The Relationship between Working Memory and Academic Writing

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Abstract
This study examines the relationship between Working Memory (WM) and L2 writing in the Algerian academic setting. The existence of such a relationship should help teachers assess their students' needs and better plan their lessons. It inspects a correlational design in order to conclude whether individual differences in WM can predict L2 academic writing performance. Measuring the WM of 29 first-year students of English at the University of Oum El Bouagh using a complex writing span test revealed its correlation with writing complexity and summary quality but not its relationship with fluency and accuracy, contrary to what was predicted.

Keywords: Working memory, academic writing, fluency, accuracy, complexity, writing quality.

العلاقة بين ذاكرة العمل والكتابة الأكاديمية

ملخص
تبحث هذه الدراسة في العلاقة بين ذاكرة العمل والكتابة في الوسط الأكاديمي الجزائري حيث يساعد وجود مثل هذه العلاقة المعلمين في تقييم احتياجات طلابهم والتخطيط لدروسهم بشكل أفضل. تعتمد دراستنا على تقصي الارتباط بين المتغيرين لاستنتاج ما إذا كانت الفروق الفردية في الذاكرة يمكنها التنبؤ بأداء الطلبة في الكتابة الأكاديمية. لأجل ذلك تم قياس ذاكرة عمل 29 من طلاب السنة الأولى في اللغة الإنجليزية في جامعة أم البواقي باستخدام اختبار معقد للذاكرة وتم قياس أدائهم الكتابي من حيث الطلاقة والدقة والتعقيد النحوي وجودة الكتابة أثناء كتابة ملخص. كشفت التحليلات الإحصائية أن هناك علاقة ارتباطية بين الذاكرة والتعقيد النحوي وجودة الملخص في حين أنه لا علاقة خطية للذاكرة مع الطلاقة والدقة ، خلافا لما كان متوقعا.

الكلمات المفاتيح: ذاكرة العمل، كتابة أكاديمية، طلاقة، دقة، تعقيد، جودة.

La Relation entre la Mémoire de Travail et l'Ecriture Académique

Résumé
Cette étude examine la relation entre la mémoire de travail et l'écriture dans une langue seconde (L2) dans le contexte universitaire algérien. L'existence d'une telle relation devrait aider les enseignants à évaluer les besoins de leurs étudiants et à mieux planifier leurs cours. La présente étude examine un modèle de corrélation afin de déterminer si les différences individuelles en mémoire de travail peuvent prédire la qualité des productions écrites en L2. Mesurer la mémoire de 29 étudiants en première année de Licence d'anglais à l'Université d'Oum El Bouaghi à l'aide d'un test complexe a révélé l'existence d'une relation de corrélation entre la mémoire de travail et les performances écrites mesurées en termes de complexité syntactique et de qualité du résumé, contrairement à celles mesurées par la fluidité et l'exactitude de l'écrit.

Mots-clés: mémoire de travail, écriture académique, fluidité, exactitude, complexité syntaxique, qualité d'écriture.

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Introduction:

Writing is one of the most complex skills to acquire, for it involves many cognitive resources and processes such as WM[(1)]. This cognitive process is involved in all aspects of language learning, comprehension and production. It also underlies and plays the most significant role in the processes of text comprehension and production of recall and summarization which are typically involved in academic writing[(2)]. Consequently, it is believed that superiority in processing and analysing new pieces of linguistic information, like words and grammatical structures, results in high L2 performance and proficiency. The immense interest in WM stems from its importance as a cognitive factor of individual variation in second language acquisition (SLA) research.

Research into the relationship between WM and writing proves that it is mediated by reading comprehension[(3)]. Academic writing usually requires the use of background information from reading texts. Whether composing an essay for an exam or writing an academic paper, learners are typically asked to integrate information from different sources into writing. This type of task might be daunting and complex for learners, especially those in their first and second years. However, it is a vital skill for academic success. While little research has been investigating the relationship between WM and writing as compared to all the studies interested in oral language[(4)], less research investigates writing as mediated by reading[(5)].

Based on the assumptions above, the primary research question addressed for this study concerns the investigation on whether or not there is a relationship between WM capacity and L2 writing performance as mediated by reading. This question is based on the hypothesis that L2 writing performance might be constrained by learners' differences in WM capacity. Therefore, a correlational study has been conducted on a sample of 29 first-year English students at the University of Oum El Bouaghi.

1- Literature Review:

1-1- Academic Writing:

Flower and Hayes[(6)] established a model of writing processes which is the planning-writing-reviewing framework in which writing is defined by Zamel[(7)] as a "non-linear, exploratory and generative process whereby writers discover and reformulate their ideas as they attempt to approximate meaning" Hyland's[(8)] book. This writing model emphasizes the cognitive processes that learners engage in rather than their creativity. It approaches writing as a problem-solving process in which writers use their intellect to deal with the task complexity.

Writing as a skill is decisive for the learners' academic success. According to Murray and Moore[(9)], not learning to write is opting for "an academic half-life in which one's legitimate scholarly voice has not been sufficiently exercised or respected". A full academic life, therefore, is one in which learners are capable of communicating their ideas through writing, participating effectively in the academic community and responding to a writing situation. A simple definition of academic writing is nowhere to be found; it is a complex set of skills through which learners express their ideas in response to others' ideas in a conventional form (such as an essay or a paper) with the primary aim of demonstrating learning to a knowledgeable audience (like the teacher or the classmates) within a given context, which is usually an assignment or an exam. The expressed ideas, the form, the learner's and teacher's aims, the audience and the context are called by Irvin[(10)] the writing situation. In academia, writing has a particular situation and has its own conventions[(11)].

Academic writing has a situation that gives it some characteristics. In academia, writing is never writing per se. It consists of language transforming, for it relies on reading one or multiple texts composed by others and making organizational selective or connective alterations. Before proceeding into generating a text, learners have first to identify whether cultural, linguistic and thematic knowledge is available in memory. It is then automatically activated by the cues provided by the writing task. After that, they have to find meaning in

what is new and show understanding. Next, learners have to analyse the text by breaking the concepts into pieces to inspect them and see how they fit together. Finally, they have to interpret what has been read or learned via summarizing, paraphrasing or synthesising it[12].

Summary writing involves the processes of comprehension, evaluation, condensation, and transformation of ideas. Summarising is described by Guido and Colwell[13] as an invaluable type of integrated writing task that is required in academic settings. The ability to summarise in an L2 reflects good understanding, and thus it is closely related to successful learning and communication[14]. According to Johnson[15], summarising is the task of writing "a brief statement that represents the condensation of information accessible to a subject and reflects the gist of the discourse". It involves condensing the substantial information in one's own words and respecting the overall meaning. A summary can include the original text propositions, main points and essential supporting details[16].

Three sets of operations form the processes of recall and summarization. These operations are the organization of meaning into a memorable coherent whole, the summarizing of this meaning into a gist and the production of a new text based on the memorized meaning[17]. Summarising benefits language learners in many ways. Most importantly, it helps developing the ability to restructure texts at a morphological, syntactic, and lexical level. It is, however, important to note that low-level learners opt for lexical restructuring by using synonyms, for they do not have the tools to understand a L2 text and properly summarise it[18]. Thus, we can claim that high-level proficiency reveals itself better at the level of syntactic complexity.

1-2- Working Memory:

WM is defined as "a limited capacity system allowing the temporary storage and manipulation of information necessary for such complex tasks as comprehension, learning and reasoning"[19]. The ability to use this system is called the working memory capacity (WMC, also known as working memory span). Cowan[20] defines WMC as "the ability to remember things in an immediate-memory task (a task with no delay between the end of the presentation of items to be recalled and the period of recall itself)". This capacity varies from one individual to another, and thus from one language learner to another. It is only reasonable to suppose that differences in WMC affect learners' performance of complex tasks since learners with high WMC have no problem with their mental processes competing for attention while learners with low WMC do[21].

Accounting for all models of WM is, according to Shah and Miyake[22], more frustrating than enlightening. According to Jackson[23], the most dominant models are Baddeley and Hitch's[24], Cowan's[25] and Engle and colleagues'[26] models. The three models take an interest in learners' differences concerning their limited WMC, as a common ground, though they differ in the way they perceive WM and in the aspects they emphasise. While Baddeley and Hitch's[27] model, as argued by Baddeley[28] stresses that WM is composed of multiple separable subsystems, Cowan's[29] model and that of Engle and his colleagues[30] point to its unitary nature. Put together, the three models offer us a bigger picture of the nature of WM and sufficient insights into its structure, principles, functions and limitations.

WM is often described as a "mental scrapbook"[31], a metaphor that suggests a widely agreed-upon fact concerning the limitation of the number of items WM can hold and the time interval during which they can be held. Therefore, only a small amount of information can temporarily be kept conscious in memory to be processed. Dehn[32], however, declares that the processing capacity of WM is of much more consequence than the number of items it can store. What is important is the ability to keep relevant information in an active state to retrieve it whenever needed. While Baddeley[33] believes in WMC limitation in both processing and storage, Cowan[34] attributes it to processing only.

1-3- Working Memory and Academic Writing:

WM is vigorously involved in all the processes underlying the four language skills. Therefore, variation in WM is what prompts variation in listening, speaking, reading and writing skills[35]. People differ in their abilities to understand and produce language due to

their differences in remembering; dividing and selecting attention, binding information, inferring and all the other processes that WM undertakes[(36)] and that are involved in summarizing using background information.

Reading depends heavily on functional WM. It is necessary to decode and understand complex and/ or lengthy sentences, for example. We use WM to preserve verbal information (words, sentences, or even texts) in storage while processing new information to make sense of the whole sequence and complete a reading task[(37)]. The ability to carry ideas across texts dictates the intensive use of WM even for good readers. To fully comprehend a text, readers must rehearse new information through sub vocalisation. Additionally, since readers' storage capacity is too limited, they must create new long-term representations of the text or have access to existing ones in their long term memory (LTM). Good readers are more able to distract irrelevant content in order to extract the gist.

Writing tasks place high demands on WM. According to Kellogg[(38)], WM helps planning concepts and translates them into words and sentences. Before plans are transformed into verbal messages, previous knowledge and lexical, syntactic and semantic information needs to be recovered from LTM. WM is also needed during the revision phase since writers need to evaluate their product[(39)]. These three operations of writing, also respectively named formulation, execution and monitoring by Kellogg[(40)], are activated at the same time, and writers constantly shift among them using their WM.

Research has proven that writers with good WM are more able to produce complex and accurate sentences. However, writing proficiency also influences WM[(41)]. Writers who have enough knowledge about the topic of the text needless cognitive effort to produce their piece of writing. This leaves much more room in their WM for other writing processes, like organising and revising. Likewise, writers who excel in writing basics, like availability of vocabulary, spelling or punctuation, have more WM accessible too[(42)].

Numerous tests have been developed to measure the limits of WMC. These tests take the form of tasks that try to mimic situations where individuals have to focus their attention and resist distraction[(43)]. A WM test can either measure only the storage capacity, or it can measure both the storage capacity and the processing capacity. The first type of tasks is called simple and the second is called complex[(44)]. WM span tasks do not all measure the same storage or the same cognitive processes though, for WM is domain-specific according to many researchers like Baddeley[(45)]. In other words, span tasks should be chosen in accordance to the studied L2 sub-skill[(46)], which is writing in our case.

In performing complex skills like writing, where all components of WM are involved, both storage capacity and processing capacity must be put to the test, and deficiency in one of them indicates weakness in the WMC[(47)]. Individuals with low WMC tend to be weak at inhibiting irrelevant information. Consequently, they process relevant information slowly with much more effort, and they are able to store fewer items when it comes to one of the span tests[(48)]. WM complex tasks, like writing span, measure the capacity of all WM components and help explaining how differences in WMC affect L2 production. They are, therefore, more efficient and useful to the current study than simple ones.

The writing span test is used to measure WM involved in the writing skill[(49)]. As proposed by Ransdell and Levy[(50)], the writing span task is one in which participants are given a list of words to memorise and asked to compose a sentence using each memorised word. How many words they can remember represents the span's measure. According to the two researchers, WMC correlates with writing quality, fluency and reading comprehension.

2- Research Questions and Hypotheses:

The present study draws on existing research on both WM and academic writing production in L2. It proposes that one of the factors predicting L2 academic writing performance is WMC. Its objective is to investigate whether or not there is a relationship between the two. Therefore, our research aims at answering the two following questions:

1- Is there a relationship between WM and L2 writing as mediated by reading?

2- Do differences in the WMC, as measured by a writing span test, predict differences in L2 writing fluency, accuracy, syntactic complexity and summary writing quality?

Based on the literature review, we hypothesise that WM may correlate with learners' performance on writing tasks which are mediated by background information from a reading text. Furthermore, we hypothesise that differences in WMC, as measured by a writing span test, may have predictive power over learners' L2 writing production as measured by fluency, accuracy, syntactic complexity and summary writing quality.

From these hypotheses, we can derive four other hypotheses:

Hypothesis 1: There may be a relationship between the WMC, as measured by a writing span test, and fluency in L2 writing production in a summary task, as measured by the number of words per T-unit.

Hypothesis 2: There may be a negative correlation between the WMC, as measured by a writing span test, and accuracy in L2 writing production in a summary task, as measured by the number of errors in syntax, morphology, and lexical choice per T-unit.

Hypothesis 3: There may be a positive correlation between the WMC, as measured by a writing span test, and syntactic complexity in L2 writing production in a summary task, as measured by the mean number of clauses per T-unit.

Hypothesis 4: There may be a positive correlation between the WMC, as measured by a writing span test, and summary writing quality as measured by the proportion of important idea units (IMUPIU/IU).

3- Methodology:

3-1- Population and Sampling:

The population of interest to our research is composed of the first year students in the Department of English at the University of OEB. The first year LMD student body enrolled during the academic year of 2017-2018 consists of 290 students divided into eight groups. A sample of 29 students was chosen from the already formed by the administration groups. Randomly chosen participants from groups 6 and 8 constitute our sample of the accessible subjects[(51)].

3-2- Data Collection and Procedure:

A correlational study has been conducted to investigate the association between the non-manipulated variables[(52)]: WMC and academic writing. To compare the two variables and see whether or not they are related, we started by gathering the data using two instruments, namely: the writing span test and a reading-to-write task. After that, we measured the data then analysed them statistically in order to conclude.

3-2-1- The Writing Span Test:

For this study we needed a complex WM test to correlate with different dimensions of writing performance. For this aim, we used the writing span test which is a complex test[(53)] in which participants are asked to memorise a list of words then compose one sentence with each word they can recall[(54)]. The number of words they can remember represents the span's measure (Appendix 01).

To conduct our study, we devised a writing span test based on Ransdell and Levy's[(55)] explanation and adapted from Daneman's[(56)] speaking span test. We presented a list of words to our participants. The words were content words taken from "The Longman Communication 3000"[(57)] which is a list of the 3000 most frequent words in spoken and written English. The list is made based on the statistical analysis of 390 million words found in the Longman Corpus Network. The words on this list account for 86% of the ones most used in English. They are marked in the "Dictionary of Contemporary English" by different symbols: S1, S2 and S3 for the top 1000, 2000 and 3000 most spoken words and W1 , W2 , and W3 for words that are the top 1000, 2000 and 3000 most frequently written. We have been careful to choose the most used in written language since we are testing writing (Appendix 02). We have also picked words that belong to different categories (W1, W2 and W3) in order to be versatile. Participants wrote the sentences with pen and paper.

Our participants were tested in a 90-minute session. They were divided into small groups of five students and were asked to sit on chairs facing the experimenter. They were given sheets of paper on which a blank space was devoted to the recalled word and another to the sentence. After that, participants were presented with 20 unrelated content words at a rate of 1 per second to read silently. The words were printed on 210 x 297 mms cards using the Times New Roman font, 130 point. The initial series of presentations was of two words, one word after the other. Next, they were shown an increasing number of words to remember: three, four, five and six. A blank flashcard was inserted after each series to separate the sets and to signal their end. After each series, the group of students was asked to write down the words and to form sentences using them. They were given 10 seconds for each word. The order of recollection of the words was taken into consideration, and only correct full sentences were counted as points in the final score. The experimenter stopped scoring at the first wrong word. Students were encouraged to write simple sentences since neither sentence complexity nor length was accounted for. One point was added to the final score for each word that is recalled in the right order and used in a correct sentence. Students have been induced to practise with several items before the actual test began.

3-2-2- The Writing Task:

Students were asked to write a summary of one text in a reading-to-write task (Appendix 03). The text for this experiment was adapted from the Cambridge IELTS practice book for students[(58)]. The International English Language Testing System or the IELTS is an international proficiency test developed for non-native speakers, and it has been used since 1989. It is based on authentic texts and real-life scenarios[(59)].

The readability which is the relative ease of this text was tested using an online readability analyser software: "Readability Analyzer"[(60)] and was estimated by the Flesch reading measure formula to be 57.49 points, which is considered plain English. This tool determines the reading ease of the text by counting the number of syllables and sentence lengths[(61)]. According to the Flesch-Kincaid measuring tool, the text can be read by the average student in the 7th-grade level[(62)].

In the pre-task stage, the students were introduced to the framework of the writing task through engaging them in revising the steps of writing a summary. In the during-task, the participants received the reading text, of which the topic was about the risks of cigarette smoking, which seemed a common topic to tackle. This stage was followed by the learners' summaries. In the post-task stage, participants read their pieces and received feedback from their peers and the teacher.

3-2-3- Measures:

To assess the fluency, accuracy, complexity and writing quality of the learners' summaries, we used four measures. The first measure was the number of words per T-unit, where T-unit is the minimal terminable unit that contains an independent clause and its dependent clauses. This measuring tool is used for writing fluency. The second measure, or the accuracy measure, was the ratio of errors to the total number of words. All errors which were syntactic, morphological, and lexical were carefully examined. We disregarded errors that are of spelling and punctuation. The third measure assessing syntactic complexity is the mean number of clauses per T-unit[(63)]. Lu's[(64)] computational system for automatic analysis of L2 writing (L2SCA: Web-based L2 Syntactic Complexity Analyzer) was used to measure syntactic complexity[(65)] As for summary writing quality, we used Head et al.'s[(66)] proportion of important idea units (IMUPIU/IU) which corresponds to the ratio of the number of important idea units (IMPIU) divided by the total number of idea units (IU) in the summary. The original passage in this study was divided into 12 idea units, five of which were important and seven extraneous. A score of one point was given to each important one included in the participants' summaries, a zero to the unimportant and a minus one to the extra ideas added by learners and the omitted important ideas. Thus, including peripheral

ideas in a summary or excluding essential ones decreases the participant's writing quality score.

4- Results:

In order to find the relationship between WM and the learners' writing fluency, accuracy complexity and quality of summaries, we used the Pearson correlation formula to calculate the correlation coefficient, which is a quantitative measure that relates to non-manipulated variables[(67)]. We aimed to see whether the WMC, as measured by a writing span test, can be a predictor for learners' L2 writing production as measured by fluency, accuracy, syntactic complexity and summary writing quality. We also calculated the coefficient of determination (R^2) to find the percentage at which the variance in academic writing can be explained by the WMC.

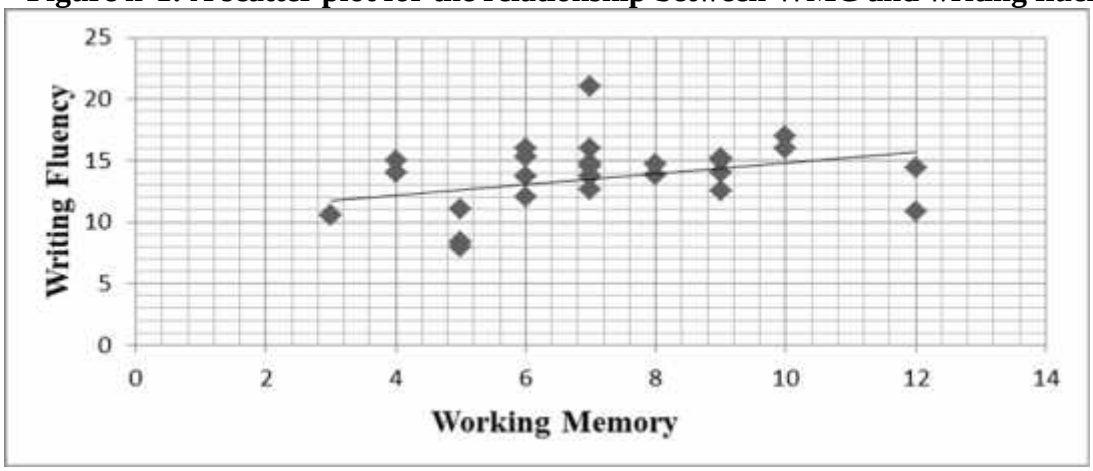
Table.1 below summarises the descriptive statistics for the instruments used, that is, the WMC and the measures of academic writing. The performances of the participants' means and standard deviations along with the relationship between writing and WMC are displayed as follows:

Table n°1: Descriptive Statistics, Pearson Coefficient and the Coefficient of Determination for WMC and Writing Fluency, Accuracy, Complexity and Summary Quality

	Mean	**Std deviation**	**R: Pearson coefficient**	**$R^{2:}$ Coefficient of determination**
WMC	**7**	**2.3604**		
Fluency	**13.5217**	**2.8371**	**0.3633**	**0.132**
Accuracy	**0.9758**	**0.5932**	**0.3912**	**0.153**
Complexity	**1.5048**	**0.3376**	**0.6077**	**0.3693**
Summary Quality	**0.4731**	**0.1938**	**0.6478**	**0.4196**

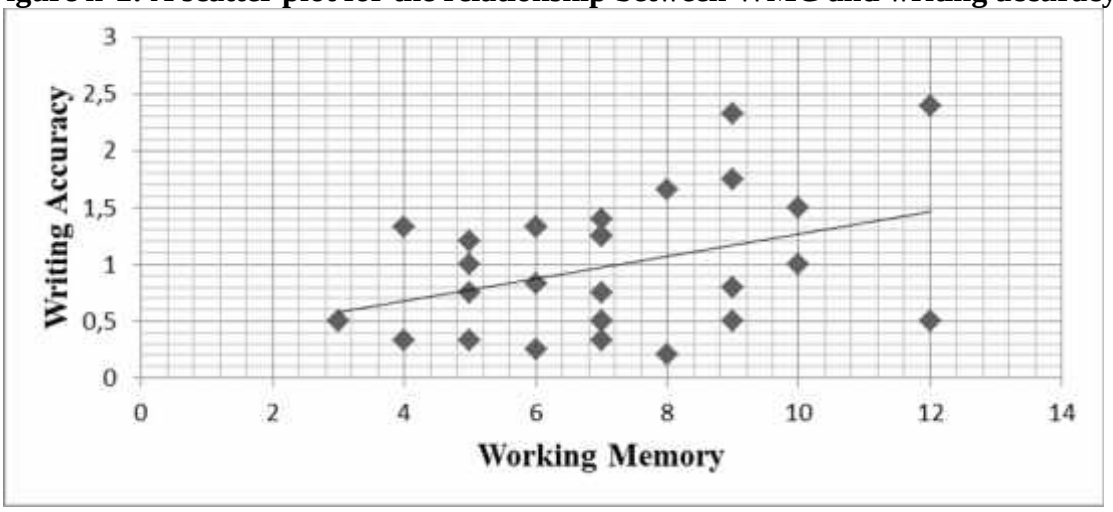
For the first measure of writing, the correlation coefficient was found to be closer to 0 than it is to 1, (R(29)= +0.3633); therefore, the correlation between WMC and writing fluency is moderate although positive which means that although the two variables move together in the same direction, they are loosely related (as Figure.1 shows). The value of R^2, the coefficient of determination on the other hand, is 0.132. This means that only 13.2% of the variance in academic writing fluency can be explained by WMC as measured by a writing span test.

Figure n°1: A scatter plot for the relationship between WMC and writing fluency.



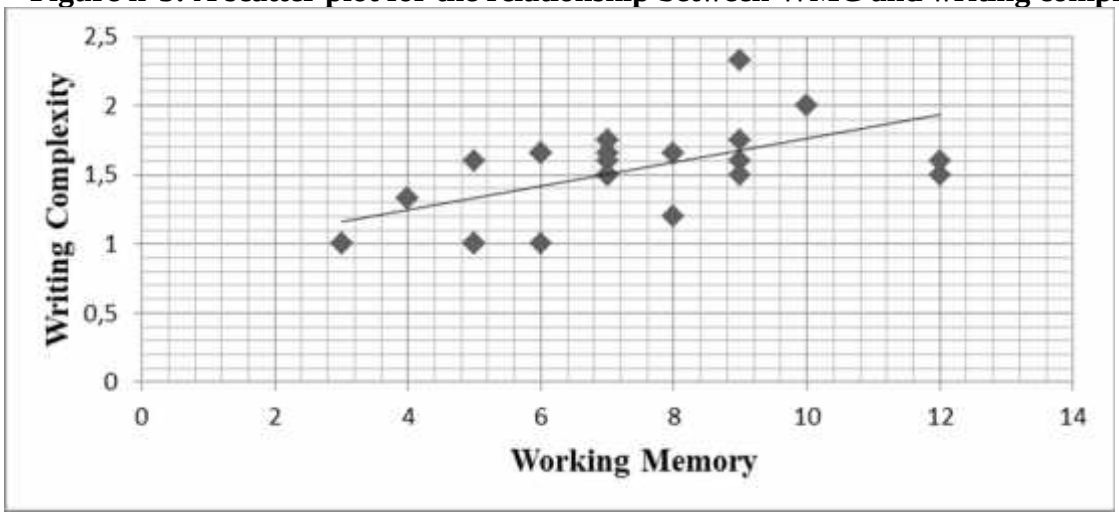
The value of the correlation coefficient (R) between WMC and writing accuracy is 0.3912. The value is positive and closer to 0 than it is to 1. Consequently, the scores of the two variables move in the same direction (Figure.2), and the relationship between them is moderate and not linear. The value of R^2 is 0.153, which means that 15.3 % of learners' errors can be determined by WMC.

Figure n°2: A scatter plot for the relationship between WMC and writing accuracy



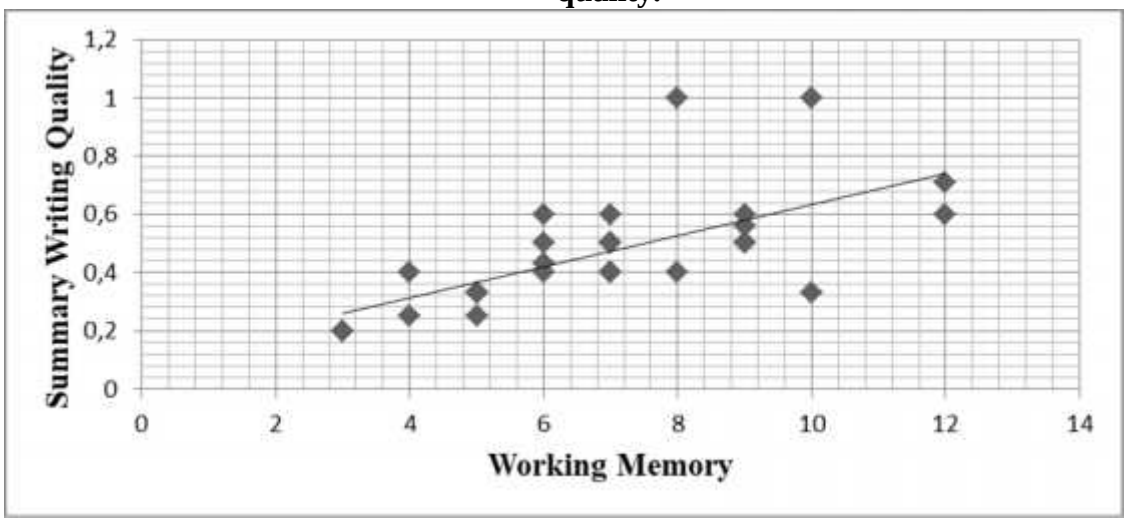
For the third measure, the value of R (29) is +0.6077 which is a moderate positive correlation. This means that there is a tendency for high complexity scores to go with high WMC scores, and a linear relationship exists between the two variables (Figure.3). The value of the coefficient of determination (R^2) is 0.3693. As a result, the percentage of 36.93% of the variance in the syntactic complexity of academic writing is determined by WMC.

Figure n°3: A scatter plot for the relationship between WMC and writing complexity



The fourth measure, which is the summary writing quality, correlates with WMC. The value of R (29) is +0.6478, which is a moderate positive correlation. This indicates that there is a linear relationship between the two variables (Figure.4). The value of the coefficient of determination (R2) is 0.4192. As a result, the percentage of 41.92% of the variance in the quality of summary writing is determined by WMC.

Figure n°3: A scatter plot for the relationship between WMC and summary writing quality.



5- Discussion:

This study investigates the potential role of WM in determining the students' level of performance in academic writing. Our correlational findings show that there is a rather significant linear relationship between WMC as measured by a writing span test and writing complexity and summary writing quality while it is of less significance for fluency and accuracy.

Our first research question was related to the relationship between the learners' WM and L2 writing as mediated by reading, and the data indicates that the two variables are strongly correlated with each other. However, this correlation does not apply to all the dimensions of L2 academic writing. As demonstrated by the data gathered and the measures taken to answer the second question of this research, only syntactic complexity and summary quality demonstrate a strong linear relationship with the WMC levels. Therefore, we can claim that the differences in WMC, as measured by a writing span test, have predictive power over the learners' L2 writing production as measured by syntactic complexity and summary writing quality, and those differences do not have the same predictive power over fluency and accuracy.

Concerning the complexity, accuracy and fluency measures of L2 writing, the results indicate that the learners with high WMC are more likely to produce more syntactically complex texts that are not necessarily more fluent and accurate. This variation can be explained through[(68)] the trade-off effect. According to this effect, complexity, accuracy and fluency (the CAF measures) compete for limited cognitive resources. These cognitive resources include WM which accounts for the learners' individual differences in learning and performing complex cognitive tasks[(69)]. This means that when confronted to a more or less complex task, like writing a summary, for example, the learners have to choose whether to use their limited WM to process complexity, accuracy or fluency which results in trading one for another. Having a high WMC does not mean improvement in the three CAF measures, for as argued by Ellis[(70)], learners can produce more accurate language by avoiding challenging structures that can cause complexity. According to Kim, Nam and Lee[(71)], L2 writing complexity shows the strongest relationship to L2 development while accuracy shows sharp, irregular ups and downs[(72)].

As for summary writing quality, the research proves a positive correlation between WMC, as measured by a writing span test, and summary writing quality as measured by the IMUPIU/IU. The results suggest that students with high WMC are more capable of differentiating between the important ideas and extraneous ideas in a passage than students with low WMC. Kintsch[(73)] explains this by arguing that learners with limited WMC must

devote this capacity to access the lexical basic meaning and make inferences to build coherence. While accessing lexical meaning and making references are lower comprehension processes, extracting the gist and the main ideas of a text is a higher process. According to Conway, Kane, Bunting, Hambrick, Wilhelm and Engle[(74)], individuals with low WMC tend to be weak at inhibiting irrelevant information. Consequently, they process relevant information slowly with much more effort. Therefore, performing well in a summary task is related to WM because it depends on learners' reading comprehension[(75)].

Some limitations of the current study might be related to our data collection and measuring instruments. Though the WM span test has proved its reliability throughout research, administering it in a classroom has been a alternative choice for doing so in a language laboratory where conditions, especially timing, could have been more controlled. Hence, the results could have been more precise. Future research may choose to test the learners' WMC using other WM span tests and choose other environments for these tests. Other alterations might be done at the level of the writing measures. A holistic measure of writing quality might be used to further depict the learners' comprehension, for as argued before in reading-to-write texts comprehension is primordial for high performance.

Conclusion:

SLA research has long been trying to answer the question of why students vary in their language learning success, and it has resolved that individual differences are the first responsible for such variation. Learning happens as a result of the optimal interaction between learners' variables and the learning environment. This study has demonstrated the association between one of the learners' cognitive differences, namely, WM and their performance in a reading-to-write task. The most important finding of this paper is the recognition of WM as a predictor for good writing. The learners with a high level of WMC can produce more syntactically complex and better quality summaries. Considering this, differences in WM among the learners need to be taken into account while making decisions about instruction design. As a result, teachers may use the results of this study to gain a better view of their learners' profiles, and thus design better lessons and writing tasks in order to enhance their writing ability. By profiling the learners' cognitive strengths and weaknesses in language learning, it should be possible to match these profiles to tasks and thus improve their chances of success in learning a L2.

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Appendices:

Appendix 01

Source: adapted from Daneman's (1992) speaking span test

Name: …….. Group: …….

Instruction:

- Write down the word you can remember.
- Form a simple sentence using this word.
- Start writing when you see the blank sheet of paper.
- Stop writing and raise your head when you hear the word '**stop'**.

1- Word: ……..
Sentence: ……
2- Word: ……..
Sentence: ……

3- Word: ……..
Sentence: …….
4- Word: ……..
Sentence: …….
5- Word: ……..
Sentence: …….

6- Word: ……..
Sentence: ……
7- Word: ……..
Sentence: …….
8- Word: ……..
Sentence: …….
9- Word: ……..
Sentence: …….

10- Word: ……..
Sentence: …….
11- Word: ……..
Sentence: …….
12- Word: ……..
Sentence: …….
13- Word: ……..
Sentence: …….
14- Word: ……..
Sentence: …….

15- Word: ……..
Sentence: ……
16- Word: ……..
Sentence: …….
17- Word: ……..
Sentence: ……
18- Word: ……..
Sentence: …….
19- Word: ……..
Sentence: …….
20- Word: ……..
Sentence: …….

Appendix 02

"The Longman Communication 3000" (Bullon, & Leech, 2007)

1st Series	2nd Series	3rd Series	4th Series	5th Series	6th Series
Accept v W1 Mystery n	opportunity n W1	problem n W1 interview n	suggest v W1 outside adj W2	violent adj W3 outside adj W2	responsible adj W2

W3	jump v W3 factory n W2	W2 extreme adj W3 mission n W2	president n W2 sympathy n W3	president n W2 sympathy n W3 violent adj W3	usually adv W1 revolution n W2 describe v W1 shopping n W3 wonderful adj W2

Appendix 03

Source: adapted from the Cambridge IELTS practice book for students (2011)

Summarise the following text:

Name: …….. Group: …….

There are simple steps to summarization.

- Read the text first to understand the author's intent.
- Pick out important details that are necessary/ Highlight the important details using keywords.
- Delete extraneous descriptors, details, and examples.
- List keywords in the order they appeared in the passage.
- Trim the list of keywords down to one topic sentence.
- In your own words, write the thesis and main ideas in point form (change only the changeable keywords).
- Reread the original work to ensure that you have accurately represented the main ideas in your summary.

The Risks of Cigarette Smoke

Discovered in the early 1800s and named 'nicotianine', the oily essence now called nicotine is the main active ingredient of tobacco. Nicotine, however, is only a small component of cigarette smoke, which contains more than 4700 chemical compounds, including 43 cancer-causing substances. In recent times, scientific research has been providing evidence that years of cigarette smoking vastly increases the risk of developing fatal medical conditions. Passive smoking, the breathing in of the side-stream smoke exhaled by a smoker, also causes a serious health risk. Research argues that the type of action needed against passive smoking should be similar to that being taken against illegal drugs and AIDS. They maintain that the simplest and most cost-effective action is to establish smoke-free work places, schools and public places.

Summary:

……
……
……
……