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The Role of Working Memory Capacity in L2 Vocabulary Learning Among Saudi EFL Students

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Abstract

Acquiring a second language (L2) involves complex cognitive processes, where working memory (WM) plays a crucial role. This study investigates the relationship between WM capacity and L2 vocabulary acquisition among 100 Saudi EFL learners, focusing on first-year university students. Utilizing the Automated Operation Span Task (AOSPAN) to measure WM capacity and a custom-designed vocabulary test, the study found significant correlations between WM capacity and vocabulary retention, immediate recall, and usage in context. The experimental group, which received WM training, outperformed the control group across all measures. These findings underscore the importance of WM in L2 vocabulary learning and suggest that WM training can enhance vocabulary acquisition. The study's implications for educational practices are discussed, highlighting the potential for integrating WM training into language curricula to support learners' vocabulary development. This research contributes to understanding cognitive factors in L2 learning and provides practical recommendations for educators to enhance vocabulary teaching strategies for learners with varying WM capacities.

Keywords: Second language vocabulary, working memory capacity, EFL, operation span task

1. Introduction

The acquisition of a second language (L2) is a complex process that engages multiple cognitive mechanisms, with working memory (WM) being particularly essential in facilitating this learning (Baddeley, 2003). Working memory is the system that temporarily holds and manipulates information necessary for complex cognitive tasks such as language comprehension, learning, and reasoning (Baddeley, 2003). In language learning, WM capacity has been linked to acquiring and retaining new vocabulary, which is a fundamental component of language proficiency (Gathercole & Baddeley, 1990).Vocabulary learning in L2 is particularly challenging for learners as it involves the retention of new words and the ability to recall and use them appropriately in different contexts. The learner's WM capacity significantly influences this cognitive load, which can vary widely among individuals (Service, 1992). Understanding this relationship can provide insights into how vocabulary acquisition can be facilitated for L2 learners.

1.1 Cognitive Load and Individual Differences

The cognitive load associated with L2 vocabulary learning can vary widely among individuals, influenced not only by WM capacity but also by factors such as prior language knowledge, motivation, and learning strategies. Learners with higher WM capacity can better manage the cognitive demands of learning new vocabulary, allowing them to focus on more complex aspects of language learning, such as syntax and discourse-level processing. Conversely, learners with lower WM capacity may struggle with the basic task of memorizing new words, which can hinder their overall language development.

1.2 Contextual and Demographic Factors

This study focuses on 100 Saudi EFL learners, specifically first-year university students, a demographic group that is particularly relevant for several reasons. First-year university students are at a critical juncture in their academic and language learning journey. At this stage, effective vocabulary acquisition can significantly impact their overall language proficiency and academic success. Moreover, Saudi EFL learners may face unique challenges in L2 vocabulary acquisition due to differences in linguistic background, educational experiences, and exposure to the target language. Understanding how WM capacity interacts with these contextual factors can provide valuable insights into how vocabulary learning strategies can be tailored to meet the needs of this specific learner population.

2 Theoretical and Empirical Background

2.1 Overview of Working Memory Capacity

Understanding the role of WM in L2 vocabulary acquisition involves exploring several theoretical models that explain how WM supports language learning. Two influential theories in this domain are the Capacity Theory of Comprehension and the Embedded-Processes Model. The Capacity Theory of Comprehension and the Embedded-Processes Model provide a comprehensive framework for understanding how working memory supports L2 vocabulary learning. The Capacity Theory explains how the amount of cognitive resources available can impact language processing, while the Embedded-Processes Model details the mechanisms by which information is maintained and manipulated within working memory. The two theories will be explained more in turn.

2.1.1 Capacity Theory of Comprehension

The Capacity Theory of Comprehension, proposed by Just and Carpenter (1992), is rooted in the idea that working memory is a limited-capacity system that can vary among individuals.

According to this theory, individuals with greater WM capacity are better equipped to allocate cognitive resources to complex tasks such as language processing. As learners encounter new vocabulary, they must process the meaning, pronunciation, and usage of each word while also temporarily storing this information to integrate it with their existing knowledge (Baddeley, 2003). Those with higher WM capacity can efficiently juggle these tasks, leading to improved vocabulary retention and recall (Gathercole & Baddeley, 1990). Additionally, language learning often involves handling multiple linguistic inputs, such as understanding a word's meaning in different contexts. This process demands significant cognitive resources, and learners with greater WM capacity can better manage these inputs, resulting in deeper comprehension and more effective vocabulary acquisition (Ellis & Sinclair, 1996). Furthermore, the sheer volume of information can be overwhelming when learning a new language. The Capacity Theory suggests that individuals with higher WM capacity can manage this cognitive overload by effectively distributing their cognitive resources, enhancing their ability to learn and retain vocabulary (Daneman & Carpenter, 1980).

2.1.2 Embedded-Processes Model

The Embedded-Processes Model, developed by Cowan (1999), offers a dynamic perspective on how working memory (WM) operates in the context of language learning, suggesting that WM capacity is not a fixed number of items but rather a flexible system where information can be actively maintained in a highly accessible state. This model posits that WM includes the items currently being processed and those that are temporarily activated from long-term memory, allowing L2 learners to link new vocabulary with existing knowledge stored in long-term memory. Maintaining these links in an accessible state can significantly enhance vocabulary acquisition (Baddeley, 2003; Oberauer, 2002). Furthermore, the model emphasizes the role of attention, asserting that individuals can focus on a limited number of items (typically 3-4), which are then processed more deeply. In vocabulary learning, this focus allows learners to have better control over their attention and concentrate on crucial vocabulary items, leading to more efficient learning and retention (Cowan, 2001; Schneider & Shiffrin, 1977). Additionally, the Embedded-Processes Model highlights the flexibility of memory processes, where information can be quickly updated, retrieved, or replaced as needed. This flexibility is crucial in language learning, enabling learners to constantly adapt to new linguistic inputs, adjust their understanding, and update their knowledge base, enhancing vocabulary acquisition (Miyake & Shah, 1999; Unsworth & Engle, 2007).

2.3 Components of Working Memory

Baddeley's (2000) working memory model, one of the most influential in the field, posits that WM consists of four main components: the central executive, the phonological loop, the visuospatial sketchpad, and the episodic buffer. The central executive is responsible for directing attention and managing the flow of information within WM. The phonological loop handles verbal and auditory information, playing a pivotal role in language learning and the retention of words and sounds—the visuospatial sketchpad processes visual and spatial information, aiding navigation and problem-solving tasks. Finally, the episodic buffer integrates information from different modalities into a coherent, time-sequenced episode, linking WM with long-term memory (Baddeley, 2000).

2.4 Measurement of Working Memory Capacity

Working memory capacity is typically measured using complex span tasks, which require participants to perform a processing task while simultaneously remembering a series of items. The most common tasks include the reading span task (Daneman & Carpenter, 1980) and the operation span task (Unsworth et al., 2005). These tasks assess the ability to maintain information in an active, easily retrievable state while engaging in additional cognitive activity. Individuals with higher WM capacity can hold and manipulate more information, which is particularly beneficial for multitasking tasks or integrating information from multiple sources.

2.5 The role of vocabulary in Language Comprehension and Production

Vocabulary learning is a fundamental component of L2 acquisition and is critical to overall language proficiency. Vocabulary is the building block of language, enabling learners to understand and produce spoken and written communication effectively. With a sufficient vocabulary, learners can express themselves, comprehend others, and engage meaningfully with the language, which impedes their language acquisition process (Nation, 2001).

One of the primary reasons vocabulary is crucial in L2 acquisition is its direct impact on both comprehension and production. According to Laufer and Ravenhorst-Kalovski (2010), there is a strong correlation between vocabulary size and reading comprehension. Learners with a broader vocabulary can better understand texts, as they are more likely to recognize and understand the words they encounter. This comprehension extends to listening, where a more prosperous vocabulary aids in recognizing spoken words, phrases, and idiomatic expressions (Schmitt, 2008).

Similarly, vocabulary knowledge allows learners to express their thoughts more precisely and fluently in language production, whether spoken or written. Learners with a limited vocabulary are often restricted to using basic language structures and may need help to convey complex ideas, leading to frustration and communication breakdowns (Wilkins, 1972). Vocabulary learning, therefore, is not just about memorizing words but involves understanding their meanings, usage, and collocations, which enables learners to use the language more effectively.

Vocabulary knowledge is a strong predictor of success in L2 environments, especially for learners in academic settings. Academic language is often more complex and abstract, requiring a higher level of vocabulary knowledge. Research by Qian (2002) highlights that vocabulary depth knowledge of word meanings, uses, and associations significantly contributes to academic reading comprehension. This finding underscores the importance of expanding vocabulary size and deepening the understanding of how words are used in different contexts.

2.6 Relationship between Working Memory and Vocabulary Learning

Working memory plays a crucial role in acquiring, retaining, and retrieving vocabulary, particularly in L2 learning. WM is responsible for temporarily holding and processing information, which is essential for tasks requiring simultaneous handling of new information and integrating existing knowledge (Baddeley, 2003; Gathercole & Baddeley, 1993). Research consistently shows that individuals with higher WM capacity are more efficient at learning new vocabulary, comprehending complex sentences, and acquiring a second language (Ellis, 2001; Service, 1992). This efficiency is primarily due to WM's ability to manage multiple pieces of information simultaneously, a necessity in language tasks such as reading or listening to extended texts in the target language (Daneman & Green, 1986). The central executive component of WM is essential in coordinating the retrieval and manipulation of lexical items during language production. This process is vital for fluency and accuracy in both speaking and writing (Baddeley, 2000). For example, Gathercole and Alloway (2008) found that individuals with higher WM capacity better retrieve vocabulary, producing more fluent language. Moreover, the phonological loop, another component of WM, is critical in the early stages of vocabulary learning. Service (1992) demonstrated that Finnish students proficient in phonological processing were more successful in learning English vocabulary, underscoring the importance of temporarily storing and rehearsing phonological forms.

Recent studies continue to explore and confirm the significant role of WM in L2 vocabulary acquisition. Linck, Osthus, Koeth, and Bunting (2014) conducted a meta-analysis of 79 studies, affirming that WM capacity strongly predicts the initial acquisition and long-term retention of new words. Subsequent research, such as that by Peng and Fuchs (2019), Rajan and Samaranayake (2020), and Johnson and Ransdell (2023), has further demonstrated that WM training can enhance vocabulary retention and overall language proficiency among L2 learners. Notably, neural studies by Smith and Zhang (2021) highlighted the relationship between WM capacity and vocabulary learning, with significant activation observed in the dorsolateral prefrontal cortex and parietal lobes. Additionally, Alrabai (2022) showed that targeted WM exercises could improve vocabulary retention and language proficiency among Saudi EFL learners.

2.7 Role of WM in Vocabulary Acquisition Among Saudi EFL Learners

In recent years, there has been a growing interest in exploring the relationship between WM and L2 learning among Saudi English as a Foreign Language (EFL) learners. This focus is particularly relevant given the increasing emphasis on English proficiency in Saudi Arabia's educational system and its importance for academic and professional success. Studies by Al-Harthy (2017), Al-Qahtani (2018), Alotaibi (2021), and Bakhsh (2023) consistently demonstrate that higher WM capacity is associated with better language learning outcomes, particularly in vocabulary retention and usage. These findings have important implications for language education in Saudi Arabia, suggesting that WM capacity should be considered and developed as part of comprehensive EFL instruction.

Research by Al-Harthy (2017) provides valuable insights into the role of WM in vocabulary acquisition among Saudi university students. In this Study, Al-Harthy investigated the WM capacity of first-year EFL students and its correlation with their ability to acquire and retain new vocabulary. The study used vocabulary tests and WM assessments, such as the Automated Operation Span Task (AOSPAN), to measure students' WM capacity. The findings revealed a significant positive correlation between WM capacity and vocabulary test performance, indicating that students with higher WM capacity were more successful in learning and recalling new English words. This suggests that WM is crucial in enabling students to manage the cognitive load associated with vocabulary acquisition, particularly when simultaneously processing and storing new lexical items.

Building on these findings, Al-Qahtani (2018) conducted a study to examine the impact of targeted WM training on vocabulary retention among Saudi EFL learners. In this experimental study, participants were divided into two groups: one received WM training through exercises designed to enhance the phonological loop and central executive functions. In contrast, the control group did not receive any such training. The WM training involved nonword repetition, digit span tasks, and memory games, all aimed at strengthening the participants' WM capacity. The results demonstrated that the experimental group showed significant improvements in immediate and delayed vocabulary recall compared to the control group. Al-Qahtani's study underscores the potential of WM training as an effective intervention to boost vocabulary retention among Saudi EFL learners, suggesting that such training could be integrated into language learning curricula to enhance overall language proficiency.

More recent studies have continued to support the critical role of WM in L2 learning within the Saudi context. For instance, Alotaibi (2021) extended this line of research by exploring the relationship between WM capacity and various aspects of language proficiency, including reading comprehension, listening skills, and speaking fluency. Alotaibi's study involved a larger sample of university students and utilized a broader range of WM assessments, including complex and listening span tasks. The findings reinforced the importance of WM in language learning, showing that students with higher WM capacity excelled in vocabulary acquisition and demonstrated superior performance in other language skills. This suggests that WM capacity may serve as a general cognitive resource supporting multiple language proficiency dimensions.

Similarly, Bakhsh (2023) focused on the role of WM in acquiring academic English vocabulary among Saudi postgraduate students. Bakhsh's study highlighted the challenges advanced EFL learners face in mastering the specialized vocabulary required for academic success. The research found that WM capacity significantly predicted students' ability to learn and use academic vocabulary. Those with higher WM capacity showed better proficiency in using these terms in context. This study adds to the growing body of evidence that WM is a critical factor in L2 learning, particularly in contexts requiring complex and specialized vocabulary acquisition.

2.8 Research Gap

While recent studies have advanced our understanding of the neural underpinnings of the relationship between WM and L2 acquisition, mainly through the identification of specific brain regions such as the dorsolateral prefrontal cortex and parietal lobes (Chein & Fiez, 2010; Smith & Zhang, 2021), significant gaps remain. Specifically, there needs to be more research on the practical integration of WM training into L2 teaching practices, especially regarding how such interventions can be tailored to enhance vocabulary learning outcomes among Saudi EFL learners. Although studies like those by Alrabai (2022) have begun to explore WM training in language education, empirical evidence is still needed on the most effective methods for applying these cognitive insights in real-world classroom settings. This gap underscores the necessity for research that examines the cognitive mechanisms at play and translates these findings into actionable strategies that educators can implement to improve L2 vocabulary acquisition.

2.9 Objectives and Research Questions of the Study

The primary objective of this study is to examine the relationship between WM capacity and vocabulary learning among Saudi EFL learners. Specifically, it seeks to answer the following research questions:

1. Is there a significant correlation between WM capacity and vocabulary retention among Saudi EFL learners?
2. How does WM capacity influence the ability to recall and use new vocabulary in context?
3. What are the implications of these findings for language teaching practices?

By addressing these questions, the study aims to contribute to understanding cognitive factors in L2 learning and provide practical recommendations for educators to enhance vocabulary teaching strategies for learners with varying WM capacities.

3. Methodology

3.1 Participants

This study involved 100 first-year female Saudi university students enrolled in an English language program. The students were between 18 and 22 years old. All participants were native Arabic speakers with similar English proficiency levels as determined by their scores on a standardized English placement test (M = 85.2, SD =6.3). They were at the B2 level (CEFR).

3.2 Instruments

3.2.1 Working Memory Capacity Test

The Automated Operation Span Task (AOSPAN) (Unsworth et al., 2005) was used to measure the participants' WM capacity. The AOSPAN assesses the ability to simultaneously process and store information, which is crucial for language learning tasks (Unsworth et al., 2005). The task involves solving simple math problems while remembering unrelated letters, thus providing a robust measure of WM capacity. This dual-task nature mimics the cognitive demands of real-life language use, where learners must process new information (e.g., understanding grammar or meaning) while retaining previously learned content (e.g., vocabulary).

3.2.2 Vocabulary Learning Task

A custom-designed vocabulary test (Schmitt, 2010) was administered to evaluate the participant's ability to learn and retain new English words. The test consisted of 30 low-frequency English words selected from academic texts, accompanied by their definitions and example sentences. The selection of low-frequency words ensures that the participants are unlikely to have prior knowledge of the words, thus providing a precise measure of their ability to learn new vocabulary. The approach of using custom-designed vocabulary tests has been supported by previous research. For instance, Schmitt (2010) emphasizes the importance of selecting vocabulary items relevant to the learners' needs and the research context. Custom tests are beneficial when studying specific populations, such as Saudi EFL learners, where standard tests may need to reflect the learners' experiences or linguistic environment adequately.

3.2.3 Questionnaire

A background questionnaire collected demographic information and self-reported data on participants' previous English learning experiences and strategies. This information was used to control for confounding variables that could influence the study's outcomes. This data helped ensure that the experimental and control groups were matched as closely as possible regarding demographics and prior knowledge.

4. Procedure

The study was conducted in three phases over four weeks.

Phase 1: Pre-Test (Week 1)

Participants completed the background questionnaire in the first week and took a pre-test to assess their baseline vocabulary knowledge. The pre-test included 50 multiple-choice questions on vocabulary that was not part of the study's target words. The test was designed to measure participants' recognition and recall abilities and identify any pre-existing vocabulary knowledge differences between the experimental and control groups.

Phase 2: Intervention (Weeks 2 & 3)

Over the next two weeks, participants were divided into two groups: the experimental group, which received WM training, and the control group, which did not. The WM training consisted of daily 30-minute sessions using the AOSPAN task. This task, widely used in cognitive psychology, requires participants to solve simple mathematical equations while simultaneously remembering a sequence of letters. The task was designed to enhance their WM capacity by training them to manage and manipulate information more efficiently under cognitive load. Both groups attended regular English vocabulary lessons during the intervention period. The lessons were structured around the 30 target words selected for the study. These words were chosen based on their academic English frequency and relevance to the participants' language learning needs. The teaching methods included:

1-Reading Passages where participants read short passages that contained the target words, allowing them to encounter the words in context.
2- Flashcards reinforced the target words with images and definitions to aid retention.
3- Lessons incorporated interactive games such as word matching, crossword puzzles, and vocabulary quizzes to make learning engaging and to reinforce the target words through

repetition and retrieval practice.

Phase 3: Post-Test (Week 4)

In the final week, participants completed the vocabulary learning task, which included immediate recall, delayed recall (one week later), and usage in context. Additionally, they retook the AOSPAN task to measure any changes in WM capacity. In the immediate recall test, participants were asked to recall the 30 target words immediately after the intervention. This test was designed to assess their short-term retention of the vocabulary items. In the delayed recall test, one week after the immediate recall test, participants were tested again on the same vocabulary words to measure their long-term retention.

Participants were required to use the target words in sentences or short paragraphs, and they were then evaluated for accuracy and appropriateness of word usage. This test assessed their ability to apply the newly learned vocabulary in context, reflecting a deeper level of vocabulary acquisition. To evaluate any changes in WM capacity, participants in the experimental group completed the AOSPAN task again at the end of the study. This post-intervention assessment aimed to measure whether the WM training had a lasting impact on their cognitive abilities, specifically in working memory.

5 Data Analysis

Data were analyzed using SPSS software. Descriptive statistics were calculated to summarize the participants' demographic information and baseline vocabulary knowledge. Table 1 presents the descriptive analyses mean *(M)* and standard deviation *(SD)* and range *(R)* were run for AOSPAN (*M* = 150., *SD* =20), Vocabulary Pre-Test (*M* = 45.0, *SD* =5.0), placement test, and age. Independent samples t-tests were conducted to compare the vocabulary learning outcomes between the experimental and control groups. Pearson correlation coefficients were calculated to examine the relationship between WM capacity and vocabulary acquisition. Multiple regression analysis was used to determine how WM capacity predicted vocabulary learning outcomes. The performance of participants in both groups on the immediate recall, delayed recall, and usage in context tests was statistically analyzed to determine the effectiveness of the WM training on vocabulary learning. The pre-and post-intervention AOSPAN scores of the experimental group were compared to identify any significant changes in WM capacity as a result of the training (table 2). This data was also correlated with vocabulary learning outcomes to explore any potential relationship between WM capacity and vocabulary acquisition.

Table 1: Descriptive Statistics for the study’s variables

Measure	Mean	Standard Deviation	Range
WM Capacity (AOSPAN)	150	20	120-180
Vocabulary Pre-Test	45.0	5.0	30-50
Placement Test Score	85.2	6.3	70-95
Age	20.5	1.5	18-22

Table 2: Pre- and Post-Intervention AOSPAN Scores

Measure	Pre-Intervention Mean (SD)	Post-Intervention Mean (SD)
AOSPAN Score	150 (20)	165 (18)

6. Ethical Considerations

The study adhered to ethical guidelines for research involving human participants. Informed consent was obtained from all participants, and they were assured of the confidentiality and anonymity of their responses.

7. Results

The results of this study are presented in two main parts: comparing vocabulary learning outcomes between the experimental and control groups and analyzing the relationship between working memory capacity and vocabulary acquisition.

7.1 Vocabulary Learning Outcomes

The mean scores for immediate recall, delayed recall, and usage in context were calculated for both the experimental and control groups. The results are summarized in Table 3.

Table 3

Group	Immediate Recall	Delayed Recall	Usage in Context
Experimental Group	24.5 (SD=3.2)	22.8 (SD=3.5)	20.6 (SD=4.0)
Control Group	20.1 (SD=3.7)	18.4 (SD=4.1)	16.9 (SD=4.5)

Independent samples t-tests revealed significant differences between the groups in all three measures:

- Immediate recall: $t(98) = 6.42$, $p < .001$
- Delayed recall: $t(98) = 5.22$, $p < .001$
- Usage in context: $t(98) = 4.31$, $p < .001$

These results indicate that the experimental group, which received working memory training, outperformed the control group in all aspects of vocabulary learning.

7.2 Relationship Between Working Memory Capacity and Vocabulary Acquisition

Pearson correlation coefficients were calculated to examine the relationship between working memory capacity (measured by the AOSPAN task) and vocabulary learning outcomes. The results are presented in Table 4.

Measure	Immediate Recall	Delayed Recall	Usage in Context
Working Memory Capacity	.52	.48	.45

$p < .01$

The correlations indicate a moderate to strong positive relationship between working memory capacity and all three measures of vocabulary acquisition.

Multiple regression analysis was conducted to determine the extent to which working memory capacity predicted vocabulary learning outcomes. The results are summarized in Table 5.

Predictor	B	SE B	β	t	p
Working Memory Capacity	0.38	0.08	0.52	4.75	< .001

Working memory capacity was found to be a significant predictor of vocabulary acquisition ($R^2 = .27$, $F(1, 98) = 22.56$, $p < .001$), accounting for 27% of the variance in vocabulary learning outcomes.

8. Discussion

This study explores the connection between WM capacity and L2 vocabulary acquisition in a cohort of 100 Saudi EFL learners, specifically targeting first-year university students. The research identified significant correlations between WM capacity and vocabulary retention, immediate recall, and contextual usage by employing the Automated Operation Span Task (AOSPAN) to assess WM capacity and a specially designed vocabulary test. The results of this study strongly emphasize the pivotal role of WM capacity in L2 vocabulary acquisition, particularly among Saudi EFL learners. These findings align with a substantial body of cognitive and applied linguistics research, consistently highlighting WM as a crucial cognitive resource that significantly impacts language learning outcomes (Baddeley, 2003; Ellis, 2001). The data from this study reinforces existing theories and contributes new insights into the specific challenges and opportunities learners face in this context. The experimental group, which received WM training, demonstrated superior performance in immediate recall, delayed recall, and usage in context compared to the control group. Other studies have also highlighted the role of WM in language learning. For example, Ellis (2001) emphasizes that WM's role is crucial not only in vocabulary acquisition but also in the retention and processing of grammar. Similarly, Conway et al. (2003) found that WM capacity is a strong predictor of proficiency in L2 learners, particularly in tasks that require syntactic processing and complex sentence construction. These findings suggest that WM training could have broader implications for language proficiency, not just vocabulary acquisition.

Moreover, the results of this study align with the broader literature, which suggests that learners with higher WM capacity are more successful in acquiring and retaining new vocabulary. This can be attributed to their superior ability to manage the cognitive demands of language learning, including the simultaneous processing and storage of new information (Gathercole & Baddeley, 1990; Linck et al., 2014). Specifically, the experimental group, which received WM training, demonstrated significantly better performance in immediate recall, delayed recall, and context usage than the control group. These findings are consistent with previous studies showing a positive correlation between WM capacity and language learning outcomes, including vocabulary acquisition (Miyake & Friedman, 1998; Peng & Fuchs, 2019). The multiple regression analysis further highlights WM capacity as a significant predictor of vocabulary acquisition, explaining 27% of the variance. This finding is consistent with Linck et al. (2014), who reported that WM capacity significantly influences the initial acquisition and long-term vocabulary retention.

8.1 The Role of WM in Vocabulary Learning

As conceptualized in Baddeley's (2003) model, working memory plays a dual role in language learning: it serves both as a temporary storage system and a workspace where information is manipulated. In vocabulary learning, WM allows learners to hold onto new words long enough to rehearse and integrate them into their existing linguistic framework. This is particularly crucial when learning vocabulary in a foreign language, where learners must memorize new words and understand and apply them in various contexts (Ellis & Sinclair, 1996). Moreover, the findings of this study provide empirical support for the Capacity Theory of Comprehension (Just & Carpenter, 1992), which posits that individuals with greater WM capacity can allocate more cognitive resources to processing and storing language information. This theory helps explain why learners with higher WM capacity performed better in tasks that required them to recall and use new vocabulary. Their enhanced ability to manage cognitive load allows them to process and retain new words more effectively, leading to improved learning outcomes (Daneman & Carpenter, 1980).

The results of this study underscore the importance of integrating WM enhancing activities into language education curricula. By incorporating such training, educators can provide students with the cognitive tools necessary to manage the demands of L2 learning more effectively. This approach aligns with the findings of Rajan and Samaranayake (2020) and Johnson and Ransdell (2023), who advocate using digital WM training tools to support language acquisition. Moreover, as explored by Smith and Zhang (2021), understanding the neural correlates of WM further highlights the potential for cognitive interventions to facilitate language learning at a neurobiological level.

8.2 Implications for Language Teaching

The cumulative findings from this study have significant implications for language education in Saudi Arabia. The significant correlation between WM capacity and vocabulary acquisition suggests that language educators should consider incorporating WM enhancing activities into their EFL programs. Training programs that strengthen WM could be particularly beneficial for L2 learners who struggle with vocabulary acquisition. Techniques such as dual n-back tasks, digit span tasks, and memory games have been shown to improve WM capacity, and their integration into language curricula could lead to better vocabulary learning outcomes (Schneider & Shiffrin, 1977; Unsworth & Engle, 2007). These interventions could help Saudi learners manage the cognitive demands of L2 acquisition more effectively, leading to improved language outcomes.

Furthermore, the findings highlight the importance of differentiated instruction. Educators should be aware of the varying WM capacities among their students and adjust their teaching strategies accordingly. For example, learners with lower WM capacity might benefit from more repetition and reinforcement of new vocabulary. In comparison, those with higher WM capacity could be challenged with tasks that require more complex language processing (Gathercole & Alloway, 2008). This is particularly important in Saudi Arabia, where English is taught as a foreign language, and students may face additional challenges in mastering the language due to limited exposure outside the classroom.

8.3 Limitations and Future Research Directions

Despite the promising results, this study has several limitations that should be addressed in future research. Firstly, the sample was limited to first-year Saudi university students, which may affect the generalizability of the findings. Future studies should aim to replicate these results with more diverse samples, including learners from different age groups and educational backgrounds (Cowan, 2010). secondly, while the study focused on vocabulary acquisition, working memory's role in other aspects of language learning, such as grammar and reading comprehension, warrants further investigation. Exploring these areas could provide a more comprehensive understanding of how WM contributes to language proficiency (Ellis, 2001; Oberauer, 2002).

Additionally, future research could examine the long-term effects of WM training on vocabulary retention. While this study showed immediate benefits, whether these gains are sustained over time remains to be determined. Longitudinal studies that track learners' progress over several months or years could provide valuable insights into the durability of WM training effects (Miyake & Shah, 1999).

9. Conclusion

This study investigated the impact of WM capacity on L2 vocabulary acquisition among 100 Saudi EFL learners. The experimental group, which received WM training, showed significantly improved vocabulary retention, immediate recall, and usage in context compared to the control group. These findings suggest that WM training can be valuable to L2 education, particularly for vocabulary acquisition. In conclusion, this study provides robust evidence that working memory capacity is critical to L2 vocabulary acquisition among Saudi EFL learners. The findings align with previous research that has consistently highlighted the pivotal role of WM in language learning (Baddeley, 2000; Gathercole & Alloway, 2008; Linck et al., 2014). Specifically, the study demonstrates that learners with higher WM capacity acquire and retain vocabulary more effectively, enhancing their overall language proficiency.

These findings have significant implications for language teaching practices and future research in the field. The study suggests that targeted WM training, such as exercises aimed at improving the central executive and phonological loop components of WM, can substantially improve vocabulary learning outcomes. For instance, Peng and Fuchs (2019) and Alrabai (2022) have shown that WM training boosts vocabulary retention and enhances broader aspects of language proficiency, including fluency and comprehension.

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Appendices

Appendix A: Sample Vocabulary Learning Task

Below is a sample vocabulary learning task used in this study:

Vocabulary Learning Task Instructions:

1. Please read the following words and their definitions.
2. Write a sentence using each word in the context provided.

Sample Vocabulary List:

1. Aberration (n.) - A departure from what is typical or expected

Example Sentence: The sudden drop in temperature was considered an aberration for the region.

2. Benevolent (adj.) - Well-meaning and kindly

Example Sentence: The benevolent older man donated a lot of money to the orphanage.

3. Capricious (adj.) - Given to sudden and unaccountable changes of mood or behavior

Example Sentence: The capricious weather left us unsure of our plans for the day.

4. Disparage (v.) - To regard or represent as being of little worth

Example Sentence: It is not good practice to disparage others based on their opinions.

5. Efficacious (adj.) - Effective, producing the desired outcome

Example Sentence: The new treatment proved highly efficacious in reducing symptoms.

Appendix B: Sample Working Memory Test

Below is a sample working memory test used in this study:

Working Memory Capacity Test (Automated Operation Span Task - AOSPAN):

Instructions:

1. You will be presented with a series of math problems and letters.
2. Solve the math problem and remember the letter that follows.
3. At the end of the sequence, recall the letters in the order they were presented.

Sample Sequence:

1. (3 x 2) + 1 = ? [R]
2. (4 / 2) + 5 = ? [L]
3. (6 - 1) x 2 = ? [M]

Recall Phase: Recall the letters in the order they were presented: R, L, M

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