Journal of English language Teaching and Learning

University of Tabriz

Volume 15, Issue 31, (Spring & Summer 2023)

L2 Writing and Working Memory: differential effects of task types under different conditions

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ARTICLE INFO:

Received date:
2023.04.11
Accepted date:
2023.05.15

Print ISSN: 2251-7995
Online ISSN: 2676-6876

Keywords:

graphic-writing task, decision-making task, reasoning task, L2 writing, working memory

Abstract

Language teachers should be aware of the effect of various task types on L2 writing. The purpose of the present study was twofold: To investigate the effect of various task types, including graphic-writing task, decision-making task, and reasoning task, on L2 writing and to examine the relationship between working memory and L2 writing ability under three task conditions. To that end, 55 upper-intermediate male and female language learners from Dorsa Institute and Zabankadeh Meli in Hashtgerd participated in this study. Oxford Placement Test (OPT) test was used to homogenize the participants and Reading Span Test to test the working memory. Participants wrote an argumentative writing before and after the treatment. SPSS (version 25) was utilized to analyze the data. Results of data analysis showed statistically significant differences between graphic-writing task and the other two tasks while no significant differences were found between decision-making and reasoning tasks. Finding of the study showed the positive relationship between L2 writing and working memory. Implications of the study for the language learners are discussed.

DOI: 10.22034/elt.2023.56150.2531
Citation: Cheraqi, R. &Esfandiari, R. (2023). L2 Writing and Working Memory: differential effects of task types under different conditions. *Journal of English Language Teaching and Learning*, 15(31), 48-65.
DOI: 10.22034/elt.2023.56150.2531

1. Introduction

There are some dilemmas regarding the teaching of writing skill. First, most of the time, teachers cannot decide on whether to focus on the process of writing or the product of writing. Second, normally they are expected to apply predetermined textbooks that are restricted to the mechanics of writing or the structure of paragraphs such as topic sentence, supporting sentence, and final sentence. Third, teachers are not presented with an organized procedure to guide learners in an appropriate direction and help them to produce a variety of ideas, arrange them in a logical order, and transfer them into a readable text, (Richards & Renandya, 2002). Therefore, teachers need an effective procedure to cover all aspects of L2 writing to improve learners' writing skill.

Concerning L2 writing research, many researchers have conducted studies to address several issues. Some researchers have examined the influence of various tasks' features and variables such as task sequencing and task planning on different aspects of L2 writing (Allaw & McDonough, 2019; Kang & Lee, 2019); however, no studies have been conducted regarding the effect of graphic writing tasks, reasoning tasks, and decision-making tasks on different components of writing, including accuracy, fluency, and complexity.

It appears that L2 writing processes engage different levels and various parts of working memory (WM). For example, phonological short-term memory helps learners to hold verbal units and enable them to produce more complex structures and longer sentences (Williams & Lovatt, 2003); however, this role may change across different situations, tasks, and learners. Therefore, it is of great value to see how WM may contribute to higher L2 writing ability under various conditions.

In addition to L2 writing, WM accounts for much of learners' success in other aspects of language learning. Many studies have been carried out to investigate the role of WM in different parts of language learning (Sagarra, 2017; Suzuki et al., 2020). The results of these studies show that the effect of WM varies based on different factors such as learners' character, age, task type, aspects of language ability, and of different situations (Juff & Harrington, 2011); as a result, the role of WM can be mediated by manipulating different factors. Some researchers have investigated the role of WM in language learning by changing some factors such as task complexity and background knowledge in task performance and L2 reading skill respectively (Cho, 2018; Shin & Dronjic, 2018); however, no studies have investigated the effect of various tasks on WM role on L2 writing skill.

Considering the importance of L2 writing and working memory in the process of language learning and language development, along with the fruitful effect of task types in task-based language teaching (TBLT), we investigated the effects of different types of tasks on L2 writing ability, and mediating role of WM in L2 writing. Therefore, the following research questions have been addressed in this study.

1. What is the effect of three task types on L2 writing?
2. What is the relationship between WM and L2 writing under three task type conditions?

2. Literature Review

2.1 Task types: Graphic Writing task, Decision-making Task, and Reasoning Task

In TBLT, a task is not a simple activity anymore. At the emergence of TBLT, there were just some limited activities with some distinctive features which were called tasks, but nowadays so many other tasks have been developed that are very complicated. Graphic writing task, decision-making task, and reasoning task are three tasks which have been used in this study. First, Graphs, in graphic writing tasks, offer so many advantages not only in learning situations, but also in various tests and research studies. For example, they provide brief and sufficient information in an appropriate way, they are one mode of meaning making through non-linguistic visual representation, and they are very controversial in research issues (choi, 2021; Yang, 2016).

Second, a decision-making task is the process of selecting and arranging. "Decision-making task is the task in which we select from among options to reach a decision" (Abbasian & Chenabi, 2016, p.7). Similar to other TBLT tasks, a number of studies have been carried out to see the effect of this type of task on language learning (Gorcia–Ponce & Tavakoli, 2022); however, it appears that its effect was not significant compared to other tasks which were used in the studies (Behtash & Etehadi, 2016).

Third, the notion of reasoning in reasoning tasks refers to an important subject in L2 learning. It appears that reasoning accounts for high percent of language learning because learners need the process of thinking purposefully critically to master language skills (Lin et al., 2016). In addition, most empirical studies show its position in many language skills, specifically speaking and writing. For example, in one study which investigated the willingness of learners to speak, students' critical thinking and reasoning influenced their ability to start and continue the communication (Peng, 2014).

2.2. L2 writing and working memory

A number of researchers integrated writing in WM. For example, Hayes and Flower (1980) claimed that writers use the total capacity of their WM while writing a paragraph. Besides, Bereiter and Scardamalia (1987) suggested that in order to store new data and take possible limitations into account writers should apply their WM capacity to transform from knowledge telling strategy to the knowledge transforming strategy.

Regarding the integration of L2 writing and WM, researchers proposed two concepts of writing acquisition and skilled writing. First, McCutchen (1996) merged writing acquisition with the capacity model of WM. This model shows that what will happen in WM demands during writing acquisition. Second, Kellogg (1996) proposed the combination of componential model of WM and skilled writing. Here, Kellogg focused on the writing processes and interpreted the demands which writing processes imposed on WM.

A variety of studies have been conducted to investigate the relationship between working memory and different aspects of language learning. It is claimed that WM plays a central role in sentence processing because learning will occur when learners process both form and meaning, so " the more WM you have, presumably the more attentional resources you process and the more you can potentially learn, because you have enough memory to process form

together with meaning (Juff & Harrington, 2012). It appears that the footprint of WM can also be seen in language production, conversation, and interaction in language classrooms. In one study, Mackey et al. (2012) examined the role of WM in interaction among learners during accomplishing tasks and activities. They found a strong relationship between WM and the amount of modified output. In addition, O'brien et al. (2006) established correlation between phonological WM and development of oral fluency. They found that phonological WM plays a key role in narrative development in L2 learning and in the acquisition of grammatical competence. Tyler (2001) found that when learners did not know the topic of the text, their use of WM capacity was different, compared to the situation when they knew the topic i.e, learners use their WM differently.

The well-known model for WM is Baddeley's multicomponent model. He has worked on this model, made changes to it, and improved it. He believed in the modular notion of WM. Modularity is defined as "the degree to which a system's components may be separated and recombined" (Baddeley, 2017, p. 2). The modularity notion of WM shows that each section is responsible for specific process and independent of each other. Although Truscott (2017) advocated modularity of WM, he did not completely agree with Baddeley's idea. Specifically, Baddeley related this notion to the internal structure of WM while Truscott's approach is in line with Cowan's (2016) state-based theory, or embedded process model, which "reject[s] the idea of WM as a location or a store rather it is the sets of items in long term memory" (Truscott, 2017, p. 2).

Since the important position of WMC has been presented in the field of SLA, there has been controversy among scholars to regard WM as a trait or state. If we view WM as a trait, it will be an individual capacity that does not change over time; however, when we define WM as a state, we will be dealing with factors which influence it (Vasylets & Marin, 2020). In sum, there is still no agreed-upon agreement by which whether we should examine WM as a stable construct or as a dynamic process which learners' experience and knowledge organization can affect it.

3. Methodology

3.1. Participants

Fifty-five male and female upper-intermediate English language learners took part in this study. Participants included students in a well-known institute in Hashtgerd, Karaj, who have been studying English for about five years with the approximate age range between 15 and 30. They are native speakers of Persian who have studied English for about two years at school.

Students from intact classes, studying Family and friends 4, 5, Touch Stone 1, 2, 3, 4, and viewpoint books from Dorsa English language institute and Zabankadeh Meli Iran in Hashtgerd, Karaj, were selected for participation in this study. They took a proficiency test and then 25 male and 30 female students whose test scores were one standard below and above average were selected. Finally, they were randomly assigned to three experimental groups and control group.

3.2 Instrumentation

In this study, we used the following three instruments: Oxford Quick Placement Test (OPT), IELTS Academic argumentative writing task 2, and Reading span test (RST). In the following paragraphs, more detailed information is given about these instruments.

Oxford Quick Placement Test (Version 2) is a useful test to measure language proficiency. It was utilized to make sure that participants were relatively homogeneous in this study. OPT was designed by Oxford University Press (2004) which is available both on Internet and on paper. It consists of 60 items that assess listening, reading, vocabulary, and grammar in which students require 30 minutes to answer the questions. This test has been validated in 20 countries (Derakhshan, 2018). The reliability of test has been estimated through Kudar-Richardson 20, and has reported to be .90 (Peidmont, 2014).

To assess learner's writing ability in both pre-test and post-test stages, they were required to write an argumentative essay. Their essay was rated based on Jacob's et al (1981) model, so that their composition was measured in terms of syntactic complexity, accuracy, lexical complexity, organization, content, and overall text quality.

One way to measure working memory capacity is through Reading span task (RST). It was first introduced by Daneman and Carpenter (1980). Persian version of RST developed by Shahnazari-Dorcheh (2013) based on Daneman and Carpenter (1980) test was applied in the present study. RST is suitable for assessing the processing and storage dimension of working memory. This task consists of 64 Persian sentences in which students should read sentences out loud, recognize their semantic acceptability, and then memorize some words at the end of each sentence. At the final stage, participants were asked to write down words that they can remember in an hour. As Shahnazari-Dorcheh (2013) noted, this newly developed test is reliable based on internal reliability of .844.

We drew on three types of tasks to conduct the study. They are decision making tasks, reasoning tasks, and graphic writing tasks. In decision making tasks, learners are given a problem and a set of solutions, then they must choose the best answer and write about their reasons and ways to solve the problem (Willis & Willis, 2007). Reasoning tasks are types of activities that learners should derive new information from given one (Nunan, 2004). It appears that these types of tasks can be very helpful to improve writing skill because in argumentative writing learners should be able to provide reasons, establish relationships between ideas, and use their logic to infer and deduct information, so that this task will equip learners to practice these elements in argumentative writing (Derakhshan, 2018; Rahimi, 2018). The third task refers to graphic writing task. This also has effective role in writing skill because providing learners information within a framework can help them to process and organize information in a more structured way (Willis & Willis, 2007).

3.3. Procedure

Sixty male and female upper-intermediate language learners in Hashtgerd, Karaj,took part in this study. The researcher used non-random sampling to select the participants and random sampling to assign learners into four groups. In this study, the following techniques were employed to collect the data. They are as follows: Oxford Placement test (OPT), Reading Span

Task (RST), and IELTS Academic argumentative writing task 2. The stages through which the present researchers passed to conduct the study are explained in the following paragraphs.

This study was conducted in Dorsa institute in Hashtgerd, Karaj province. First, 120 upper-intermediate language learners took OPT test among whom 60 learners were chosen as participants. Sixty participants were randomly assigned to three experimental groups and one control group. In each group, there were 15 learners. Three experimental groups received instruction based on three types of tasks while control group received an ordinary and usual instruction. The lead researcher herself was the teacher, and she taught all three experimental groups based on three tasks chosen in the study, so that each group would take one specific task and she would teach control group without using any tasks. Also, the teacher used Big English 5 (Salazar & Cruz, 2016) as a course book in the process of instruction. Participants received fourteen 60-minute sessions of instruction twice a week.

In order to obtain high precision of measurement, a pilot study was conducted to evaluate feasibility and identify design issues before the main research. Therefore, there was a less chance of unreliable results. The main purpose of piloting was to evaluate the correctness of the instructions that respondents in the pilot sample would follow the directions as indicated. It also provided better information on whether the type of survey was effective in fulfilling the purpose of the study.

3.4. Research design

The present study is quantitative in methodology and experimental in design. It is quantitative because the researchers used numerical data and statistics to find the answer of the questions in the study. Quantitative research has some characteristics, including (1) It uses measurable data to formulate facts and uncover patterns in research (Dornyei, 2007); (2) in this method, the researchers try to study variables, find their common features, and establish the relationship between variables by measuring and manipulating them; and (3) it possesses standardized procedure in which statistics is the most important component (Dornyei, 2007). One of the most common types of this method is quasi-experimental design which is appropriate for this study. In quasi-experimental design, the researchers used pre-test and post-test, divided participants into experimental and control group, there was an intervention or treatment, so that experimental group would receive treatment while control group would receive a standard instruction, and there was no randomization. In order to analyze the data, the comparison was made between groups by statistical procedures (Fred & Perry, 2005). Although random selection was not be possible, intact classes were randomly assigned to experimental and control groups.

3.5. Data analysis

The computer program that was utilized in this study is SPSS (Statistical Package for the social sciences), version 25. It is the most commonly used computer program to analyze data in applied linguistics. SPSS is suitable for analyzing different types of data such as test data, ordinal data, and frequency data.

In order to analyze the collected data, the present researchers used one-way analysis of variance (ANOVA). ANOVA is appropriate for the situations in which a researcher wants to conduct a pre-test and post-test design and compare the effect of two various interventions on

pre-test ad post-test phases, when some of the assumptions of analysis of co-variance are not met.

The relationship between L2 writing and WM was estimated both in pre-test and post-test stages of the study. To assess the relationship, Pearson-product moment correlation between L2 writing and WM was estimated in computer program SPSS

4. Results

This study was undertaken in order to first investigate the effect of task types (i.e., graphic writing, reasoning task, decision making and traditional instruction on L2 writing of Iranian EFL learners) and, second, to explore any significant relationships between working memory and L2 writing across the three experimental groups. One-way analysis of variance (one-way ANOVA), and Pearson correlation were employed to analyze the data collected through this study. These statistical techniques assume normality of the data. Table 1 displays the skewness and kurtosis indices and their ratios, which are analogous to z-scores (Field 2018) over the standard errors. All computed ratios were lower than +/- 1.96 (i.e., critical value of z-score at .05 level). Thus, it was concluded that the present data did not show any significant deviation from normality.

Table 1. *Skewness and Kurtosis Indices of Normality*

		N	Skewness			Kurtosis		
Group		Statistic	Statistic	Std. Error	Ratio	Statistic	Std. Error	Ratio
Graphic writing	PreWM	13	-.094	.616	-0.15	-1.516	1.191	-1.27
	PreL2	13	-.464	.616	-0.75	-.049	1.191	-0.04
	PostWM	13	-.265	.616	-0.43	-1.554	1.191	-1.30
	PostL2	13	-.367	.616	-0.60	-1.496	1.191	-1.26
Reasoning task	PreWM	14	.823	.597	1.38	.863	1.154	0.75
	PreL2	14	-.643	.597	-1.08	-1.041	1.154	-0.90
	PostWM	14	.334	.597	0.56	-.775	1.154	-0.67
	PostL2	14	-.619	.597	-1.04	-1.272	1.154	-1.10
Decision making	PreWM	14	.555	.597	0.93	-.118	1.154	-0.10
	PreL2	14	.193	.597	0.32	-1.224	1.154	-1.06
	PostWM	14	.549	.597	0.92	-.450	1.154	-0.39
	PostL2	14	-.527	.597	-0.88	.031	1.154	0.03
Control	PreWM	14	.448	.597	0.75	-.091	1.154	-0.08
	PreL2	14	-.600	.597	-1.01	-.587	1.154	-0.51
	PostWM	14	.427	.597	0.72	-.653	1.154	-0.57
	PostL2	14	-.186	.597	-0.31	.036	1.154	0.03

Note. Pre = Pretest, Post = Posttest, L2 = L2 Writing, WM = Working Memory.

The pretest and posttest of L2 writing were rated by two raters. Pearson correlations were run to probe the inter-rater reliability indices of the two raters on pretest and posttest of L2 writing. Based on the results displayed in Table 2, it was concluded that there were significant agreements between two raters on pretest (r (53) = .850 representing a large effect size, $p <$ .05) and posttest (r (53) = .900 representing a large effect size, $p < .05$) of L2 writing. Thus, it was concluded that the pretest and posttest of L2 writing enjoyed significant inter-rater reliability indices. It should be noted that the Pearson correlation coefficient itself is an index of effect size (Field, 2018; Gray & Kinner, 2012; Pallant, 2016), which can be interpreted based

on the following guidelines: .10 = weak, .30 = moderate, and .50 large. Since the values of Pearson correlations were higher than .50, it was concluded that the inter-rater reliability indices enjoyed large effect sizes.

Table 2. *Pearson Correlations of Inter-Rater Reliability Indices of Pretest and Posttest of L2 Writing*

		PreR2	PostR2
PreR1	Pearson Correlation	.850**	
	Sig. (2-tailed)	.000	
	N	55	
PostR1	Pearson Correlation		.900**
	Sig. (2-tailed)		.000
	N		55

**. Correlation is significant at the 0.01 level (2-tailed).

The KR-21 reliability indices were computed for pretest and posttest of working memory. As displayed in Table 3, the KR-21 reliability indices for pretest and posttest of working memory were .79 and .90 respectively. As noted by Fulcher and Davidson (2007), "Tests that do not achieve reliabilities of 0.7 are normally considered to be too unreliable for use, and high-stakes tests are generally expected to have reliability estimates in excess of 0.8 or even 0.9". Based on these criteria it can be concluded that the pretest and posttest of working memory enjoyed appropriate reliability indices.

Table 3. *KR-21 Reliability Indices of Pretest and Posttest of Working Memory*

Working Memory	N	Minimum	Maximum	Mean	Std. Deviation	Variance	KR-21
Pretest	55	10	50	24.62	7.658	58.648	.79
Posttest	55	18	54	33.24	10.428	108.739	.90

A one-way ANOVA was run to compare the graphic writing, reasoning task, decision making and control groups' means on pretest of L2 writing in order to show that the four groups were homogenous in terms of their L2 writing ability prior to the administration of the treatments. Before discussing the results, it should be noted that the researchers tried to run one-way analysis of covariance (one-way ANCOVA) in order to compare the four groups' means on the posttest of L2 writing after controlling for the effect of pretest; however, as displayed in Table 4 and Table 5, the assumptions of linearity and homogeneity of regression slopes were violated.

It should be mentioned that one-way ANCOVA assumes that the relationship between the dependent variable (posttest of L2 writing) and pretest (covariate) is a linear one. The non-significant results of the linearity test ($F_{(1, 40)} = 3.47$, $p > .05$) (Table 4) indicated that the statistical null hypothesis, which says the relationship between pretest and posttest of L2 writing was not a linear one, was supported.

Table 4. *ANOVA Test of Linearity of Relationship between Pretest and Posttest of L2 Writing*

			Sum of Squares	df	Mean Square	F	Sig.
PostL2 PreL2	Between *Groups	(Combined)	228.450	14	16.318	.886	.579
		Linearity	63.302	1	63.302	3.437	.071
		Deviation from Linearity	165.148	13	12.704	.690	.761
	Within Groups		736.750	40	18.419		
	Total		965.200	54			

Analysis of covariance (ANCOVA) assumes that the linear relationship between the dependent variable (posttest) and the covariate (pretest) is the same across the four groups, i.e. homogeneity of regression slopes. The significant interaction between the covariate and the independent variable ($F_{(3, 47)} = 8.07$, $p < .05$, partial $22 = .340$ representing a large effect size) (Table 5) indicated that the statistical null hypothesis that the relationship between pretest and posttest of L2 writing was non-linear across the four groups was rejected. In other words, there were not linear relationships between pretest and posttest of L2 writing across the groups. The violation of the assumption of linearity and homogeneity of regression slopes were the reasons why the researchers decided to run two separate one-way ANOVA procedures on pretest and posttest of L2 writing, instead of a single one-way ANCOVA.

Table 5. *Testing Homogeneity of Regression Slopes Posttest of L2 Writing by Groups with Pretest*

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Group	257.879	3	85.960	11.530	.000	.424
PreL2	111.689	1	111.689	14.981	.000	.242
Group * PreL2	180.635	3	60.212	8.076	.000	.340
Error	350.409	47	7.456			
Total	11138.000	55				

The results of the one-way ANOVA on pretest of L2 writing are discussed below. Before discussing the results, it should be noted that one-way ANOVA, besides the assumption of normality which was checked under Table 1, assumes homogeneity of variances of the groups that was explored through the Levene's test (Table 6). The non-significant results of the Levene's test ($F_{(3, 51)} = .853$, $p > .05$) indicated that the four groups were homogenous in terms of their variances on pretest of L2 writing.

Table 6. *Test of Homogeneity of Variances of Pretest of L2 Writing by Groups*

		Levene Statistic	df1	df2	Sig.
PreL2	Based on Mean	1.230	3	51	.308
	Based on Median	.853	3	51	.472
	Based on Median and with adjusted df	.853	3	42.890	.473
	Based on trimmed mean	1.224	3	51	.311

Table 7 displays the four groups' means on pretest of L2 writing test. The results showed that the graphic writing (M = 9.62, SD = 3.86, 95 % CI [7.28, 13.58]), reasoning task (M = 11.07, SD = 4.34, 95 % CI [8.57, 13.58]), decision making (M = 11.07, SD = 3.99, 95 % CI [8.77, 13.38]); and control (M = 9.79, SD = 2.86, 95 % CI [8.13, 11.44]) groups had almost the same mean values on pretest of L2 writing.

Table 7. *Descriptive Statistics of Pretest of L2 Writing by Groups*

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
					Lower Bound	Upper Bound
Graphic writing	13	9.62	3.863	1.071	7.28	11.95
Reasoning task	14	11.07	4.341	1.160	8.57	13.58
Decision making	14	11.07	3.990	1.066	8.77	13.38
Control	14	9.79	2.860	.764	8.13	11.44
Total	55	10.40	3.759	.507	9.38	11.42

Finally, Table 8 displays the results of the one-way ANOVA. The results ($F_{(3, 51)}$ = .597, p > .05, η^2 = .037 representing a weak effect size) indicated that there were not any significant differences between the four groups' means on pretest of L2 writing. That is to say, the four groups were homogenous in terms of their L2 writing ability prior to the administration of the treatments.

Table 8. *One-Way ANOVA of Pretest of L2 Writing by Groups*

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	25.909	3	8.636	.597	.620
Within Groups	737.291	51	14.457		
Total	763.200	54			

Figure 1. Means on Pretest of L2 Writing by Groups

4.1. Investigation of the First Research Question

A one-way ANOVA was run to compare the graphic writing, reasoning task, decision making and control groups' means on posttest of L2 writing in order to probe the first research question which asked What is the effect of task types on L2 writing? Before discussing the results, it should be noted that the assumption of homogeneity of variances of the groups was retained (Table 9). The non-significant results of the Levene's test ($F(3, 51)$ = 1.72, p > .05) indicated that the four groups were homogenous in terms of their variances on posttest of L2 writing.

Table 9. *Test of Homogeneity of Variances of Posttest of L2 Writing by Groups*

		Levene Statistic	df1	df2	Sig.
PostL2	Based on Mean	2.285	3	51	.090
	Based on Median	1.726	3	51	.173
	Based on Median and with adjusted df	1.726	3	46.988	.175
	Based on trimmed mean	2.165	3	51	.104

Table 10 displays the four groups' mean values on posttest of L2 writing test. The results showed that the graphic writing group (M = 17.77, SD = 1.83, 95 % CI [16.66, 18.88]) had the highest mean on posttest of L2 writing. This was followed by the reasoning task (M = 13.79, SD = 4.20, 95 % CI [11.36, 16.22]), decision making (M = 11.64, SD = 3.77, 95 % CI [9.46, 13.82]); and control (M = 11.50, SD = 3.59, 95 % CI [9.43, 13.57]) groups.

Table 10. *Descriptive Statistics of Posttest of L2 Writing by Groups*

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
					Lower Bound	Upper Bound
Graphic writing	13	17.77	1.833	.508	16.66	18.88
Reasoning task	14	13.79	4.209	1.125	11.36	16.22
Decision making	14	11.64	3.775	1.009	9.46	13.82
Control	14	11.50	3.590	.959	9.43	13.57
Total	55	13.60	4.228	.570	12.46	14.74

Finally, Table 11 displays the results of the one-way ANOVA. The results ($F(3, 51) = 9.32$, $p < .05$, $\eta 2 = .354$ representing a large effect size) indicated that there were significant differences between the four groups' means on posttest of L2 writing. Thus, it can be concluded that the first directional hypothesis as "task types had a positive effect on L2 writing" was supported.

Table 11. *One-Way ANOVA of Posttest of L2 Writing by Groups*

	Sum of Squares	df	Mean Square	F	Sig.
BetweenGroups	341.821	3	113.940	9.322	.000
Within Groups	623.379	51	12.223		
Total	965.200	54			

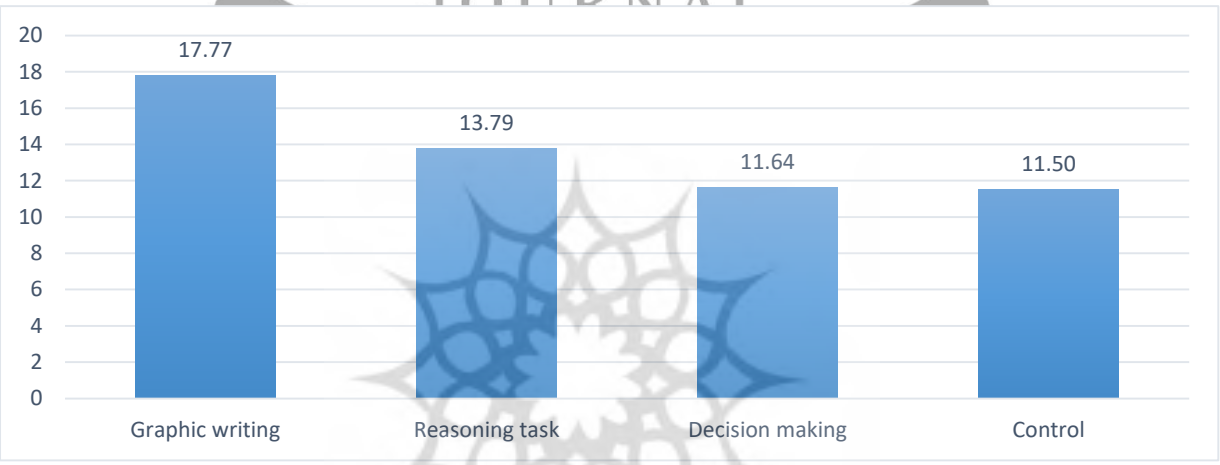
Table 12 displays the results of the post-hoc Scheffe's test which compared the groups' means two by two. Based on these results and the means displayed in Table 4.10, it can be concluded that (a) the graphic writing group ($M = 17.77$) had a significantly higher mean than the reasoning task group ($M = 13.79$) ($MD = 3.98$, $p < .05$); (b) the graphic writing group ($M = 17.77$) had a significantly higher mean than the decision making group ($M = 11.64$) ($MD = 6.12$, $p < .05$); (c) the graphic writing group ($M = 17.77$) had a significantly higher mean than the control group ($M = 11.50$) ($MD = 6.26$, $p < .05$); (d) although the reasoning task group ($M = 13.79$) had a higher mean than the decision making group ($M = 11.64$), the difference between the two means was not significant ($MD = 2.14$, $p > .05$); (e) although the reasoning task group ($M = 13.79$) had a higher mean than the control group ($M = 11.50$), the difference between the two means was not significant ($MD = 2.28$, $p > .05$); and (f) although the decision making group ($M = 11.64$) had a higher mean than the control group ($M = 11.50$), the difference between the two means was not significant ($MD = .143$, $p > .05$).

Table 12. *Post-ccc cceeffett ttttt tttt tttt tt t 2 Wttt GGG GGGGGGGG*

(I) Group	(J) Group	Mean Difference J)	(I-Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Graphic writing	Reasoning task	3.984*	1.347	.043	.09	7.88
	Decision making	6.126*	1.347	.001	2.23	10.02
	Control	6.269*	1.347	.000	2.38	10.16
Reasoning task	Decision making	2.143	1.321	.459	-1.68	5.96
	Control	2.286	1.321	.402	-1.53	6.11
Decision making	Control	.143	1.321	1.000	-3.68	3.96

*. The mean difference is significant at the 0.05 level.

Figure 2. *Means on Posttest of L2 Writing by Groups*



4.2. Investigation of the Second Research Question

The second research question was aimed at establishing whether there is any significant relationship between working memory and L2writing. Using IMM SPSS, Pearson-product moment correlation was run. The results are given in Table 13.

Table 13. *Correlation between working memory and L2 writing*

		Working memory	L2 writing
Working memory	Pearson Correlation	1	G706”
	Sig.(2-tailed)		.000
	N	55	55
L2 writing	Pearson Correlation	G706”	1
	Sig.(2-tailed)	.000	
	N	55	55

Correlation is significant at the 0.01 level (2-tailed).

According to Table 13, there is a strong, positive correlation between working memory and L2 writing (r = .706, n = 55, p = .000, R2 = .49) with a very big effect size. Therefore, the second hypothesis of the present study is accepted, suggesting that the more working memory learners have, the better their L2 writing ability will be and vice versa.

5. Discussion

Based on the results of statistical analysis, there were significant differences between graphic writing group and the other three groups, namely, decision-making group, reasoning group, and control group; however, the difference between reasoning-group and decision-making group was not significant. Additionally, no statistically significant difference was found between reasoning-task group and control group, decision-making task and control group subsequently. Besides, there were positive relationship between L2 writing and WM under three task conditions.

Based on the results of the study, graphic-writing task has positive effect on L2 writing. The findings of the study are in line with those of Cumming et al. (2004), who claimed that those types of writing tasks which need learners to compose a text using a language input particularly visual input such as graph or diagram are useful and can lead to positive washback effect in learning and teaching writing.

Graphic writing task is more useful than others because of two reasons. First, the processes involved in describing and interpreting the graphs such as decoding the meaning, deducing the existing relationship, summing up the main idea and trying to form logical and appropriate schema facilitate the processes which learners will engage while composing a text (Yang, 2016). Second, the processes that learners involve in graphic–writing are similar to the processes of Weigle's (2002) writing model who claimed that creating a context in which writers can interact with the text is important and graphs can prepare this context (Yang, 2012).

Based on the results of the study, there is a significant difference between graphic-writing task and decision-making task due to some reasons. Graphic-writing task processes is similar to the processes of L2 writing while decision-making tasks require learners to choose an option among given ones and then write about it (Richards & Rogers, 2001). Besides, it appears that a decision-making task is more useful for strategic competence (Abbasian & Chenabi, 2016). However, the findings obtained from this study contradict those of some previous studies which showed that there is a significant difference between groups who received decision-making task and those who received other tasks, so that the effect of decision-making tasks turned to be positive (Khoram, 2019; Najmi, 2021).

The present study was also aimed at examining the relationship between working memory and L2 writing skill. It was found that working memory correlated positively with L2 writing. This finding is in line with that of Mallahi (2019), who found that there is a significant difference between different levels of a learner's WM and the accuracy and fluency of the writings which they produced. However, the finding of this study does not support that of Belghoul and Merrouche (2021), who claimed that although there is a relationship between WM and writing complexity, there is no relationship between WM and writing fluency and accuracy.

Based on the results of the study learners with high working memory capacity are more likely to produce more complex, grammatical, and fluent texts. This result can be explained by theoretical contention proposed by Kellogg et al. (2013) and Ackerman's (1988) theory of compensation. According to Kellogg et al. (2013), planning process of L2 writing is related to

the visuospatial sketchpad, so that when writers want to select or organize information, they use their visuospatial working memory. In the next stage of writing, i.e translation, writers apply their auditory part of working memory, namely, phonological loop. Finally, to accomplish the final piece of writing central executive part is engaged. Therefore, higher working memory capacity helps learners to improve reading and revision processes so that they can decrease their errors in writing a text. In addition, "WM could be instrumental in suppressing the competing erroneous linguistic representations and thus could support error-free production of newly acquired and not stabilized L2 items" (Vasylet & Marin, 2020, p. 9).

Furthermore, the positive correlation between WM and L2 writing can be explained in light of Ackerman's (1988) theory of compensation. Based on this theory, learners with high WMC can compensate for their gap in L2 proficiency so that they can solve their linguistic challenges and problems successfully without any mistakes. However, low working memory capacity learners cannot differentiate between related ideas and irrelevant information in order to access important data (Conway et al, 2005)

6. Conclusion and Implications

The present research was an attempt to investigate the effectiveness of graphic-writing task, decision-making task, and reasoning task on L2 writing skill and to examine the relationship between working memory and L2 writing under these three task conditions. Through analyzing the data obtained from learners' scores on pretest and posttest, the findings revealed that the experimental group outperformed the control group. Theoretically, this finding lends partial support to the Cognition Hypothesis (Robinson, 2011) in that increasing the level of reasoning and the number of elements resulted in increasing the cognitive complexity of the task and in the improvements in syntactic and lexical complexity of L2 wriitng. Specifically, the graphic writing group performance was better than the other two groups. Therefore, graphic-writing task proved its effectiveness on developing the learners' writing skill. However, there was no statistically significant difference between decision-making group and reasoning group on their writing performance. Therefore, it can be concluded that using graphic-writing task was more effective on L2 writing learning than decision-making and reasoning task.

In addition, based on the results of the study, correlation between working memory and L2 writing is positive. Theoretically, this result confirms theories which consider a relationship between working memory and L2 writing. For example, Wen (2015), utilized various models of working memory such as Baddeley's multi-component model and Cowan's (2014) embedded-process model then proposed an integrated framework in which they mixed working memory in second language learning. Based on this framework, working memory is a limited capacity which is used for multiple functions and processes in learning a language. Besides, two parts of working memory that are obviously present in language learning are phonological working memory and central executive working memory. The former stores the information for a short time and deals with remembering the data in order to express and articulate them. The latter is applied to regulate the attention and do some controlling actions such as updating, shifting, and inhibition (Miyak & Freidman, 2012).

The results of this study may have several pedagogical, theoretical, and research implications. Regarding pedagogical implications, the results of the study would encourage

teachers to exploit various writing tasks for improving EFL learners' writing performance qualitatively and quantitatively. Specifically, English language teachers can utilize graphic-writing task to improve learners' writing skill and make use of decision-making task, graphic-writing task, and reasoning task to enhance learners' working memory in order to heighten the quality of writing performance of EFL learners.

In addition, stakeholders and teacher trainers can consider the results of this study. They can make use of positive effect of graphic-writing task and the role of working memory in L2 writing in training novice teachers, producing more effective content books, and conducting courses to instruct how to use these types of tasks in English classrooms and how to work on learners' working memory capacity with the aim of improving their writing skill as well.

This research was done with 55 upper-intermediate Iranian EFL students involving three types of tasks. It is suggested that more research be done on different levels of proficiency in larger samples with different educational background as well as different L1s and L2s. It is also recommended that similar studies be done involving the two genders separately in order to see if the results may vary depending on the gender. In addition, using other tasks can be suggested to see if there is also any effect of tasks on L2 writing.

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