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Working Memory Capacity and Language Processing Efficiency in EFL Learners

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Abstract*:This study aims to explore how working memory capacity influences language processing efficiency among English as a Foreign Language (EFL) learners. Using a qualitative approach, data were collected through language processing tasks and semi-structured interviews that examined participants' cognitive experiences while engaging with complex linguistic input. Interpretative Phenomenological Analysis (IPA) revealed several key patterns. Learners with higher working memory capacity were able to retain information longer, process complex sentences more efficiently, and employ strategies such as chunking and contextual prediction. In contrast, learners with lower capacity experienced higher cognitive load, frequent information loss, and reliance on linear processing that hindered their ability to construct global meaning. Subjective factors such as anxiety also influenced processing efficiency, particularly for those with lower capacity. These findings indicate that language processing efficiency is shaped by an interplay of cognitive resources, processing strategies, and subjective experiences. The pedagogical implications highlight the need for instructional approaches that account for cognitive differences, enabling instruction to be more responsive to learners' individual needs.*

Keywords: *Working memory; Language Processing Effieciency; EFL*

Abstrak:Penelitian ini bertujuan untuk mengeksplorasi bagaimana kapasitas working memory memengaruhi efisiensi pemrosesan bahasa pada pembelajar English as a Foreign Language (EFL). Menggunakan pendekatan kualitatif, data dikumpulkan melalui tugas-tugas pemrosesan bahasa dan wawancara semi-terstruktur yang menggali pengalaman kognitif peserta selama berinteraksi dengan input linguistik kompleks. Analisis menggunakan Interpretative Phenomenological Analysis (IPA) mengungkap beberapa pola penting. Peserta dengan kapasitas working memory tinggi mampu mempertahankan informasi lebih lama, memproses kalimat kompleks dengan lebih efisien, dan menerapkan strategi seperti chunking serta prediksi konteks. Sebaliknya, peserta dengan kapasitas lebih rendah menunjukkan beban kognitif tinggi, kehilangan informasi, serta ketergantungan pada pemrosesan linear yang menghambat pemahaman global. Faktor subjektif seperti kecemasan juga memengaruhi efisiensi pemrosesan, terutama bagi peserta dengan kapasitas rendah. Temuan ini menegaskan bahwa efisiensi pemrosesan bahasa dipengaruhi oleh interaksi antara kapasitas kognitif, strategi pemrosesan, dan pengalaman subjektif. Implikasi pedagogisnya menunjukkan perlunya pendekatan pengajaran yang mempertimbangkan variasi kapasitas kognitif agar pembelajaran lebih adaptif terhadap kebutuhan pembelajar.

Kata kunci: Working memory; Efisiensi Pemrosesan Bahasa; EFL

1. INTRODUCTION

In the field of second language acquisition (Saville-Troike, 2012), cognitive factors have increasingly been recognized as crucial determinants of learners' success in understanding, processing, and producing a foreign language (Huang & Rawian, 2025). Among these factors, Working Memory Capacity (WMC) has emerged as one of the most influential cognitive constructs linked to language performance. Working memory refers to the cognitive system responsible for the temporary storage and manipulation of information during complex tasks

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such as comprehension, problem-solving, and reasoning (Li, 2023). Recent research from Flores-Salgado & Gutiérrez-Koyoc (2024) demonstrates that WMC supports the ability to hold linguistic input in mind long enough for meaningful processing to occur, making it pivotal for learners navigating the challenges of an additional language. As English continues to function as a global lingua franca, understanding how WMC contributes to Language Processing Efficiency (LPE) in EFL contexts remains an important area of investigation.

For EFL learners, processing efficiency encompasses a broad range of abilities, including rapid lexical access, accurate syntactic parsing, and efficient integration of semantic information. Unlike native speakers who acquire these skills implicitly during childhood, EFL learners face the dual challenge of limited exposure and reliance on conscious learning strategies (Malik et al., 2025). This often results in slower processing speed, greater cognitive load, and reduced automaticity in comprehension and production. Scholars suggest that learners with higher WMC are better equipped to manage these demands because they can maintain larger amounts of linguistic information while simultaneously manipulating it to interpret meaning. Conversely, learners with lower WMC may struggle to integrate incoming information, especially when faced with complex syntax, unfamiliar vocabulary, or time-pressured tasks (Mota, 2003). Thus, exploring the link between WMC and LPE is essential for understanding why some learners progress more rapidly than others despite similar instructional conditions.

The role of working memory in language learning has been widely discussed within cognitive psychology and psycholinguistics (Steinberg & Sciarini, 2006), particularly through Baddeley's multicomponent model. According to this model, the phonological loop, visuospatial sketchpad, central executive, and episodic buffer work together to support real-time language processing. The phonological loop, for instance, is responsible for temporarily storing verbal and auditory information, which is crucial for listening comprehension and vocabulary retention (Martín-Loeches et al., 1997). The central executive, on the other hand, allocates attentional resources and coordinates cognitive activities required for syntactic interpretation and discourse-level understanding. These components allow learners to manage linguistic input, suppress irrelevant information, and maintain attention during communication. However, the efficiency of these processes varies among individuals, leading to observable differences in language proficiency and performance.

In EFL settings, working memory plays an even more significant role because learners often encounter linguistic input that exceeds their automatic processing capacity (Demir, 2021). For example, when reading academic texts or listening to dense spoken passages, learners must

juggle multiple cognitive operations simultaneously identifying lexical items, mapping syntactic structures, and constructing overall meaning all while compensating for unfamiliar vocabulary or cultural references. Learners with higher WMC can typically allocate resources more flexibly, allowing them to decode complex structures more efficiently and with less cognitive strain. In contrast, learners with limited WMC may experience cognitive overload; they may lose track of sentence constituents, misunderstand key information, or fail to integrate new information into their developing mental representation. These challenges highlight the importance of examining how WMC supports the efficiency of linguistic processing in different modalities such as listening, reading, speaking, and writing.

Research in SLA has attempted to quantify this relationship through a variety of experimental tasks(Fiebach, 1998). For instance, studies have shown that WMC predicts learners' ability to parse garden-path sentences, comprehend long or syntactically complex utterances, and perform real-time language tasks such as shadowing or self-paced reading. Other studies reveal that learners with higher WMC demonstrate faster lexical retrieval, greater fluency in speaking, and better performance in tasks involving dual processing demands (Mota, 2003).Nevertheless, findings across studies are not always consistent, in part because of variations in task design, measurement instruments, and learner backgrounds. This inconsistency underscores the need for more context-specific research, particularly in EFL environments where learners' exposure, proficiency, and instructional practices differ widely from ESL or immersion contexts.

Furthermore, the concept of Language Processing Efficiency (LPE) itself encompasses multidimensional aspects of linguistic performance. Efficiency does not solely refer to speed, but also accuracy, automaticity, and cognitive economy (Xu & Futrell, 2025). For example, a learner who reads quickly. but misinterprets key details cannot be considered an efficient processor. Similarly, a learner who produces accurate sentences but requires substantial planning time may display limited processing efficiency. Thus, the interplay between WMC and LPE is likely complex, involving interactions between cognitive capacity, linguistic knowledge, attention control, and the degree of automatization achieved through practice (Mota, 2003).This multidimensional perspective suggests that WMC may support some components of processing more strongly than others, depending on task demands and learner proficiency.

Another important consideration is that working memory is not a static trait but can be influenced by factors such as anxiety, fatigue, motivation, and task complexity. EFL learners

often experience heightened cognitive stress during tasks requiring real-time communication, which may temporarily reduce their functional working memory capacity. Similarly, learners encountering unfamiliar discourse types or academic vocabulary may experience increased processing load, leading to slower or less accurate performance. Understanding these situational influences is essential for interpreting the relationship between WMC and LPE and for considering pedagogical implications.

Given the centrality of working memory to cognitive functioning and language processing, a deeper understanding of how WMC shapes EFL learners' processing efficiency has significant pedagogical value. Educators can benefit from recognizing that learners differ in their cognitive capacities and that instructional design should account for these differences. Strategies such as scaffolding, chunking information, reducing unnecessary cognitive load, and providing repeated exposure can help learners with lower WMC improve their processing efficiency. At the same time, tasks that encourage automatization—such as timed reading, fluency training, and rapid lexical retrieval exercises—may help strengthen learners' processing abilities regardless of cognitive capacity.

In light of these considerations, the present study (or article) aims to explore the intricate relationship between Working Memory Capacity and Language Processing Efficiency among EFL learners. By examining how cognitive resources support the demands of real-time linguistic processing, this article seeks to contribute to a more comprehensive understanding of individual differences in SLA and to offer insights that may inform instructional practices, assessment design, and curriculum development in EFL settings.

2. RESEARCH METHOD

This study employed a qualitative research approach to explore how working memory capacity influences language processing efficiency among EFL learners. A qualitative design was chosen because the aim of the study was to gain an in-depth understanding of learners' cognitive experiences, their strategies in handling linguistic information, and the subjective challenges they face during language processing (Rustamana et al., 2024). Rather than focusing on numerical relationships, this approach allowed the researcher to capture rich descriptions and interpret participants' meanings and perspectives.

2.1. Data Collection

Data were collected through two primary techniques: task-based elicitation and semi-structured interviews. First, participants completed several language processing tasks, including reading complex sentences, recalling linguistic information, and describing how they

managed cognitive load while completing the tasks. These tasks were designed to naturally reveal differences in working memory capacity and individual processing styles. Following the tasks, semi-structured interviews were conducted to explore participants' experiences more deeply. The interview questions focused on how they maintained information while reading, how they approached complex sentence structures, and what factors made processing easier or more challenging. All interviews were audio-recorded and transcribed verbatim to ensure accuracy in the analysis phase.

2.2. Data Analysis

Data were analyzed using Interpretative Phenomenological Analysis (IPA). The analysis began with repeated readings of each transcript to understand participants' individual experiences. The researcher then identified meaning units related to working memory, processing strategies, attention management, and perceived linguistic difficulty.

These meaning units were coded and organized into emerging themes. Themes were compared across participants to identify shared patterns as well as unique variations in how they experienced cognitive load and processing demands. The interpretation of these themes provided insights into the ways working memory capacity shapes the efficiency of language processing among EFL learners.

3. FINDING AND DISCUSSION

The findings of this study reveal several key patterns that demonstrate how working memory capacity influences language processing efficiency among EFL learners. Through the task-based elicitation activities, participants with higher working memory capacity were able to maintain and manipulate linguistic information more effectively, particularly when dealing with complex sentence structures. They showed the ability to hold multiple clauses in mind, integrate meaning across segments, and recall information accurately during follow-up questions. Their descriptions during interviews indicated that they could regulate attention, avoid unnecessary distractions, and strategically break down difficult passages into manageable units.

In contrast, participants with lower working memory capacity experienced noticeable cognitive strain during the processing tasks. Many of them reported losing track of sentence components, especially when sentences contained embedded clauses or unfamiliar vocabulary. During recall tasks, they tended to omit details or mix information, suggesting difficulty in simultaneously storing and processing linguistic input. Several participants mentioned that they

needed to reread or mentally repeat words to keep information active, which slowed their processing and increased overall cognitive load.

Across participants, another significant pattern emerged related to the strategies they employed. Those with higher working memory capacity tended to apply more flexible strategies, such as chunking information, predicting meaning based on context, and using syntactic cues to resolve ambiguity. Meanwhile, participants with lower capacity relied heavily on word-by-word processing and often focused excessively on unknown vocabulary, which disrupted the construction of global meaning. These differences in strategy use contributed to variations in processing efficiency during the tasks.

A final pattern revealed that emotional and situational factors also played a role. Participants with lower working memory capacity often reported experiencing performance pressure, which further reduced their ability to concentrate and maintain information. On the other hand, participants with higher capacity appeared less affected by task difficulty and reported greater confidence in approaching complex texts. These findings highlight the intricate relationship between cognitive capacity, strategy use, and subjective experiences in shaping overall language processing efficiency.

4.1. Working Memory as a Foundation for Linguistic Processing

The findings demonstrate that working memory capacity serves as a foundational cognitive resource that enables learners to manage the demands of real-time language processing. Participants with higher working memory capacity exhibited greater flexibility in handling linguistic information, confirming the notion that working memory supports essential processes such as lexical access, syntactic parsing, and meaning integration. These learners were able to sustain attention, retain multiple pieces of information, and coordinate their understanding across sentence segments, which allowed them to process complex structures more efficiently.

Furthermore, their ability to maintain information while manipulating it reflects the function of the verbal storage and attentional control components of working memory. This aligns with previous viewpoints in SLA that suggest learners require sufficient cognitive resources to manage both the temporary storage and the processing aspects of language tasks. The findings reinforce that working memory serves not just as storage but as an active workspace that supports comprehension and meaning construction.

4.2. Strategy Use and Cognitive Load Management

A second key theme relates to the variation in strategy use between learners with different working memory capacities. Participants with higher capacity applied strategies such as

chunking, contextual prediction, and selective attention, which contributed to smoother and more efficient processing. These strategies enabled them to reduce cognitive load and focus their attention on linguistic components that were essential for comprehension. As a result, they experienced fewer disruptions and maintained coherence across entire texts.

On the other hand, participants with lower working memory capacity tended to engage in linear and rigid processing strategies. Their reliance on word-by-word decoding and their frequent focus on unfamiliar vocabulary increased their cognitive load and fragmented their understanding. This tendency limited their ability to integrate information and hindered the development of efficient processing patterns. The findings suggest that working memory not only shapes learners' capacity to process information but also influences the kind of strategies they choose or rely on during difficult tasks.

4.3. The Role of Subjective Experience in Processing Efficiency

The final theme concerns the influence of emotional and situational experiences on processing efficiency. Participants who reported anxiety, confusion, or pressure tended to experience greater difficulty maintaining information, regardless of the linguistic complexity of the task. This was especially evident among learners with lower working memory capacity, whose cognitive resources were more easily overwhelmed by psychological factors. Their reduced confidence and heightened sensitivity to errors appeared to further impair their processing, creating a cycle of cognitive strain.

In contrast, learners with higher working memory capacity showed greater resilience toward task difficulty. They approached tasks with more confidence and showed less susceptibility to emotional interference. Their stable cognitive control allowed them to remain focused even when encountering challenging linguistic input. These findings highlight that processing efficiency is not solely a cognitive matter but also involves affective and situational dimensions that interact with working memory.

4. CONCLUSION

This study demonstrates that working memory capacity plays a significant role in shaping language processing efficiency among EFL learners. Participants with higher working memory capacity were able to retain and manipulate linguistic information more effectively, employ flexible cognitive strategies, and maintain greater resilience when confronted with demanding tasks. In contrast, those with lower capacity experienced higher cognitive load, difficulty

maintaining information, and reliance on limited processing strategies. Differences in subjective experiences, such as anxiety or pressure, further illuminated the extent to which working memory influences real-time language processing.

Overall, the findings confirm that language processing efficiency depends not only on linguistic knowledge but also on the cognitive resources learners possess. The pedagogical implications highlight the need for instructional approaches that consider cognitive differences, such as reducing unnecessary cognitive load, teaching chunking strategies, and fostering more automatic processing skills. By understanding the relationship between working memory and language processing, educators can design more responsive and individualized learning experiences.

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