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Influence of Working Memory Capacity on English Language Learning of High School Students School

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Abstract: In recent years, the relationship between working memory and second language acquisition has been a hot topic in the field of second language acquisition. The impact of second language learners' working memory capacity on their second language acquisition is inconclusive. Researchers have called for further investigation into the role of working memory in second language development when reviewing literature on working memory in second language acquisition. called for further investigation into the role of working memory in second language development when reviewing literature on working memory in second language contexts and language contexts. Therefore, this study aims to explore whether and how working memory capacity affects overall English proficiency. The research question is: what is the correlation between high school students' working memory capacity and their English grades? This study used empirical research methods and randomly selected 37 high school students from a school in Dujiangyan, Chengdu as participants. empirical research methods and randomly selected 37 high school students from a school in Dujiangyan, Chengdu as participants. Data sources included Data sources included working memory capacity tests and English proficiency tests, both of which were conducted in the students' classrooms. Descriptive statistics and Pearson correlation analysis were performed using SPSS 26.0 statistical analysis software. The study shows that there is a significant correlation between working memory capacity and English proficiency test scores. The correlation between The correlation between working memory and English proficiency test scores suggests that individual differences in working memory capacity can affect important cognitive activities such as listening, reading comprehension, reasoning, writing, and problem-solving. The correlation between working memory and English proficiency test scores suggests that individual differences in working memory capacity can affect important cognitive activities such as listening, reading comprehension, reasoning, writing, and problem-solving.

Keywords: English Grades; Second Language Acquisition; Working Memory.

1. Introduction

There are many factors affecting English learning, categorized differently, intellectual and non-intellectual factors, social and environmental factors, school and family factors, and this paper focuses on the influence of learners' own factors on English learning, i.e. working memory capacity, which belongs to the cognitive level. And after Service (1992) introduced working memory into second language research, the influential role of working memory in second language acquisition has attracted the attention of researchers [2, 3, 4]. Working memory interacts with the process of second language acquisition, and this interaction is thought to occur in the cognitive operations of input and output in the target language, as well as in problem solving and comprehension that occurs during the learning process [5].

The size of working memory capacity affects learners' word memory, reading, listening, and writing, and also plays a moderating role, and task difficulty affects learners' second language reading comprehension under the moderation of working memory capacity[6]. Meanwhile, in the process of unintentional learning, such as learning new vocabulary by watching movies and videos, individual differences also affect learners, and learners with high working memory capacity have better unconscious memory for words[7]. Many studies on working memory are more specific and detailed, grasping a very small point to explore, and few scholars have studied working memory and learners' overall English proficiency.

This paper measures the working memory capacity and English proficiency of high school students to explore the effect of learners' working memory capacity on English learning. The significance of this study is that learners can improve their English performance by practicing their working memory capacity and improving their memorization of words in their future studies.

2. Literature Review

2.1. Definition of Working Memory

Working memory is a capacity-limited memory system for the temporary processing and storage of information that underlies cognitive processes and provides the interface between perception, long-term memory and action. Simply put, working memory refers to "the memory system of the human brain that performs both storage and information processing functions and plays an important role in human cognitive activity."

The working memory model proposed by Baddeley includes three components: the phonological loop, the visuo-spatial sketchpad, and the central executive. The phonological loop is a channel for sound processing and storage, which is responsible for realizing the functions of auditory discrimination, vocalization, and discourse output; the visuo-spatial sketchpad is an element of image spatial information, which is responsible for visual discrimination; and the central executive is similar to the central system, which is used for allocating the attentional resources and controlling the processing.

The same component is responsible for different tasks, so

scholars use different components for the different components involved in the object under study.

Measures such as the n-back test are used to test a subject's executive working memory. After a stimulus is presented to a subject, the subject is asked to identify the target stimulus among a series of distractor stimuli presented later, and the total number of target stimuli found by the subject is the working memory capacity[7]; and scholars have also used a web-based version of the Automated Operation Span Task to measure working memory capacity, subjects recall images or words appearing on the screen in sequence and solve a series of simple math problems, the two tasks alternate, and the OSpan score is the subject's working memory capacity[8]; and other scholars have used the Wechsler Scale of Intelligence Memory Breadth Test to measure working memory capacity[9].

2.2. Working Memory and Vocabulary Learning

As early as 2012, scholars verified the roles played by phonological short-term memory (STM) and working memory in second language grammar learning as well as vocabulary learning, finding that both STM and working memory predicted vocabulary learning, while vocabulary and grammar were positively correlated[10]. Some scholars used second language level, working memory capacity, and three different vocabulary exercises (comprehension group, fill-in-the-blank group, and sentence writing group) as independent variables to explore the effects of the three independent variables on vocabulary learning, and the results of the linear modeling showed that the subjects' level of English language learning, working memory capacity, and vocabulary acquisition showed a significant correlation; vocabulary learning of the subjects in the sentence-writing group was the best, followed by the fill-in-the-blank group and the comprehension group[7]. In other words, subjects in the sentence-writing group used the most working memory capacity and had the best learning effect. Simon Ruiz, Patric Rebuschat, and Detmar Meuers also conducted a study on the effect of working memory on vocabulary, which explored the effects of different types of vocabulary memory (meaning-focused instruction and form-focused instruction) on vocabulary learning. instruction and form-focused instruction), and individual differences in cognitive abilities (working memory and declarative memory), this experiment was conducted in an Intelligent Computer-Assisted Language Teaching (ICALL) environment, and the results showed that working memory and vocabulary learning were highly correlated, and that specifically, working memory was more affected by the form group.

For some learners, they learn vocabulary by watching movies or videos, and this process is called incidental vocabulary learning. Therefore, Mariabel et al. investigated the role of learners' vocabulary knowledge and working memory capacity in the process of incidental vocabulary learning while watching videos. The results showed that the higher the working memory capacity, the more vocabulary learners can learn[11].

The casual learning of individual words is further explored, and Mark Feng Teng explores working memory from the perspective of the form-focused instruction rather than meaning-focused instruction[8].

Whether learners can learn and memorize vocabulary and its effectiveness in videos with subtitles, the authors used a between-subjects design to verify the effectiveness of two types of working memory, i.e., phonological loop and central executive system, on vocabulary learning and memorization for three types of subtitle cues (annotated subtitle, full subtitle, and keyword subtitle) that appeared in the videos; the results showed that learners, when watching videos with annotated types of subtitles, vocabulary learning and memorization are best; the phonological loop is more predictive of learners' vocabulary learning and memorization than the central executive system, and learners' different working memory types learn and memorize vocabulary differently under the influence of different subtitle types when watching videos with different vocabulary annotation types[12]. Most of the findings suggest that working memory capacity predicts learners' vocabulary learning, however, different working memory types have different effects on vocabulary memorization.

2.3. Working Memory and Hearing

A Korean scholar conducted a study on test-taker characteristics, which are cognitively and affectively evolving in young L2 learners. The author explored the extent to which the cognitive characteristics of the test-takers, which consist of three dimensions, namely, aptitude, phonological working memory, and first-language proficiency, can predict L2 listening comprehension and reading comprehension. In addition, the authors also explored the effects of affective (motivation) and demographic (social status and gender) factors on second language listening comprehension and reading comprehension, and the results showed that learners' natural talent and phonological working memory effectively predicted second language listening comprehension and reading comprehension, while motivation only predicted listening comprehension, and in general, the higher the natural talent, the better the phonological working memory, and the higher the motivation, the better the learners' second language acquisition[13]. Metacognition and working memory each affect learners' listening comprehension and reading comprehension, but the effect of the interaction between the two on listening and reading comprehension has not yet been verified, therefore, Barbara et al. divided the subjects into a reading group, a listening group, and a control group, and the first two groups were subjected to corresponding experimental treatments of metacognition and working memory, while the control group was subjected to ordinary reading, and the results showed that both metacognition and working memory positively affected reading comprehension, however, working memory had little effect on listening comprehension[14]. The presence of noise definitely affects learners' listening comprehension, Homira et al. set up three noise environments to explore the effects of noise on learners' listening working memory[14].

Auditory working memory is presented in terms of task complexity, and the results are clear that the more complex the task is with the presence of noise, the higher the subjects' need to store and process information [15]. Scholars in Japan and the United States, Minkyung Kim and Yunjung Nam explored the effects of working memory, first-language reasoning ability, and language knowledge on listening at different lengths.

The effect of power comprehension was examined by 193 Korean ninth grade students using path analysis to test the relationship between the variables, which showed that students with better working memory capacity comprehended

longer listening materials better, and those with better reasoning ability comprehended shorter listening materials more readily, controlling for the variable of second-language linguistic knowledge. At the same time, working memory capacity can help students form information-intensive expressions in longer discourse and can interact with reasoning ability and second language knowledge, which implies that working memory capacity may benefit students' listening comprehension when they have better second language knowledge or first language reasoning ability[16].

2.4. Working Memory and Reading

Scholars have also explored the relationship between working memory and second language reading. The degree of difficulty of cognitive tasks affects second language reading comprehension, meanwhile, working memory capacity moderates this effect. Therefore, scholars in Korea randomly selected 52 school college students and divided them into two groups to read simple or complex TOEFL articles, and then conducted numerical breadth tests as well as non-textual repetition tests to measure the subjects' working memory capacity, which showed that, although the subjects could clearly feel that the complex reading task is more laborious, it does not affect the reading comprehension scores, at the same time, the higher the working memory capacity of the subjects, the higher the reading comprehension scores under the complex task, that is to say, there is no difference in the moderating effect of the working memory capacity when the task is simple, and the moderating effect of the working memory can be realized only when completing the complex tasks[17]. In addition, some scholars have also explored the factors affecting young learners' second language reading, including working memory capacity, age size, and difficulty of the reading task. The authors randomly selected 94 sixth and seventh grade subjects to complete the TOEFL Comprehensive Reading Test for Adolescents as well as the working memory capacity test, and the results of the mixed-effects modeling showed that the higher the working memory capacity and the higher the grade, the more the reading comprehension accuracy of the subjects was reading comprehension accuracy, and that reading task difficulty was not significantly associated with subjects' reading scores [18]. Currently, paperless learning methods are favored by many people, so the way information is presented on electronic screens becomes a factor that affects learners, Burcu et al. conducted a study on the types of annotations in e-reading (lexical and topic-level), the location of annotations (pop-up window and separate window) and the effect of learners' working memory capacity on language comprehension were investigated, and the results showed that working memory had a significant effect on e-reading, specifically, learners with high working memory capacity performed better in e-reading of the pop-up window type, while in other aspects there was not much difference between learners with high working memory capacity and those with low capacity[9]. There is no significant difference between learners with high working memory capacity and those with low capacity[9].

2.5. Working Memory and Writing

Some studies have shown that working memory affects the process of second language writing, and some studies have explored the role that working memory plays in the process of second language writing. Marije et al. explored the role that working memory plays in young second language learners' learning to write, and also verified the relationship between the achievement of second language writing and the type of writing and the grade level, and whether or not the effect of cognitive capacity on second language writing varies with the type of task and the grade level. changes, the subjects were 94 sixth and seventh graders who had to complete the TOEFL Comprehensive Test of Reading for Young Adults as well as the Working Memory Capacity Test, and the results showed that the students performed better in the email writing and comprehensive dictation tasks, and that the seventh-grade subjects performed better than the sixth-grade subjects in both of these tasks, and that working memory had a significant effect on academic writing, but had a non-significant relationship with the other types of writing,. The effect of working memory on academic writing was less significant in the seventh grade subjects, however, it was more prominent in the sixth grade subjects [18]. It has been argued that learners can make constant corrections when writing in second language and that learners' working memory may play a role in this process; therefore, Shaofeng Li et al. explored the relationship between two types of working memory (complex working memory and phonological short-term memory) and four types of written corrective feedback (direct corrective feedback, direct corrective feedback with revision, meta-linguistic interpretation, and meta-linguistic interpretation with revision) The relationship between the authors, who randomly selected 79 adult English language learners to complete three writing tasks and two working memory tests, showed that complex working memory was able to significantly influence the two types of written corrective feedback (meta-linguistic interpretation, direct corrective feedback with revision), whereas phonological working memory had a significant negative correlation with direct corrective feedback with revision, i.e., differences in the type of working memory affected the type of feedback,. Meanwhile, complex working memory and phonological working memory have opposite associations on writing feedback[19].

To summarize, this study poses the following research question: to what extent does working memory capacity correlate with English achievement among high school students?

3. Methodologies

3.1. Subject in the Experiment

The subjects of this study were 37 students, aged 16-17 years old, from the sophomore class of a middle school in Dujiangyan, all of whom were native speakers of Chinese, and all of whom spoke English as a second language.

3.2. Experimental Material

3.2.1. Working Memory Capacity Test

The Reading Breadth Test [20] measures information processing ability and storage ability in terms of two main indicators of subjects' working memory capacity was tested with a total of 42 meaningfully unrelated sentences, each of which was of length between 6 and 11 words, the 42 sentences were divided into 5 modules, each with 3 families within the module columns of sentences, 1 sentence per series in the first module and 2 sentences per series in the second module. In the third module there are 3 sentences per series (e.g., in the fourth module, there are 3 series, each with 4 sentences in the column, containing a total of 12 sentences.) After each series

is presented, students are first asked to recall and write down the last word of each sentence, and then are presented with a sentence in which they judge whether the presented sentence has the same meaning as the one presented at the beginning, with one point awarded for a correctly written word, and one point awarded for a correctly made judgment.

The test lasted 45 minutes and the total score was 84 points. For example, after presenting the first sentence I don't think its very great, the test taker needs to write down the last word great on the answer card, and then judge whether the sentence I think it's very great presented on the screen has the same meaning as the sentence presented before it, and write F on the answer card. Then they should decide whether the sentence I think it's very great presented on the screen has the same meaning as the sentence presented before it and write F on the answer sheet.

One of the English evening study sessions was selected to test working memory capacity by presenting the subjects with a pretest, explaining the rules as soon as the pretest was administered, and then taking the formal test.

3.2.2. English Proficiency Test

The English proficiency test scores were based on the results of a monthly test in the second half of the second semester of the high school's school year, which was conducted jointly by a number of schools in Chengdu and had a high degree of reliability and validity. The test lasted 2 hours and was scored out of 150 points. It was cross-marked and objectively and fairly graded by experienced teachers from other classes in the school.

3.3. Data Processing

SPSS 26.0 was used to process and analyze the collected data.

4. Results

4.1. Descriptive Statistics of Working Memory Capacity and English Language Proficiency

It is necessary to examine the data and perform hypothesis testing before performing formal statistical testing. Conducting data examination allows you to test whether the data are correct, for example, incorrectly entered, too large, too small or singular values. Hypothesis testing is to test whether the distributional trends and characteristics of the data meet the conditions of the parametric test in order to determine which statistical method to use for later statistics and analysis. The various items of data are examined, mainly to test whether the data are normally distributed.

The manuscript should include a conclusion. In this section, summarize what was described in your paper. Future directions may also be included in this section. Authors are strongly encouraged not to reference multiple figures or tables in the conclusion; these should be referenced in the body of the paper.

The statistical scales described in Table 1 include the mean, variance, standard deviation, maximum, minimum, skewness, and kurtosis of the English test scores, working memory scores, objective question scores, and subjective question scores. The standard deviation of working memory capacity of the subjects was 6.576, which is a very large difference from their mean value of 71.08, which indicates that there is a large difference in the working memory test scores among the students, which means that there is a significant difference in the working memory capacity of the subjects in English language. Similarly, the standard deviation of the subjects' English test scores is 10.3334, which is a very large difference from their mean value of 93.892, which indicates that there are some differences in English test scores among the students, and in this table it can be determined by skewness and kurtosis whether the English test, objective questions, subjective questions and working memory capacity are normally distributed or not. If the data are normally distributed, then their skewness and kurtosis should be between negative 1 and positive 1.

Table 1. Descriptive Statistics of English Test Scores, Working Memory Scores, Objective Question Scores and Subjective Question Scores (a)

	average	variance	standard deviation	maximum
English test grades	93.892	106.778	10.3334	117.5
Working memory tests grades	71.08	43.243	6.576	79

(b)

	minimum	skewness	kurtosis
English test grades	75.5	0.416	-0.246
Working memory tests grades	54	-0.972	0.472

Table 2. Normality Tests for English Test Scores, Working Memory Scores

Objective Question Scores, and Subjective Question Scores Kolmogorov-Smirnova			
	Statisticians	Degrees of freedom	Significance
English test grades	0.121	37	0.188
Working memory tests grades	0.144	37	0.052

The kurtosis and skewness of the English test, objective, subjective and working memory capacities are between negative 1 and positive 1. In addition, from the normality test of English test scores, working memory scores, objective questions scores and subjective questions scores, it can be concluded that the level of significance is greater than 0.05, therefore, it cannot be considered that the distribution of the four variables of English test, subjective questions, objective questions and working memory is significantly different from the normal distribution, therefore, it can be concluded that the four variables of English test, subjective questions, objective questions and working memory can be used in the parametric test.

4.2. Correlation Analysis of English Test Scores with Working Memory Capacity

The relationship and degree of correlation between English test scores and working memory capacity were examined using Pearson's correlation.

The analysis was done to test the degree of correlation and the results are shown in Table 4.3. In statistics, usually if the absolute value is greater than 0.90, it is the highest correlation, but this is rare; 0.70-0.90 is high correlation, which means significant correlation; 0.40-0.70 is effective correlation, which means more significant correlation; 0.20-0.40 is low

correlation; and the correlation coefficient with the absolute value lower than 0.20 is called the lowest correlation. Table 4.3 shows that the correlation coefficient between English test scores and working memory capacity is 0.642, which means that there is a significant correlation and a positive linear relationship between them.

Table 3. The Relationship between English Grades and Working Memory Capacity

		English Test Grades	Working Memory Capacity
English Test Grades	Pearson correlation	1	0.642**
	Significance (two-tailed)		0.000
	Number of cases	37	37

5. Discussion and Conclusion

This study explored and analyzed the relationship between working memory capacity and English reading comprehension, which is significantly correlated. The working memory capacity test in this study requires subjects to process and store information accurately and efficiently within a time-limited period of time, that is, each set of working memory capacity test examines the subjects' processing and storing capacity, and for each set of test questions presented on the computer, subjects first need to determine whether the meaning of the sentence is correct to test information processing capacity, and then read and memorize the words at the end of the sentence to examine the information storing capacity The computerized test questions are presented on the computer. In terms of working memory, its four subsystems: the visuospatial template, the phonological loop, and the central executive system and situational buffer, the entire reading process requires the active participation of working memory. During second language reading comprehension, the phonological loop in working memory is responsible for linguistic repetition of visual vocabulary to prevent forgetting, as well as the establishment of connections to information in long term memory. For the preparation of further lexical processing, concept extraction, and meaning formation; for the context of incomplete information, the working memory is provided with related knowledge and speculation about schemas and other information; for the processing of information (Baddeley, 2007) to form schemas and scenarios there is a context buffer; for the supervision of processing, collaboration, and adjustment of other parts of the information there is a central executive management; and for the supervision of processing, collaboration, and adjustment of other parts of information there is a central executive management; and if there is a need to process information, there is a central executive management. adjustment is managed by the central executive; and if spatial information such as distance and location in the text needs to be processed, the attempted spatial template will come into play. In addition, when the learner embarks on the English task, the relevant knowledge points of the language in the text will be decoded and processed in the executive system. The visuospatial template is then temporarily recalled and important information is temporarily stored. Scenario buffers are devices with limited capacity for temporarily storing the information provided by the centralized Various coded information for performing system control. And the system can detect and extract relevant information from the memory and reflective information, but also to correct the information if necessary.

During reading, learners may attempt to analyze and process information based on their high-level knowledge. This primarily requires them to have a comprehensive understanding of the world, language and context. The reading process requires a complementary combination of the two approaches, which is the process that demonstrates the readers' full understanding of the content of the text. Comprehending readers use a top-down approach to grasp the overall structure of a text, and then use a bottom-up approach to check that the details are fully and reasonably understood. The comprehension results obtained from these interactions should be simultaneous rather than sequential.

References

[1] Linck, J. A., Osthus, P., Koeth, J. T. & Bunting, M. F. Working memory and second language comprehension and production: a meta-analysis [J]. Psychonomic Bulletin Review, 2014, (21), 861-883.

[2] Leeser, M. J. Learner-based factors in L2 reading comprehension and processing grammatical form: topic familiarity and working memory [J]. Language Learning, 2007, (57), 229-270.

[3] Chen, B. & Xu, H. H.. (2010). Effects of differences in working memory capacity on second language syntactic ambiguous sentence processing. Journal of Psychology (02), 185-192.

[4] Ren Hulin. (2013). A study of the effect of working memory capacity size on the processing of bilingual complex sentences. Chinese Foreign Language(02),73-78+82. doi:10.13564/j. cnki.issn.1672-9382.2013.02.014.

[5] Skehan, P. Working memory and second language performance: a commentary [A].

[6] Jung, J. (2018). Effects of task complexity and working memory capacity on L2 reading comprehension. system, 74, 21-37. doi:10.1016/j.system.2018.02.005.

[7] Montero Perez, M. (2020). Incidental Vocabulary Learning through Viewing Video. Studies in Second Language Acquisition, 42(4), 749-773. doi:10.1017/s0272263119000706.

[8] Zang, Q., Zheng, Yuxuan & Xu, H. M.. (2020). Analysis of lexical error patterns in interpreting tests - A working memory perspective. Foreign Language Testing and Teaching (01), 17-25.

[9] Teng, M. F. (2022). The Roles of Second-Language Proficiency Level and Working Memory on Vocabulary Learning from Word-Focused Exercises. RELC Journal. doi:10.1177/ 00336882221102228.

[10] Ruiz, S., Rebuschat, P., & Meurers, D. (2019). The effects of working memory and declarative memory on instructed second language vocabulary learning: insights from intelligent CALL. language Teaching Research, 25(4), 510-539. doi:10.1177/ 1362168819872859.

[11] Varol, B., & Erçetin, G. (2019). Effects of gloss type, gloss position, and working memory capacity on second language comprehension in electronic reading. computer Assisted Language Learning, 34(7), 820-844. doi: 10.1080/ 09588221. 2019.1643738.

[12] Martin, K. I., & Ellis, N. C. (2012). The Roles of Phonological Short-Term Memory and Working Memory in L2 Grammar and Vocabulary Learning. studies in Second Studies in Second

Language Acquisition. 34(3), 379-413. doi: 10.1017/ s0272 263112000125.

[13] Teng, M. F. (2023). Effectiveness of captioned videos for incidental vocabulary learning and retention: the role of working memory. Computer Assisted Language Learning,. 1-29. doi:10.1080/09588221.2023.2173613.

[14] Sok, S., Shin, H. W., & Do, J. (2021). Exploring which test-taker characteristics predict young L2 learners' performance on listening and reading comprehension tests. Language Testing, 38(3), 378-400. doi: 10.1177/ 026553222 1991134.

[15] Carretti, B., Caldarola, N., Tencati, C., & Cornoldi, C. (2014). Improving reading comprehension in reading and listening settings: the effect of two training programs focusing on metacognition and working memory . br J Educ Psychol, 84(Pt 2), 194-210. doi:10.1111/bjep.12022.

[16] Osman, H., & Sullivan, J. R. (2014). Children's Auditory Working Memory Performance in Degraded Listening Conditions. Journal of Speech, Language, and Hearing Research, 57(4), 1503- 1511. doi: 10.1044/ 2014_jslhr -h-13-0286.

[17] Kim, M., Nam, Y., & Crossley, S. A. (2022). Roles of working memory, syllogistic inferencing ability, and linguistic knowledge on second language listening comprehension for passages of different lengths. Language Testing, 39(4), 593-617. doi:10.1177/02655322211060076.

[18] Brunfaut, T., Kormos, J., Michel, M., & Ratajczak, M. (2021). Testing young foreign language learners' reading comprehension: exploring the effects of working memory, grade level, and reading task. Language Testing, 38(3), 356-377. doi:10.1177/0265532221991480.

[19] Li, S., & Roshan, S. (2019). The associations between working memory and the effects of four different types of written corrective feedback. journal of Second Language Writing, 45,. 1-15. doi:10.1016/j.jslw.2019.03.003.

[20] Michel, M., Kormos, J., Brunfaut, T., & Ratajczak, M. (2019). The role of working memory in young second language learners' written performances. Journal of Second Language Writing, 45, 31-45. doi. 10.1016/j.jslw.2019.03.002.