The role of Working Memory in enhancing listening comprehension for pre-intermediate Vietnamese EFL learners

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ABSTRACT

In recent years, there has been a significant surge in interest regarding the interplay between Second Language (L2) Acquisition and Working Memory (WM). However, the impact of WM on L2 Listening Comprehension (LC) remains a subject of ongoing debate, as evidenced by inconsistent results from various empirical studies. Consequently, this study aims to explore the relationship between LC and WM capacity among novice English as a Foreign Language (EFL) learners. It also seeks to determine how the presentation mode of WM assessments, whether visual or auditory, affects L2 listening skills. The study collected data from 65 Vietnamese college beginners who participated in the DIALANG listening test and undertook memory tests, including both visual and auditory versions of the forward and backward Digit Span Tasks. Contrary to our expectations, the analysis revealed only a weak positive correlation between LC and WM. This tenuous connection is likely influenced by the participants' L2 proficiency, individual characteristics, and the nature of the WM measures used. These findings add to the body of inconsistent evidence regarding the LC-WM relationship. The study discusses several pedagogical implications and acknowledges its limitations based on these results.

1. Introduction

According to Bozorgian (2012), listening skills are foundational to language acquisition, highlighting their integral connection not only to the other primary language skills but also to the overall proficiency of EFL learners. Listening involves complex, real-time processing of information that includes prosody and is inherently fleeting. These characteristics can pose significant challenges for non-native speakers who must simultaneously and instantaneously process multiple streams of information (Lynch & Mendelsohn, 2010). Furthermore, the degree to which aural comprehension presents difficulties for L2 learners is also shaped by various factors, including individual differences like memory capacity (Vandergrift & Baker, 2015).

In Wright's analysis (2019), WM plays a vital role in L2 acquisition as it aids learners in retaining and processing information under the pressures of live listening situations. However, the limitations in WM capacity for storage and processing can frequently lead to comprehension failures (Baddeley, 2018). Consequently, recent research has sought to better understand the interplay between LC and WM, aiming to enhance pedagogical strategies that support improved listening skills. Studies indicate that learners with greater WM capacity tend to exhibit superior listening abilities (Fay & Buchweitz, 2014; Gu & Wang, 2007; Namaziandost et al., 2018;

Satori, 2012, among others). These studies suggest that WM influences both the duration for which short-term memory retains information and the efficiency with which it retrieves existing data from long-term memory.

Contrarily, some researchers argue that individual variations in WM capacity do not necessarily correlate with differences in LC achievements (Andringa et al., 2012; Brunfaut & Révész, 2015). They propose that WM capacity is an independent cognitive function, and the effectiveness of WM is contingent upon the specific tasks at hand and the listener's overall language proficiency. Overall, the debate continues within the field concerning the role of WM in listening and whether its functionality is affected independently of the type of listening material and prior learning experiences (Wright, 2019). What is more, the choice of the presentation mode of WM tasks is also controversial. Auditory and visual modalities are argued to have their own pros and cons in information processing (Jensen, 1971; Olsthoorn et al., 2014; Penny, 1989). This ongoing discussion underscores the complexity of the relationship between WM and LC and highlights the dynamic nature of language learning research.

In the Vietnamese context, recent research has increasingly focused on WM in foreign language acquisition. Phan (2021) uncovered that short-term memory affected the acquisition of English vocabulary but was not significantly correlated with the acquisition of English grammar. In the meantime, Duong and Le (2022) discovered that WM appeared to be good predictors of EFL learners' lexical complexity and fluency. Given the pivotal role of WM in L2 learning and ongoing discussion among different viewpoints in the existing literature, there is a compelling need for further research-based validation. Therefore, this study seeks to examine further the connection between LC and WM, particularly in the case of beginning EFL learners. At the same time, it aims to identify the role of presentation modes in WM testing. Guided by these goals, the study addresses the following two research questions:

1. Is there any correlation between LC and WM?

2. Is there any difference between auditory and visual digit-span performances regarding their relationship with LC?

2. Literature review

2.1. Understanding the process of Listening Comprehension (LC)

The literature review reveals that the concept of LC has been defined variously by researchers. For instance, Buck (2001) characterizes LC as the outcome of interactions among numerous information sources, including acoustic inputs, various types of linguistic knowledge, contextual details, and general world knowledge. Buck (2001) notes that listeners selectively use the information they deem relevant to interpret the speaker's message, requiring both top-down and bottom-up processing. Anderson and Lynch (2003) outline a more procedural view of LC, describing it as a series of steps that include identifying and recognizing continuous speech streams, understanding syntactic structures, and employing linguistic knowledge to construct meaning. Expanding on this, Lynch and Mendelson (2010) describe listening as a dynamic process wherein listeners interpret spoken language by leveraging their prior knowledge and contextual cues.

Rost (2016) offers another perspective, defining LC as a cognitive activity where listeners activate and adapt related concepts to achieve comprehension. He emphasizes the need for coordination among various types of knowledge to enable efficient and continuous activation, ranging from partial to complete understanding. Despite the variations in these definitions, a

common thread is evident: listening is fundamentally an individual and internalized activity. The interpretation of spoken language varies based on the listener's ability to apply their unique knowledge reservoir within specific contexts. This personal processing is inherently selective, and influenced by varying levels of attention, which in turn affects the construction of meaning.

2.2. The models of Working Memory

Working Memory (WM) has attracted considerable attention from researchers in the field of L2 learning due to its significant role and impact on the process of learning languages (Juffs & Harrington, 2011; Wen, 2012). Jackson (2016) identifies several key models frequently cited in L2 research, including Baddeley's multicomponent model (2000), Cowan's embedded-processes model (2005), and Engle's resource-dependent inhibition model (2010). These models primarily vary in terms of the complex architecture of WM, the role of the Central Executive, and the definition of their capacity constraints. Notably, Baddeley's model (2000) is distinguished by its detailed description of individual subsystems and their specific functions. It includes four main components: the Phonological Loop and the Visuo-Spatial Sketchpad, responsible for processing verbal and spatial information, respectively; the Central Executive, which manages and coordinates these subsystems; and the Episodic Buffer, which holds a variety of information temporarily. Particularly, the Phonological Loop, or Phonological Working Memory (PWM), along with the Central Executive (EWM), are deemed essential for acquiring language (Juffs & Harrington, 2011).

2.3. Evaluations of Working Memory

Two main types of tasks are utilized to assess WM capacity: simple tasks for PWM evaluation and complex tasks for EWM assessment. Simple tasks, like the Forward Digit Span Task (DST) and the Word Span Task (WST), primarily test the memory storage function by presenting participants with sequences of digits or words. For instance, the Forward DST requires participants to memorize and reproduce sequences of random numbers as they were shown (Harrington & Sawyer, 1992). The WST, created by Gathercole (2006), includes exercises such as the Non-Word Recognition or Repetition Span Task, where participants repeat sequences of made-up or nonsensical words.

Complex tasks, in contrast, evaluate both the storage and processing functions of memory. These tasks include the Reading/Listening Span Task, the Operation Span Task (OST), and the Backward Digit Span Task. Introduced by Daneman and Carpenter in 1980, the Reading Span Task involves reading sentences aloud and remembering the last word of each sentence for later recall. Similarly, the Listening Span Task requires participants to listen to sentences and remember the final words. The Operation Span Task, proposed by Turner and Engle (1989), combines solving math operations with memorizing words linked to each calculation. Later, Kormos and Sáfár (2008) proposed the Backward DST, which tests both the storage and processing functions of WM. This task mirrors the Forward DST, except participants recall numbers in reverse order. Overall, complex WM tasks impose dual demands on participants, thereby testing more than the passive storage capabilities evaluated in simpler WM tasks (Miyake, 2001).

2.4. Related studies

Studies have shown the critical importance of WM in mastering foreign languages (Daneman & Merikle, 1996). A comprehensive meta-analysis by Linck et al. (2014), which reviewed 79 studies and involved 3,707 participants, found a strong positive relationship

between WM and both language processing and proficiency in a second language (L2). This correlation extends to various L2 skills such as speech production (Finardi & Silveira, 2011), oral fluency (Rezai & Okhovat, 2016), writing ability (Satori, 2021), and reading comprehension (Adams & Shahnazari-Dorcheh, 2014). Despite these findings, there is a notable scarcity of empirical research focusing on WM in L2 listening scenarios.

The research examining the impact of WM capacity on L2 listening is generally categorized into two methodologies: one that employs complex memory tasks and another that uses a mix of simple and complex tasks. In the first method, studies typically assess EWM, which involves both storing and processing information. For example, a study by Gu and Wang (2007) on EFL learners in China utilized listening span tests in both their first and second languages, demonstrating that higher WM capacity leads to better listening comprehension. Similarly, research by Namaziandost et al. (2018) found that WM is a significant predictor of listening comprehension among Iranian EFL learners.

Conversely, other researchers have incorporated both simple and complex tasks to explore WM's impact on LC. Satori (2012) found significant correlations, particularly among lower proficiency Japanese EFL students using both digit span and listening span tasks, contrasting with findings by Zafarghandi and Bahrpeyma (2017), who noted a stronger WM influence on LC at higher proficiency levels. The difference in listening test formats (IELTS vs. TOIEC) used in these studies may explain the discrepancies in their findings.

Further contrasting these results, Andringa et al. (2012) observed a negligible correlation between WM and LC among non-native listeners, suggesting that WM capacity is an independent cognitive function and not a determinant of superior listening skills. Similarly, Brunfaut and Révész (2015) found no correlation in their study, suggesting that the specific nature of the listening task and text might influence these outcomes.

The role of PWM and EWM in L2 learning is also seen as variable, depending on the learner's language knowledge (Kormos and Sáfár, 2008; Martin & Ellis, 2012; Sato, 2019). For instance, Kormos and Sáfár (2008) found differing impacts of PWM and EWM on L2 acquisition, with the latter showing a stronger correlation with overall language competence at higher proficiency levels.

Regarding the presentation mode of WM tasks, the debate continues. Jensen (1971) advocated for the superiority of auditory memory, whereas Penney (1989) argued for distinct processing streams for auditory and visual modalities. More recent studies suggest that the choice between visual and auditory presentation in memory tasks should consider the specific requirements of the language and cognitive strategies of the learners (Olsthoorn et al., 2014).

In summary, while the correlation between LC and WM is established, it remains nuanced and subject to the intricacies of task design and language proficiency. Furthermore, the roles of PWM and EWM in L2 acquisition, as well as the optimal modality for presenting memory tasks, continue to be areas ripe for further investigation. The forthcoming study aims to explore these dynamics among novice EFL learners in Vietnam, examining the interplay between LC, PWM, EWM, and task presentation models.

3. Methods

3.1. Participants

The study involved 65 Vietnamese non-English major EFL learners (29 females and 36 males) from a private language institute in Ho Chi Minh City, Vietnam. These participants were

second-year university students, aged between 19 and 21, originating from various parts of Vietnam. They were enrolled in various academic programs, including automotive engineering, accounting, mechanics, marketing, and information technology, and had been studying English for eight years. None of the students had previously taken any standardized English proficiency tests. The participants first completed the DIALANG test to gauge their English skills and to check the uniformity of their listening comprehension abilities. The results categorized them at Level A1, which is the introductory level according to the Common European Framework of Reference for Languages (CEFR). They later engaged in L2 forward and backward digit span tasks, delivered both visually and acoustically, to measure their memory capacity. The data collected from these assessments were analyzed using the SPSS version 23.0.

3.2. Research instruments

3.2.1. The listening test

The DIALANG test is an online, cost-free diagnostic tool for assessing foreign language skills, which evaluates five areas of language knowledge: reading, listening, writing, grammar, and vocabulary. The choice of the DIALANG test for assessing language proficiency is attributed to its free access and non-high-stakes nature. Additionally, its proven validity and reliability allow students to benchmark their performance against a recognized standard of skill (Alderson, 2005). The test was conducted in a language laboratory with Internet access. Before beginning, students received instructions on the test's structure and operation. Although there was no set time limit, most participants finished all sections within two hours. In the listening component, the test examined three skills: detailed listening, main idea identification, and inference-making. It included 30 items featuring both dialogues and monologues and offered three types of response tasks: multiple-choice, short-answer, and gap-fill exercises (either drop-down or text-entry). Each audio clip was played only once, with durations ranging from 30 to 60 seconds.

3.2.2. Tests of Working Memory capacity

The memory assessments utilized in this study were the Digit Span Tasks (DSTs) sourced from Inquisit Scripts, accessible via https://www.millisecond.com. The Forward DSTs were used for measuring PWM and EWM was evaluated by the Backward DSTs.

These computerized tasks from the Millisecond collection encompass both visual and auditory digit span tasks, executed in forward and backward sequences. Participants were briefed on the operation of the tests and engaged in practice trials beforehand. During the test, they either viewed or listened to sequences of digits increasing in length and were required to reproduce these sequences either forward or backward by selecting digits from a circular array using a mouse. The starting sequence length was three digits for forward tasks and two digits for backward tasks. Based on their performance, participants either advanced to a more challenging level or repeated the current one. The testing concluded after 14 trials, with each task taking approximately 15 minutes, culminating in a total duration of one hour for the entire memory assessment.

The tests were conducted in the participants' L2, influenced by research (Gu & Wang, 2007; Karimi & Naghdivand, 2017), indicating a stronger correlation between L2 memory and L2 listening comprehension compared to that between L1 memory and L2 listening.

4. Results and discussion

4.1. A positive connection was observed between WM and LC

Pearson Correlation analyses were conducted to examine the relationship between LC scores and WM scores. Table 1 presents the correlations between digit span scores and LC scores. The results primarily indicate a positive, albeit non-significant, correlation between students' listening performance and both auditory forward and backward digit span scores ($r = .169$, $p > .05$ and $r = .014$, $p > .05$, respectively). Conversely, when DSTs were presented visually, a weak positive correlation emerged between visual forward digit span scores and LC ($r = .249$, $p < .05$). Similarly, visual backward digit span scores showed a weak positive association with listening ($r = .130$, $p < .05$). Collectively, these correlation analyses suggest a generally weak relationship between students' LC performance and their WM capacities.

This observation aligns with prior research indicating an absence of significant correlations between LC and WM measures (Andringa et al., 2012; Brunfaut & Révész, 2015), supporting the view that WM functions independently of LC. Andringa et al. (2012) suggest that WM might reflect language experience among L2 learners, implying that L2 memory may not significantly enhance listening skills in the initial stages of language learning. Furthermore, Brunfaut and Révész (2015) attribute this lack of significant correlation to the nature of the listening tasks used, particularly those less reliant on WM.

Table 1

Correlations between Listening Comprehension and digit span tasks (N = 65)

	PWM	**EWM**	**PWM**	**EWM**
	Visual Forward	Visual Backward	Auditory Forward	Auditory Backward
LC	.249*	.130	.169	0.014

Note. *. Correlation is significant at the 0.05 level (2-tailed)
Source. Data analysis result of the research

The findings also diverge from several previous studies that identified a statistically significant relationship between listening comprehension and Working Memory (WM) (e.g., Fay & Buchweitz, 2014; Gu & Wang, 2007; Namaziandost et al., 2018; Satori, 2021). A potential explanation for this discrepancy could be rooted in the design of the memory tests, the nature of the listening tests, and the personal affective factors of the listeners. An examination of the memory tests employed in earlier research reveals a lack of consensus on their administration. Some researchers (e.g., Fay & Buchweitz, 2014; Kormos & Sáfár, 2008) conducted memory tests in the first language (L1) to eliminate confounding effects from second language (L2) proficiency on WM test scores. In contrast, others (e.g., Gu & Wang, 2007; Karimi & Naghdivand, 2017; Namaziandost et al., 2018; Satori, 2021) used a modified listening span task in both L1 and L2, concluding that WM in L2 has a more significant impact on L2 listening comprehension. These contradictory findings suggest that measuring WM in different languages can lead to variations in results.

Regarding listening measures, Brunfaut and Révész (2015) suggest that the characteristics of the task may contribute to the insignificant relationship between WM and LC. In this study, the DIALANG listening test, which targets both local and global listening aspects, features audio clips and questions that are relatively less demanding on WM. It appears that the more a task requires WM, the stronger the observed correlation (e.g., Gu & Wang, 2007);

conversely, tasks that demand less from WM tend to show weaker correlations (e.g., Brunfaut & Révész, 2015). This aligns with Just and Carpenter's (1992) assertion that when tasks impose extrinsic loads or involve more complex linguistic structures, the limitations of memory capacity become more pronounced.

Another potential reason for the lack of a substantial correlation between WM and LC could be related to personal affective factors. Due to the complexity of the listening process, students may experience varying levels of anxiety, which can adversely affect their performance (Namaziandost et al., 2018). Internal factors contributing to this anxiety may include confusion, lack of concentration, and diminished self-confidence (Noro, 2005). These types of listening-related stress are often linked with instructional methods, process-related aspects, and the characteristics of the input (Vogely, 1998). Although the listening test in the current study was not high-stakes, learners likely felt stressed due to low confidence in their English listening skills and concerns about the difficulty of the test (Chang, 2008; Kimura, 2008; Zheng & Cheng, 2018). This phenomenon is understandable, as listening can provoke significant anxiety, a situation over which learners feel they have little control, potentially impacting their test performances.

In relation to the roles of EWM and PWM in L2 listening, Table 1 reveals weak positive correlations between listening and both EWM and PWM in both presentation modes. This suggests that the phonological loop and general working memory have limited influence on LC at the beginner stage of L2 learning, contradicting Kormos and Sáfár's (2008) conclusion that EWM and PWM play crucial roles in L2 acquisition. A possible explanation for this discrepancy might be the language used in the memory tests, as previously discussed. For low-proficiency L2 learners, L1 PWM may be associated with L1 EWM (e.g., Kormos & Sáfár, 2008; Sato, 2019), but this may not hold true for L2 WM. In other words, proficiency in the language in which the task is administered (L1 or L2) can affect performance on WM tasks (Mitchell et al., 2015).

4.2. Visual DSTs are preferable to auditory DSTs for assessing WM in EFL learners

Descriptive statistics for all WM measures indicate that students performed better on the visual forward and backward digit span tasks (mean scores of 9.00 and 8.48, respectively) than on the auditory forward and backward digit span tasks (mean scores of 6.38 and 6.54, respectively). Notably, only the visual forward digit span tasks showed a slight correlation with LC ($r = .249$, $p < .05$), suggesting a minimal but statistically significant relationship between PWM and LC. This finding aligns with previous research (e.g., Bigelow & Poremba, 2014; Lindner et al., 2009), which suggests that auditory attention may not be as effective as visual retention. Furthermore, the results from Olsthoorn et al.'s study (2014) support our findings by demonstrating that L2 WM scores in visual mode were not significantly different from those in L1, advocating for the use of visual rather than auditory digit span tasks in testing L2 learners.

However, these findings diverge from earlier reports, such as those by Jensen (1971), which noted superior recall for auditory over visual presentations. A possible explanation for this discrepancy might be the characteristics of the tasks used in the memory tests, which could favor one modality over the other (Mascio, 2017). Additionally, the challenge of accessing and retrieving acoustically presented information in a second language could be greater due to learners' limited L2 phonological knowledge, making visual tasks more accessible (Olsthoorn et al., 2014).

Nevertheless, it is important to acknowledge that the correlation observed in this study is not robust enough to justify broad generalizations. Therefore, the preference for visual over auditory presentation modes in measuring WM should be interpreted with caution. This conclusion

might be particularly relevant to novice Vietnamese EFL learners when digit span tasks are presented in L2, not L1. Indeed, the debate over the superiority of visual or auditory memory cannot be definitively resolved across all contexts and subject types (Jensen, 1971). Further research is necessary to explore the interaction more thoroughly between L2 listening and WM.

5. Conclusion

The study has contributed to understanding the relationship between LC and WM among Vietnamese EFL beginners, revealing a weak positive association between LC and both PWM and EWM. This finding aligns with, yet also diverges from, previous research, highlighting some inconsistencies and gaps in the existing literature, such as the variability in test methods and participant differences, which may influence WM effects (Mizera, 2006). Furthermore, the impact of PWM or EWM on L2 listening is found to be task-specific (Wright, 2015).

Despite the weak connection identified between LC and WM in the initial stages of L2 learning, the study offers some significant pedagogical implications. The observed minimal relationship between learners' WM and their language skills may stem from the learners' low language proficiency in the target language, which hampers their ability to process unfamiliar information effectively. This problem may be explained by the fact that learners struggle with the phonological aspects of that new language, or English in this case. To enhance their listening skills, it is crucial to provide L2 learners with ample phonological training and tasks that strengthen their abilities to discern and remember sounds L2 rather than L1. This training should be accompanied by tasks designed to enhance their WM capacity in L2 contexts.

Additionally, listening materials should be tailored to beginners to suit their current language levels. Teachers should consider the cognitive load involved in L2 processing. Overloading these tasks can lead to anxiety, potentially impacting comprehension. Therefore, it is important to adjust the complexity of the listening tasks to ensure they are challenging yet manageable. In this way, teachers can promote a positive learning experience without overwhelming the learners. This approach helps in gradually building their linguistic as well as cognitive skills, resulting in the improvement of their overall language proficiency over time.

This study has some limitations, including its small sample size, which renders the results provisional and necessitates further validation with a larger cohort. The participants' limited language experience, due to their beginner level, may also skew the observed correlations between listening and memory capacity in L2. Future research should consider including participants with intermediate or advanced language skills. Moreover, this study exclusively used L2 DSTs to measure memory capacity. A more comprehensive approach that includes L1 digit span tasks and additional tasks such as the Listening Span Task and backward digit span task might yield deeper insights into the relationship between WM and LC. Finally, given the correlational nature of this study, it would be informative to explore whether any causal relationships between LC and WM can be established through intervention studies.

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