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The Role of Working Memory in Second Language Sentence Processing: The Case of English Relative Clause Comprehension among Korean Learners*

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ABSTRACT

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The present study investigates the relationship between working memory (WM) and second language (L2) sentence processing, specifically focusing on the comprehension of English relative clauses (RCs). While previous studies have observed that object RCs typically impose greater cognitive demands than subject RCs, the role of WM in mediating this difficulty remains unclear. To investigate this relationship, we employed a self-paced reading method to assess reading times and comprehension accuracy among advanced Korean learners of English. WM was measured using both digit span and reading span tasks. Results revealed that higher WM was associated with faster reading speeds and better comprehension across RC types. Although object RCs took longer to process, there was a lack of a significant interaction between WM and RC types. Peak reading times were observed at region 4 (corresponding to the object position in subject RCs and the main verb position in object RCs). This pattern diverges from previous research findings and suggests that advanced learners engage in proactive resource allocation. These results emphasize WM's role in L2 sentence processing and indicate processing strategies for improving learners' management of complex syntactic structures.

KEYWORDS

sentence processing, working memory, relative clauses, self-paced reading, reading times, individual differences, Korean learners of English

1. Introduction

Current work in second language (L2) processing highlights how learner-specific cognitive resources shape comprehension patterns. Among the factors that vary across learners, working memory (WM) and overall L2 proficiency are consistently implicated in real-time sentence interpretation (Linck et al. 2014, Skehan 1998). WM—the capacity to maintain and manipulate information while processing input—has been linked to faster reading times and more accurate interpretations for syntactically challenging materials in both first language (L1) and L2 contexts (Juffs and Harrington 2011, Just et al. 1982, King and Just 1991). Relative clauses (RCs) serve as a well-explored testing ground for examining WM effects, as they contrast structurally simpler subject RCs (SRCs) with more cognitively demanding object RCs (ORCs). Memory-based, meaning-based, and frequency-based accounts all predict a processing advantage for SRCs, while acknowledging that WM constraints exacerbate the processing difficulties associated with ORCs (Gordon and Lowder 2012). Dependency-based models such as the Dependency Locality Theory (DLT) attribute the cost to longer integration distances in ORCs (Gibson 2000).

For Korean learners of English, processing challenges are further intensified by cross-linguistic differences. Korean's head-final structure and SOV word order contrasts with English, requiring learners to maintain unresolved dependencies in memory as they process English head-initial RCs. Despite these typological differences, research has consistently demonstrated SRC advantages in L1 Korean (Kwon et al. 2010), though evidence on how WM modulates English RC processing in Korean learners is limited. Recent findings suggest that WM capacity correlates with more efficient resolution of globally ambiguous RCs in this population (Cho and Song 2023), but the extent of these effects across clearly disambiguated SRC-ORC pairs requires further examination. The current study investigates the relationship between WM capacity and Korean learners' online processing of English SRCs and ORCs. Using a self-paced reading paradigm, we examine region-specific reading times and comprehension accuracy while controlling for L2 proficiency. By determining whether enhanced WM resources reduce processing costs for ORC in a typologically distant L2, the study aims to enhance theoretical frameworks connecting individual cognitive capacities to sentence processing mechanisms.

1.1 Background Literature

English RCs can be challenging for L2 learners due to substantial cross-linguistic differences. English, a head-initial language, requires learners to process dependencies over extended distances, while head-final languages like Korean place modifiers before the noun. This structural disparity increases cognitive load during sentence processing (Gibson et al. 2013). The present study focuses on Korean learners of English because their head-final L1 contrasts sharply with English's head-initial structure, amplifying the cognitive demands of RC processing and highlighting WM's role (Baek 2019, Kwon et al. 2010). Prior research on head-final languages like Korean and Japanese has shown that ORCs are consistently more difficult than SRCs, suggesting greater WM involvement due to non-local dependencies (Kwon et al. 2010, Ueno and Garnsey 2008). Korean learners often rely on L1 strategies, such as connective adverbs or verb endings, which conflict with English syntactic rules, leading to errors or longer processing times (Baek 2019). These challenges are especially pronounced in ORCs, which reverse the subject-verb-object order, requiring complex mental rearrangements (Gibson 2000). Previous studies have explored WM's role in RC processing through frameworks such as the DLT, which predicts increased processing costs with greater syntactic distance, and the Structural Prediction Locality Theory (SPLT), which emphasizes costs of structural predictions (Gibson 1998). For Korean learners, the DLT suggests heightened WM demands in

English ORCs due to L1 and L2 structural differences, while the SPLT might predict additional difficulty from mismatched predictive strategies, offering complementary insights that this study tests in an L2 context.

Research consistently shows that ORCs are more demanding than SRCs, even for native speakers. The greater syntactic complexity and longer dependencies of ORCs impose higher cognitive demands. For instance, when processing a sentence like "The reporter who the senator attacked admitted the error," learners may initially interpret it as an SRC and need to revise their understanding when encountering the verb. Such revisions highlight the cognitive load involved in processing ORCs, especially for learners whose L1 lacks post-nominal RCs (Warren and Gibson 2002). Advanced Korean learners of English often develop anticipatory strategies to address these challenges. By reallocating cognitive resources earlier in the sentence, learners proactively manage ambiguities (Baek 2019). While such strategies mitigate some difficulties, they cannot fully resolve the inherent complexity of ORCs. On the same note, eye-tracking studies demonstrate longer fixation times on relative pronouns and verbs, reflecting the cognitive effort required to resolve syntactic dependencies (Warren and Gibson 2002).

Cross-linguistic comparisons further illustrate the influence of L1 on RC processing. For example, while Japanese learners also follow a subject-object-verb order, their RC structures are more like English, resulting in less difficulty (Nakamura and Miyamoto 2013). Conversely, Chinese learners, despite sharing a subject-verb-object order with English, struggle due to their language's pre-nominal RCs, which differ fundamentally from English's post-nominal RCs (Chen and Shirai 2014). These differences underscore the unique processing demands Korean learners face, combining unfamiliar word order with syntactic structure differences, particularly in ORCs.

WM may play a crucial role in managing these challenges. WM supports the temporary storage and manipulation of linguistic information, enabling learners to resolve dependencies and integrate meaning (Baddeley and Hitch 1974). Research has consistently shown that learners with higher WM demonstrate faster reading times and better comprehension accuracy in RC processing tasks. For instance, Juffs and Harrington (2011) found that WM predicts syntactic processing efficiency in L2 learners, especially in both immediate and delayed comprehension tasks. This is especially evident for ORCs, where longer dependencies demand greater cognitive resources (Just and Carpenter 1992). These findings highlight the interaction between cognitive capacity and syntactic complexity, emphasizing WM's role in L2 sentence processing.

1.2 The Present Study

The primary aim of this study is to investigate how WM shapes the processing of English RCs in advanced Korean learners of English. Building on evidence that ORCs impose greater cognitive demands than SRCs, we ask whether WM helps learners cope with this syntactic complexity.

1) How do advanced Korean learners process different types of RCs (i.e. SRCs vs. ORCs), and what specific challenges do they encounter when processing these structures?

2) Does WM capacity lessen the processing cost of ORCs relative to SRCs, leading to faster reading times and higher comprehension accuracy for learners with greater WM?

The present study hypothesizes that (1) ORCs will yield longer reading times and lower comprehension accuracy than SRCs because of their longer dependency distances and (2) learners with higher WM will show attenuated ORC costs reflecting an advantage in maintaining and integrating syntactic information.

To test these predictions, this study employs a self-paced reading task to measure region-specific reading times for SRCs and ORCs. This method allows participants to control the pace of sentence presentation, providing

insights into real-time processing. Reading times across key sentence regions and comprehension accuracy are analyzed to identify patterns of processing difficulty and the role of WM in mediating these challenges. By isolating WM as the key individual difference factor, this study aims to clarify whether memory resources explain why some L2 readers manage complex RCs more efficiently than others—without conflating WM effects with broader proficiency measures already held constant in our advanced learner sample.

2. Methods

2.1 Participants

Fifty advanced Korean learners of English (M_{age} = 24.3, SD_{age} = 2.97, range = 18–34 years) participated in this study. All participants were classified as advanced learners of English on the basis of recent Test of English for International Communication (TOEIC) scores of 850 or higher (M = 917.4, SD = 42.7). Scores were verified from official reports submitted within the previous 12 months, ensuring that the proficiency measure reflected current ability. Among Korean learners, TOEIC performance correlates strongly with cloze test scores and other general-proficiency indices (Chae and Shin 2015), which likely supports its use as a valid benchmark for advanced-level selection. None had resided in English-speaking countries for more than three months. Participants were recruited through a university online bulletin board and completed an online survey for demographic information. All participants received monetary compensation for their participation in the study.

2.2 Materials

The stimulus set comprised 80 English sentences—40 SRCs and 40 ORCs—adapted from Yalçın et al. (2016). The material balances syntactic complexity and lexical familiarity, ensuring reliable assessment of RC processing while limiting vocabulary-related confounds. The complete list of items appears in the Appendix. No filler sentences were included to maintain focus on examining reading time differences between SRCs and ORCs. Because the goal of this study was to compare SRCs and ORCs, including fillers might introduce unnecessary variability in comparing these two RC types. Based on these considerations, the sentence segmentation was structured as follows: ‘regions’ denote broader functional divisions within sentences (e.g. subject, verb, RC areas), while ‘segments’ represent sequential units presented during the self-paced reading task. This distinction enables analysis of both fine-grained processing differences at specific positions (segments) and broader syntactic effects (regions).

[Original Version (King and Just 1991)]
The / reporter that attacked the / senator / admitted / the error.
The / reporter that the senator / attacked / admitted / the error.

[Revised Version]
Subject-relative clause:
[The reporter]$_1$ [that]$_2$ [attacked]$_3$ [the senator]$_4$ [admitted]$_5$ [the error]$_6$.
Object-relative clause:
[The reporter]$_1$ [that]$_2$ [the senator]$_3$ [attacked]$_4$ [admitted]$_5$ [the error]$_6$.

This revised version equalizes word count within RCs, minimizes spill-over effects, and maintains natural sentence flow. Reading time analysis concentrates on critical positions and subsequent words, excluding sentence-final reading times due to wrap-up effects. Following each sentence, participants complete comprehension questions assessing their understanding. Both RC comprehension accuracy and region-specific self-paced reading times are recorded. The analysis examines six distinct sentence areas: The initial area$_1$, RC beginning$_2$, RC middle$_3$, RC end$_4$, main verb$_5$, and final area$_6$. The initial area ('The reporter') and the final area ('the error') are excluded from analysis as peripheral to the study's hypotheses. Primary analysis focuses on the RC middle$_3$, and end$_4$, as well as the main verb$_5$ in ORC sentences. These areas correspond to the verbs 'attacked' and 'admitted,' which are expected to demand higher cognitive processing compared to other sentence segments. For SRC sentences, analysis emphasizes the RC end (specifically 'attacked') in comparison with the main verb 'admitted.'

To measure WM, we used two different tasks: (backward) digit span and reading span task. In the digit span task, participants had to recall number sequences in reverse order. For the reading span task, following Conway et al.'s (2005) protocol, participants completed 12 sets of sentences (42 sentences in total). Each set contained 2–5 sentences. While reading each sentence, participants had to judge whether it made sense and remember letters that appeared randomly.

2.3 Procedure

The experiment was conducted in a quiet laboratory setting. Participants first completed a practice session to familiarize themselves with the self-paced reading task. During the main task, sentences were presented in random order. For each sentence, regions were presented one at a time on the computer screen using the *OpenSesame* software (Mathôt et al. 2012). Participants controlled the pace by pressing a key, with reading times recorded for each region. After the self-paced reading task, participants completed the digit span and reading span tasks. Each experiment lasted approximately 40 minutes.

2.4 Analysis

To ensure the reliability of the study, careful preprocessing steps were applied to the self-paced reading and WM data. For the self-paced reading data, criteria for comprehension accuracy and reading time outliers were applied based on psycholinguistic research guidelines (Keating and Jegerski 2015). Trials with incorrect answers to comprehension questions were excluded, as they might show that participants were not focused or did not understand the sentences properly. This step removed about 4% of the data (1,043 observations). Additionally, reading times shorter than 200 ms or longer than 6,000 ms were excluded because they were considered unrealistic, maybe due to accidental key presses or a lack of attention. Following standard procedures (e.g. Ferreira and Clifton 1986), reading times that were more than ±2.5 standard deviations away from each participant's average reading times were also excluded. This step removed another 14% of the data (4,767 observations) resulting in a total of 17% of the data being excluded.

For the WM tasks (i.e. the digit span and reading span tasks), a partial credit scoring method was used to account for partially correct responses and provided a more nuanced assessment of WM compared to traditional all-or-nothing scoring (Conway et al. 2005, Waters and Caplan 1996). Partial credit scoring allows participants to earn partial points for partially correct answers, which gives a more detailed measure of performance than traditional methods. In the digit span task, participants had to recall a list of digits in reverse order. Scores were based on the proportion of digits recalled correctly (e.g. recalling 5 out of 7 digits gave a score of 0.71). In the reading span

task, participants were required to read sentences and determine whether each sentence was logically coherent or not. After evaluating the logicality of the sentence, participants were asked to recall a set of unrelated letters presented alongside the sentences. This task could measure both the participants' ability to process sentence meaning and their capacity to store and recall unrelated information simultaneously. The points were awarded only if participants correctly evaluated the logicality of the sentence, with additional partial credit given based on the proportion of letters recalled accurately (e.g. recalling 2 out of 3 letters resulted in a score of 0.67). If the sentence comprehension failed, no points were awarded for letter recall, ensuring the task effectively measured both processing and storage abilities. The composite WM score was created by combining the scores from the digit and reading span tasks, following the methods of Just and Carpenter (1992) and King and Just (1991).

To examine the relationship between WM and sentence processing, a linear regression analysis was conducted in R (R Core Team 2021), based on the methods used in previous studies (e.g. Gibson 2000, King and Just 1991). The dependent variable was reading times across regions, and the independent variables were RC types (SRCs vs. ORCs), WM scores, and the interaction between RC types and WM scores. This analysis helped to understand how WM affects sentence processing in different regions of the sentences and across different RC types. These preprocessing and analysis methods ensured the reliability of the data and provided a clear understanding into how L2 learners process sentences.

3. Results

3.1 Descriptive Statistics

Reading times and question response times were analyzed for both SRCs and ORCs. Table 1 summarizes these results.

Table 1. Descriptive Statistics of Reading Times (RT) and Question Reading Times (QRT) (ms) by RC Type

RC Type	RT Mean (*SD*)	RT Range	QRT Mean (*SD*)	QRT Range
SRCs	848 (577)	201–4610	3006 (2196)	576–9952
ORCs	871 (602)	208–4649	3057 (2722)	521–9944

Reading times were generally longer for ORCs (M = 871 ms, SD = 602) compared to SRCs (M = 848 ms, SD = 577), showing a difference of 23 ms. Similarly, question reading times showed longer durations for ORCs (M = 3057 ms, SD = 2722) than SRCs (M = 3006 ms, SD = 2196), with a difference of 51 ms.

3.2 Regional Reading Time Patterns

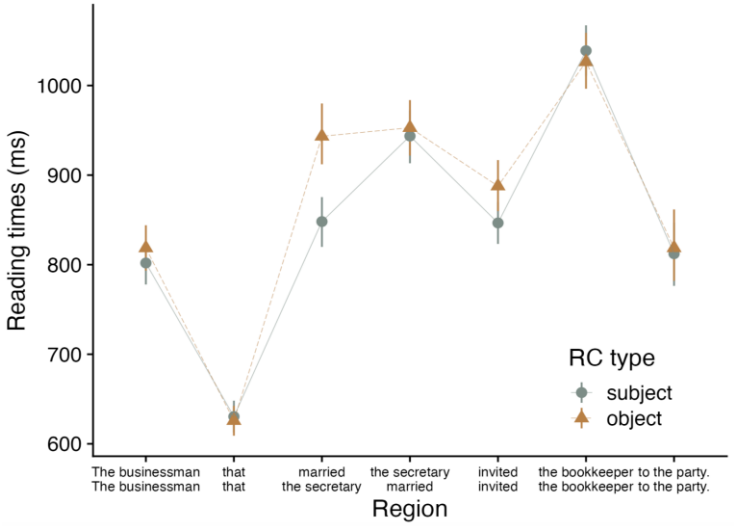

Figure 1. Reading Times by Region for Subject and Object Relative Clauses

Figure 1 illustrates reading times across sentence regions for SRCs and ORCs. In the beginning parts of sentences (Regions 1–2), reading times are similar for both clause types. However, starting from Region 3, distinct differences become apparent where ORCs take longer to read than SRCs. This difference becomes smaller in the final parts of sentences (Regions 6–7), which suggests that participants start to understand the complex sentence structure as they read toward the end. The unexpected neutralization of reading time differences in Region 4 requires careful interpretation. While the previous studies predicted sustained processing difficulties for ORCs, the data from this study suggest that Korean learners employ unique processing strategies at this critical stage. The temporary convergence of reading times between SRCs and ORCs (difference of only +11 ms) indicates that learners may have developed compensatory mechanisms specific to this region.

Table 2. Comparison of Reading Times (ms) Between SRCs and ORCs in Regions 3 to 5

Region	SRCs	ORCs	Difference
3	909	1012	+103
4	946	957	+11
5	845	894	+49

To examine a more detailed analysis of region-specific differences in processing, we conducted a comparative examination of reading times for SRCs and ORCs across Regions 3 to 5. As Table 2 summarizes, ORCs took 103 ms longer to read than SRCs in Region 3. This difference became much smaller in Region 4 (11 ms) but increased again in Region 5 (49 ms). These results suggest that participants needed different amounts of time to process each region, and they spent more time especially when they first started to read ORCs compared to SRCs.

3.3 Working Memory Effects on Processing

The role of WM in processing RCs was explored through regression analyses across Regions 3 to 5 (Tables 3–5).

Table 3. Summary of Region 3 Model for Reading Times

Term	*β*	*SE*	*t*	*p*
(Intercept)	903.03	66.95	13.49	<0.001
RC type	103.60	31.11	3.33	0.001
WM	−161.29	131.73	−1.22	0.227
RC type × WM	3.22	31.44	0.10	0.918

Note: Model coefficient estimates (*β*), standard errors (*SE*), corresponding *t*-values, and *p*-values.

Table 3 shows the results of regression analysis for reading times in Region 3. The intercept value (903.03) represents the average reading times when all other variables are at their mean values. For RC type, there was a significant effect ($\beta = 103.60$, $SE = 31.11$, $p = 0.001$), showing that ORCs took longer to read than SRCs in this region. The WM score showed a negative effect ($\beta = -161.29$, $SE = 131.73$), suggesting that participants with higher WM tended to read faster. However, this effect was not statistically significant ($p = 0.227$). The interaction between RC type and WM was also not significant ($\beta = 3.22$, $SE = 31.44$, $p = 0.918$), which means that the effect of RC type on reading times did not change depending on participants' WM.

Table 4. Summary of Region 4 Model for Reading Times

Term	*β*	*SE*	*t*	*p*
(Intercept)	960.62	66.99	14.34	<0.001
RC type	11.55	33.88	0.34	0.734
WM	−129.08	131.11	−0.98	0.330
RC type × WM	25.56	32.43	0.79	0.431

Note: Model coefficient estimates (*β*), standard errors (*SE*), corresponding *t*-values, and *p*-values.

Table 4 reveals the findings of regression analysis for reading times in Region 4. The intercept value is 960.62 ($SE = 66.99$, $p < 0.001$), which represents the average RT when all other variables are at their mean values. For RC type, there was no significant effect ($\beta = 11.55$, $SE = 33.88$, $p = 0.734$), which means that reading times were similar for both SRCs and ORCs in this region and WM also did not show a significant effect ($\beta = -129.08$, $SE = 131.11$, $p = 0.330$), although participants with higher WM tended to read slightly faster. The interaction between RC type and WM was not significant either ($\beta = 25.56$, $SE = 32.43$, $p = 0.431$), suggesting that WM did not change how participants processed different types of RCs in Region 4.

Table 5. Summary of Region 5 Model for Reading Times

Term	*β*	*SE*	*t*	*p*
(Intercept)	873.62	49.26	17.74	<0.001
RC type	48.86	14.83	3.29	0.001
WM	−191.16	93.28	−2.05	0.046
RC type × WM	−21.10	29.45	−0.72	0.474

Note: Model coefficient estimates (*β*), standard errors (*SE*), corresponding *t*-values, and *p*-values.

Table 5 summarizes the results of regression analysis for reading times in Region 5. The intercept value (873.62) indicates the average reading times when all other variables are at their mean values. For RC type, there was a significant effect ($\beta = 48.86$, $SE = 14.83$, $p = 0.001$), showing that ORCs took longer to read than SRCs in this region. WM also showed a significant effect ($\beta = -191.16$, $SE = 93.28$, $p = 0.046$), indicating that participants with higher WM read faster in this region. However, the interaction between RC type and WM was not significant (*β*

= −21.10, *SE* = 29.45, *p* = 0.474), which means that WM did not change how participants processed different types of RCs in Region 5.

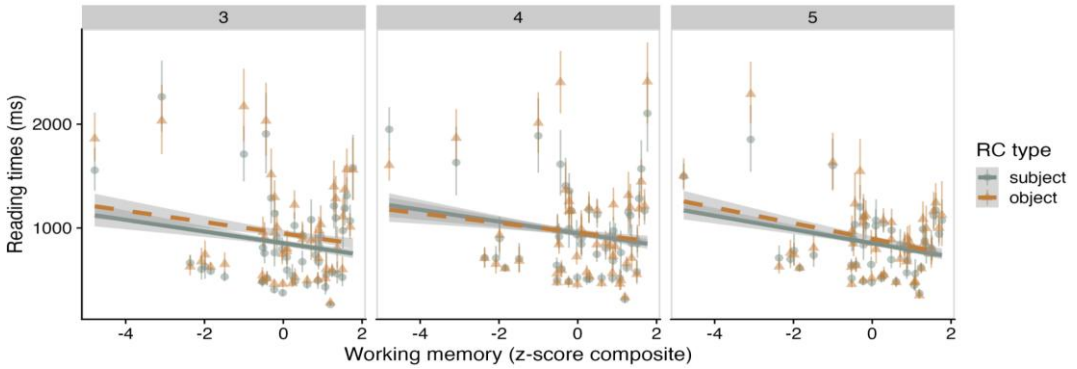

Figure 2. Reading Times as a Function of Working Memory for Subject and Object Relative Clauses across Regions 3–5

Figure 2 illustrates how WM scores relate to reading times in Regions 3, 4, and 5. In all three regions, participants who had higher WM scores read sentences faster. This pattern was the strongest in Region 5, where participants with higher WM showed much shorter reading times. These results suggest that individuals with better WM can process complex sentence structures more efficiently. The results revealed that higher WM was associated with faster reading speeds, with a statistically significant effect observed in Region 5 (p = 0.046), though non-significant trends toward faster processing were noted in Regions 3 and 4. The lack of a significant interaction between RC type and WM across regions suggests that WM's effect on processing speed does not differ substantially between SRCs and ORCs. While a post-hoc test could further clarify potential differences, the current regression results indicate no strong evidence of WM modulating the SRC-ORC distinction.

3.4 Question Response Time Analysis

We also analyzed how participants' response times to comprehension questions were affected by RC types and WM capacity. The results of this analysis are shown in Table 6.

Table 6. Summary of Regression Model for Question Response Times

Term	*β*	*SE*	*t*	*p*
(Intercept)	2522.36	87.29	28.90	<0.001
RC type	−30.60	12.09	−2.53	0.011
WM	−288.88	172.39	−1.68	0.100
RC type × WM	−69.27	24.19	−2.86	0.004

Note: Model coefficient estimates (*β*), standard errors (*SE*), corresponding *t*-values, and *p*-values.

Table 6 presents the findings derived from the regression analysis for question response times. The intercept value (2522.36) shows the average question response times when all other variables are at their mean values. For RC type, there was a significant effect (β = −30.60, *SE* = 12.09, p = 0.011), indicating that participants responded faster to questions about SRCs than ORCs. WM showed a negative effect (β = −288.88, *SE* = 172.39, p = 0.100), suggesting that participants with higher WM tended to respond faster, but this effect was not statistically significant

(p = 0.100). Notably, there was a significant interaction between RC type and WM (β = −69.27, SE = 24.19, p = 0.004). This means that the difference in response times between SRCs and ORCs was larger for participants with higher WM scores. Figure 3 highlights this interaction, showing that WM provided a distinct advantage in responding to more complex ORC questions.

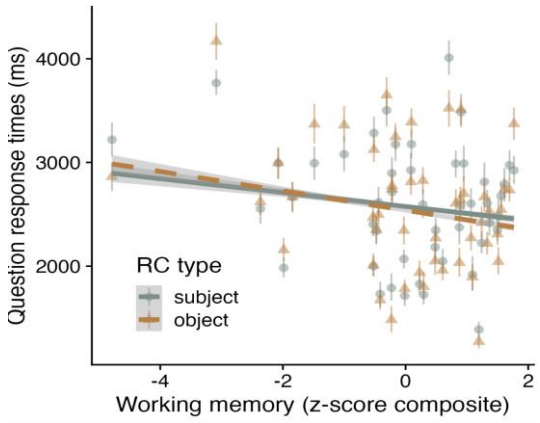

Figure 3. Question Response Times as a Function of Working Memory for Subject and Object Relative Clauses

4. Discussion

The present study confirmed that ORCs are more cognitively demanding than SRCs for advanced Korean learners of English. ORCs elicited significantly longer reading times, particularly in Regions 3 and 5, consistent with the DLT, which posits that longer syntactic dependencies increase processing difficulty (Gibson 2000). In Region 4, however, reading times for ORCs and SRCs converged, suggesting learners employed anticipatory processing strategies to allocate cognitive resources effectively (Baek 2019, Hopp 2014). This pattern indicates that advanced learners adapt their strategies to mitigate some of the structural challenges of English. The findings emphasize the influence of Korean as a head-final language on learners' processing strategies. Longer reading times in earlier sentence regions reflect the cognitive demands of adjusting to English's head-initial structure.

Examining Korean learners, whose head-final L1 intensifies the memory burden of head-initial English RCs (Kwon et al. 2010), clarifies how language-specific syntax shapes sentence processing. We define complexity as the cognitive load of non-local dependencies, indexed by region-specific reading times and comprehension accuracy (Gibson et al. 2005). The results extend the DLT to L2 contexts: longer ORC dependencies trigger retrieval costs, yet Korean learners' effort peaks earlier than in native speaker data, indicating that anticipatory parsing reallocates resources before integration (Baek 2019, Hopp 2014). Surprisal-based predictive accounts (SPLT) reach the same ORC > SRC ranking but attribute the load to expectation mismatches between L1 and L2. Thus, the DLT and the SPLT offer complementary explanations—retrieval versus prediction—for the same L2 difficulty pattern.

The current findings show that WM significantly influenced sentence processing, particularly in syntactically demanding regions such as Region 5. Learners with higher WM demonstrated faster reading times and more efficient integration of syntactic dependencies, especially for ORCs (Juffs and Harrington 2011, Just and Carpenter 1992). This is in line with capacity-based theories, which emphasize WM's role in both temporary storage and

syntactic integration (Caplan and Waters 1999). Interestingly, WM effects were not significant in Region 3, where learners encountered initial structural complexity. This suggests that early-stage challenges may depend more on L1 influence than WM capacity. However, WM's role became pronounced during later integration stages, highlighting its dynamic contribution across different phases of sentence processing.

The impact of WM was most evident in comprehension questions, where participants responded faster to questions about SRCs compared to ORCs, with higher WM providing a particular advantage for ORC questions. This finding supports Wen's (2016) observation that WM affects different stages of language processing in different ways, emphasizing its dynamic role in both reading and comprehension phases. Despite the overall advantage of higher WM, ORCs remained challenging even for participants with high WM, particularly in Regions 3 and 5, where the RC verb and main verb appear. These findings align with Traxler et al.'s (2002) work, which suggests that some sentence structures are inherently difficult regardless of individual differences in WM. Moreover, the head-final structure of Korean may further intensify the cognitive demands of processing English's head-initial RCs. These cross-linguistic influences highlight the limitations of WM in overcoming structural complexity, even among advanced learners and suggest the need for pedagogical strategies such as explicit training in structural markers and chunking exercises. The findings extend capacity—supporting both early-stage resource allocation and late-stage syntactic integration—with its influence varying across sentence regions and syntactic complexities. These insights emphasize the need for L2 processing models to account for both cognitive resources and cross-linguistic influences.

While this study provides insights into the role of WM in L2 sentence processing, several limitations must be acknowledged. The research focused exclusively on advanced Korean learners with relatively high WM scores, which restricts the generalizability of findings to learners with lower proficiency or WM capacity. A post-hoc test was not conducted to further explore WM's interaction with RC types due to the lack of significant interaction in the regression analyses. Future research should examine broader range of learner profiles, including beginners and individuals with varying cognitive abilities, to develop a comprehensive understanding of how WM interacts with syntactic complexity across different stages of language development. Investigating other syntactic structures, such as passives or conditionals, would provide a broader perspective on L2 processing. Further research should also examine how individual differences beyond WM—including motivation, language learning experience, and exposure to English—influence L2 sentence processing. Additionally, while our self-paced reading methods were useful for measuring reading times, they could be enhanced through complementary techniques such as eye-tracking, which would reveal more natural reading patterns.

5. Conclusion

The findings of this study point to the challenges Korean learners face when processing English RCs, particularly ORCs, due to fundamental differences between Korean's head-final structure and English's head-initial structure (Gibson et al. 2005). While English emphasizes key elements early in sentences, Korean positions them at the end, requiring distinct processing strategies. Korean learners demonstrated greater difficulty with earlier parts of sentences, contrasting with native speakers, who found later parts more difficult. These results are consistent with Juffs and Harrington's (2011) findings, emphasizing the significance of L1 background and individual differences in L2 sentence processing.

Advanced Korean learners exhibited effective adaptive strategies, supported by WM capacity, in managing complex syntactic structures. The reduced reading time differences in Region 4 and the phase-specific role of WM

demonstrate its dynamic contribution across processing stages, challenging conventional perspectives of WM as a uniform construct. ORCs consistently elicited longer reading times than SRCs, reflecting greater cognitive demands associated with longer syntactic dependencies (Gibson 2000). However, advanced Korean learners demonstrated adaptive strategies, such as anticipatory parsing, which mitigated some of these challenges, as seen in the convergence of reading times in Region 4 (Baek 2019). Higher WM capacity was associated with faster reading times and improved comprehension accuracy, particularly in later sentence regions like Region 5 (Just and Carpenter 1992). Nevertheless, learners with higher WM capacity consistently found ORCs more challenging than SRCs, indicating that WM has limitations in addressing structural complexity. These findings illustrate how cognitive resources interact with cross-linguistic influences in real time comprehension. This research enhances our understanding of how Korean learners adapt to English structural patterns and how WM facilitates these adaptations. The findings have implications for L2 pedagogy, indicating the potential benefits of targeted training in syntactic parsing and WM enhancement exercises to support learners in managing complex sentence structures.

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Examples in: English
Applicable Languages: English
Applicable Level: Tertiary

Appendix

Relative clause sentences

1. The babysitter /that/ chased /the child / tripped over / the toy truck.
Who tripped over the toy?
(Z) The toy
(M) The babysitter
Correct Answer: M

2. The babysitter /that / the child / chased / tripped over / the toy truck.
Who did the child chase?
(Z) The babysitter
(M) Another child
Correct Answer: Z

3. The play / that /delighted /the actor / was given / first prize / at the awards dinner.
Which play was given first prize?
(Z) The one that delighted the actor
(M) No one
Correct Answer: Z

4. The play / that /the actor / rehearsed/ was given / first prize / at the awards dinner.
Who rehearsed the play that won first prize?
(Z) The actor
(M) The awards
Correct Answer: Z

5. The flight attendant /that /complimented / the pilot / feared flying / before this job.
What did the attendant fear before this job?
(Z) Swimming
(M) Flying
Correct Answer: M

6. The flight attendant/ that/ the pilot / complimented / feared flying / before this job.
Who feared flying before this job?
(Z) The flight attendant
(M) The job
Correct Answer: Z

7. The quarterback /that/ hated /the linebacker / played / a practical joke.
What did the quarterback do to the linebacker?
(Z) Played a practical joke
(M) Apologized
Correct Answer: Z

8. The quarterback /that/ the linebacker / hated / played / a practical joke.
Who played a practical joke?
(Z) The quarterback
(M) The door
Correct Answer: Z

9. The student /that /practiced /the instrument / had been around / for a few months.
How long had the student been around?
(Z) A few months
(M) instrument
Correct Answer: Z

10.The student/ that /the instrument / frustrated / had been around/for a few months.
Who was frustrated by the instrument?
(Z) A few months
(M) The student
Correct Answer: M

11. The businessman/ that/ married /the secretary/invited /the bookkeeper /to the party.
Who invited the bookkeeper to the party?
(Z) The lion
(M) The businessman
Correct Answer: M
12. The businessman/ that/ the secretary/ married / invited / the bookkeeper /to the party.
Who married the businessman?
(Z) The bookkeeper
(M) The moon
Correct Answer: Z

13. The spy /that /encoded /the message / was smuggled / out of the country /in a crate.
How was the spy extracted from the country?
(Z) By plane
(M) In a crate
Correct Answer: M

14.The spy/ that /the message / alarmed / was smuggled / out of the country /in a crate.
Who was alarmed by the message?
(Z) The fly

(M) The spy
Correct Answer: Z

15. The mechanic / that / divorced /the waitress / cheated/ on her.
Who was cheated on by the mechanic?
(Z) The waitress
(M) The car
Correct Answer: Z

16. The mechanic /that / the waitress / divorced / cheated /on her.
Who divorced the mechanic?
(Z) The pasta
(M) The waitress
Correct Answer: M

17.The murderer /that/ killed / the lady / entered /the house / through the back door.
How did the murderer enter the house?
(Z) Drink water
(M) Through the back door
Correct Answer: M

18. The murderer /that /the lady /fled /entered /the house / through the back door.
What did the old lady do when she saw the murderer?
(Z) Ran away
(M) Laughed
Correct Answer: Z

19.The lady/ that/ fled/ the murderer / entered/ the house / through the back door.
Who entered the house through the back door?
(Z) The dog
(M) The lady
Correct Answer: M

20. The lady /that/ the murderer / killed / entered / the house / through the back door.
Who was killed by the murderer?
(Z) The cat
(M) The lady
Correct Answer: M

21. The message /that /alarmed /the spy / was smuggled / out of the country / in a crate.
What happened to the message that alarmed the spy?
(Z) It was message
(M) It was smuggled out
Correct Answer: M

22. The message/ that /the spy / encoded / was smuggled / out of the country / in a crate.
Who encoded the message?
(Z) The spy
(M) The zebra
Correct Answer: Z

23. The writer /that / complimented /the photographer / worked for / a national magazine.
Where did the writer work?
(Z) TV
(M) A national magazine
Correct Answer: M

24. The writer /that/ the photographer / complimented / worked for / a national magazine.
Who was complimented by the photographer?
(Z) The sun
(M) The writer
Correct Answer: M

25.The photographer /that /complimented /the writer / snapped / award-winning photos.
What kind of photos did the photographer snap?
(Z) singing
(M) Award-winning
Correct Answer: M

26.The photographer /that / the writer / complimented / snapped / award-winning photos.
Who complimented the photographer?
(Z) The writer
(M) The first
Correct Answer: Z

27. The burglar/ that /scared/ the policeman / robbed / three houses/ in one night.
How many houses did the burglar rob?
(Z) Zero
(M) Three
Correct Answer: M

28. The burglar /that /the policeman/ scared / robbed/ three houses /in one night.
What did the burglar do in one night?
(Z) Danced
(M) Robbed three houses
Correct Answer: M

29.The policeman/ that /scared/ the burglar / carried /a pistol and a can of mace.

What did the policeman carry?
(Z) A radio
(M) A pistol and a can of mace
Correct Answer: M

30.The policeman /that /the burglar / scared / carried /a pistol and a can of mace.
Who was scared in this scenario?
(Z) The burglar
(M) The table
Correct Answer: Z

31.The salesman/ that/ cheated /the customer / was wearing / white patent leather shoes.
What was the dishonest salesman wearing?
(Z) White patent leather shoes
(M) chicken
Correct Answer: Z

32.The salesman/ that/ the customer / trusted / was wearing / white patent leather shoes.
Who was wearing white shoes?
(Z) The sofa
(M) The salesman
Correct Answer: M

33. The customer /that /trusted /the salesman / was wearing / white patent leather shoes.
Who wore white shoes?
(Z) The panda
(M) The customer
Correct Answer: M

34.The customer /that /the salesman / cheated / was wearing / white patent leather shoes.
Who was cheated?
(Z) The lift
(M) The customer
Correct Answer: M

35.The waiter /that /served /the customer / spoke with / an unusual accent.
How did the waiter who served the customer speak?
(Z) In the hospital
(M) With an unusual accent
Correct Answer: M
36.The waiter/ that / the customer / summoned / spoke with / an unusual accent.
Who summoned the waiter?
(Z) The baggage
(M) The customer
Correct Answer: M

37. The babysitter /that /spanked /the child / got scolded / when the parents returned.
What happened when the parents returned?
(Z) Happening
(M) The babysitter was scolded
Correct Answer: M

38.The babysitter/ that/ the child / escaped / got scolded / when the parents /returned.
Who got scolded when the parents returned?
(Z) The newspaper
(M) The babysitter
Correct Answer: M

39.The child / that/ escaped / the babysitter /got scolded / when the parents /returned.
Who got scolded?
(Z) The carpet
(M) The child
Correct Answer: M

40.The child /that /the babysitter / spanked / got scolded / when the parents returned.
What did the babysitter do to the child?
(Z) cooked
(M) Spanked
Correct Answer: M

41.The terrorist/ that/ captured /the hostage / delivered /a speech /on the video.
Who delivered a speech on the video?
(Z) The terrorist
(M) The TV
Correct Answer: Z

42.The terrorist /that/ the hostage / begged / delivered/ a speech /on the video.
What did the hostage do?
(Z) Begged
(M) Smiled
Correct Answer: Z

43.The hostage /that /begged /the terrorist / delivered/ a speech /on the video.
Who delivered a speech on the video?
(Z) The building
(M) The hostage
Correct Answer: M

44.The hostage /that /the terrorist / captured / delivered /a speech /on the video.
Who was captured?
(Z) The bird
(M) The hostage
Correct Answer: M

45.The consultant/ that /advised /the client / developed / the company's marketing plan.
Who developed the marketing plan?
(Z) The consultant
(M) The paper
Correct Answer: Z

46.The consultant/ that/ the client / hired / developed / the company's marketing plan.
Who hired the consultant?
(Z) The rose
(M) The client
Correct Answer: M

47.The tenant/ that/ despised/ the landlord / phoned /the newspaper /to complain.
Who phoned the newspaper?
(Z) The tenant
(M) The flower
Correct Answer: Z

48.The tenant /that/ the landlord / despised / phoned / the newspaper/ to complain.
What action did the tenant take?
(Z) Drank some beer
(M) Phoned the newspaper
Correct Answer: M

49.The doctor/ that/ diagnosed /the patient / walked /through/ the hospital's lobby.
Who walked through the lobby?
(Z) The cat
(M) The doctor
Correct Answer: M

50. The doctor/ that /the patient / worshipped / walked / through/ the hospital's lobby.
Who walked through the hospital's lobby?
(Z) The doctor
(M) The car
Correct Answer: Z

51.The patient / that / worshipped /the doctor / walked / through /the hospital's lobby.
Who walked through the lobby?
(Z) The road
(M) The patient
Correct Answer: M

52. The patient /that /the doctor / diagnosed / walked / through /the hospital's lobby.
Who walked through the hospital's lobby?
(Z) The patient
(M) The smartphone
Correct Answer: Z

53. The executive / that/ fired/ the secretary / was angry / after /the stock price fell.
Who was angry after the stock price fell?
(Z) The monster
(M) The executive
Correct Answer: M

54. The executive /that /the secretary / assisted / was angry / after /the stock price fell.
Why was the executive angry?
(Z) stood well
(M) The stock price fell
Correct Answer: M

55. The secretary /that /assisted /the executive / was angry / after the stock price fell.
Who was angry?
(Z) The secretary
(M) The window
Correct Answer: Z

56.The secretary /that /the executive / fired / was angry / after the stock price fell.
Who was fired?
(Z) The pot
(M) The secretary
Correct Answer: M

57. The sheriff/ that/ killed /the cowboy / smelled like / an old whiskey bottle.
Who smelled like whiskey?
(Z) The bottle
(M) The sheriff
Correct Answer: M

58. The sheriff /that/ the cowboy/ killed / smelled like / an old whiskey bottle.
What did the sheriff smell like?
(Z) Fresh perfume
(M) An old whiskey bottle

Correct Answer: M

59. The client /that /hired /the consultant / developed / the company's marketing plan.
Who developed the marketing plan?
(Z) The client
(M) The forest
Correct Answer: Z
60. The client /that/ the consultant / advised /developed /the company's marketing plan.
Who developed the company's marketing plan?
(Z) The fax
(M) The client
Correct Answer: M

61. The musician /that /witnessed /the accident / angered / the policeman a lot.
What did the musician do?
(Z) tripped
(M) Angered the policeman
Correct Answer: M

62. The musician /that/ the accident /terrified / angered / the policeman a lot.
What happened to the musician?
(Z) Terrified by the accident
(M) composed
Correct Answer: Z

63. The plumber/ that /helped /the electrician / retired / after twenty years /on the job.
Who retired?
(Z) The job
(M) The plumber
Correct Answer: M

64. The plumber /that /the electrician / helped / retired / after twenty years /on the job.
What did the plumber do after twenty years on the job?
(Z) Continued
(M) Retired
Correct Answer: M

65. The electrician/ that /helped /the plumber / knew / where the spare/ was kept.
Who knew where the spare was kept?
(Z) The electrician
(M) The spare
Correct Answer: Z

66. The electrician /that /the plumber/ helped / knew / where the spare/ was kept.
What did the electrician know?
(Z) singing
(M) Where the spare was kept
Correct Answer: M

67. The instrument /that /frustrated/ the student / had been around /for a few months.
What was the instrument's effect on the student?
(Z) Inspiring
(M) Frustrating
Correct Answer: M

68. The instrument /that /the student /practiced / had been around/ for a few months.
Who practiced the instrument?
(Z) The student
(M) Practiced
Correct Answer: Z

69. The movie / that/ pleased /the director / received /a prize /at the film festival.
What happened to the movie that pleased the director?
(Z) Was ignored
(M) Received a prize
Correct Answer: M

70. The movie /that /the director/ watched / received /a prize /at the film festival.
Who watched the movie?
(Z) The prize
(M) The director
Correct Answer: M

71. The accident/ that /bothered /the woman / caused / a number of /serious injuries.
What was the result of the accident?
(Z) Serious injuries
(M) Slept
Correct Answer: Z
72. The accident/ that /the woman/ reported / caused / a number of /serious injuries.
What did the woman do about the accident?
(Z) saw it
(M) Reported it
Correct Answer: M

73. The psychologist/ that/ printed /the notes / got lost / somewhere /in the basement.
What happened to the psychologist?

(Z) Found out
(M) Got lost in the basement
Correct Answer: M

74. The psychologist /that/ the notes /annoyed / got lost /somewhere/ in the basement.
What was the psychologist's reaction to the notes?
(Z) Ran
(M) Annoyed
Correct Answer: M

75. The notes /that /annoyed /the psychologist / got lost / somewhere/ in the basement.
What happened to the notes?
(Z) Were happy
(M) Got lost
Correct Answer: M

76. The notes /that /the psychologist /printed / got lost / somewhere/ in the basement.
Who printed the notes?
(Z) The psychologist
(M) The monkey
Correct Answer: Z

77. The actor /that /rehearsed/ the play / was given / first prize/ at the awards dinner.
Who was given first prize?
(Z) The song
(M) The actor
Correct Answer: M

78. The actor/ that /the play/ delighted / was given / first prize/ at the awards dinner.
What delighted the actor?
(Z) The house
(M) The play
Correct Answer: M

79. The prize/ that /delighted /the contestant / made / a big impression /on Mary.
Who was impressed by the prize?
(Z) Mary
(M) The prize
Correct Answer: Z

80. The prize/ that /the contestant / misplaced / made /a big impression /on Mary.
What did the contestant do with the prize?
(Z) Quickly
(M) Misplaced
Correct Answer: M