Working Memory and Second Language Acquisition: Effects on Vocabulary, Grammar, Reading, and Writing

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ABSTRACT

This research explores the role of working memory in L2 acquisition, attempting to provide c insight into how individual variations in working memory capacity lead to variability in language learning performance. A descriptive correlational research design was employed to examine the natural variations in working memory and their relationship with English proficiency among high school students in Surabaya, Indonesia. Participants were divided into high and low-working memory groups. Their performance was measured based on four aspects of language: vocabulary, grammar, reading comprehension, and writing. Results showed that working memory positively correlates with language proficiency in reading comprehension, vocabulary, and grammar. On the other hand, this trend is weaker in writing. Using linear regression analysis, working memory predicted performance in three aspects: vocabulary, grammar, and reading comprehension. These findings indicate the significance of individualized teaching methodologies concerning individual cognitive potential. The study concludes by calling for adaptive language teaching techniques that exploit working memory for efficient L2 learning while at the same time calling for further research into instructional approaches and other cognitive factors affecting language acquisition.

Keywords: cognitive capacity; language education; neurolinguistics; second language acquisition; working memory

INTRODUCTION

Second language learning or foreign language learning is one of the essential topics in language education globally, especially when globalization requires people to know more than one language (Farvardin, 2019; Jia & Hew, 2023; Kayhan, 2018; Kogan et al., 2020; Mallol & Alsina, 2017; Masykar et al., 2022; Nasrullah et al., 2019, 2023; Permadi et al., 2022). Working memory is among the cognitive factors central to second language acquisition and is defined as the cognitive system that is in charge of storing and manipulating information in the short term (Kirana, 2022; Lerman et al., 2023; Lyu & Fries, 2023; Ward & Sanoudaki, 2021; Wen et al., 2022). Working memory relates to several aspects of language learning, such as vocabulary, grammar, and reading (Ghazi-Saidi & Ansaldo, 2017; Styati & Rodliyah, 2021).

Working memory is crucial in second language learning as it helps with actual language input processing and temporarily holds information to integrate new knowledge with existing knowledge (Huang et al., 2022; Li, 2022; Shen & Park, 2020; Zhao, 2022). Stronger working memory makes students use better processes for complicated sentence processing, comprehending

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new vocabulary, and gaining mastery of grammar. On the other hand, students with low working memory capacity are hindered in their ability to remember and manipulate language information and thus experience difficulty in acquiring a second language (Juffs & Harrington, 2011).

Over the last ten years, research has associated working memory capacity with language skills, suggesting a significant relationship between them. Accordingly, Flores-Salgado and Gutiérrez-Koyoc (2024) state that individuals with greater working memory capacity acquire vocabulary better in second language learning. A study conducted by Teng (2022) shows that working memory is involved in reading; the higher the student's working memory, the better their comprehension of the texts in the second language.

Sagarra (2017) argues that working memory plays a role in grammatical ability, especially in language learning, because grammatical rules are too complicated to process. This is because working memory capacity is connected with understanding complex sentence structures and codeswitching between students' first and second languages (Moscati et al., 2023).

While many studies have shown a positive relationship between working memory and language acquisition, some show certain dissimilarities concerning the results. In that direction, Chai (2022) found that working memory's effect on language acquisition varies depending on the teaching method applied. Some methods, such as project-based activities, provide better or more effective results for those with lower working memory capacity than the traditional approaches.

While numerous studies address the relationship between working memory and second language learning, previous studies focus only on one language skill, such as vocabulary or reading (Johann et al., 2020; Montero Perez, 2020; Vafaee & Suzuki, 2020). Few studies have investigated how Working Memory affects different aspects of language acquisition, like grammar, vocabulary, reading comprehension, and writing (Brunfaut et al., 2021; Johann et al., 2020). Some other studies have explored the degree to which individual differences in students' working memory capacity may affect their responses to alternative methods of teaching languages (Ahmadian, 2018; Bertilsson et al., 2020; Masrai, 2020).

While previous studies confirm the role of working memory in second language acquisition, they often focus on single linguistic components and fail to address the pedagogical relevance of potential cognitive differences between learners. Ideally, the educational delivery mechanisms would be neurocognitively adaptive, providing students with different ratios of second-language input based on their mental abilities, thereby optimizing the chances of successful language acquisition as a function of second-language experience. Yet, the existing context shows limited systematic integration of cognitive-based methods into language learning. The increasing gap from working memory itself calls for a fundamental understanding of how different working memory capacities can predict multiple linguistic skills and vice versa and how teaching methodologies can be tailored differently based on these more comprehensive accounts.

While past studies have touched upon the relationship between working memory capacity and domains within second language acquisition, like vocabulary, grammar, and reading comprehension, further nuanced exploration is still warranted. This research leverages a neurocognitive lens to add to the accumulating empirical data on how inherent cognitive abilities impact second language learning outcomes. One of the major difficulties this project addresses is disentangling how particular aspects of language acquisition may be influenced by working memory, ranging from word knowledge to producing written words. It is hoped that some additional exploration here will help feed directly into more individualized pedagogical approaches based on a student's cognitive profile, leading ultimately to fairer and more effective language education for all students.

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A primary aim of the study is to examine the extent to which working memory capacity influences different aspects of second language acquisition - in particular, vocabulary learning, grammar, reading comprehension, and writing (Ansarimoghaddam et al., 2017). In this research, we use a statistical correlational approach to investigate how cognitive differences between learners lead to different language learning outcomes. This study has three objectives: to see which types of language are affected by working memory capacity and how strong these effects tend to be; whether one aspect of language learning is more dependent on working memory than another; and finally, what the implications of these findings might be for more sensitive language teaching strategies.

LITERATURE REVIEW

During the past few decades, working memory in language acquisition has become a hot spot in research. For Ghazi-Saidi and Ansaldo (2017) and Styati and Rodliyah (2021), working memory represents the cognitive process of temporarily maintaining and, at the same time, manipulating information, which is vital for many language learning tasks. In second language acquisition, working memory helps real-time language comprehension and production by giving learners a place to store new language items and letting them build on the language they already know. Working memory capacity impacts an individual's efficiency in processing linguistic input, particularly for tasks requiring higher cognitive engagement, such as reading comprehension, grammar analysis, and vocabulary acquisition, as research by Huang et al. (2022), Li (2022), Shen and Park (2020), and Zhao (2022) has shown. In addition, working memory allows learners to keep multiple linguistic representations in mind simultaneously while linking them together to go beyond the shallow understanding of a new language. Apart from this, working memory capacity has been found to affect other cognitive processes such as deductive reasoning, cognitive flexibility and inferential reading ability, which are crucial for language learning. By processing, storing and integrating linguistic data in a new language, one's working memory capacity plays an essential role in second language acquisition.

Extensive research has proven the correlation between working memory and a range of language abilities. Predominantly important among these are lexicon absorption, understanding of syntax, and analysis of written language. For example, learners with greater working memory ability tend to be better at finding and recalling new words and use them properly. Leaners can think about new words once vocabulary has been constructed in working memory. Meanwhile, learners with smaller working memories cannot hold on to and actively put new terminology to use in different contexts. The transient storage and manipulation of linguistic information by working memory lets learners keep refreshing their mental presentation of new words for facile retrieval.

Most of all, working memory contributes to the grammatic art by allowing learners to comprehend and use the trickiest sentence patterns. For instance, Sagarra (2017) demonstrates a direct correlation between working memory capacity and the ability to acquire and apply complex grammatical rules, particularly in languages with flexible word order or intricate morphological structures. It was also pointed out by Moscati et al. (2023) that mastering advanced syntactic structures and moving between first and second language, calls for one's having access to both various grammatical points in simultaneous working memory and a method for stretching them out there as needed. The ability to link different aspects of grammar with each other and change perspectives is indispensable for embodying a working memory advantage. Conversely, with

lower limits on working memory, one cannot deftly fit and maneuver the various components of syntax that are indispensable for acquisition in any language, initial or subsequent.

In studying comprehension, working memory has an indispensable part to play. According to Johann et al. (2020) and Brunfaut et al. (2021), one's working memory capacity fundamentally predicts reading comprehension since it is a trait necessary for picking up information stated in texts and holding on to or incorporating that information for a brief moment. More significant working memory permits students to recall key details from the text, make connections between ideas within different sections, and comprehend in a more unified manner. Reading is quite challenging from the view of cognition - this makes it necessary to put a lot and be loaded with information held in working memory to win the kind of deep comprehension. In addition, it is essential to stay focused on a text for a long time while ignoring outside disturbances, which calls for healthy working memory skills. Learners often have to remember earlier information while focusing on later ones. Holding multiple ideas active at once cannot be done without a large or flexible working memory. These studies point to several important observations about the role of working memory in reading and identify targets for intervention.

Although there is no definitive evidence linking working memory capacity with writing proficiency, composing a well-structured text remains a challenging task. It requires not only accurate word order, proper verb usage, and correct punctuation, but also the ability to maintain readability and coherence through continuous self-monitoring and revision. However, research shows that previous drafting experience, creativity, and critical thinking ability, among others, influence writing performance. In a study by Bertilsson et al. (2020), working memory not only makes some fundamental writing processes possible—like organizing sentences to maintain coherence and lucidity—but its relative importance in writing rather than reading or learning new words is not high. This suggests that while working memory plays a role in certain stages of the writing process, other psychological and experiential factors may have a greater influence on writing quality.

While the connection between working memory and language learning has been well established, studies in this respect vary in their results. Cai (2022) demonstrates that project-based teaching is more effective than rote memorization for learners with low working memory capacity. Therefore, it can be inferred that the role of working memory cannot be studied in isolation. Different instructional conditions may pose different cognitive demands on learners.

MATERIALS AND METHOD

RESEARCH DESIGN

This descriptive correlational study measured the working memory of participants in Surabaya, Indonesia. This study investigated various correlations between second language skills and working memory capacity among high school students. This is unlike experimental designs that manipulate independence or quasi-experiments that administer interventions. Instead, the study explored natural variations in working memory and its association with English proficiency without external manipulation. Participants were classified into high working memory and low working memory groups based on their scores on a standardized test. The quality of their English was then judged according to four primary areas of language: lexical items and meaning (vocabulary), syntax and grammar (grammar), the ability to read (comprehension), and the flow of writing.

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The investigation employed an unmanipulated correlational methodology that was well-suited to examine cognitive influences on language learning sans interventions. Working memory capacities differed noticeably between students, with some exhibiting robust retention and others demonstrating considerably weaker working memory. Assessment of English competency across various domains unveiled that those with vastly superior working memory often displayed markedly enhanced language skills compared to peers with minimal working memory. However, surprisingly, a few participants with normally developed working memory showed language proficiency closer to students in the reduced working memory group.

To ensure the study's internal validity, potential confounding factors, such as motivation level, prior exposure to English, and previous language education background, were controlled using an initial questionnaire. These measures aimed to minimize external bias and isolate the influence of working memory capacity on second language acquisition.

PARTICIPANTS

Participants were Grade 11 (ages 16–17, mean age 16.5 years, SD = 0.8) high school students studying English as a foreign language in Surabaya, East Java. The participants were chosen because they have basic and intermediate knowledge of English, having learned the language for at least three years in a formal educational context. They were selected because students in Grade 11 are believed to be mature enough to undergo complex cognitive and language tests. All participants are confirmed to have no cognitive or neurological impairment that would hinder their performance in the current study's working memory and language acquisition tests. Cognitive health was verified via a survey completed by their respective parents, which was further validated by their school officials.

The sampling was done randomly from the Grade 11 student population of three public and private schools in Surabaya. This was to ensure that the sample used in this study is representative of the student population in a big city with diverse socio-economic backgrounds. Participants were recruited using stratified random sampling to ensure representativeness across socio-economic backgrounds. Both male and female students participated, with a balanced gender distribution (male = 24, female = 26).

Fifty Grade 11 students who met the inclusion criteria participated in the research. They were divided into two groups based on their working memory span test score, which is the main instrument in the measurement of working memory capacity. Students with scores ≥ 25 were categorized into the High Working Memory Group, while those below 25 were classified into the Low Working Memory Group. Whereas the high working memory group was expected to show an advantage during processing information in the English language, the low working memory group was expected to face more significant challenges concerning the understanding and processing language information.

RESEARCH INSTRUMENTS

In this study, two conceptually validated measurement instruments that have been widely used in cognitive research and language pedagogy were used. The two instruments are the multi-segment Automated Working Memory Evaluation (AWMA) span test, which is designed for online use (Carpenter & Alloway, 2023; Fartoukh et al., 2014; Funayama et al., 2021; Kobayashi & Okubo, 2014; Spencer-Smith et al., 2020). The test mainly concerns two forms of recall, namely number

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sequencing and sentence reading. In the number sequence aspect, subjects were given a series of numbers and then asked to recall them (Petra et al., 2020). This test reflects the subject's ability to store numerical information and process it quickly and precisely until the language is finally mastered.

Conversely, in the reading span task, subjects must process material from sentences that they have memorized or manipulated. This demonstrates their capability for memory, processing information, and getting text with the context of what has been looked at – in short, reading. For both assignments, scores were standardized, with 30 as the maximum possible score. The credibility and reliability of the AWMA have been confirmed through numerous experiments (e.g., Carpenter & Alloway, 2023; Fartoukh et al., 2014; Funayama et al., 2021; Kobayashi & Okubo, 2014; Spencer-Smith et al., 2020) so that it has now become an important and reliable meter for measuring essential cognitive abilities related to language acquisition.

In this study, an English proficiency test has been used to assess individuals' mastery of language skills. It tests word usage, sentence patterns (syntax), sentence comprehension (in terms of structure and cohesion in written language), and written composition skills, with a total score of 100 points. As for word usage, the ability to correctly choose words from a list of multiple-choice questions was tested in this question. These questions have proven valuable in testing the linguistic abilities of second-language learners, particularly in areas such as reading comprehension.

Other sub-tests were designed to test grammar skills, English reading comprehension and sentence or paragraph construction. These subtests were used to balance the assessment of the interdependent aspects. The test results have provided important information about the success of English language learning and the challenges that still need to be addressed (Mohd-Ali et al., 2018; Stoeckel et al., 2021). The keywords section checks a student's ability to grasp the meaning of a wide range and variety of English vocabulary. It covers use analysis, choosing the right form for sentences or phrases, and sentence completion (Kintsch et al., 1993). The comprehension portion of the test was based on Kintsch's approach to reading comprehension (Britton & Gülgöz, 1991). In this part, a short essay was given to students to read, and then they were asked questions that probe into their complete understanding- structured details of the meaning of the text.

The writing component of the assessment was designed to assess students' ability to produce structured and coherent essays, focusing on writing fluency, sentence structure, and grammatical accuracy. The test was administered using a rubric adapted from the internationally recognized standard, the Common European Framework of Reference for Languages (CEFR) (Darmi et al., 2018; Mohamed, 2023; Uri & Aziz, 2020).

These instruments were selected due to their comprehensive measurement of the different skills in the English language and their validity, which has been recognized in several studies. These tests do not just measure students' abilities in one specific aspect, but they also give an overall picture of how students process and master English more holistically than basic cognitive abilities that support language learning for practical purposes in real life.

DATA COLLECTION

Data was collected in two sessions in a controlled environment to ensure consistency and reliability in the results obtained. In the first session, all participants underwent a 30-minute working memory span test under quiet and conducive classroom conditions that minimized outside distractions. Each participant was given the same instructions and the supervisor (in this case the

researcher) ensured that the conditions of the test environment remained constant for each participant. This was done to maintain the validity of the test and to eliminate the influence of bias caused by variations in the test environment.

Participants were divided into two groups based on their working memory scores: a high and low working memory group. Participants took a 90-minute English proficiency test during their second session. The test was designed to measure students' proficiency in four main aspects: vocabulary, grammar, text comprehension, and writing. To ensure consistency and minimise external influences, the test conditions in this session were exactly the same as in the first session, with controlled and quiet environmental conditions maintained throughout. All data collected was recorded and processed by SPSS software version 25. Data were analysed systematically to ensure rigorous and scientifically sound treatment.

DATA ANALYSIS

Various relevant statistical techniques were used to analyze the data collected in this study and to answer the research questions comprehensively. The first analytical technique used in this study was the Pearson Correlation Test, which aimed to ascertain the relationship between working memory capacity and English proficiency scores. In most cognitive and linguistic research, Pearson's correlation is usually adopted when analyzing interval variables. Correlation in this context was employed to provide data that answer the research questions on whether students' proficiency in English is related to their working memory and the strength of the relation.

In addition, an independent t-test was conducted for this experiment to compare the proficiency scores of two students: those with high working memory capacity and those with low working memory capacity. The t-test analyses the mean difference between the two groups to determine whether differences in working memory capacity affect students' outcomes in acquiring the English language.

In addition, linear regression analysis was also conducted to predict the effect of working memory capacity on specific components of the English language acquisition process, such as vocabulary development, grammar, text comprehension, and writing skills. This research applies linear regression analysis to probe into how working memory impacts different language acquisition aspects differently and what variables working memory capacity will have the most significant effect on.

Finally, to ensure that the instruments utilized were valid, Validity and Reliability Tests were conducted. First, the suitability of the questionnaire was tested; the content validity procedure was applied to ensure that the English test used measured the intended competencies. Meanwhile, the reliability test was done through the Cronbach alpha coefficient; the cut-off point was ≥ 0.7, indicating that the instrument is internally consistent and thus reliable in effectively measuring the participants' abilities.

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RESULTS

THE IMPACT OF WORKING MEMORY CAPACITY ON ENGLISH LANGUAGE PROFICIENCY

Correlation analysis between working memory and English mastery showed a significant positive relationship between working memory capacity and students' English language acquisition. Pearson Correlation Test shows that the correlation between the two variables was $r = 0.78$ with a p-value < 0.01, indicating a strong, statistically significant correlation. This means that the participants can better grasp the general features of the English language and its various components of acquisition if their working memory capacity is high.

Working memory empowers language learners to store and manipulate linguistic information temporarily. Students with vast working memory hold an edge as they adeptly process, stash, and retrieve vocabulary, syntax, and passages. Such students absorb and recall terms, skillfully analyze intricate grammar, and profoundly grasp readings. On the other hand, high-functioning working memory acts as a core mechanism for nimble data handling during knotty cognitive deeds like language acquisition. It provisionally retains and reconstructs material, facilitating adroit comprehension and production. Those with ample working memory channel capacity manipulate language dexterously in real time by retaining various components simultaneously before skillfully reassembling and responding to them. Overall, a sizeable working memory endows students with linguistic prowess as they learn a new tongue.

Previous studies also confirm these findings, with working memory contributing to different language skills. Lee et al. (2020) show that working memory contributes to L2 vocabulary acquisition, and Cho and Song (2023) found that working memory relates to grammar comprehension and text processing. The current findings support these previous studies that show that students with high working memory capacity tend to have a better command of English in all the components of language skills (see Table 1).

TABLE 1. Correlation Between Working Memory and Various Components of English Language Mastery

Language Mastery Component	Correlation with Working Memory (r)	Significance (p-value)
Vocabulary	0.74	<0.01
Grammar	0.69	<0.01
Text Comprehension	0.81	<0.01
Writing Skills	0.55	<0.05

Table 1 shows the significant relationship between working memory capacity and English language acquisition in its various components. In language learning, vocabulary is often reinforced through repetition. Working memory plays a crucial role in managing and storing new vocabulary information. Through repeated exposure, students with higher working memory capacity can reinforce word retention, leading to faster vocabulary acquisition and more accurate usage in appropriate contexts.

Results also reveal a highly significant relation between working memory and the capacity to apprehend grammar rules; higher working memory enables students to apply more complex grammar rules. More complicated sentences can be processed more effectively if students can simultaneously hold and manipulate several grammar rules in their working memory so they can understand the overall structure of the sentence. A higher working memory capacity enables students to manage multiple grammatical rules simultaneously, facilitating the comprehension and application of more complex sentence structures.

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The highest correlation was between working memory capacity and text comprehension, r = 0.81, $p < 0.01$. Students with high working memory can understand texts in greater detail. They can temporarily retain key information from the text and integrate it with their prior linguistic and contextual knowledge to construct a more comprehensive understanding. Text comprehension demands high cognitive engagement, requiring readers to actively retain key details, connect ideas across different text sections, and use working memory to process and integrate information into a coherent understanding.

As for the writing skills component, though the correlation was positive, the relationship that working memory shared with writing skills was a bit weaker compared to the other components, at a value of r = 0.55, $p < 0.05$. Writing is an art that includes other factors besides working memory capacity, such as creativity, experience in writing, and the ability to put scattered ideas together as a coherent piece of writing. Working memory may support writing skills by temporarily storing information during the writing process. However, its role in writing may not be as prominent as in vocabulary acquisition, grammar processing, and text comprehension, which rely more directly on cognitive capacity.

IMPACT OF WORKING MEMORY CAPACITY ON ENGLISH PROFICIENCY SCORES

The independent t-test results indicate a significant difference in English proficiency scores between students with high and low working memory capacity. Students with a high working memory capacity (≥ 25) achieved an average proficiency score of 89.65 (SD = 3.24), whereas those with a low working memory capacity (< 25) had a mean proficiency score of 74.77 (SD = 5.98).

Students with high working memory capacity remember vocabulary better, process more complicated grammar, and understand the texts deeper than those with low working memory capacity.

Table 2 compares the mean proficiency scores for these groups: High and Low Working Memory, including the standard deviation, standard error, and 95% confidence interval.

TABLE 2. Comparison of Average English Proficiency Scores by Working Memory Capacity

Working Memory Group	Average Proficiency Score	Standard Deviation	Standard Error	95% Confidence Interval (Lower)	95% Confidence Interval (Upper)	Sample Size
High (≥ 25)	89.65	3.24	0.72	88.23	91.07	20
Low (< 25)	74.77	5.98	1.09	72.63	76.91	30

As shown in Table 2, results imply that students with greater working memory perform better in general English proficiency. The smaller standard deviation in the high working memory group also supports the claim that students in this group have lesser dispersion in scores than students in the low working memory group. This further proves that a higher working memory capacity has affected language acquisition ability and provides greater student performance consistency.

IMPACT OF WORKING MEMORY ON DIFFERENT ASPECTS OF ENGLISH LANGUAGE ACQUISITION

The Linear Regression Analysis results show a significant effect of working memory capacity on three major components comprising English language acquisition: vocabulary, grammar, and text comprehension. The regression coefficients for the three components show a strong relationship, with the *p*-value less than 0.01, implying this relationship is significant at 99% confidence. However, the impact of working memory capacity did not reach an important level of statistical significance in writing skills, $p = 0.06$.

In the vocabulary component, the regression coefficient of 0.62 with a *p*-value <0.01 shows that working memory capacity would significantly affect students' remembering and mastering of new vocabulary. Students with better working memory tend to manage new vocabulary information more effectively.

The regression coefficient for the grammatical components (of 0.58 ($p < 0.01$)) stipulates that the working memory capacity significantly influences the student's capabilities in understanding and applying complex grammar rules. Grammar involves intellectual processes that require the capability for temporary storage and the management of complicated grammatical rules, which depend heavily on high working memory.

The text comprehension component produced the highest regression coefficient, at 0.70, with a *p*-value of less than 0.01. This, therefore, confirms that working memory will play the biggest role in helping students achieve comprehension of reading texts. Indeed, text comprehension requires temporary information storage and integration of information emanating from different parts of the text, which is a cognitive task that requires adequate working memory capacity.

On the other hand, the 0.32 regression coefficient, seen for the writing skills component, has a *p*-value=0.06, reflecting a statistically insignificant effect of working memory on writing skills. This would support the idea that creative thinking ability, experience in writing, and the ability to organize ideas are among the other factors that are probably even more potent than working memory and modulating writing skills (see Table 3).

TABLE 3. Results of Linear Regression Analysis on the English Mastery Component

Language Component	Regression Coefficient	Standard Error	Significance (p-value)
Vocabulary	0.62	0.10	0.01
Grammar	0.58	0.12	0.01
Reading Comprehension	0.70	0.08	0.01
Writing	0.32	0.15	0.06

The regression analysis confirms the importance of working memory across language learning, particularly concerning vocabulary, grammar, and text comprehension. Students with higher working memory capacity demonstrate a better ability to remember new words and apply more complicated grammatical rules. This is supported by most studies, which show that mastery of such components depends on the student's cognitive capacity to process and store language information efficiently.

The strongest influence of working memory was observed in the text comprehension component, highlighting its critical role in processing and integrating information during reading tasks. Effective reading comprehension requires students to retain textual information temporarily,

synthesize it with prior knowledge, and construct meaningful interpretations—all of which rely heavily on working memory capacity.

In contrast, the impact of working memory on writing skills was comparatively weaker. While working memory alone does not dictate the quality of written output, it is a foundational tool during composition. Beyond this necessary cognitive capacity lies one's creativity, accumulated practice in expressive communication, and skill for arranging thoughts in a sensible sequence. However, the transient retention and manipulation of linguistic and conceptual information over brief periods remains integral to forming syntactically sound sentences and a unified progression of topics. Writers can enhance their ability to organize and connect ideas in extended written compositions through repeated practice that engages their working memory and cognitive processing skills.

DISCUSSION

The study illuminated the import of active remembrance in additional language acquisition, distinctively in vocabulary, sentence structure, and examining comprehension. Pearson correlation analysis revealed a positive relationship between working memory capacity and language proficiency, with the strongest correlation observed in reading comprehension ($r = 0.81$, $p < 0.01$), followed by vocabulary ($r = 0.74$, $p < 0.01$) and grammar ($r = 0.69$, $p < 0.01$). These findings recommend that learners with higher working memory capacity are better equipped to handle linguistic information, master complex language structures, and comprehend detailed textual content.

Furthermore, the t-test results accentuate huge contrasts in English mastery amongst the high and low lively remembrance limit understudies. The group with a higher working memory capacity achieve an average English proficiency score of 89.65, whereas the group with lower working memory capacity scored an average of 74.77. These findings thus confirm the well-established theories of cognition, which place working memory among the highest in the list of cognitive functions involved in real-time language processing responsible for L2 learning.

The linear regression analysis also shows that the capacity of the working memory significantly predicts language performance, especially regarding vocabulary, grammar, and reading comprehension. Specifically, the coefficients are 0.62 for vocabulary, 0.58 for grammar, and 0.70 for reading comprehension. These results may indicate that working memory allows learners to handle several linguistic elements simultaneously to build meaning from the input they have received. However, the relatively weaker effect from working memory on writing skills was coefficient = 0.32, $p = 0.06$ – this probably proves that writing depends more on factors other than cognitive capacity, such as creativity experience and organizational skills.

These findings thus fell in line with the previous research that had focused so much on working memory in language learning. For example, the findings by Zhang et al. (2022) and Woan & Tat (2017) that children perform better in vocabulary tasks because of high working memory capacity confirm the current study's results. However, Nitin et al. (2023) have highlighted the important role that working memory plays in processing grammatical structures. This relationship is further supported by the findings of this study on the relationship between working memory capacity and grammar proficiency.

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The present research further adds to the emerging evidence of the key role of working memory in reading comprehension. For instance, Mervis et al. (2022), when pointing out that working memory relates to the predictor of reading ability, confirm that working memory has the strongest influence on reading comprehension. The results of this study further support the role of working memory as an important cognitive factor in supporting the language learning process in almost all linguistic aspects.

However, the influence of working memory will be inconsistent, depending on instructional methods. This current study has not been interested in how different teaching approaches interact with working memory capacity; therefore, this would be a further avenue for the research.

THEORETICAL AND PRACTICAL IMPLICATIONS

The results of this study confirm the important role of working memory in the context of second language acquisition, especially in several aspects of language, namely vocabulary learning, grammar comprehension, reading, and writing skills. The significant correlation shows that students with higher working memory capacity are better equipped to process, store, and retrieve linguistic information more effectively and efficiently. Conceptually, this supports the cognitive model theory which emphasizes the importance of working memory in real-time language processing and long-term acquisition.

Furthermore, from a teaching perspective, the results highlight the need for language teaching that pays more attention to individual differences in working memory capacity. Instructional techniques should of course also be designed on the basis of the working memory status of the learner. For learners with low working memory capacity, teaching strategies that reduce cognitive load – e.g. reducing task complexity for more basic and piece-by-piece learning, or giving the learner an extra booster pack when studying grammar – might help transfer and comprehension. On the other hand, learners with high memory capacity may benefit from tasks that require them to swallow all these different linguistic elements at once, such as reading exercises that involve inference as well as syntactic pattern manipulation exercises.

Moreover, as one of the findings of the study was a relatively weak relationship between working memory and writing ability, it is important to further explore instructional approaches that incorporate integrated cognitive support mechanisms for the development of writing competence. A number of relevant techniques, such as integrated planning, structured outlining and iterative drafting, may provide greater support for students as they learn through the cognitively demanding process of composing coherent written texts.

By adapting learning strategies to take account of differences in working memory capacity, teachers can make better use of language learning outcomes while providing more equitable opportunities for second language acquisition for all learners. Future research could focus on further investigating how differentiated teaching methods correlate with learners' cognitive differences in order to provide more nuanced insights into effective language pedagogy.

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CONCLUSION

This study reveals strong empirical support regarding the critical and significant role of working memory in second language acquisition for major linguistic aspects, such as vocabulary aspect, grammar, reading comprehension achievement, etc. In this regard, by identifying significant correlations between working memory capacity and such structures in a language, it becomes well evidenced that learners whose working memory capacities were superior succeeded better in processing, retaining, and utilizing linguistic information. These findings are in good accordance with current cognitive theories which places working memory at the heart of real-time language processing and long-term language learning.

Moreover, linear regression analysis also supports the proof of working memory as a strong predictor of language proficiency. It is beneficial because it allows learners to juggle multiple linguistic elements simultaneously, essential in comprehension and new vocabulary acquisition in complex sentences. However, the fact that working memory predicts writing skills to a lesser extent may suggest that writing depends more on other cognitive and experiential factors, such as creativity and organizational skills.

The implications are both theoretical and practical. This study attests to the centrality of working memory in language processing and learning. Based on the findings, language teaching strategies should consider individual differences in working memory capacity. Tailored learning approaches, memory-enhancing techniques, and adaptive technologies may enhance language learning by better meeting individual learners' cognitive strengths and weaknesses.

However, though the study does have its limitations regarding sample size and focus on working memory, it has not considered other cognitive and environmental factors. Future research should overcome such limitations by dealing with the interaction between working memory and other cognitive mechanisms, looking at the effectiveness of teaching methodologies for learners with varying working memory capacities. In this way, future research can further understand how cognitive factors contribute to second language acquisition and provide better evidence-based teaching practices.

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