

The Effect of Prior Knowledge on the Contribution of Working Memory to L2 Reading Comprehension

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Abstract

Working memory is believed to interact with a second language (L2) learning at the cognitive level. The present study sought to explore the impact of L2 readers' prior knowledge on the contribution of working memory to reading comprehension. Eighty Iranian English learners were divided into two groups of high and low by their scores on L2 knowledge and the topic knowledge tests. Their working memory spans, and reading comprehension abilities were measured via a working memory test and a reading comprehension test respectively. The results indicated that working memory significantly predicted L2 reading comprehension only when the readers had sufficient topic knowledge. The results also show that the learners' comprehension was mostly determined by their L2 linguistic knowledge, even when they had considerable working memory capacity. The findings imply that readers' prior knowledge could moderate the contribution of working memory in L2 reading comprehension. A certain level of knowledge in the target language and on the topic is required for L2 readers to help working memory work more efficiently.

Keywords: L2 knowledge, topic knowledge, memory span, reading comprehension, working memory

1. Introduction

Successful readers possess the ability to put information together, make connections, remember and retell facts, evaluate what they read, and corroborate their understandings, conclusions, and predictions (Westwood, 2008). By contrast, poor readers identify words slowly and laboriously, and comprehend texts with difficulty. It is a very frustrating experience that may arise from limited vocabulary knowledge, lack of familiarity with the subject matter, problems with processing information, and problems in recalling information after reading (Westwood, 2008). Despite a substantial body of research, there are still discrepancies shown in the interrelationships among working memory (WM), background knowledge, and language processing (e.g., Alptekin & Erçetin, 2011; Leeser, 2007; Shabani et al., 2018; Shin, 2020).

A considerable body of recent studies on WM has concentrated on the learning of words, morphemes, or syntactic rules by L2 learners. The research on the role of WM concerning reading comprehension beyond the sentence level has either been slim or inadequate (Joh & Plakans, 2017). In a meta-analysis of 25 studies, Shin (2020) reports on a moderate relationship between working memory and L2 reading comprehension. To fill up this gap, this research aims to examine L2 readers' prior knowledge on the contribution of working memory to reading comprehension. It focuses on whether and how WM interacts with prior knowledge which is conceptualized as the knowledge of L2 language (vocabulary and grammar) and topic knowledge (topic-related vocabulary).

2. Review of Related Literature

Working memory is considered to be a cognitive system associated with “temporary storage and manipulation of the information necessary for complex

cognitive tasks such as language comprehension, learning, and reasoning” (Baddeley, 1992, p. 556) as it provides “an interface between perception, long-term memory, and action” (Baddeley, 2003, p. 829). Research has shown that there is a significant relationship between WM and language skills such as listening (Daneman & Carpenter, 1980), reading comprehension (Daneman & Merikle, 1996), writing skills (Abu-Rabia, 2003), and learning vocabulary (Alexiou, 2009).

The most influential model of working memory was introduced by Baddeley and Hitch (1974) which integrates a cognitive system focusing on a form of visual and spatial temporary memory (the visuospatial scratchpad) along with a range of control processes (a central executive) as well as serial ordered verbal memory (the phonological loop). The visuospatial sketchpad operates on visual images and spatial information, the phonological loop controls language-based information, and the central executive controls attention and coordinates the two other components (Baddeley, 1992).

The number of words that can be stored in WM depends on the amount of time spent on articulating those words and their length. Since only about two seconds of information can be rehearsed in the phonological loop, people with faster articulation rate can store more words in the WM (Baddeley, 1992; 2003). The storage capacity also depends on the similarity as well as recency and primacy effects. The similarity effect refers to the WM capability to retain words with similar sounds more easily. Recency and primacy mean that individuals can recall the first and last words less effortlessly than the words in the middle (Baddeley, 1992, 2003).

Research has it that WM plays a significant role in realizing cognitive abilities such as language displays (Baddeley, 1986; Gilhooly et al., 1993, Sarani, 2018) and more particularly a direct predictor of reading comprehension.

Reading comprehension is the formation of a meaning-based representation of texts, often called the mental model or situation model (van den Broek & Kremer, 2000). Human beings accomplish this complex task of understanding by utilizing cognitive skills (Cain & Nash, 2011) and through different mental processes like decoding, inference making, integrating new and old information, and monitoring understanding newly acquired knowledge. In turn, working memory allows readers to recall and manipulate information to create their concepts and ideas. WM participates in cognitive processes not only passively but also actively, serving both for executing processes and for storing the products of these processes (Baddeley & Hitch, 1974). In reading comprehension, WM is responsible for retaining and integrating syntactic, semantic, and pragmatic information in a previous text with the present text.

Research indicates that there is no difference between the skilled and unskilled readers in their moving and placing their eyes during the reading process (Just & Carpenter, 1987; Olson et al., 1983) nor do they differ in the amount of visual information they can extract from a single fixation (Samuels et al., 1978). However, they do differ on many other component processes of reading comprehension ability (Cain et al., 2004).

One of the issues in WM studies concerns whether it uniquely and independently contributes to L2 reading comprehension, or if its contribution is moderated by other factors, particularly knowledge of the L2 or knowledge of the reading topic. Garner and Gillingham (1991) studied the facilitating effect of background knowledge on language comprehension in L1. Their study shows that even a low-level of topic knowledge held by readers may lead to an easier recall process at the end. However, what could predict the rate of participants' recall confidently was cognitive interest.

Miller et al. (2006) carried out an experiment in which participants were divided into high and low based on their working memory capacity measures. These participants read and recalled some ambiguous texts with or without topic title that provided contextual knowledge. Findings indicated that contextual knowledge was the strongest predictor of reading efficiency (time for recalling the proposition). The contextual knowledge decreases demands on WM capacity.

Hamrick and Oswald (2005) suggested that both working memory capacity and domain knowledge contribute to individual differences in higher-level cognition. Besides, they concluded that WM capacity and domain knowledge may operate independently.

In another study, Leeser (2007) investigated the effect of WM and topic familiarity on beginning Spanish learners' processing of some grammatical morphemes during reading. His findings indicated that individuals with higher WM capacity could recall the morphemes more frequently than those with low WM capacity. The results revealed that topic familiarity yielded the most significant results in learners' reading comprehension. Also, learners benefited from higher WM only if they were familiar with passage topics. Unlike Lesser (2007), Swanson et al (2011) explored the contribution of working memory to children's 2nd language reading. Results proved that WM contributed to L2 reading uniquely.

Payne et al. (2009) believed that reading comprehension in L2 demands knowledge of grammar and vocabulary as well as controlled attention for continuous updating of information. They investigated the relative contribution of WM, first language comprehension, and domain experience on L2 reading comprehension. The conclusion was an independent influence of working

memory on L2 reading, regardless of L1 reading skills, background knowledge, or previous experience in L2 reading.

Joh and Plakans (2017) investigated the influence of readers' prior knowledge on the contribution of working memory to L2 reading comprehension. They uniquely defined prior knowledge. This prior knowledge consisted of two categories of L2 linguistic knowledge and topic knowledge. L2 linguistic knowledge or L2 knowledge was operationalized as knowledge of grammatical structures and vocabulary items in the target language. Topic knowledge was defined as the knowledge of the words/phrases appearing in a given text that directly pertained to the topic of the text. The results of their study revealed that the effect of WM on reading comprehension was highly influenced by prior knowledge. Furthermore, this contribution depends on the level of readers' prior knowledge. For those having more prior knowledge, WM was the strongest predictor of L2 reading comprehension. For those having less prior knowledge, L2 linguistic knowledge was the most powerful predictor of L2 reading comprehension.

Shin et al. (2018) studied the influence of combined working memory and background knowledge on L2 reading comprehension. They found that L2 readers with higher WMC equipped with background knowledge were better readers than readers with lower WMC. Schurer et al. (2020) investigated the effects of prior knowledge, text difficulty, and working memory on mind wandering and reading comprehension. They noticed that while prior knowledge had no significant effect on mind wandering, it could influence reading comprehension significantly. They also found that WMC along with textual difficulty could modulate reading comprehension. Drawn upon a similar study to Joh and Plakans' (2017), the present research seeks to answer the following questions:

1. Does readers' prior knowledge influence the contribution of working memory in second language reading comprehension?
2. Does readers' L2 linguistic knowledge influence the contribution of working memory in second language reading comprehension?
3. Does readers' topic knowledge influence the contribution of working memory in second language reading comprehension?

3. Method

3.1. *Participants*

The participants were 80 Persian-speaking students (34 males and 46 females) from an initial population of 130 doing their masters in English major at Yazd University and those doing their bachelor in the second, third, and fourth year in English major at Yazd University. Their ages ranged from 20 to 28 years with a mean range of 24. All the participants were exposed to English instruction for a period ranging from 4 to 10 years. Besides, they had no experience of living long in an English country. In order to assess their general English proficiency level at the time of the experiment, the participants took the Oxford Quick Placement Test (OQPT). The participants were not made aware of the purpose of the study.

3.2. *Instruments*

Reading-span test

The reading-span test, developed by Shahnazari (2013), is a memory test designed to tap both processing and recall functions in immediate processing. Processing assessment needs the participants to report on the semantic acceptability of each sentence, while the storage assessment needs the

individuals to recall the final word of each sentence when prompted. The test is a validated translated version of the test originally developed by Daneman and Carpenter (1980). It includes 64 Persian sentences and takes around 20 minutes to be completed.

The test had proved to enjoy an internal reliability index of .844 and .790 for reading span processing and recall scores, respectively. All the sentences in this study were in Persian and were arranged in three sets of 3, 4, 5, and 6 sentences. Half of the sentences were constructed as “nonsense” sentences. This was done by reordering a few words in such a way that sentences were semantically irregular (Chun & Payne, 2004; Lesser, 2007). This was to make sure that the participants processed sentences for meaning without merely focusing on the retention of the recalled items. Each sentence appeared on screen for 7 seconds after which the computer transitioned to the next slide.

Prior Knowledge Test

The prior knowledge test consisted of two sets of tests, a test of L2 linguistic knowledge and a test of topic knowledge. L2 linguistic knowledge was operationally defined to include knowledge for grammatical structures and vocabulary items in the target language. In order to assess L2 linguistic knowledge, a total of 60 items were prepared. Thirty items were related to grammar, and 30 items were questioning participants' vocabulary knowledge. The L2 knowledge items were selected from the published preparation materials for popular standardized English tests such as the TOEFL. The Cronbach's Alpha showed the internal reliability of .693. The grammar subpart contained two sets of 15 items. At the first set of grammar subpart which contained 15 items, participants chose the correct grammatical form to fill a blank in a sentence. In the second half of the grammar subpart, containing 15 items,

participants were to identify the one underlined word/phrase that would be changed. That is, there were four underlined words/phrases in a sentence, however, one was incorrect. The incorrect one would be identified by the learners as the correct answer.

The vocabulary subpart also included two different types of items again each having 15 items, and the participants were asked to choose the synonym for a given word in a sentence and select a word or phrase that best completed a given sentence or a short paragraph. All 30 items of vocabulary were in multiple-choice form. The second part of prior knowledge test was on topic knowledge, operationally defined as the knowledge of the words/phrases appearing in a given text that directly pertained to the topic of the text. As topic knowledge is a relatively abstract cognitive construct, assessments of it tended to be indirect. The present study took topic vocabulary knowledge as a measure of what is often referred to as topic knowledge in the literature. To design the test in order to assess the prior topic knowledge, first, it was required to set a valid and firm framework in which vocabulary items were identified out of the passages. Therefore, the passages of the reading comprehension test were handed to three experienced faculty members in the English Department at Yazd University. They were requested to underline the words related to the main topic of each passage. Fifty-eight words were extracted out of 5 passages. For each item, participants provided the meaning(s) of the given vocabulary items in Farsi, the participants' L1.

The measure of topic knowledge was the participants' knowledge of the lexical items from the test texts, while the measure of L2 knowledge was based on selected syntactic structures and lexical items not directly related to the text topics. The inter-rater reliability for this test was 0.651.

Reading Comprehension Test

A 32-item test was constructed to assess L2 reading comprehension ability, based on five different passages with about 200 words long on various topics. The readability of the reading passages, based on smog formula, was calculated to be 10-13. All the items were in multiple-choice format. The reliability (Cronbach's Alpha) of the comprehension test proved to be 0.741.

3.2. Procedure

Participant's WM capacity in this research was assessed by the Reading Span Test (RST) for data collection, which was originally adapted from Daneman (1991). The test has been commonly used and proven as certification for interpreting differences in working memory capacity amongst participants individually (Prebianca, 2010; Weissheimer & Mota, 2009).

The present study encompassed a Persian computerized version of the Reading Span Test consisting of 10 unrelated long sentences in two sets of three and a set of four sentences in a PowerPoint format. This test was taken individually. The participants were asked to read each sentence displayed on the computer screen one by one while their answers were recorded by a voice recorder. The participants reported on the semantic acceptability of each sentence (WM processing assessment), and then read aloud the last word in each sentence when prompted (WM storage assessment). In order to help learners better understand the Reading-Span Test, a sample of this test was needed to be practiced prior to the main test. The sample test was taken along with an oral clarification of the procedures. The participants were given a training session comprising 10 sentences in two sets of three and a set of four sentences. The reading span test included 54 test sentences, all of which were in an active and positive form within a range of 13-16 words. The test was administered

individually using a computer-based format. In the presence of the first slide containing three sentences, the participants had to read each sentence silently. Then the participants had to judge whether it made sense by saying “Yes” or “No”. After the end of the set, the respondents had to recall the final word of each sentence in the order as the visual prompt quickly appeared on the computer screen. The test began with a set of 3 sentences, and as the test continued, the number of sentences presented on each trial increased successively from three to six, with three trials being presented at each series length. The quick slide transitions increased accordingly from 12 to 18 seconds based on the length of each set. The visual prompt appeared on the computer screen, as for the participants not to miss the recall time. The participants were asked to recall the sentence-final words and articulate them. The responses were recorded. As the visual prompt disappeared, the recall time was over. The same procedure was followed for the other sets up to the end. In scoring the test, the participants’ correct judgment and correct recall received one point, 54 in total. Thus, the participants’ scores were ranging from 0 to 54.

After students went through RST individually, they participated in the prior knowledge test that was paper-based. The participants all took a seat in a quiet classroom at Yazd University. The test papers were distributed to them. At this session, the students answered all the items of L2 knowledge and topic knowledge tests, with a total of 118.

All L2 knowledge items were in multiple-choice format. On the other hand, for the fifty-eight item topic knowledge test, the participants wrote all the meanings they knew for given words in their L1. According to the pilot test, the allocated time to the participants was 118 minutes.

To score the L2 knowledge test, full credit (1 point) was given if the participants selected the correct item. Otherwise, no mark (0 points) was

allocated to that item. To score the topic knowledge test, full credit (1 point) was given if the participants provided the exact meaning of a word as it was used in the context, and partial credit (0.5 points) if only one or more possible meanings were given but not meaning from the text.

In the fourth session of giving tests, the students gathered in a classroom at Yazd University. They participated in a paper-based test in order to assess their reading comprehension test. The papers were distributed to them. Firstly, the participants read the texts. Secondly, they selected only one option. Full credit was allocated to the correct response.

4. Results

As it was mentioned before, the participants were asked to take four different tests. The descriptive statistics related to each test are presented in Table 1.

Table 1

Descriptive Statistics of the Four Variables in the Study

	N	Lowest (min.)	Highest (max.)	Mean	SD
L2 knowledge	80	17	57.00 (60)	37.94	8.36
Topic knowledge	80	8.00	55.00 (58)	31.47	8.71
Working memory	80	2	54.00 (54)	17.25	10.91
Reading comprehension	80	8.00	32.00 (32)	26.31	4.90

A correlation test was conducted in order to see how much each variable is related to another one. It must be said that the assumptions for checking correlation (linearity, normality, and independency) were all checked and none was violated. As seen in Table 2, there is a strong correlation between L2 reading comprehension and topic knowledge ($r=0.62$, $p<.001$). Also, a strong

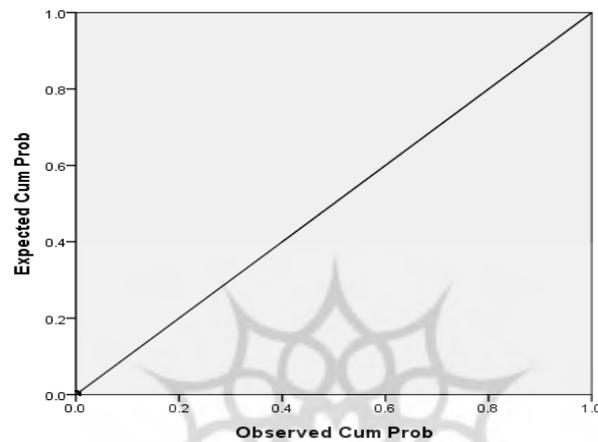
correlation was found between L2 reading comprehension and L2 knowledge ($r=0.61, p<0.001$). It was found that there was a lower correlation between working memory and L2 knowledge and also between working memory and topic knowledge. Working memory was weakly correlated with L2 knowledge and topic knowledge ($r=0.24, p=0.015$ and $r=0.27, p=0.08$). The test also shows that working memory and L2 reading comprehension were moderately correlated ($r=0.34, p=0.01$).

A regression analysis was run to check the contribution of the variables to L2 reading comprehension. Multicollinearity, outliers, normality, linearity, homoscedasticity, and independence of residuals were checked. All the variables had some relationship with L2 reading comprehension which is the dependent variable. Also, there was no high correlation between each of the independent variables (i.e., working memory, topic knowledge, and L2 knowledge) and all of them were below 0.7. Therefore, all variables were retained. The resulting tolerance for all variables was above 0.1 (0.92, 0.51, and 0.51). Moreover, the VIF values obtained from this test were below 10 for all variables (1.08, 1.96, and 1.93). According to these values, it can be concluded that the multicollinearity assumption is not violated.

As it is shown in Figure 1, according to the Normal P-P Plot and the scatterplot, the data were normally distributed and there are no outliers that have standardized residuals of more than 3.3 or less than -3.3. Moreover, the maximum value of Mahal. Distance (11.68) didn't exceed the critical value (i.e., 16.27).

Figure 1

Normal P-P Plot of Regression Standardized Residual-Dependent Variable: L2 Reading Comprehension



The total variance accounted was 47% ($R^2 = .470$) which means that this model explained 47% of the variance in L2 reading comprehension which is quite an acceptable and respectable result. Also, we had $F(3, 196) = 22.44, p < 0.001$.

All the variables significantly and uniquely contribute to L2 reading comprehension but the magnitude of their contribution is different. That is, L2 knowledge could explain more than one-third of the total variance in L2 reading ($Beta = .366$); topic knowledge about one third ($Beta = 0.3$) and working memory just about one-sixth ($Beta = .18$)

Table 2

Contribution of Each Predictor to L2 Reading Comprehension

	Beta	T	Sig.	Tolerance	VIF
Working memory	.180	2.064	.042	.921	1.086
Topic knowledge	.300	2.568	.012	.510	1.960
L2 knowledge	.366	3.157	.002	.518	1.930

The scores were supposed to be divided into two groups i.e. higher and lower L2 knowledge groups. The mean and the median of here were 37.94 and 38, respectively. In order to make the higher and lower groups, the scores which were around the median score were not considered in the analysis. Therefore, the participants whose scores were below 34 were considered to be in lower group L2 knowledge ($N = 26$), and the ones whose scores were higher than 43 were considered to be in higher group L2 knowledge ($N = 31$). Consequently, the participants' scores which were between 34 and 43 were in the middle group ($N = 23$) and were not the focus of this data analysis. The descriptive statistics related to these new groups are presented in Table 3.

Table 3
Descriptive Statistics for L2 Knowledge Groups

	Range	N	Mean	Std. Deviation	SD
lower group	17-34	26	27.73	4.133	.811
higher group	43-57	31	45.90	2.868	.515
Total	17-57	80	37.94	8.366	.935

A one-way between-groups ANOVA with planned comparisons was conducted in order to see if they were different in L2 knowledge. Before conducting the test, the needed assumptions were checked i.e. normality of distribution and equality of variance. The data were normally distributed in all groups and the Levene's test for homogeneity showed no violation of the assumption of homogeneity of variance ($p = 0.12$). The ANOVA showed that there was a statistical difference between the two groups in L2 knowledge ($F(1,77) = 428.90, p < 0.001$). The effect size using eta squared was 0.84 indicating a large effect size.

Another ANOVA was also conducted for distinguishing if there was a significant difference between the groups in working memory. The assumptions

were also checked and the Levene's test for homogeneity showed that the assumption of homogeneity of variance was not violated ($p = 0.08$). The ANOVA showed that there was not a significant difference between groups in working memory capacity ($F(1,77) = 10.98, p = 0.17$). The effect size using eta squared was 0.22 showing a small effect size.

For both the higher and lower L2 knowledge groups, a separate regression analysis and correlation analysis were conducted. For this aim, the middle group was omitted and the data were split into two groups which were higher and lower.

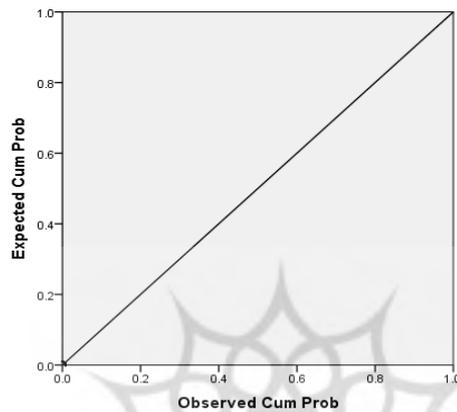
In order to run the correlation and regression tests, the needed assumptions had to be checked again. All the variables had some relationship with L2 reading comprehension which is the dependent variable. Also, there was no high correlation between each of the independent variables (i.e., working memory, topic knowledge, and L2 knowledge) and all of them are below 0.7. Therefore, all variables were retained.

The resulting tolerance for all variables was above 0.1 (0.93, 0.97, and 0.95 for the lower group and 0.99, 0.98, and 0.99 for the higher group). Moreover, the VIF obtained from this test was below 10 for all variables (1.07, 1.03, and 1.04 for the lower group and 1.00, 1.01, and 1.00 for the higher group). According to these values, it can be concluded that the multicollinearity assumption is not violated.

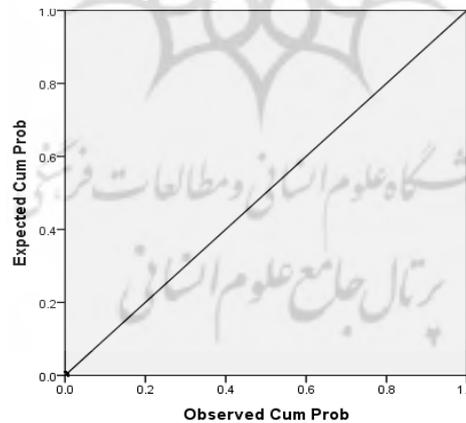
As it is shown in Figures 2 and 3, according to the Normal P-P Plot, the data were normally distributed. Moreover, the maximum value of Mahal. Distance for both lower and higher groups (i.e., 11.32 and 15.69 respectively) didn't exceed the critical value (i.e., 16.27).

Figure 2

*Normal P-P Plot of Regression Standardized Residual: Lower L2 Knowledge Group-
Dependent Variable: L2 Reading Comprehension*

**Figure 3**

*Normal P-P Plot of Regression Standardized Residual: Higher L2 Knowledge Group-
Dependent Variable: L2 Reading Comprehension*



In the higher L2 knowledge group, working memory was correlated to L2 reading comprehension significantly and moderately ($r = 0.45, p = 0.023$). In the lower group, L2 knowledge was significantly and strongly correlated with L2 reading comprehension ($r = .67, p < 0.001$), followed by topic knowledge ($r =$

0.60, $p = 0.003$). But working memory and L2 reading comprehension were weakly correlated and their correlation was not significant ($r = 0.137$, $p = 0.172$).

Table 4

Higher L2 Knowledge: Contribution of Each Predictor of L2 Reading Comprehension

	Beta	T	Sig.
Working memory	.370	2.064	.042
Topic knowledge	.109	.575	.107
L2 knowledge	.173	.925	.173

$N = 31$, $R\ square = 0.27$, $F(3,24) = 2.97$, $p = 0.04$

In the higher group, only working memory could predict the L2 reading comprehension performance (Beta=0.37, $p=0.04$). None of the other variables, i.e. L2 knowledge and topic knowledge were significant ($p=0.17$ and $p=0.10$ respectively). In the lower group, only L2 knowledge was the significant and strong predictor (Beta=0.55, $p=0.03$).

Table 5

Lower L2 Knowledge: Contribution of Each Predictor of L2 Reading Comprehension

	Beta	T	Sig.
Working memory	.370	2.064	.042
Topic knowledge	.109	.575	.107
L2 knowledge	.550	.925	.03

$N = 26$, $R\ square = 0.46$, $F(3,24) = 11.61$, $p = 0.03$

In this step, the scores on the topic knowledge test were supposed to be divided into two groups, i.e. higher and lower topic knowledge groups. The mean and the median of here were 31.47 and 34, respectively. For assigning the scores into the higher and lower group, the scores which were around the median score were not considered in the analysis. Therefore, the participants whose scores were below 31 were considered to be in lower group topic knowledge ($N = 30$)

and the ones whose scores were higher than 36 were considered to be in higher group topic knowledge ($N = 28$). Consequently, the participants' scores which were between 34 and 43 were in the middle group ($N = 22$) and were not the focus of this data analysis. The descriptive statistics related to the higher and lower group of topic knowledge are presented in Table 6.

Table 6*Descriptive Statistics for Topic Knowledge Groups*

	Range	N	Mean	Std. Deviation
lower group	8-31	30	22.63	6.15
higher group	36-55	28	39.21	5.27
Total	8-55	80	31.47	8.71

In order to investigate if the groups are different in topic knowledge, a one-way between-groups ANOVA with planned comparisons was conducted. The needed assumptions were checked (i.e., normality of distribution and equality of variance) before conducting the test. The data were normally distributed in all groups and the Levene's test for homogeneity showed no violation of the assumption of homogeneity of variance ($p = 0.12$).

Table 7*Contrast Tests ANOVA between Topic Knowledge Higher Group and Lower Group in Topic Knowledge*

		Contrast	Value of Contrast	Std. Error	t	df	Sig.
Topic knowledge	Assume equal variances	1	-16.5810	1.29717	-12.78	77	.000
	Does not assume equal variances	1	-16.5810	1.50130	-11.04	55.615	.000

The ANOVA showed that there was a statistical difference between the two groups in topic knowledge ($F(1,77) = 165.63, p < 0.001$). The effect size using eta squared was 0.68 indicating a moderate effect size.

An ANOVA was also conducted for distinguishing if there was a significant difference between the groups in working memory. The assumptions were also checked and the Levene's test for homogeneity showed that the assumption of homogeneity of variance was not violated ($p = 0.09$). The ANOVA showed that there was not a significant difference between groups in working memory capacity ($F(1,77) = 428.90, p = 0.11$). The effect size using eta squared was 0.20 showing a small effect size (Table 8).

Table 8

Contrast Tests between L2 Knowledge Higher Group and Lower Group in Topic Knowledge

		Contrast	t	df	Sig. (2-tailed)
L2_knowledge	Assume equal variances	1	-20.711	77	.113
	Does not assume equal variances	1	-18.922	43.370	.110

For both the higher and lower topic knowledge groups, a separate regression analysis and correlation analysis were conducted. For this aim, the middle group was omitted and the data were split into two groups which were higher and lower.

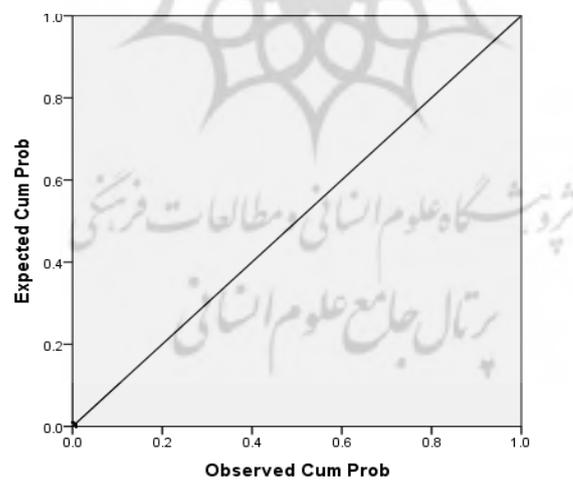
In order to run the correlation and regression tests, the needed assumptions had to be checked again. For both groups, all the variables had some relationship with L2 reading comprehension which is the dependent variable. Also, there was no high correlation between each of the independent variables (i.e., working memory, topic knowledge, and L2 knowledge) and all of them are below 0.7. Therefore, all variables were retained.

The resulting tolerance for all variables was above 0.1 (0.97, 0.99, and 0.96 for the lower group and 0.97, 0.96, and 0.99 for the higher group). Moreover, the VIF obtained from this test was below 10 for all variables (1.03, 1.00, and 1.03 for the lower group and 1.02, 1.03, and 1.00 for the higher group). According to these values, it can be concluded that the multicollinearity assumption is not violated.

As it is shown in Figures 4 and Figure 5, according to the Normal P-P Plot, the data were normally distributed. Moreover, the maximum value of Mahal. Distance for both lower and higher groups (i.e., 7.82 and 14.54 respectively) didn't exceed the critical value (i.e., 16.27).

Figure 4

Normal P-P Plot of Regression Standardized Residual: Lower Topic Knowledge Group- Dependent Variable: L2 Reading Comprehension



In the higher topic knowledge group, working memory was correlated to L2 reading comprehension significantly and strongly ($r = 0.65, p = 0.03$) while this relationship was not significant in the lower group ($r=0.20, p=0.14$). In the lower group, topic knowledge was significantly and strongly correlated with L2 reading comprehension ($r = .72, p = 0.01$), followed by topic knowledge ($r = 0.51, p = 0.01$).

Table 9

Higher Topic Knowledge: Contribution of Each Predictor of L2 Reading Comprehension

	Beta	T	Sig.
Working memory	.47	3.12	.02
Topic knowledge	.06	.58	.48
L2 knowledge	.42	2.75	.03

$N = 28, R \text{ square} = 0.38, F(3,24) = 13.56, p = 0.004$

In the higher group, working memory was the best predictor for the L2 reading comprehension performance ($Beta=0.47, p=0.02$). For other variables, i.e. L2 knowledge and topic knowledge, Beta was equaled with 0.42 and 0.06 respectively. ($p=0.03$ and $p= 0.48$ respectively). In the lower group, only L2 knowledge was the significant and strong predictor ($Beta = 0.63, p = 0.01$).

Table 10

Lower Topic Knowledge: Contribution of Each Predictor of L2 Reading Comprehension

	Beta	T	Sig.
Working memory	.18	.95	.63
Topic knowledge	.09	.84	.43
L2 knowledge	.63	3.157	.01

$N = 28, R \text{ squared} = 0.40, F(3,24) = 13.52, p = 0.008$

Mentioning other variables in higher group, i.e. L2 knowledge and topic knowledge, Beta equaled with 0.42 ($p = 0.03$) and 0.06 ($p =0.48$), respectively.

In the lower group, for working memory and topic knowledge, Beta equaled .18 ($p = .63$) and .09 ($p = .84$), respectively.

5. Discussion

The present study aimed to examine the interactions between working memory, L2 knowledge, and L2 reading comprehension. It was confirmed that working memory significantly predicted better L2 text comprehension only for the higher-proficiency participants. Instead, for those with lower target language knowledge, L2 knowledge was the most powerful predictor of their L2 reading comprehension. Presumably, the readers with lower target language knowledge might have relied exclusively on their L2 knowledge when processing the L2 text. That is, the contribution of working memory to L2 text comprehension depended on the learner's degree of L2 knowledge and topic knowledge.

In the higher L2 knowledge group, processing and decoding L2 grammar and vocabulary are automatized as they are skilled. Therefore, few demands are made upon working memory in order to process L2 linguistic materials. Thanks to this automatization, the free capacity of working memory leads to a prominent role of WM in reading comprehension. By contrast, in learners with lower L2 knowledge, learners should labor over processing and decoding grammar and vocabulary as it is not an automatic process. Hence, the limited capacity of working memory is occupied by the linguistic input. In this way, the learners do not benefit from working memory capacity while comprehending L2 texts. It was L2 knowledge that significantly predicted the reading comprehension of lower L2 knowledge participants. Working memory then can function as a distinguishing measure to explain differences in reading ability. Learners with lower L2 proficiency are likely to resort more frequently to more cognitive resources than more proficient learners. This can confirm Adams and

Shahnazari-Dorcheh's (2014, p. 29) claim that "the more fluent the learners are, the more automatic their processes, and the less memory demanding L2 reading will be."

The results from the current study are in line with those reported by Joh and Plakans (2017). WM significantly predicts L2 reading in both Korean and Iranian higher L2 knowledge, whose second language is English. Working memory was a more decisive measure of L2 reading comprehension for the learners with higher topic knowledge whereas for the learners with less topic knowledge, the L2 knowledge was more prominent. With lower L2 knowledge groups, L2 knowledge itself predicts L2 reading. Also, the findings confirm Foote's (2011) and Hummel's (2009) results in that readers' characteristics can moderate the role of working memory to L2 reading comprehension.

The findings revealed here, however, are in disagreement with Payne et al. (2009). They concluded that L2 experience and WM independently affected L2 reading comprehension. They viewed and measured L2 experience in their study as the time spent learning the L2 and the number of the L2 classes taken by the participants. Notably, this study measured L2 knowledge more precisely.

More specifically, working memory functions as a facilitator in reading comprehension only when a reader has enough knowledge of topic-related vocabulary in that text. The readers with lower knowledge of related vocabulary (topic knowledge) consume more of their storage of working memory (Klane et al., 2001). Instead, they benefit from their knowledge of L2 linguistics, L2 grammar, and vocabulary. By contrast, in the higher-topic knowledge group, the process of decoding and understanding related vocabulary is automatic as they are more skilled than the lower-group. Therefore, the capacity of working memory is abandoned unloaded. Thus, the working memory prominently correlates with L2 reading comprehension. It is in line with Cowan's (2014)

finding that WM becomes prominent when ones' long-term knowledge of the topic is limited. However, the current study proved that WM did not compensate for limited topic knowledge for the adult L2 learners with proficiency ranging from intermediate to advanced level. This might be due to the differences existing between L1 and L2. It means that L2 reading is cognitively more demanding than L1 reading. Readers with limited topic knowledge reading their L1 possibly have no issues with decoding the text. On the other hand, these readers, with limited topic knowledge, benefit from their WM free the capacity to comprehend the text. Miller et al. (2006) believed that the contribution of WM to L2 reading comprehension depends on the degree of the readers' background knowledge. Also, Joh and Plakans (2017) stated that the contribution of WM to L2 reading comprehension is affected by readers' prior knowledge.

Our findings are inconsistent with the results presented by Alptekin and Erçetin (2011). They reported that WM and background knowledge contributed independently to the understanding of L2 texts by Turkish EFL learners. The contrast between these studies might arise from differences in learners' L2 proficiency.

6. Conclusion

The current study investigated the effect of readers' prior knowledge on the contribution of the working memory to L2 reading comprehension. The results have indicated that the role of the working memory capacity is undeniable and crucial in L2 reading comprehension. Theoretically, the findings bring about more interest for researchers in order to attend key factors involved in successful L2 reading comprehension, such as working memory. The researchers can follow the path to discover more factors, ways, and methods to boost the limited capacity of working memory.

From the practical point of view, L2 reading teachers with the knowledge of the cognitive operation of WM can benefit from the usefulness of the results in their classes. Confronting with higher proficiency readers, teachers are informed that these readers draw on their working memory. Lower proficiency readers took advantage of their knowledge of the topic. The results of this study imply that building topic knowledge is necessary. Teaching a list of vocabulary directly related to the topic of a text before reading the text can help L2 readers fully bring their working memory capacity into service. Besides, the teachers should set their lesson plans in a way in which they present their materials and tasks in order not to impose an excessive load on L2 readers' WM capacity.



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