.

### *Overview of contents*

The SI opens with the position paper by Kormos in which she revisits and expands her 2012 analysis on the role of cognitive IDs research in creating synergies between L2 writing and SLA research. Kormos starts with an updated analysis of older and more recent models of the role of WM in L1 writing and discusses their relevance and application to L2 writing. This is followed by a comprehensive discussion of the state-of-the-art work on the role of cognitive factors (aptitude and working memory) in L2 writing processes, the quality of the writing product, and the potential language development that can take place during L2 writing promoting the development of L2 writing skills. Finally, and rather importantly, she offers the theoretical model referred to above of how cognitive factors can mediate writing processes and products as well as L2 learning through writing, which leads the author to put forward a full program of research for future WM studies. The model assumes a complex interplay of learner-related variables (including L2 proficiency, L1 skills, cognitive abilities) and task-related variables (including both task type and task implementation conditions). It can be anticipated that future SLA-oriented L2 writing research on cognitive IDs in L2 writing will heavily rely on Kormos's *Task-Mediated Cognitive Model of L2 Writing and Writing to Learn*.

The global perspective adopted in Kormos's contribution leads to Li's analysis of theory and systematic review of empirical research on the implication of WM in L2 writing. The theoretical part of the paper offers a detailed exploration of the construct and measurement of WM, together with an analysis of the main theoretical models that have informed WM empirical research. This is followed by a systematic review of methods and findings of 16 empirical studies on the effects of WM on writing products and processes. In terms of methods, the synthesis provides a detailed description of key dimensions of the primary research (in terms of research design, methods of working memory, measurement of writing performance, methods of

data elicitation for writing processes, and data analysis, and reporting), as well as a critique of the validity of the methods used. Findings in the primary research are then synthesized in line with the research questions examined in them, including predictive power, associations with other IDs, and role of moderating variables. The article concludes by highlighting major findings and by proposing future directions in terms of questions to be addressed in future research agendas and needed methodological refinements and advances. As noted in the case of Kormos's contribution, it is anticipated that Li's suggestions for moving research forward will surely inform future SLA-oriented L2 writing research on the role and effects of IDs on writing processes and products.

Against the background provided by Kormos's and Li's contributions, the three empirical contributions are unified by a common focus on WM effects. The three papers also converge on a focus on essay writing and on their correlational designs, but, as mentioned earlier, diverge in the components of WM investigated and their measurement, as well as in the dimension of writing investigated, namely WM effects on writing processes in Révész et al's and Torres's studies, and WM effects on written texts in Manchón et al's contribution. The three studies include updating as the common WM subcomponent within executive function (see expanded analysis in Granena's paper). Updating consists in actively manipulating information retained in memory (Smith & Jonides, 1997). Of the subcomponents, updating is the most closely linked to a broad notion of WM, and this is probably why the three studies measured this particular subconstruct. As more fully discussed in Granena's contribution, Révész et al additionally looked at other WM components beyond updating to include all three executive functions as well as phonological short-term memory (STM), and visual-spatial STM. Torres and Manchón et al investigated potential interactions of WM with language dominance in HLLs, language



proficiency, and task complexity. Taken together, the samples in the three studies add breadth to the traditional EFL population, adding heritage language learners (Torres), different writing systems (L1 Mandarin, Révész et al) and diverse L2s (L2 English & Spanish).

Following some of the recommendations for key items in future research agendas in Li's piece, and Granena's call for measuring all WM components, the study conducted by Révész, Michel, and Li investigated the extent to which WM components (phonological and visual short-memory, together with executive functions of task-switching, updating and inhibitory control) relate to L2 pausing and revision behaviours in L2 writing across various stages of writing (early, middle, and end stages) by triangulating keystroke logging and eye tracking data. Thirty advanced Chinese L2 users of English completed an essay writing task in a digital environment using a keystroke logging program. The participants' keystrokes were logged to capture their pausing and revision behaviors and their eye-movements were also recorded to examine their viewing behaviors whenever they paused or revised their text. In order to analyze the influence of writing stage, the writing process was divided into five equal time intervals for each participant. Results showed that various executive functions and verbal and visual short-term memory had a significant impact on pausing behaviors depending on the stage of writing. The results also provided additional evidence of the temporal distribution of processes, revealing that, as reported in previous research, planning, linguistic encoding, and monitoring processes were found to be more prominent in the initial, middle, and later composing periods respectively. In contrast, the researchers did not find evidence of WM effects in the temporal distribution of revision behaviors, although, as noted above, they did find that various WM components had a differential impact on pausing behaviors during the course of writing.

In line with Kormos's recommendations for expanding populations in IDs research, and Kormos's and Li's calls for triangulating data sources, Torres's study adapted Kellogg's (1996) cognitive writing model and integrated keystroke logging and think-aloud methodologies to investigate heritage language (HL) bilinguals' pausing and revision behavior. A group of 61 Spanish-English heritage bilinguals completed argumentative writing tasks in Spanish and English on comparable topics, took a WM test, and completed a questionnaire to estimate language dominance. A subset of 16 participants engaged in thinking aloud while composing texts in both languages. The main results revealed no significant differences in the participants' pausing and revision across their two languages. However, the nature of their cognitive processes underlying these writing behaviors were found to fluctuate as their cognitive activities shifted when writing in Spanish vis-à-vis in English. Regarding WM effects, participants with higher WM cores spent more time addressing linguistic encoding episodes during pauses within words when writing in both languages. In contrast, language dominance as a global dimensional construct did not contribute to these writing behavior results.

Also in line with some the directions for future research advanced in the three theoretical contributions to the special issue, especially in connection with the study of potential variables that may moderate WM effects, Manchón, McBride, Mellado, and Vasylets report on a study that builds on and adds to previous work on WM effects on written performance by exploring the independent effects of WM, and the interactive effects of WM/ L2 proficiency, and WM/task complexity on L2 written performance. The study thus followed a within-between-participant factorial design, with two levels of task complexity as the within-participant variable, and L2 proficiency and WM as between-participants variables. The outcome measure was L2 writing performance as measured by diverse CAF indices. The participants, 40 college-aged advanced

English L2 users, completed (in counterbalanced fashion) the simple and complex version of a writing task, a proficiency test, and a WM test. Regarding WM independent effects, results show that WM did not have an effect on L2 writing performance: The correlation analyses showed that the effects of WM were similar in the simple and complex tasks in all CAF measures, except for syntactic complexity and fluency in the complex task. As for interactive effects, the researchers found no significant interaction between WM, proficiency, or task complexity. In contrast, L2 proficiency emerged as the sole significant predictor of L2 writing performance at both levels of task complexity. The lack of WM effects contradicts previous findings, which the researchers discuss in part as a function of methodological considerations, some of which feature as part of the methodological discussions in Granena's, Kormos's and Li's contributions.

In the final paper in the special issue, Granena takes theoretical and empirical perspectives to examine research on the effects of cognitive IDs (aptitude and WM) in the process and product of L2 writing, with specific reference to the three empirical papers in the special issue. The first part of the paper reviews theoretical models and empirical research on the effects of aptitude and WM on writing processes and products. Granena then provides a detailed, critical analysis of the aims, methods, findings, and contributions of the three empirical studies. Especially relevant is her discussion of wider implications for SLA research on IDs. The last part of the paper provides a wealth of suggestions for future research (including future lines of research, and methodological considerations), and a most welcome discussion of the theoretical and pedagogical relevance of anticipated insights in these future agendas. In this sense, Granena argues that, since research on how cognitive IDs are implicated in writing, expanding research would potentially result in important theoretical and pedagogical implications. The latter are claimed to be closely related to the acknowledgement of the crucial role of writing in instructed

SLA, and, as a result, to the potential of research to inform about optimal performance and learning conditions for learners with diverse cognitive ability profiles.

## **Moving Forward in Research Agendas**

We mentioned earlier that one of the aims of the special issue is to suggest future avenues for SLA-oriented studies of WM and writing. This forward-looking analysis is a central component in the three theoretical contributions, and the three empirical studies also put forward specific suggestions for future studies on WM effects on writing processes and products. Accordingly, in this final section we will simply list pending questions and further research avenues and refer readers to the articles in the special issue for further analyses of the questions raised here. We will divide our analysis into relevant items in future research agendas, on the one hand, and key methodological considerations, on the other.

### ***Relevant items and directions for future research agendas***

Collectively, the contributions to the special issue provide the field with a full research program on both IDs and L2 writing in general, and WM and L2 writing in particular. We list next central research preoccupations in these future research agendas.

#### *Future research agendas on IDs and L2 writing.*

1. A new model of IDs and L2 writing to be tested

A key contribution of this special issue is Kormos's "Task-Mediated Cognitive Model of L2 Writing and Writing to Learn", which represents a notable attempt to strengthen SLA-L2 writing interfaces. Fully informed by an SLA-oriented writing-to-learn framework, the model describes

the role of cognitive factors in L2 writing processes and in L2 learning through writing. The model further predicts that such role may vary as a function of learner-related and task-related variables. The former includes L2 proficiency and relevant L1 literacy skills, whereas the latter encompass task demands, task implementation conditions (including task instructions and time on task), and the transcribing technology (i.e. handwritten vs typed writing). Testing these predictions therefore constitute most welcome future research avenues, which are fully delineated in Kormos's contribution and, importantly, are wholly compatible with the items for future research agendas discussed in the rest of contributions to the special issue.

## 2. Expand the range of IDs under the spotlight

The contributions to the special issue call for an expansion of the range of IDs to be investigated in future SLA-oriented L2 writing research. Thus, Li advocates more research on IDs that have not been central preoccupation in past research, such as the non-cognitive individual factors of motivation, anxiety, self-efficacy. Taking stock of developments in L1 writing research, Kormos recommends investigating the effects of cognitive dissonance, the role of social regulation, as well as the interaction of anxiety and WM and their combined effects on writing processes and outcomes. In Li's view, this expansion of IDs under study would allow to uncover the contributions of each factor and their interactions on L2 writing processes and products.

## 3. Expand research on cognitive IDs

- Aptitude

Li and Granena coincide in their assessment of the relevance of expanding research on aptitude and L2 writing, which Granena considers a predictor of L2 writing in need of exploration. She notes that although previous reviews (e.g. Li, 2016, 2019) suggest that aptitude may be a weak predictor of writing skills as they did not show evidence of a positive correlation between

aptitude and writing, the body of research on aptitude and writing is scarce and limited in terms of populations under study. Therefore, she calls for expanding populations (crucially including adult L2 users) and opting for more controlled, lab studies, which allow for the manipulation of experimental conditions and the investigation of the effects of potential factors on L2 writing.

Many more suggestions for expanding research on aptitude and L2 writing are put forward in the theoretical contributions to the special issue. Thus, Kormos discusses the theoretical and applied dimensions of future work on the combined effects of aptitude and WM. Both Granena and Kormos discuss at length the need to investigate both implicit and explicit aptitude components, and they do so on the basis of the nature of the processing dimension of text production. Important in this respect is Granena's expanded analysis of the more recent theoretical models of aptitude that ought to guide this research. Among other arguments put forward in both papers for this expansion of aptitude research, Kormos claims that both implicit and explicit aptitude components need to be explored as factors that potentially affect L2 development that results from intentional as well as incidental learning. Similarly, Granena contends that researching implicit cognitive abilities may throw light on the degree of automaticity of processes underlying L2 writing, especially when considering the potential moderating role of task-related conditions, such as writing environment (handwriting vs typing) or time-on-task considerations in the relationship between cognitive IDs and L2 writing. In this respect, Kormos puts forward the following predictions about the implication of cognitive IDs in learning through writing under different attentional constraints:

Based on aptitude-treatment interaction research [...] one would presume that efficient WM storage and processing capacity, high levels of rote learning and inductive learning ability, and grammatical sensitivity, which are assumed to be part of explicit cognitive aptitude, would assist L2 writers in the acquisition of new L2 knowledge using conscious,

controlled and explicit learning mechanisms, such as problem-solving, hypothesis testing and meta-linguistic reflection. In contrast, implicit inductive learning abilities and implicit memory might influence the extent to which L2 writers are able to exploit the learning potentials of writing via implicit learning mechanisms.

- Working memory

The volume leaves us with one statement: We can confidently state the existence of WM effects on L2 writing, especially L2 writing processes, with less overwhelming evidence on the effects of WM on writing products. But the volume also leaves us with many important questions related to the nature of those effects. We know little about the timing of the involvement of WM in the process of writing, and whether outcomes reflect the involvement of WM in those processes. Questions also remain on the specific subcomponents of WM involved, on whether WM effects are independent of proficiency and task-related variables, and on whether WM effects are moderated by other variables, like L1 writing skills, or anxiety. These open questions are reflected in the suggested future avenues discussed in the contributions to the SI, which we synthesize next.

#### A) Theoretical models guiding research

Complementing her call to frame aptitude research in recent aptitude models, Granena convincingly argues that a relevant development for future WM studies would be to frame them in WM models that have theoretically challenged Baddeley's (1986) modular WM model (e.g. Cowan, 2005; Engle & Kane, 2004; Miyake et al., 2000). Kormos also calls for an expansion of L1 writing models of the role of WM in writing processes and the incorporation of these new models into research on the role of cognitive factors in L2 writing; likewise, Kormos argues that Kellogg's (1996) model (the one that has informed most L2 writing WM studies), has been

substantially elaborated, and that future research needs to rely on its recent formulation. Granena's and Kormos' analyses evidence the relevance of the suggested theoretical reframing of WM studies not only for providing answers to the existing empirical questions on the involvement of WM components in text production, but also for testing and expanding current models of WM and writing. Thus, a key implication from the three theoretical articles in this volume is the need to carefully choose the model, the construct, and the operationalization of WM in future research.

#### B) Factors moderating WM effects

The three theoretical papers also coincide in underscoring the need to advance in the exploration of factors that may moderate WM effects on products and processes. As mentioned in earlier sections, learner-related variables, including proficiency and L1 literacy skills, and task-related variables, such as task demands, task implementation conditions, and transcription technology are predicted as moderators in Kormos's model. Granena's, Kormos's and Li's contributions shed light on how to transform these predictions into empirically testable hypotheses. Regarding task-related considerations in particular, readers are referred to Li's tripartite distinction between task selection, task implementation, and task scoring (a distinction with important methodological implications, as we will see in a later section on methodology), as well as Kormos's detailed discussion of task environment dimensions and, within them, her analysis of cognitive processing demands subdimensions.

#### C) WM and learning through writing

Kormos's position paper is full of suggestions on how to move forward in WM studies in an attempt to shed light on how writing may be a site for language learning. Her *Task-Mediated Cognitive Model of L2 Writing and Writing to Learn* predicts that aptitude and WM can affect



language learning opportunities that arise during writing even in the absence of feedback. She acknowledges methodological difficulties and challenges as factors that may explain the lack of research in this domain and suggests several worthy avenues to explore in future research agendas, two of which are especially worthy of mention. One would be to examine the differential implication of aptitude components and WM subcomponents the development of more or less complex linguistic constructions at different levels of proficiency, as in Serafini & Sanz (2016). This knowledge would then inform the tailoring of writing tasks and instruction to better fit the learner needs". A second avenue to explore is the limitations imposed by WM constraints on the processing of different feedback conditions.

#### D) WM training

Granena suggests that a worthy avenue for future research is WM training and potential effects on text quality. She refers to WM training studies in the oral domain and notes the absence of writing in this strand. Filling this gap, in Granena's opinion, would contribute to L2 writing studies but, importantly, to the discussion on the nature of WM as a trait or as a state, and its malleability.

#### E) WM and writing processes: WR behaviors and macro-writing processes

Li advocates more process-based research on the involvement of WM in the implementation of macro-writing processes, namely, planning, translating, transcribing, and editing. It is important to note in this respect that a distinction is made in the L2 writing literature between on-line writing behaviors (such as pauses) and higher-order writing processes. Put it another way, the distinction is between writing phenomena at the point of inscription and those above and beyond the point of inscription. L2 writing WM studies to date have targeted only the former, hence the need to expand research on the latter, perhaps starting by testing the specific predictions some L1

writing models make about how WM is implicated in these macro-writing processes. Opening WM studies along this path would not only contribute to advancing our empirical understanding of WM effects, but would also represent a step forward in the global SLA interest in the language learning potential of L2 writing. In this respect, in her recent discussion of the psycholinguistics of L2 writing, Manchón (2023) noted that an important question for the field is to ascertain in what way L2 process studies that focus on on-line writing phenomena at the point of inscription (such as pausing behavior) and those that target writing processes above and beyond the point of inscription (such as formulation or depth of processing of feedback) differentially contribute to our understanding of L2 writing as a site for L2 learning. As potential advancements in this direction, Granena provides examples of key questions for future WM studies on the involvement of the executive function of WM in macro writing processes and effects on written production. She notes:

Overall, further research is needed to shed light on the potentially differential contribution of executive functions in the product of L2 writing and the extent to which they are more or less relevant to explain variability in writing outcomes. For example, if, as Kellogg et al. (2013) suggested, inhibitory control is involved in the selection of task-pertinent information during planning and in the selection of appropriate lexis and grammar during sentence generation, results may show a relationship between IDs in inhibitory control and lexical or grammatical complexity. If updating is more important for the outcome of editing, results may show a relationship with accuracy. Finally, if the coordination of writing processes (planning, sentence generation, and reviewing) depends on task-switching, the greater ability to orchestrate all these processes efficiently may have an impact on the amount of written text, or fluency.

### ***Methodological considerations for future research agendas***

All contributions to the special issue provide a wealth of new methodological directions for future IDs L2 writing studies and, very specially, WM studies. Within the latter, the way forward

goes through a more finely-grained line of research that includes multiple WM subcomponents as well as variables in within-subjects designs, a proposal that we discuss in the next points.

### *Measurement of the predictor variable*

A general agreement in all contributions to the special issue is that the measurement of predictor variable, namely, WM and its subcomponents, requires close scrutiny. Decades of SLA research on the effects of WM has discussed the matter, but recently the discussion has moved even more to the center (Shin & Hu, 2022; Wen et al., 2021). An issue of debate has been whether WM tests should be administered in the L1 or the L2 to avoid confounding proficiency and WM, or whether the storage and processing components should be scored separately or combined into one score. An additional issue of debate is what type of WM test (simple/complex; verbal/non verbal) should be used. In this respect, Zalbidea and Issa (in progress) report initial evidence showing that content-embedded tests (e.g., memorize letters while solving math equations unrelated to said letters) explain more unique variance in measures of language analytic ability and associative learning skills than complex span tests (i.e., judge the grammaticality of a sentence and remember its last word). Following Was et al. (2011), the authors argue that while both types of WM tests require processing and maintenance of information, they differ in that content-embedded tests demand maintenance in memory of task-irrelevant elements during processing, while complex-task tests demand the same task-relevant elements processed and stored.

Very importantly, and in line with some of the observations presented in the section on items for future research agendas, future L2 writing research should explicitly address and justify the choice of theoretical and methodological approaches to WM available in the literature, and

empirically test their predictions. In other words, to increase the explanatory and predictive power of WM in L2 writing, researchers should consider the relationship between WM as a construct and the tests used to operationalize it, followed by the implications of their choices and the limits that their choices set on their interpretation of the relationships between L2 writing and learners' WM capacity. In this sense, Li specifically recommends the use of verbal, rather than nonverbal tests, always administered in the L1. He further encourages protocols that use scoring of all items rather than scoring the maximum number of items test-takers can memorize, and that include processing components - reaction times and plausibility judgments- of working memory, or, at a minimum, that these measures are controlled for. Finally, Li proposes researchers examine visual and spatial working memory separately.

#### *Measurement of outcome variables*

In the study of the relationship between WM and L2 writing, the operationalization of the “L2 writing” construct is also key and may account for current results suggesting that WM does not generally account for differences in the product of writing. The question that emerges is whether general, product-oriented CAF measures are sensitive enough and can isolate the effects of the many contributing factors and their interactions.

In contrast, most WM components appear to be significantly related to processing measures, especially pauses, which suggests that processing measures may be better able to capture the effects of cognitive abilities on L2 writing. Results from Révész et al. and Torres show that greater updating (and sometimes switching) capacity appear to be related to longer pauses in certain locations (i.e., within or between words) and certain stages in the writing process. Verbalizations in Torres's paper show that these greater updating skills allow more time for

linguistic encoding, and in his research synthesis, Li argues that pauses are related to text quality. However, Granena posits the possibility that writers with higher updating skills use their pauses not to improve their text, but to try more complex structures with less success, a question worth investigating. In order to understand how positive processes translate into better writing, and the role of WM capacity in those processes, we need within subjects designs that incorporate both process and product measures in the same study. Similarly, to understand how the same subcomponent operates in the L1 and the L2, we need to incorporate within group L1- L2 writing comparisons. An investigation of the role of inhibition in planning in L2 writing, where not only ideas, as in L1 writing, but also lexicon and grammar compete between the L1 and the L2 is possible only when both languages are included, as in Vallejos (2020). Within-subjects designs that include both process and product, and that include L1 and L2 and different subcomponents of WM in the same design would greatly strengthen the current research program on the role of WM in L2 writing.

#### *The mediation of task conditions*

As discussed in previous sections, task conditions are also an important consideration, including writing environment, time constraints, and task complexity; all three are involved in the differential taxing of attentional resources. Of special relevance from a methodological perspective is the argument that effects of cognitive IDs emerge only when the task is complex and task completion is time constrained (McCormick and Sanz,2022). When in a given study results suggest that WM does not differentially affect writing in more and less complex tasks, the question to be asked is whether the tasks really differ enough in complexity, and, even more important, whether the task is complex enough for the specific sample's level, both of proficiency and of expertise. This is why Li recommends empirically validating task complexity

in future research. Therefore, just as researchers have to carefully choose and justify their choice of WM construct and operationalization, they should also put as much care on their task selection, always in relation with their sample's level of proficiency and of expertise, aware of the limits their choices set on their results and their interpretation.

Following from the above, an important methodological detail that often gets overlooked is a possible interaction between WM and writing environment- paper & pencil vs. computer. Although results are mixed (Vasylets et al, 2022), the writing environment makes a difference for participants with higher or lower updating capacity. This is a variable worth investigating that has implications for education and testing given the growing number of students who cannot handwrite and who receive special accommodations. At a minimum, studies should report environment in the methods section. Also, because typing fast is not equivalent to L2 writing fluency -but typing speed will determine L2 writing fluency, especially if the task has time constraints-, designs should include an L1 fluency measure as baseline.

### *Sampling issues*

Currently, research samples do not represent the whole learner population. Li's systematic research synthesis of WM studies distinctively points to sampling heterogeneity and sampling size, as well as biased sampling problems. This is why he notes that the consideration of sample characteristics is crucial not only when making sampling decisions, but also when interpreting results as level of education, writing expertise, language proficiency, and age, will surely be related to cognitive capacity.

Populations certainly need to be expanded as it is a fact that samples in WM studies come too often from English majors with writing expertise who are completing or have completed

academic writing courses (see field-wide evidence of such concerns in Bylund et al., 2023, and in Plonsky, 2023). This almost exclusive focus on English L2 justifies Kormos's claim to focus on WM effects in learners of other L2s. Both Torres and Révész et al.'s studies show that WM components are not significantly related to revisions, contrary to predictions generated by Kellogg's model. Révész et al posit that explicit use of strategies among their highly competent sample may compensate for WM limitations. In this regard, studies that investigate WM and writing of biliterate samples with different writing systems, students beyond the traditional L2 classroom to include heritage language learners prior to and after writing instruction, and refugees, who typically present different degrees of literacy levels would throw new light on the relationship between WM and L2 writing. For example, Torres' study of his HLL sample questions the importance of language dominance vs. proficiency. Torres's study shows that HL writers engage in similar processes in both languages, their dominant language and the non-dominant language, and that the processes identified were those documented in L1 and L2 writing. Also, higher updating skills were associated with longer pauses independently of dominance. However, and importantly, writing in the HL required more attentional resources dedicated to encoding in detriment of planning. Two questions appear worth investigating: did participants access the same pool of WM resources (Granena)? And, is it dominance, or rather proficiency, or expertise what matters in heritage learners' writing? Questions like these can only emerge and be answered when we diversify our samples.

### *Research designs and analyses*

Methodological observations and recommendations on issues of research designs and analyses abound in the contributions to the special issue, some of which have been mentioned in passing in previous sections. We would like to stress the need for within-subject designs that include not

only measures of different sub-components of WM, as in Révész et al's study, but also process and product measures, together with samples of L1 and L2 writing from the same participants. This will help to generate not just more robust designs capable of handling the small samples that characterize the field, but also designs that would provide answers to key research questions.

Continuing with designs, and at the most global level of testing the predictions in Kormos's model, given the predicted complex interplay of task-related and learner-related variables in the model, as Kormos herself notes, future work that attempts to put it to the empirical test will require carefully controlled and complex experimental designs. Following from here, Granena contends that research on cognitive IDs and L2 writing would benefit from factorial rather than correlational designs that include pre-screened groups of high and low levels of the cognitive factor.

Li calls for transparent reporting of instruments, materials, coding, scoring, and procedure, which were underreported in the primary research included in his review. In terms of analyses, and in line with his recommendations regarding decisions on WM and L2 writing constructs and operationalizations, Li categorically asks for justifiable and informed decisions in data analysis, and discusses this crucial point with reference to past studies. He also adds a most welcome analysis of reporting issues that shows the direct impact that transparent reporting has on research replicability and credibility.

## **Final remarks**

Our central interest with this volume has been to expand research on cognitive IDs, and especially WM, in L2 writing looking at both the processing and product dimension of L2 writing. To achieve this global aim, the special issue pursued three specific objectives. First,



given the recency and heterogeneity of research in the domain, the first aim guiding our collective project was to provide a scoping review of the current literature in WM and writing. Second, another central aim of this collective volume was to contribute new findings on the nature and effects of WM in L2 writing processes and outcomes. Third, the special issue was conceived as a contribution to the field in terms of providing worthy directions for future research agendas, including discussion of theoretical considerations informing future work, empirical questions waiting to be investigated, and crucial methodological considerations in carrying out such research.

It is hoped that the special issue has achieved these three aims. It is also hoped that the special issue has equally succeeded in strengthening SLA-L2 writing interfaces, a worthy endeavor if the role and central position of literacy practices in instructed SLA is acknowledged. In this respect, we started this Introduction with an assessment of the theoretical, empirical, and applied relevance of adding writing to SLA research agendas on IDs. We shall finish by highlighting the crucial contribution that Kormos's *Task-Mediated Cognitive Model of L2 Writing and Writing to Learn* makes to needed cross-pollination between SLA and L2 writing fields, by referring to Li's expanded analysis of key methodological considerations guiding future SLA-oriented studies of IDs and writing, and by reiterating Granena's assessment of the wider implications that adding L2 writing will have for SLA research on IDs in terms of broadening current understandings of the role of cognitive capacities in SLA and their involvement in the development of different types of L2 knowledge and skills.

## References

- Adams, A.M., & Guillot, K. (2008). Working memory and writing in bilingual students. *International Journal of Applied Linguistics*, 156(1), 13-28. <https://doi.org/10.2143/ITL.156.0.2034417>.
- Ahmaddian, M., & Vasylets, O. (2022). The role of cognitive individual differences in writing performance and written corrective feedback processing and use. In R. M. Manchón, & C. Polio (Eds.), *Handbook of second language acquisition and writing*. Routledge.
- Baddeley, A. (2000). The episodic buffer: a new component of working memory? *Trends in Cognitive Sciences*, 4(11), 417-423 [https://doi.org/10.1016/S1364-6613\(00\)01538-2](https://doi.org/10.1016/S1364-6613(00)01538-2)
- Baddeley, A. D. (2007). *Working memory, thought, and action*. Oxford University Press
- Benson, S., & DeKeyser, R. (2018). Effects of written corrective feedback and language aptitude on verb tense accuracy. *Language Teaching Research*, 23(6), 702– 726. <https://doi.org/10.1177/1362168818770921>
- Bitchener, J. (2019). The intersection between SLA and feedback research. In K. Hyland & F. Hyland (Eds.), *Feedback in second language writing. Contexts and issues* (pp. 85-105). Cambridge University Press.
- Bylund, E., Khafif, Z., & Berghoff, R. (in press). Linguistic and geographic diversity in research on second language acquisition and multilingualism: An analysis of selected journals. *Applied Linguistics*. <https://doi.org/10.1093/applin/amad022>
- Cho, M. (2018). Task complexity, modality, and working memory in L2 task performance. *System*, 72, 85–98. <https://doi.org/10.1016/j.system.2017.10.010>.
- Cowan N. (2010). The Magical Mystery Four: How is Working Memory Capacity Limited, and Why?. *Current directions in psychological science*, 19(1), 51–57. <https://doi.org/10.1177/0963721409359277>
- Engle, R. W., & Kane, M. J. (2004). Executive attention, working memory capacity, and a two-factor theory of cognitive control. In B. Ross (Ed.), *The Psychology of Learning and Motivation*, Vol. 44, (pp. 145-199). Elsevier.
- Granena, G., & Long, M. H. (2013). Age of onset, length of residence, language aptitude, and ultimate L2 attainment in three linguistic domains. *Second Language Research*, 29(3), 311–343. <https://doi.org/10.1177/0267658312461497>
- Han, Y. (2017) Mediating and being mediated: Learner beliefs and learner engagement with written corrective feedback. *System*, 65, 133-143.
- Han, Y. & Hyland, F. (2015). Exploring learner engagement with written corrective feedback in a Chinese tertiary EFL classroom. *Journal of Second Language Writing*, 30, 31–44. <http://dx.doi.org/10.1016/j.jslw.2015.08.002>
- Harklau, L. (2002). The role of writing in classroom second language acquisition. *Journal of Second Language Writing*, 11, 329–350. [https://doi.org/10.1016/S1060-3743\(02\)00091-7](https://doi.org/10.1016/S1060-3743(02)00091-7)
- Hayes, J. R. (1996). A new framework for understanding cognition and affect in writing. In C. M. Levy & S. Ransdell (Eds.), *The science of writing: Theories, methods, individual differences, and applications* (pp. 1–27). Lawrence Erlbaum Associates, Inc.
- Ishikawa, M. (2019). *Written languaging, learners' aptitude and second language learning*. Doctoral thesis, University College London.
- Ishikawa, M., & Révész, A. (2023). Written languaging, learners' aptitude, and L2 learning through dictogloss tasks. In S. Li (Ed.), *Individual differences in task-based language learning and teaching* (pp. ). John Benjamins.
- Ishikawa, M. & Suzuki, W. (2023). Effects of written languaging on second language learning: Mediating roles of aptitude. *The Modern Language Journal*, DOI: 10.1111/modl.12817

- Jang, Y., & Lee, J. (2019). The effects of ideal and ought-to L2 selves on Korean EFL learners' writing strategy use and writing quality. *Reading and Writing, 32*(5), 1129-1148.
- Johnson, M. (2022). Task complexity studies. In R.M. Manchón & C. Polio (Eds.), *The Routledge handbook of second language acquisition and writing* (pp. 42–64). Routledge.
- Kellogg, R. T. (1996). A model of working memory in writing. In C. M. Levy, & S. Ransdell (Eds.), *The science of writing: Theories, methods, individual differences, and applications* (pp. 57–71). Lawrence Erlbaum Associates.
- Kellogg, R. T., Whiteford, A. P., Turner, C. E., & Cahill, M. (2013). Working memory in written composition: An evaluation of the 1996 model. *Journal of Writing Research, 5*(2), 159–190.
- Kormos, J. (2012). The role of individual differences in L2 writing. *Journal of Second Language Writing, 21*(4), 390–403. <https://doi.org/10.1016/j.jslw.2012.09.003>.
- Kormos, J., & Sáfár, A. (2008). Phonological short-term memory, working memory and foreign language performance in intensive language learning. *Bilingualism, 11* (2), 261–271. <https://doi.org/10.1017/S1366728908003416>
- Kormos, J., & Trebits, A. (2012). The role of task complexity, modality, and aptitude in narrative task performance. *Language Learning, 62*(2), 439–472. <https://doi.org/10.1111/j.1467-9922.2012.00695.x>
- Lado, B. (2017). Aptitude and pedagogical conditions in the early development of a nonprimary language. *Applied Psycholinguistics, 38*(3), 679-701. doi:10.1017/S0142716416000394
- Leijten, M., & Van Waes, L. (2013). Keystroke logging in writing research: Using Inputlog to analyze and visualize writing processes. *Written Communication, 30*, 358-392. <https://doi.org/10.1177/0741088313491692>
- Leow, R. & Manchón, R.M. (2022). Directions for future research agendas on L2 writing and feedback as language learning from an ISLA perspective. In R.M. Manchón & C. Polio (Eds.), *The Routledge handbook of second language acquisition and writing* (pp. 299-311). Routledge.
- Leow, R. P. (2020). L2 writing-to-learn: Theory, research, and a curricular approach. In R. M. Manchón (Ed.), *Writing and language learning: Advancing research agendas* (pp. 95-117). John Benjamins.
- Li, S. (2016). The construct validity of language aptitude: A meta-analysis. *Studies in Second Language acquisition, 38* (4), 801-842. DOI: <https://doi.org/10.1017/S027226311500042X>
- Li, S. (2019). Six decades of language aptitude research: A comprehensive and critical review. In Z. Wen, P. Skehan, A. Biedron, S. Li, & R. Sparks (Eds.), *Language aptitude: Advancing theory, testing, research, and practice* (pp. 78–96). Routledge.
- Li, S. (2022). Working memory and second language learning: A critical and synthetic review. In Aline Godfroid, & Holger Hopp (Eds.), *The Routledge handbook of second language acquisition and psycholinguistics*. Routledge.
- Li, S., & Roshan, S. (2019). The associations between working memory and the effects of four different types of written corrective feedback. *Journal of Second Language Writing, 45* (1), 1–15. <https://doi.org/10.1016/j.jslw.2019.03.003>
- Lu, Y. (2015). Working memory, cognitive resources and L2 writing performance. In Z. E. Wen, M. B. Mota, & A. McNeill (Eds.), *Working memory in second language acquisition and processing* (pp. 175–189). Multilingual Matters.

- Manchón, R. M. (2011). Writing to learn the language: Issues in theory and research. In R.M. Manchón (Ed.), *Learning-to-write and writing-to-learn in an additional language* (pp. 61–82). John Benjamins.
- Manchón, R.M. (2023). The psycholinguistics of L2 writing. In A. Godfroid & H. Hopp (Eds.), *The Routledge handbook of second language acquisition and psycholinguistics* (pp. 400-412). Routledge.
- Manchón, R.M. & Polio, C. (Eds.) (2022). *The Routledge handbook of second language acquisition and writing*. Routledge
- Manchón, R. M., & Vasylets, O. (2019). Language learning through writing: Theoretical perspectives and empirical evidence. In J. B. Schwieter, J. B. & A. Benati (Eds.), *The Cambridge Handbook of language learning* (pp. 341-362). Cambridge University Press
- Manchón, R. M., & Williams, J. (2016). L2 writing and SLA studies. In R. M. Manchón & P. K. Matsuda (Eds.), *The handbook of second and foreign language writing* (pp. 567–586). de Gruyter Mouton.
- Mavrou, I. (2020). Working memory, executive functions, and emotional intelligence in second language writing. *Journal of Second Language Writing*, 50. <https://doi.org/10.1016/j.jslw.2020.100758>
- McCormick, T., & Sanz, C. (2022). Working memory and L2 grammar learning among adults. In J. Schwieter & Z. Wen (Eds.), *The Cambridge handbook of working memory and language* (pp. 573-592). Cambridge University Press. doi:10.1017/9781108955638.032
- Michel, M., Kormos, J., Brunfaut, T., & Ratajczak, M. (2019). The role of working memory in young second language learners' written performances. *Journal of Second Language Writing*, 45, 31-45. <https://doi.org/10.1016/j.jslw.2019.03.002>
- Miyake, A. N., Friedman, P., Emerson, M., Witzki, A., Howerter, A., & Wager, T. (2000). The Unity and Diversity of Executive Functions and Their Contributions to Complex “Frontal Lobe” Tasks: A Latent Variable Analysis. *Cognitive Psychology*, 41, (1), 49-100. <https://doi.org/10.1006/cogp.1999.0734>.
- Mujtaba, S., Reynolds, B., Parkash, R., Mehar Singh, M. (2021). Individual and collaborative processing of written corrective feedback affects second language writing accuracy and revision. *Assessing Writing*, 50, 10.1016/j.asw.2021.100566
- Mujtaba, S. M., Kamyabi Gol, A., & Parkash, R. (2021). A study on the relationship between language aptitude, vocabulary size, working memory, and L2 writing accuracy. *Foreign Language Annals*, 54(4), 1059-1081. <https://doi-org.ezproxy.lancs.ac.uk/10.1111/flan.12584>
- Olive, T. (2022). How do novice and skilled writers engage working memory? In J. Schwieter & Z. Wen (Eds.), *The Cambridge handbook of working memory and language* (pp. 504-526). Cambridge University Press. doi:10.1017/9781108955638.028
- Papi, M. (2022). The role of motivational and affective factors in L2 writing performance and written corrective feedback processing and use. In R.M. Manchón & C. Polio (Eds.), *The Routledge handbook of second language acquisition and writing* (pp.152-165). Routledge.
- Papi, M., Bondarenko, A. V., Wawire, B., Jiang, C., & Zhou, S. (2020). Feedback-seeking behavior in second language writing: Motivational mechanisms. *Reading and Writing*, 33, 485-505. <https://doi.org/10.1007/s11145-019-09971-6>
- Papi, M., Hiver, P. & Li, S. (Eds.) (2021). *Handbook of second language acquisition and individual differences*. Routledge.

- Papi, M., Wolff, D., Nakatsukasa, K., & Bellwoar, E. (2021). Motivational factors underlying learner preferences for corrective feedback: Language mindsets and achievement goals. *Language Teaching Research*, 25 (6), 1-20. <https://doi.org/10.1177/13621688211018808>
- Plonsky, L. (2023). Sampling and generalizability in Lx research: A second order synthesis. *Languages*, 8, 75. <https://doi.org/10.3390/languages8010075>
- Rahimi, M., & Zhang, L. J. (2019). Writing task complexity, students' motivational beliefs, anxiety and their writing production in English as a second language. *Reading and Writing*, 32(3), 761-786.
- Révész, A. Michel, M., & Lee, M. (2017). Investigating IELTS academic Writing Task 2: Relationships between cognitive writing processes, text quality, and working memory. *IELTS Research Reports*, 3, 5– 44.
- Robinson, P. (2012). Individual differences, aptitude complexes, SLA processes, and aptitude test development. In P. Mirosław (Ed.), *New perspectives on individual differences in language learning and teaching* (pp. 57-75). Springer.
- Sagarra, N. (2017). Longitudinal effects of working memory on L2 grammar and reading abilities. *Second Language Research*, 33(3), 341-363
- Sasaki, M., Mizumoto, A., & Murakami, A. (2018). Developmental trajectories in L2 writing strategy use: A self-regulation perspective. *The Modern Language Journal*, 102(2), 292-309.
- Schwietzer, J. & Wen, Z. (Eds.). (2022) *The Cambridge handbook of working memory and language*. Cambridge University Press
- Serafini, E. J., & Sanz, C. (2016). Evidence of the decreasing impact of cognitive ability on second language development as proficiency increases. *Studies in Second Language Acquisition*, 38(4), 607–646. <https://doi.org/10.1017/S0272263115000327>
- Schmidt, R. (1993). Awareness and Second Language Acquisition. *Annual Review of Applied Linguistics*, 13, 206-226. <http://dx.doi.org/10.1017/S0267190500002476>
- Sheen, Y. (2007). The effect of focused written corrective feedback and language aptitude on ESL learners' acquisition of articles. *TESOL Quarterly*, 41(2), 255– 283. <https://doi.org/10.1002/j.1545-7249.2007.tb00059.x>
- Shin, J., & Hu, Y. (2022). A methodological synthesis of working memory tasks in L2 research. In J. Schwietzer & Z. Wen (Eds.), *The Cambridge handbook of working memory and language* (pp. 722-746). Cambridge University Press. doi:10.1017/9781108955638.038
- Shintani, N., & Ellis, R. (2015). Does language analytical ability mediate the effect of written feedback on grammatical accuracy in second language writing? *System*, 49 (1),110– 119. <https://doi.org/10.1016/j.system.2015.01.006>
- Smith, E. & Jonides, J. (1997). Working memory: A view from neuroimaging. *Cognitive Psychology*, 33(1), 5-42. <https://doi.org/10.1006/cogp.1997.0658>
- Stefanou, C., & Révész, A. (2015). Direct written corrective feedback, learner differences, and the acquisition of second language article use for generic and specific plural reference. *The Modern Language Journal*, 99(2), 263– 282. <https://doi.org/10.1111/modl.12212>
- Tahmouresi, S., & Papi, M. (2021). Future selves, enjoyment and anxiety as predictors of L2 writing achievement. *Journal of Second Language Writing*, 53, 100837. <https://doi.org/10.1016/j.jslw.2021.100837>
- Vallejos, C. (2020). Fluency, Working Memory and Second Language Proficiency in Multicompetent Writers [Doctoral Dissertation, Georgetown University]

- VanPatten, B. (2004). *Processing instruction: Theory, research and commentary*. Lawrence Erlbaum
- Vasylets & Gilabert (2022). Task effects across modalities. In R.M. Manchón & C. Polio (Eds.), *The Routledge handbook of second language acquisition and writing* (pp. 39–51). Routledge.
- Vasylets, L. & Manchón, R.M. (2023). Individual differences and writing instruction. In H. Mojembi & Y. Wang (Eds.), *Insights into teaching and learning writing. A practical guide for early-career teachers* (pp. 87-100). Castledown.
- Vasylets, O., & Marín, J. (2021). The effects of working memory and L2 proficiency on L2 writing. *Journal of Second Language Writing*, 52, 100786. <https://doi.org/10.1016/j.jslw.2020.100786>
- Vasylets, O., Mellado, M., & Plonsky, L. (2022). The role of working memory and language aptitude in digital versus pen-and-paper L2 writing. *Studies in Second Language Learning and Teaching*, 12(4), 721–743. <https://doi.org/10.14746/ssl.2022.12.4.9>
- Waller, L., & Papi, M. (2017). Motivation and feedback: How implicit theories of intelligence predict L2 writers' motivation and feedback orientation. *Journal of Second Language Writing*, 35, 54-65.
- Was, C. A., Rawson, K. A., Bailey, H., & Dunlosky, J. (2011). Content-embedded tasks beat complex span for predicting comprehension. *Behavior Research Methods*, 43, 910-915. <https://doi.org/10.3758/s13428-011-0112-x>
- Wen, Z. (2019). Working memory as language aptitude: The Phonological/Executive Model. In E. Wen, P. Skehan, A. Biedron & S. Li (Eds.), *Language aptitude: Advancing theory, testing, research and practice* (pp. 187-214). Routledge.
- Wen, Z. (2022). Working memory. In J. Schwieter & Z. Wen (Eds.), *The Cambridge handbook of working memory and language* (pp. 54-66). Cambridge University Press.
- Wen, Z., Biedron, A., & Skehan, P. (2017). Foreign language aptitude theory: Yesterday, today and tomorrow. *Language Teaching*, 50(1), 1-31
- Williams, J. (2012). The potential role(s) of writing in second language development. *Journal of Second Language Writing*, 21, 321-331.
- Yamashita, T. (2022). Effectiveness and inclusiveness of locally adapted human-delivered synchronous written corrective feedback for English referential articles. *Computer Assisted Language Learning*, DOI: 10.1080/09588221.2022.2068612
- Yang, Y, Sun, Y, Chang, P. & Li, Y. (2019). Exploring the relationship between language aptitude, vocabulary size, and EFL graduate students' writing performance. *TESOL Quarterly*, 53(3), 845-856. <https://doi.org/10.1002/tesq.510>
- Zabihi, R. (2018). The role of cognitive and affective factors in measures of L2 writing. *Written Communication*, 35(1), 32–57. <https://doi.org/10.1177/0741088317735836>
- Zalbidea, J. (2017). 'One task fits all'? The roles of task complexity, modality, and working memory capacity in L2 performance. *The Modern Language Journal*, 101, 335-352. <https://doi.org/10.1111/modl.12389>
- Zalbidea, J. (2021). On the scope of output in SLA: Task modality, salience, L2 grammar noticing, and development. *Studies in Second Language Acquisition*, 43, 50- 82. <https://doi.org/10.1017/S0272263120000261>
- Zalbidea & Issa (in progress). Exploring the potential of content-embedded working memory tasks for advancing SLA research.

Zalbidea, J. & Sanz, C. (2020). Does learner cognition count on modality? Working memory and L2 morphosyntactic achievement across oral and written tasks. *Applied Psycholinguistics*, 41(5), 1171-1196. <https://doi.org/10.1017/S0142716420000442>