

The Effects of Task Types and Working Memory Capacity on the Writing Production of Chinese EFL Learners

Ziming Zhao

Department of English, Faculty of Modern Languages and Communication, Universiti Putra Malaysia, Kuala Lumpur, Malaysia;

School of English, Jilin International Studies University, Changchun, China

Vahid Nimehchisalem*

Department of English, Faculty of Modern Languages and Communication, Universiti Putra Malaysia, Kuala Lumpur, Malaysia

Mei Yuit Chan

Department of English, Faculty of Modern Languages and Communication, Universiti Putra Malaysia, Kuala Lumpur, Malaysia

Abstract—The current study aimed to examine the effects of two types of writing tasks—an independent writing task and an integrated writing task—on 144 Chinese EFL learners' writing production in terms of fluency, accuracy, lexical complexity, and syntactic complexity. Additionally, it investigated whether the learners' working memory capacity has a mediating effect on their writing when responding to the two different types of writing tasks. The participants took an Ospan test to measure working memory capacity. They were then randomly assigned to either the independent writing task group or the integrated writing task group. The findings revealed that, compared to the independent task group, participants in the integrated task group performed significantly better in language accuracy but worse in fluency. The results of this study partially supported Robinson's Cognition Hypothesis (CH). Results showed that working memory capacity has a significant positive effect on syntactic complexity and accuracy; however, its interactive role with task type was only observed in accuracy.

Index Terms—task complexity, task type, working memory, CALF, EFL writing

I. INTRODUCTION

As the basis of Task-Based Language Teaching (TBLT), tasks are presumed to facilitate language acquisition in EFL/L2 classrooms. A significant amount of research on TBLT has focused on how manipulating the cognitive demands of tasks, or task complexity, impacts second language (L2) performance and development. Previous research indicates that task type is an important variable both in how learners approach language production and in how it affects the fluency, accuracy, and complexity of language products (Foster & Skehan, 1999; Skehan, 2001). In the context of TBLT, the traditional approach of evaluating writing competence through a single independent writing task has raised concerns. As a result, there is a growing trend towards using multiple writing tasks in high-stakes assessments. For example, the Test of English as a Foreign Language (TOEFL) and the Chinese National Test for English Majors (TEM-4 and TEM-8) now include both independent and integrated tasks in their writing sections. Research on the impacts of task types, specifically traditional independent writing tasks and integrated writing tasks, requires an expansion of its investigative scope. On the other hand, while many of these studies examine task complexity in independent writing, integrated writing is comparatively understudied (Abrams, 2019).

The most widely adopted theories in the research on task complexity are Skehan's Trade-Off Hypothesis (TOH) and Robinson's Cognition Hypothesis (CH), which explain the effects of task cognitive characteristics on language output and development. Both of these theories explore how different aspects of task design that affect task cognitive demands can either enhance or challenge the cognitive resources of L2/EFL learners, thereby directing learners' attention towards particular linguistic dimensions. Although the two hypotheses are widely adopted as the theoretical underpinnings of task complexity studies, their claims are in opposition to each other, and past research has demonstrated varying degrees of support for both theories. Rahimi and Zhang (2019) remark that studies based on the Trade-Off Hypothesis (TOH) and the Cognition Hypothesis (CH) have not thoroughly investigated the role of individual characteristics. In addition to

* Corresponding Author. Email: vahid@upm.edu.my

the significance of individual differences in working memory capacity, they call for more research on the effects of task types, task designs, and task implementation on L2 writing production.

Working memory has been identified as one of the most important individual differences that may potentially affect L2/EFL writing success (Michel et al., 2019; Kormos, 2012; Güvendir & Uzun, 2023). The process of producing written text requires significant cognitive effort from L2 learners. Previous studies have found that, compared to independent writing tasks (writing only), the use of integrated writing tasks (reading and writing) increases the cognitive demands on learners' working memory capacity (e.g., Plakans & Gebriel, 2012). It was claimed that differences in working memory capacity (WMC) can significantly affect writing performance (Michel et al., 2019; Kormos, 2012; Güvendir & Uzun, 2023). Still, there is a need for further research due to the paucity of the study.

As a result, the present study aimed to examine whether EFL learners' writing production is affected by different types of writing tasks (independent and integrated writing tasks) in terms of syntactic complexity, accuracy, lexical complexity, and fluency (CALF), and whether the relationship between task type and writing performance is mediated by the working memory capacity of learners.

II. LITERATURE REVIEW

A. Task Complexity and L2/EFL Writing

In the area of Task-Based Language Teaching (TBLT), task complexity refers to the "attentional, memory, reasoning, and other information processing demands imposed by the structure of the task on the language learner" (Robinson, 2001b, p. 29). According to Robinson's Triadic Componential Framework for task classification, the complexity of a task is manipulated along two dimensions: the resource-directing dimension and the resource-dispersing dimension. The resource-dispersing dimension of task complexity pertains to the procedural and behavioral requirements a given task imposes upon individuals, while the resource-directing variables dimension places varying levels of conceptual demands on learners. It is widely acknowledged that both Skehan's Trade-Off Hypothesis (1996, 1998) and Robinson's Cognition Hypothesis (2001a, 2003, 2005b, 2011a), two predominant theories on cognitive task complexity, provide a framework for investigating how task design, through the manipulation of task complexity, can influence learners' cognitive resources and focus their attention on specific linguistic components. However, these theories present competing hypotheses. The Trade-Off Hypothesis suggests that learners will allocate more attention to meaning as tasks become more challenging in complexity. L2/EFL performance tends to decline with more cognitively complex tasks. In contrast, the Cognition Hypothesis posits that learners can access multiple attentional resources simultaneously, as these resources are not limited. Increased task complexity directs learners to focus on specific language aspects, potentially sacrificing fluency for greater accuracy and complexity. Thus, more cognitively complex tasks positively impact linguistic complexity and accuracy but negatively affect fluency.

Guided by two hypotheses, recent years have witnessed significant interest in studies investigating the predictive power of task complexity in L2/EFL written production. However, the results of these studies have been inconsistent. According to Robinson (2001, 2003a), some tasks may be more effective than others in assisting learners in noticing language form, depending on their attentional demands. In light of this, an increasing number of studies are exploring the effect of manipulating cognitive demands through different types of tasks, such as narrative and argumentative ones. Nevertheless, few studies have examined the impact of manipulating independent or integrated writing tasks, along with individual cognitive characteristics, on learners' writing performance.

B. Working Memory and L2/EFL Writing

Working memory (WM) momentarily stores and manipulates input to perform any task. Additionally, it entails a number of subsystems, each of which is connected to the distinct character of the information to be processed (Baddeley, 2020). Given its role in attention and conscious awareness, working memory has attracted significant interest from researchers exploring its function in second language processing. From the perspective of second language acquisition (SLA), Robinson (2005) suggested that studies should investigate the interaction between individual differences (IDs) in ability variables (e.g., working memory, aptitude, etc.) and learning production under various instructional exposure conditions and across tasks with different levels of complexity. By reviewing prior literature, it was found that, inspired by Kellogg's Model, the majority of studies have explored the role of working memory (WM) from a nuanced perspective of WM types (e.g., verbal WM, phonological short-term memory, visual-spatial information, and the like) on EFL/L2 writing at various stages of writing. Based on Kellogg's Model, the writing process depends on components of working memory, as individuals utilize the central executive function when generating ideas and converting them into linguistic expressions. Individuals with high working memory capacity are expected to retain more ideas and expressions in memory, which would manifest in their writing performance. Writing performance assessment has predominantly focused on two dimensions: overall writing scores and performance in complexity, accuracy, and fluency (CAF).

Zabihi (2018) observed that a greater working memory capacity (WMC) was predictive of higher L2 writing scores, particularly concerning syntactic complexity and fluency. Vasylets and Marin (2021) delved into the intricate relationship between WM and L2 writing ability, and their findings revealed that, at lower proficiency levels, WM exhibited a correlation with writing accuracy, while at higher levels of L2 competence, it became associated with

enhanced lexical sophistication. In terms of complexity, WMC emerges as a positive predictor, particularly with regards to syntactic complexity, often measured through subordination (Mavrou, 2020). Conversely, some studies have found no correlation between WMC and L2 writing performance in terms of syntactic complexity, accuracy, lexical diversity, and fluency (CALF) (Cho, 2018). Even a negative impact of working memory was found on writing accuracy (Révész et al., 2017). Additionally, some research found that L2 proficiency and WMC mediate writing performance metrics (Kormos & Sáfár, 2008). It was claimed by some researchers that the impact of WMC on L2 writing interacts with factors such as task type, task complexity, and learners' language proficiency (Lu, 2010; Michel et al., 2019). Therefore, the current study seeks to ascertain whether learners with different WMCs are affected differently when tasked with assignments of varying complexity levels.

C. Independent Writing and Integrated Writing

The majority of L2 task-based writing studies focus on the impact of task demands on independent writing, with few examining integrated writing performance and task complexity. Integrated writing research mainly explores discourse features in reading-to-writing situations. Academically, integrated writing tasks require students to summarize a reading passage and provide comments or suggestions. Unlike independent writing, which involves an impromptu essay on a general topic, integrated writing responds to a specific scenario. Synthesizing the concepts, main ideas, or key points from reading sources is a crucial step in an integrated writing task (Plakans & Gebriel, 2013). Another key difference between the two types of writing tasks lies in the degree of reliance on learners' existing knowledge. In an independent writing task, writers are free to present viewpoints and supporting evidence drawn from their own knowledge or experiences (Plakan, 2008). In contrast, integrated writing tasks require students to extract facts and viewpoints from the reading passage—information they might be unfamiliar with—and justify and explain their responses accordingly. An integrated writing task requires participants to “produce written compositions that display appropriate and meaningful uses of and orientations to source evidence, both conceptually and textually” (Cumming et al., 2005, p. 34). This process may place greater cognitive demands on participants. Based on this rationale, the present study hypothesized that the integrated writing task is more cognitively demanding or more complex, whereas the independent writing task has a relatively lower cognitive demand or is less complex as a task.

Still, relatively little research has been conducted regarding how L2/EFL students respond to these two types of writing tasks and how individual factors, such as working memory capacity, have an impact on their writing performance in terms of syntactic complexity, lexical complexity, accuracy, and fluency (CALF). From the limited research available, the influence of resource-directing variables on integrated writing performance remains inconsistent. On one hand, some studies have shown that learners exhibit better performance in lexical and/or syntactic complexity in integrated writing tasks (Biber et al., 2016). On the other hand, however, Kyle and Crossley (2016) found no significant difference in linguistic complexity between integrated and independent writing tasks. Additionally, Plakans et al. (2019) reported increased fluency in learners' writing in response to integrated writing tasks. Abrams (2019) found that integrated writing tasks led to improvements across all linguistic features compared to independent writing tasks. The inconclusive evidence highlights the need for more research in this area.

The study is designed to investigate the impact of task complexity on L2/EFL writing performance in two types of writing tasks: independent writing and integrated writing. Additionally, the potential mediating role of working memory is examined. To achieve the objectives of the current study, the following research questions are addressed:

- RQ1: What are the effects of writing task types (independent writing task versus dependent writing task) on Chinese EFL learners' writing production in terms of lexical complexity, syntactic complexity, accuracy, and fluency?
- RQ2: Does individual working capacity play a mediating role in the relationship between task types and Chinese EFL learners' writing performance?

III. METHODOLOGY

A. Research Design

This research aimed to explore how task complexity, varied by task type, and learners' working memory capacity (WMC) of learners influence their writing output, specifically regarding syntactic complexity, lexical complexity, accuracy, and fluency (CALF). An experiment-based research project was conducted with 144 English-major students at a Chinese university. The study began with a participant screening process that included an English language proficiency test and a survey questionnaire. The participants with comparable levels of English proficiency were then randomly assigned to one of two different writing task groups: the independent writing task group and the integrated writing task group. They were then instructed to complete their designated writing tasks on a computer. Following a two-week interval, the participants proceeded to undertake the Ospan Test (measuring working memory capacity) within three time slots in a computer lab. The data was gathered from the computer and analyzed using SPSS 25.0.

B. Participants

Participants in the current study were recruited from a Chinese university on a volunteer basis. A total of 143 (61 male and 82 female) sophomores majoring in English were enrolled. To minimize potential confounding factors related to language proficiency, the study applied the inclusion criteria of intermediate-level and advanced-level English

learners, necessitating a minimum overall score of 60 (out of 100) and a minimum score of 12 (out of 20) in the writing section on the most recent mock TEM-4 test. The participants had varying levels of English learning experience, ranging from 8 to 10 years, and none of them had lived or studied in English-speaking countries for more than three months prior to this study.

C. Writing Tasks

The writing tasks for this research were sourced from the mock TEM-4 Test (Test for English Majors-Band 4). It is an English proficiency exam for non-native speakers in China. Under the purview of the Higher Education Department within China's Ministry of Education, the TEM-4 is regarded as an intermediate-level English proficiency examination, and it serves as a nationally recognized standard evaluation. The integrated writing task was a reading-to-write activity. Students first read a news report excerpt about plastic pollution, summarized it, and then suggested ways to increase public awareness of environmental protection, focusing on banning plastic bags. The independent writing task involved only writing and asked students to comment on methods to enhance public awareness of environmental protection. Both tasks required a minimum of 200 words and had to be completed within 45 minutes. Some scholars emphasize the need to validate the cognitive demands of tasks before examining their effects on language performance (Révész, 2014; Sasayama, 2016). SLA researchers increasingly use subjective self-rating scales and self-report questionnaires to study task cognitive complexity, which has been shown to be valid and reliable for assessing cognitive load (Sasayama, 2016). Following this perspective, a pilot study with 35 participants involved completing independent and integrated writing tasks and filling out a Self-Perceived Writing Task Questionnaire (Rahimi & Zhang, 2018). The results confirmed that the integrated writing task is complex, while the independent writing task is simple.

D. Working Memory Capacity Measurement

To measure participants' working memory capacity, this study used the Operation Span (Ospan) task, a common tool in educational and psychological research (Malone, 2018; Unsworth et al., 2009). In this task, students solve a simple math equation and, within 1 second, click "T" for true or "F" for false. After each math problem, a letter appears briefly for memorization, followed by another math equation. This cycle repeats for 4-6 rounds, after which participants recall the letters presented. In this study, participants completed the automated Ospan task in a language lab using a mouse-driven interface via *Inquisit 6* software (Millisecond), a user-friendly online tool. The results page displayed the Ospan absolute score, total correct answers, math errors, speed errors, and accuracy errors. The median Ospan absolute score was recorded as the participants' working memory capacity. Students chose one of three time slots in the computer lab to take the Ospan test, and their scores were collected. The mean WMC score was 116.58.

E. CALF Measures

The constructs of L2 performance are inherently multi-componential, encompassing fluency, accuracy, syntactic complexity, and lexical complexity (CALF). These factors have long been key research variables in L2/EFL studies. In TBLT research, CALF constructs are crucial for evaluating whether task complexity manipulations affect cognitive demands (e.g., Kormos et al., 2011; Kuiken & Vedder, 2012; Ong, 2013; Tabari, 2022).

In the current study, fluency was measured by "the total number of words (TW) a writer can produce within a specific time frame" (Wolfe-Quintero et al., 1998, p. 225). Both integrated and independent writing tasks had a fixed time limit of 45 minutes. *Coh-Metrix 3.0*, a free software tool for linguistic and discourse analysis, was used to assess the TW. Two indicators, mean length of T-unit (MLT) and the number of clauses per T-unit (C/T), were utilized to measure syntactic complexity. In previous studies, the most prevalent measure of syntactic complexity proposed was "clauses per T-unit" (e.g., Bulté & Housen, 2014; Lu, 2011). According to the Cognition Hypothesis, an increase in task complexity along resource-directing dimensions, such as increasing demands for causal reasoning, will necessitate the use of logical subordinators, resulting in increased complexity in subordination. Hence, the current study investigated syntactic complexity through two dimensions: overall complexity, quantified using the mean length of T-unit (MLT), and complexity via subordination, assessed by the number of clauses per T-unit (C/T).

In L2/EFL writing performance, lexical complexity is measured by the ratio of advanced word types to total word types (type/type ratio) and the type-token ratio (TTR), which accounts for word-type variation relative to the total number of words and the duration of the writing sample (Wolfe-Quintero et al., 1998). Unlike TTR, the number of different words (NDW) is a robust measure of lexical diversity that is unaffected by text length (McCarthy & Jarvis, 2010). Recently, NDW has gained broader use as an indicator of lexical complexity, supported by growing theoretical and empirical research (e.g., Zhang, 2019; Zhou, 2023). Therefore, this study used NDW and TTR to measure the lexical complexity of participants' writing. Accuracy was measured using the EFT ratio (number of error-free T-units divided by the total number of T-units) and the EFC ratio (number of error-free clauses divided by the total number of clauses). This study followed Polio's guidelines for coding errors (Polio, 2014), modified from her earlier work (Polio, 1997). Participants' writing accuracy was evaluated by calculating the EFT and EFC ratios. Due to the complexity of identifying errors, the assessment was done manually with the assistance of *Grammarly*. The inter-coder reliability was 0.892 for EFT and 0.903 for EFC. Any disagreements during the process were resolved through group discussion.

F. Data Collection and Data Analyses

Supervised by research assistants, the writing tasks were distributed and collected through *iWRITE*, an online English writing teaching platform. Once the writing tasks were submitted, researchers and their assistants were responsible for data coding and analysis. Multiple tools, including the L2 Syntactic Complexity Analyzer and *Coh-Metrix 3*, among others, were employed to analyze the data for three primary constructs: linguistic complexity (syntactic and lexical), accuracy, and fluency (e.g., Ellis & Yuan, 2004; Storch, 2009; Kormos, 2012; Kuiken & Vedder, 2012). Regarding the manually analyzed data, initial checks were conducted to ensure inter-rater reliability. Subsequently, standard diagnostic tests, independent sample t-tests, and multi-linear regression models were adopted using SPSS 26.0 and the PROCESS macro to explore the changes in writing performance under the two different writing task conditions as well as the mediating effects of working memory capacity. The alpha level was set at $p < .05$.

IV. RESULTS

In this study, the independent variable, writing task type (independent and integrated), is a binary classification variable. The dependent variables consist of eight measures under four dimensions (fluency, accuracy, syntactic complexity, and lexical complexity), all of which are continuous. Prior to data analysis, outliers and missing values were examined. To examine the mediating effects of an individual's working memory, the data on working memory capacity (WMC) was first subjected to a centering process. To address the non-normality observed in the data, a logarithmic transformation was employed on the variables to achieve a normal distribution. The values of kurtosis and skewness indicated that the distribution of the variables was approximately symmetrical and exhibited a moderate tail, which satisfied the assumptions of t-test analysis.

A. Results Concerning the Effects of Task Type

To manipulate task complexity along the resource-directing dimension, the present study devised two distinct types of writing tasks with varying cognitive demands for the learners: the independent writing task, characterized as a lower cognitively demanding task, and the integrated writing task, characterized as a higher cognitively demanding task. To answer the first research question (RQ1), independent sample t-tests were conducted between the independent task group and the integrated task group. The analysis of written production, measured in two groups that responded to different writing tasks, yielded mixed results, as presented in Table 1.

TABLE 1
RESULTS OF WRITING PRODUCTION IN TWO TYPES OF WRITING TASK GROUPS (N=143)

Measures	Code	Task	Mean	SD	95% CID (low, high)	df	t	Sig (2-tailed)
Fluency	TW	IND	249.76	42.30	1.128 (low)	142	2.137	.034*
		INT	234.72	41.87	38.06 (high)			
Syntactic Complexity	MLT	IND	25.18	11.66	-4.15 (low)	142	-.138	.890
		INT	25.45	11.80	3.61 (high)			
	C/T	IND	2.29	1.56	-4.11 (low)	142	.240	.810
		INT	2.23	1.25	.52 (high)			
Lexical Complexity	NDW	IND	126.15	21.22	-2.96 (low)	142	1.090	.278
		INT	122.51	18.68	10.25 (high)			
	TTR	IND	0.49	0.50	-.037 (low)	142	-2.298	.023
		INT	0.52	0.52	-.003 (high)			
Accuracy	EFC	IND	0.77	0.14	.11 (low)	142	-3.30	.001**
		INT	0.84	0.12	-.03 (high)			
	EFT	IND	1.09	0.15	-.12 (low)	142	-3.10	.002**
		INT	1.37	0.12	-.03 (high)			

Note: * $p < 0.05$, ** $p < 0.01$; 95% CID= 95% Confidence Interval Differences; IND=independent writing task group, INT=integrated writing task group

(a). Fluency

Table 1 presents the results of tests conducted to assess the written fluency performance of two distinct groups assigned to independent and integrated writing tasks, each with varying levels of cognitive demand. To measure writing fluency, the researchers utilized the index of TW (the total number of words), which quantifies the total number of words produced by participants during the time-limited writing task. The results indicate a significant difference between the groups, with a p-value reaching a significant level ($t=2.137, p=.034 < .05$). This demonstrates a distinction between the participants in the two groups regarding their ability to generate written content with fluency under the constraints of time. To be specific, the mean TW score for the integrated task group is 231.61, with a standard deviation (SD) of 42.84. In contrast, the independent task group achieved a mean TW score of 249.76 with an SD of 42.30. Participants assigned to the integrated task exhibited a decrease in TW by approximately 18.15 words compared to the independent task group. This observation suggests that the integrated writing task had an impact on the fluency of the participants, resulting in a decrease in the number of words produced.

(b). Syntactic Complexity

The results in Table 1 indicate that the syntactic complexity measures exhibited a noteworthy pattern in response to variations in task cognitive demands. The mean length of T-unit (MLT), a measure of sentence length, did not show any significant change between the two writing tasks ($t=-.138, p=.890 > .05$). Similarly, the number of clauses per T-unit (C/T), which reflects the complexity of sentence structure, also failed to demonstrate any significant variations between the simple and complex writing tasks ($t=.240, p=.810 > .05$). This indicates that, in responding to different writing tasks, participants did not alter the composition of their sentences in response to task complexity, maintaining a consistent level of structural complexity. Based on the comparative data between the two groups, it can be observed that, overall, participants in the complex task group performed slightly better in terms of syntactic complexity compared to the simple task group. Specifically, for mean length of T-unit (MLT), the integrated task group had a mean score of 25.18 ($SD=11.66$) and the independent task group had a mean score of 25.45 ($SD=11.80$). Similarly, for the number of clauses per T-unit (C/T), the integrated task group had a mean score of 2.29 ($SD=1.56$) and the independent task group had a mean score of 2.23 ($SD=1.25$). These results suggest that participants maintained a comparable level of syntactic complexity across both task types, with slight variations favoring the complex task group.

(c). *Lexical Complexity*

The comparison of lexical complexity measures, specifically the number of different words (NDW) and the type-token ratio (TTR), yielded mixed results. Firstly, the number of different words (NDW) did not show significant variations ($t=1.090, p=.278 > .05$). This implies that participants used a similar range of vocabulary in both the independent and integrated writing tasks. Secondly, the type-token ratio (TTR), which assesses the ratio of unique words to the total number of words, demonstrated a significant difference between the two task groups ($t=-2.298, p=.023 < .05$). The comparative results for lexical complexity showed that in the TTR dimension, the integrated task group exhibited better performance ($M=0.52, SD=0.52$) in word sophistication than the independent task group did ($M=0.49, SD=0.50$).

(d). *Accuracy*

The results presented in Table 1 indicated that there were significant differences in the accuracy of the writing production of Chinese EFL learners between the two groups engaged in different types of writing tasks. For the ratio of error-free clauses (EFC), the statistical analysis ($t=-3.30, p=.001 < .05$) demonstrated a substantial difference between the two groups. The comparative findings suggest that the group engaged in the integrated writing task ($M=0.84, SD=0.12$) exhibited a significantly higher level of accuracy compared to the group assigned to the independent writing task ($M=0.77, SD=0.14$). This result implies that the more cognitively demanding integrated writing task led to a higher proportion of error-free clauses in the participants' writing.

Similarly, the results for the ratio of error-free T-units (EFT) ($t=-3.10, p=.002 < .05$) also showed a significant difference between the two groups. The integrated writing task group ($M=1.37, SD=0.12$) displayed a higher EFT ratio compared to the group that undertook the independent writing task ($M=1.09, SD=0.15$). This outcome indicates that the integrated writing task contributed to a greater proportion of error-free T-units in the participants' written work.

B. *Results Concerning Effects of Working Memory*

Research Question 2 of this study focused on examining the influence of individual working memory capacity (WMC), and, particularly, its mediating role. Therefore, based on the results shown in Table 2, the effects of WMC on learners' writing performance were examined first. Subsequently, the results of multiple linear regressions were analyzed to explore the interactive effects between WMC and task type on participants' writing performance, measured by fluency, syntactic complexity, lexical complexity, and accuracy.

TABLE 2
RESULTS OF INDIVIDUALS' WMC IN RESPONSE TO TWO WRITING TASKS (N=143)

Measures	Code	Model	B	SE	<i>t</i>	<i>Sig</i>	<i>F</i>	<i>R Square</i>
Fluency	TW	WMC	-0.89	0.39	-2.23	.027*	0.39	0.112
		Task*WMC	0.28	0.45	0.62	.536		
Syntactic Complexity	MLT	WMC	0.11	0.12	0.93	.355	0.93	0.007
		Task*WMC	-0.13	0.13	-0.97	.336		
	C/T	WMC	0.005	0.01	0.36	.726	0.88	0.01
		Task*WMC	-0.015	0.02	-0.94	.350		
Lexical Complexity	NDW	WMC	0.26	0.19	1.325	.187	1.09	0.021
		Task*WMC	-0.23	0.22	-1.044	.298		
	TTR	WMC	0.03	0.04	6.66	.000**	3.89	0.46
		Task*WMC	0.01	0.07	1.97	.050		
Accuracy	EFC	WMC	0.004	0.001	3.34	.000**	1.82	0.14
		Task*WMC	0.004	0.001	3.29	.001**		
	EFT	WMC	0.005	0.001	3.89	.000**	1.54	0.16
		Task*WMC	0.006	0.001	3.814	.000**		

Note: * $p<0.05$, ** $p<0.01$; Task=Task Type; WMC=Working Memory Capacity

(a). Fluency

As presented in Table 2, participants' working memory capacity (WMC) has a significant influence on the total number of words (TW) in their writing performance ($t=2.23, p=.027 < .05$). This suggests that individuals with higher WMC are able to produce more words, thereby demonstrating greater fluency in their writing. However, the results of the linear regression analysis indicated that the interaction between task types and WMC does not have a significant effect ($F=0.39, p=.536 > .05$) on fluency in writing. In other words, while both WMC and task type were found to significantly impact participants' fluency, WMC does not mediate the influence of task type on writing production in terms of fluency.

(b). Syntactic Complexity

Regarding syntactic complexity, the results demonstrated that working memory capacity (WMC) had a positive but non-significant effect on both the mean length of T-unit (MLT) ($t=0.93, p=.355 > .05$) and the number of clauses per T-unit (C/T) ($t=-0.97, p=.726 > .05$). It suggested that while individuals with higher WMC might produce slightly longer T-units or more clauses per T-unit, the effect is not statistically significant. Additionally, the interactive effects between task type and WMC were not found to be significant for syntactic complexity with both MLT ($F=0.93, p=.336 > .05$) and C/T ($F=0.88, p=.350 > .05$). This indicated that WMC alone does not significantly influence syntactic complexity, nor does it interact with task type to affect this measure.

(c). Lexical Complexity

From Table 2, it was revealed that WMC had a non-significant effect on the number of different words (NDW) ($t = 1.325, p = .187 > .05$). This indicates that while individuals with higher WMC tended to use a greater variety of words, the effect was not statistically significant. Furthermore, the interaction between task type and WMC on NDW was also non-significant ($F=1.09, p = .298 > .05$).

In contrast, the effect of WMC on the type-token ratio (TTR) was found to be highly significant ($t = 6.66, p=.000 < .001$). This significant positive effect suggests that individuals with higher working memory capacity produce greater lexical diversity in their writing. The interaction between task type and WMC on TTR was marginally significant ($F=3.89, p=.050$). This indicates that WMC had a borderline significant influence on the relationship between task type and lexical diversity. In this model, the predictive power of task type on writing lexical complexity in terms of TTR varied according to participants' working memory capacity. Overall, the explanatory power reached 46% ($R^2 = .46$), demonstrating a strong influence.

(d). Accuracy

Based on the results, a significant positive effect of WMC was found on the ratio of error-free clauses (EFC) ($t = 3.34, p = .000 < .001$). Learners with higher working memory capacity tend to produce a higher proportion of error-free clauses, suggesting that greater working memory capacity enhances accuracy in clause construction. Task type and WMC significantly interacted with each other, indicating that the effects of task type on EFT were highly influenced by WMC. However, the explanatory power of the model is 14% ($R^2 = 0.14$), which is relatively limited.

Similarly, WMC had a significant positive effect on the ratio of error-free T-units (EFT) ($t = 3.89, p=.000 < .001$). Higher WMC is associated with a higher proportion of error-free T-units. The interaction between task type and WMC on EFT also reached a significant level ($F=1.54, p=.001 < .05$), indicating that working memory capacity significantly mediated the relationship between task type and the proportion of error-free T-units in writing. The explanatory power of the model is 16% ($R^2 = 0.16$).

V. DISCUSSION

A. Effects of Task Type on Writing Production

The first aim of this study was to examine how different types of writing tasks influence the writing production of the participants in independent and integrated writing tasks. Following previous studies, the independent writing task was designed to be less complex, while the integrated writing task was more complex (Lee, 2020; Révész et al., 2016). The findings partially support the Cognition Hypothesis, which predicts that increased task complexity, particularly in cognitive demands, enhances language complexity and accuracy but reduces fluency in written production.

Regarding writing fluency, the independent writing group outperformed the integrated writing group. These results align with previous findings suggesting that higher cognitive demands lead to weaker fluency in writing performance (e.g., Robinson, 2005). Integrated writing tasks involve multifaceted cognitive demands, which introduce heightened challenges during the writing process. Participants must allocate substantial cognitive resources to meet these demands. In this study, those in the integrated writing task had to summarize the reading text, which required them to conceptualize the main ideas and translate them into written words. This process was frequently disrupted by the need to retrieve information from the text, significantly impacting their writing speed in a timed setting. Conversely, participants in the independent writing group, while also required to include background information as an initial part of their writing, had the liberty to draw upon their existing knowledge from memory. They were not burdened with the task of organizing new information from the reading text, which likely made their writing process smoother and

allowed them to generate a greater amount of content within the given time constraints. This distinction in cognitive processing between the two groups may account for the differences in writing fluency observed in the study.

With regard to accuracy, the comparative results indicate that participants in the integrated writing task demonstrated significantly better performance in writing accuracy, as measured by the ratio of error-free clauses (EFC) and error-free T-units (EFT), compared to those in the independent task group. This finding aligns with the Cognitive Hypothesis, which posits that as cognitive demands increase, learners allocate more attentional resources to regulating the existing L2/EFL system. This increased focus on linguistic form results in more accurate written output. Engaging learners in complex tasks promotes greater attention to detail, deeper information processing, and more meticulous execution of the writing process, thereby enhancing accuracy in language production.

The results regarding lexical complexity were mixed: there was a significant difference in the type-token ratio (TTR) but no significant difference in the number of different words (NDW). Thus, the impact of task type on lexical complexity was inconsistent. Gebril and Plakans (2016) found that learners' lexical diversity improved through textual borrowing during read-and-write tasks, suggesting that participants could expand their vocabulary by drawing inspiration from the reading text. However, lexical richness and sophistication can also be influenced by topic formality (Jovari, 2020). In this study, the topic for both writing tasks was "environmental protection", chosen to reduce the likelihood of learners borrowing words from the source text due to high topic familiarity. This familiarity provided participants with sufficient vocabulary resources to support their writing. Consequently, even in the independent writing task, without reading materials as vocabulary references, participants had a rich enough vocabulary to write effectively.

In the present study, the two groups of students completing different writing tasks did not exhibit significant differences in syntactic complexity. A possible explanation for this lack of disparity could be the influence of the participants' language proficiency. During the participant screening process, language proficiency was used as a criterion, and the proficiency levels of participants were controlled within the intermediate to high range. Therefore, to a significant extent, this control may have concealed the differences in language complexity that could have arisen from variations in task complexity.

B. Effects of Working Memory Capacity on Writing Production

To gain a more nuanced understanding of the potential mediating effects of learners' working memory capacity (WMC) on their writing performance, the interactive effects between WMC and task types on participants' writing fluency, syntactic complexity, lexical complexity, and accuracy were examined. The main prediction is that higher WMC will lead to better writing production, with a positive interaction between WMC and task types, suggesting that the benefits of higher WMC on writing performance are more pronounced in tasks with greater cognitive load. The study found that the positive interactive effects between task types and WMC were significant in terms of accuracy, partially supporting the hypothesis. However, non-significant mediating impacts were observed in fluency and syntactic complexity. A marginally significant difference was found in the type-token ratio (TTR). The interaction was non-significant in the number of different words (NDW).

First, the findings of the positive mediating role of WMC on linguistic accuracy partially align with Robinson's assertions that "as L2 tasks increase in complexity, [individual differences] in cognitive abilities increasingly differentiate performance" (Robinson, 2007, p. 210). As noted by Engle (2002), differences in working memory capacity among individuals also reflect their diverse abilities in attention control. It can also be explained by Kellogg's (1999) claims that the writing process entails the active engagement of working memory components, especially in the information formulation and monitoring stages. Higher working memory capacity would benefit learners with more sufficient attentional resources for information storage and processing, which results in better linguistic performance and accuracy. In the context of integrated tasks, working memory plays an important role in regulating attentional resources, which explains its effect on mediating the impact of task complexity on writing accuracy, especially when cognitive demands intensify.

Secondly, the findings of non-significant effects of WMC on fluency, syntactic complexity, and lexical complexity were inconsistent with some previous research that concluded individuals with higher working memory capacity tend to exhibit superior performance in terms of linguistic complexity and fluency (Baoshu & Chuanbi, 2015; Bergsleithner, 2010; Mavrou, 2020; Zabihi, 2018). Nonetheless, the results of the current study are consistent with the conclusions drawn by Cho (2018) and Vasylets and Marín (2021), who postulated that WMC has no bearing on the linguistic complexity of written production by EFL learners. The inconsistent findings in investigations of the effects of working memory on EFL/L2 learners' writing performance can be attributed to various factors. One significant factor contributing to this inconsistency is the variation in methods used to assess working memory. In the present research, working memory capacity (WMC) was quantified using an adapted Ospan task, which differs from the methods employed by Vasylets and Marín (2021) and Cho (2018), where the Reading Span test was utilized to assess working memory capacity. Notably, these studies did not find any discernible effects of working memory on learners' linguistic performance in writing. This variance in results can be further explained by Mavrou's (2020) research, which revealed that verbal working memory, measured using the Ospan test, significantly predicted aspects of writing such as syntactic complexity and accuracy.

VI. CONCLUSION

Robinson (2001a) claims the complexity of tasks “will facilitate the ‘means’ of language learning, and therefore it will lead to transitions in the learner's knowledge states” (p. 30). The findings in the effects on lexical complexity and accuracy indicate the potential role of the integrated writing task in EFL/L2 development. Using task type to demonstrate the impact of task complexity on L2 writing, the current study enriches the task complexity literature. As part of this study, it aims to contribute to the field of writing and task complexity theories by providing empirical evidence to support the hypothesis that manipulating task type can have a significant effect on the writing performance of EFL learners. Beyond this theoretical contribution, the research also shed light on the intricacies of the mediating role of working memory capacity in EFL learners writing.

The practical implications of these results are noteworthy for educational settings. Firstly, given the positive impact of integrated writing—specifically the reading-to-writing task—on written output, it is suggested that writing instruction should prioritize training in the necessary skills for this task type. Incorporating integrated writing skills into the classroom can enhance students' EFL/L2 writing development. Moreover, the lower accuracy observed in responses to independent writing tasks suggests that students need more opportunities for monitoring and revision during these activities. Secondly, educators and curriculum developers might focus on enhancing working memory capacity (WMC) as a means to improve writing fluency across diverse writing tasks. Interventions and training programs aimed at bolstering WMC could potentially lead to improvements in students' writing performance, equipping them with a valuable cognitive tool that enhances their ability to produce more extensive written work, irrespective of the specific nature of the writing task.

Future research could explore additional cognitive factors that might interact with other individual differences to influence writing performance. For instance, investigating the role of motivation, topic familiarity, and writing strategies could provide a more comprehensive understanding of the dynamics at play. Moreover, although in the current study, eight indices were carefully selected to provide a comprehensive overview of students' writing performance in terms of fluency, complexity, and accuracy, additional measures or indices are needed to offer a more accurate and comprehensive understanding of learners' writing performance. At last, longitudinal studies examining how changes in learners' working memory over time affect their writing development across different educational stages would offer valuable insights into the long-term benefits of enhancing working memory in writing education.

REFERENCES

- [1] Abrams, Z. I. (2019). The effects of integrated writing on linguistic complexity in L2 writing and task-complexity. *System*, *81*, 110-121.
- [2] Baddeley, A. (2020). *Working memory. Memory* (pp. 71-111). Routledge.
- [3] Biber, D., Gray, B., & Staples, S. (2016). Predicting patterns of grammatical complexity across language exam task types and proficiency levels. *Applied Linguistics*, *37*(5), 639-668.
- [4] Cho, M. (2018). Task complexity, modality, and working memory in L2 task performance. *System*, *72*, 85-98.
- [5] Cumming, A., Kantor, R., Baba, K., Erdosy, U., Eouanzoui, K., & James, M. (2005). Differences in written discourse in independent and integrated prototype tasks for next generation TOEFL. *Assessing Writing*, *10*(1), 5-43.
- [6] Engle, R. W. (2002). Working memory capacity as executive attention. *Current Directions in Psychological Science*, *11*(1), 19-23.
- [7] Güvendir, E., & Uzun, K. (2023). L2 writing anxiety, working memory, and task complexity in L2 written performance. *Journal of Second Language Writing*, *60*, 101016, 1-15.
- [8] Jovari, M. (2020). Effect of topic familiarity on summary writing of Iranian intermediate EFL learners. *International Journal of Linguistics, Literature and Translation*, *3*(8), 22-35.
- [9] Kellogg, R. T. (1999). *The Psychology of Writing* (pp. 157-187). Oxford University Press.
- [10] Kormos, J. (2012). The role of individual differences in L2 writing. *Journal of Second Language Writing*, *21*(4), 390-403.
- [11] Kormos, J., & Sáfár, A. (2008). Phonological short-term memory, working memory and foreign language performance in intensive language learning. *Bilingualism: Language and Cognition*, *11*(2), 261-271.
- [12] Kuiken, F., & Vedder, I. (2012). Syntactic complexity, lexical variation and accuracy as a function of task complexity and proficiency level in L2 writing and speaking. *Dimensions of L2 Performance and Proficiency: Complexity, Accuracy and Fluency in SLA* (pp.143-170). John Benjamins Publishing Company
- [13] Kyle, K., & Crossley, S. (2016). The relationship between lexical sophistication and independent and source-based writing. *Journal of Second Language Writing*, *34*, 12-24.
- [14] Lee, J. (2020). Task closure and task complexity effects on L2 written performance. *Journal of Second Language Writing*, *50*, 100777, 1-14.
- [15] Lu, X. (2010). Automatic analysis of syntactic complexity in second language writing. *International Journal of Corpus Linguistics*, *15*(4), 474-496.
- [16] Malone, J. (2018). Incidental vocabulary learning in SLA: Effects of frequency, aural enhancement, and working memory. *Studies in Second Language Acquisition*, *40*(3), 651-675.
- [17] Mavrou, I. (2020). Working memory, executive functions, and emotional intelligence in second language writing. *Journal of Second Language Writing*, *50*, 100758, 1-15.
- [18] 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.
- [19] Ong, J. (2013). Discovery of ideas in second language writing task environment. *System*, *41*(3), 529-542.

- [20] Plakans, L. (2008). Comparing composing processes in writing-only and reading-to-write test tasks. *Assessing Writing*, 13(2), 111-129.
- [21] Plakans, L., & Gebril, A. (2012). A close investigation into source use in integrated second language writing tasks. *Assessing Writing*, 17(1), 18-34.
- [22] Plakans, L., & Gebril, A. (2013). Using multiple texts in an integrated writing assessment: Source text use as a predictor of score. *Journal of Second Language Writing*, 22(3), 217-230.
- [23] Plakans, L., & Gebril, A. (2017). Exploring the relationship of organization and connection with scores in integrated writing assessment. *Assessing Writing*, 31, 98-112.
- [24] Rahimi, M., & Zhang, L. J. (2018). Effects of task complexity and planning conditions on L2 argumentative writing production. *Discourse Processes*, 55(8), 726-742.
- [25] Révész, A., Kourтали, N. E., & Mazgutova, D. (2017). Effects of task complexity on L2 writing behaviors and linguistic complexity. *Language Learning*, 67(1), 208-241.
- [26] Révész, A., Sachs, R., & Hama, M. (2014). The effects of task complexity and input frequency on the acquisition of the past counterfactual construction through recasts. *Language Learning*, 64(3), 615-650.
- [27] Robinson, P. (2001a). *Task complexity, cognitive resources, and syllabus design: A triadic framework for examining task influences on SLA* (pp. 287-318). In Cambridge University Press eBooks.
- [28] Robinson, P. (2003). The cognitive hypothesis, task design, and adult task-based language learning. *Second Language Studies*, 21(2), 45-105.
- [29] Robinson, P. (2005b). Cognitive complexity and task sequencing: Studies in a componential framework for second language task design. *International Review of Applied Linguistics in Language Teaching*, 43(1), 1-32.
- [30] Robinson, P. (2007). Task complexity, theory of mind, and intentional reasoning: Effects on L2 speech production, interaction, uptake and perceptions of task difficulty. *International Review of Applied Linguistics in Language Teaching*, 45(3), 193-213.
- [31] Robinson, P. (2011a). Task Based Language Learning: A review of issues. *Language Learning*, 61(s1), 1-36.
- [32] Sasayama, S. (2016). Is a 'complex' task really complex? validating the assumption of cognitive task complexity. *The Modern Language Journal*, 100(1), 231-254.
- [33] Skehan, P. (2001). Tasks and language performance. In *Researching pedagogic tasks: Second Language Learning, Teaching, and Testing* (pp. 167-185). Routledge.
- [34] Skehan, P., & Foster, P. (1996). Task type and task processing conditions as influences on foreign language performance. *Language Teaching Research*, 1(3), 185-211.
- [35] Storch, N. (2009). The impact of studying in a second language (L2) medium university on the development of L2 writing. *Journal of Second Language Writing*, 18(2), 103-118.
- [36] Tabari, M. A. (2022). Investigating the interactions between L2 writing processes and products under different task planning time conditions. *Journal of Second Language Writing*, 55.10871, 1-16.
- [37] Unsworth, N., Redick, T. S., Heitz, R. P., Broadway, J. M., & Engle, R. W. (2009). Complex working memory span tasks and higher-order cognition: A latent-variable analysis of the relationship between processing and storage. *Memory*, 17(6), 635-654.
- [38] Vasylets, O., & Marín, J. (2021). The effects of working memory and L2 proficiency on L2 writing. *Journal of Second Language Writing*, 52, 100786, 1-14.
- [39] Wolfe-Quintero, K. E., Inagaki, S., & Kim, H. Y. (1998). *Second Language Development in Writing: Measures of Fluency, Accuracy* (pp. 103-115), University of Hawaii Press.
- [40] Zabihi, R. (2018). The role of cognitive and affective factors in measures of L2 writing. *Written Communication*, 35(1), 32-57.
- [41] 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(2), 335-352.
- [42] Zhang, J. (2018). The effect of strategic planning training on cohesion in EFL learners' essays. *Reading & Writing Quarterly*, 34(6), 554-567.



Ziming Zhao is currently a Ph.D. candidate majoring in English Language in Universiti Putra Malaysia. She completed her master's degree of English Language and Literature at Northeast Normal University, China. She taught at the School of English at Jilin International Studies University. By integrating her teaching practice with scientific research, Ziming has published four empirical research papers in Chinese journals. Furthermore, she co-authored a book and contributed to the creation of two textbooks.



Vahid Nimehchisalem completed his Ph.D. in Teaching English as a Second Language at the Faculty of Educational Studies, UPM, Serdang, Malaysia. He was a postdoctoral fellow at the same faculty in 2012 before joining Universiti Malaya as a research fellow the following year. He's currently an Associate Professor at the Faculty of Modern Languages and Communication, UPM, and an Adjunct Professor at Asia e University (AeU), Malaysia. Dr. Nimehchisalem is the founding and chief editor of the *International Journal of Education and Literacy Studies*, managing editor of the *Journal of Language and Communication*, and a board member of several other scientific journals in the area. His main area of teaching and research interest is language assessment.



Mei Yuit Chan obtained her PhD in Linguistics from the University of Malaya, Malaysia. She is currently an associate professor at the Department of English, Faculty of Modern Languages and Communication, Universiti Putra Malaysia. Her research interests include investigation of language in social interactions, language learning and language for specific purposes. Orcid ID: <https://orcid.org/0000-0002-4726-9117>