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Working Memory and Vocabulary Learning

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Abstract: The importance of cognitive factors, in particular, working memory, stands out as a crucial thread that connects the learning and retention processes in the complex web of second language acquisition. The limited capacity mechanism known as working memory, which is in charge of temporarily storing and manipulating information, is essential to the acquisition of vocabulary. Therefore, this study aims to explore the relationship between working memory and vocabulary learning in adult second language (L2) learners. The investigation engaged 40 adult participants who undertook a series of tasks designed to probe their working memory capabilities and assess their vocabulary learning outcomes. These tasks included a comprehensive questionnaire to gather demographic and linguistic background data, a Corsi block tapping task to measure working memory span, a targeted vocabulary learning session, and a subsequent word test to evaluate retention and application. The result showed a strikingly strong correlation between working memory capacity and vocabulary learning efficiency among L2 learners.

Keywords: Vocabulary learning, working memory, L2 learning.

1. Introduction

In the process of learning a language, both cognitive and affective memory play a decisive role. As a complicated mental workspace, memory is the area of the brain in which various kinds of information and resources are maintained, processed and retrieved, and where countless tasks are performed in the process. Working memory (WM) is an important component of memory, and it is largely responsible for the process of language learning. Due to the determinative role, it plays in the required cognitive processes, WM is regarded as the most necessary part of language attainment [1].

Baddeley gave a definition of WM as a system for temporarily storing and controlling the information demanded for various complicated cognitive activities [2]. Shenfield [3] stated that WM is the capacity that mentally preserve previously acquired knowledge and receive updated source, applying them to accomplish tasks and resolve problems. Working memory is influenced by many factors, such as the speed and effectiveness of information processing, the capacity to retain both verbal and spatial data, and the deft balancing of attention needed to harmonize and integrate the various components of storage and processing [4,5].

The Multicomponent Model of Working Memory includes four components [4]: the phonological loop, the visuospatial sketchpad, the central executive and the episodic buffer. The pivotal component, commonly referred to as the central executive, holds the crucial responsibility of deciding the precise timing and location for information delivery. Additionally, it oversees critical functions such as

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focusing attention, dividing it among various tasks, switching attention between them, and establishing connections between working memory and long-term memory. The central executive controls two temporary storage systems: the phonological loop and the visuospatial sketch. The phonological loop functions as a repository for speech-oriented information, tasked with storing, manipulating, and retaining auditory material for brief durations. Meanwhile, the visuospatial sketch serves as a storage system for visual and spatial data, which comes into play during thinking, recollection, and processing tasks. Additionally, the episodic buffer represents a crucial storage element of the central executive.

Daneman and Carpenter [6], Ibarra-Santacruz and Martínez-Ortega pointed out that different individuals have unequal WM capacities. Corroborated by Atkins and Baddeley [7] as well as Daneman and Hannon [8], it is proven that people with a greater working memory capacity show better competence in learning the vocabulary of both first and second languages. Since vocabulary learning is the most critical part of the acquisition of a second language [9], most learners are informed that it is necessary to learn a sufficient number of new words in order to attain a higher language level [10]. Based on the research of Service [11], It is widely held that Finnish children who possess strong working memory capabilities tend to excel in acquiring English vocabulary and syntax as a second language, in contrast to those with limited WM capacity. Taken together, these findings show the significance of the role played by working memory in the process of acquiring a second language.

Many researchers have observed the close relationship between working memory and language learning [12]. Daneman and Merikle [13] suggested that there exists a significant correlation between one's working memory capacity and their ability to comprehend language, and other researchers [14,15] have stated that working memory and fluid intelligence of language are closely related. Therefore, in response to these studies, this paper proceed from the hypothesis that a positive correlation exists between working memory and word learning. This would be proven by better performance in the Corsi block tapping task corresponding with a higher score in the word test.

2. Methodology

2.1. The Participants

A total of 40 participants took part in this experiment, of which 26 were female and 14 were male. Their average age was around 38.2 years. In terms of languages spoken, all of the participants were able to use English as either their mother tongue or a second language. There were 3 monolinguals, 13 bilinguals and 24 multilinguals who were capable of speaking several languages. The participants were various regarding had varied language backgrounds, but were predominantly speakers of English, Dutch, German and Romanian. Most of them had no experience in learning Turkish before this experiment, the relevance of which will be shown in the following section. Most importantly, none of the participants had any form of brain disease or disorder, and all were right-handed.

2.2. Design And Procedure

2.2.1. Background Questionnaire

Firstly, each participant completed a questionnaire which was comprised of four parts. The first part asked for individual information requiring them to fill in their age, gender, languages spoken and nationality. This information would be used to show the demographic independent variables of participants. Next, as was necessary to accomplish the experiment, the respective situations of brain health and the usage of the left hand were inquired about, aiming to ensure experimental accuracy. The final part shown as Table 1 was the self-reported attitudes of participants towards the Turkish language, in order to know their individual views about Turkish vocabulary learning.

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Table 1: Self-reported attitudes questionnaire

	Strongly disagree	Disagree	Rather disagree	Rather agree	Agree	Strongly agree
a) I enjoy learning new languages.						
b) I think it's easy to learn new languages.						
c) I like the Turkish language.						
d) I would like to be able to speak Turkish.						
e) I consider myself a bilingual/multilingual.						

2.2.2. Corsi Block Tapping Task

As the goal of experiment is to compare the proficiency of working memory and word learning, the Corsi block tapping task was chosen to best present working memory because it is extensively applied in the assessment of visuospatial working memory. While nine square blocks placed on a wooden board are traditionally used, some digital versions are popular nowadays because of their advantages in installation and ease of use and more accurate time control, as well as automatic span and reaction time measurement [16]. For this reason, this paper chose to use the digital version of the Corsi block tapping task to assess working memory.

A total of nine blocks were shown on the screen. The participant used the mouse to point to a series of blocks, and each participant was demanded to replicate the sequence in which the blocks were pointed to. The number of blocks was increased as long as the participant continued to be successful [17]. Otherwise, the incorrect number of blocks would be repeated again. If the participant made a mistake again, the test would be ended.

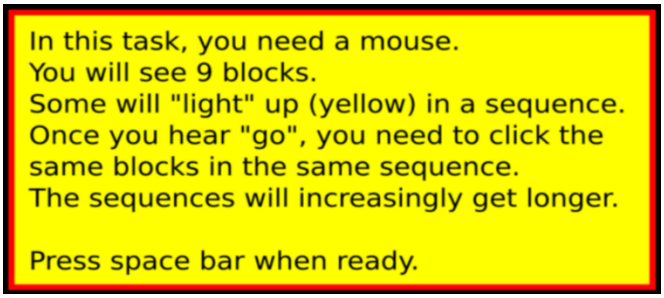

Figure 1: The instruction of the Corsi block tapping task

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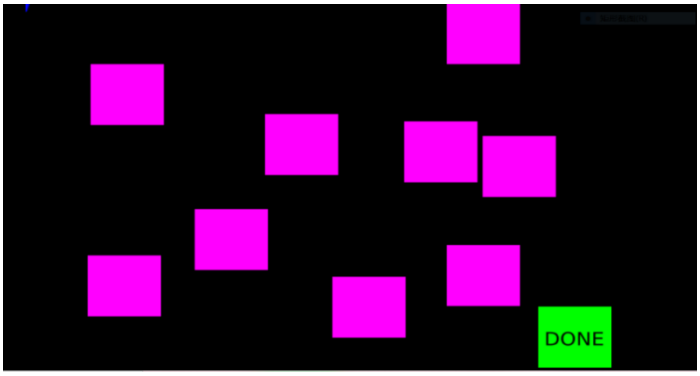

Figure 2: The Corsi task showing on the screen.

2.2.3. Vocabulary Learning

Thirdly, this paper selected fifteen Turkish words for the word learning and test. Among these words, five of them were easy and cognate words of English, Dutch, German and Romanian while the other ten words were more difficult, non-cognate and in a lower frequency. For the participants to learn and memorize them in a limited time, this paper designed four YouTube videos to automatically transmit and demonstrate fifteen Turkish words on the left and their translation into the four respective languages on the right. For the experimental accuracy and efficacy, it was necessary to maintain the time at five seconds for each Turkish word and a pause of one second after each word.

2.2.4. Word Test

The final step of the experiment was to take a vocabulary assessment (see Table 2.), the purpose of which was to measure the proficiency of the participants. A multiple-choice assessment was designed which included 15 questions on word meaning for each of the language speakers. The score of the test was referred to as the performance of word learning.

Table 2: Turkish Word List

	Turkish	English Translation	Dutch Translation	German Translation	Romanian Translation
1	Adaptasyon	Adaptation	Aanpassing	Anpassung/Adaption	Adaptare
2	Ofis	Office	Kantoor	Büro	Birou
3	Branş	Branch	Afdeling	Zweig (Branche?)	Branșă
4	Prensip	Principle	Principe	Grundsatz/Prinzip	Pirincipiu
5	Patates	Potato	Aardappel	Kartoffel	Cartofi
6	Kitap	Book	Boek	Buch	Carte
7	Ayakkabı	Shoe	Schoen	Schuh	Încălțăminte
8	Zengin	Rich	Rijk	Reich	Bogat
9	Belediye	City hall	Gemeentehuis	Rathaus (Gemeinde?)	Primărie
10	Kaşık	Spoon	Lepel	Löffel	Lingură
11	Kız kardeş	Sister	Zus	Schwester	Soră
12	Fikir	Opinion	Mening	Stellungnahme (Idee?)	Opinie
13	Köpek	Dog	Hond	Hund	Câine
14	Tembellik	Laziness	Luiheid	Faulheit	Leneș
15	Araba	Car	Auto	Auto	Mașină

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3. Results

As Table 3 and Table 4 shown, the characteristics of participants and the descriptive statistics data of the score of the tapping task and word learning test. And in terms of Figure 3, the results of the Spearman correlation test show that the relationship between working memory and word learning is positively significant, $P < .05$, $r=0.883$.

Table 3: Participants' characteristics

Language spoken	Dutch		English		German		Romanian	
	Male	Female	Male	Female	Male	Female	Male	Female
Group size (N)	3	7	4	6	2	8	5	5
Mean age (SD)	35 (8.1)	30.4 (8.5)	35.5 (5.3)	27.7 (9.7)	27 (5.1)	30.3 (8.2)	25.2 (3.8)	33.8 (5.2)
Language background (N)	Bilingual: 1 Multilingual: 9		Monolingual: 3 Bilingual: 3 Multilingual: 4		Bilingual: 5 Multilingual: 5		Bilingual: 7 Multilingual: 3	
Higher education background	College degree: 2 Bachelor degree: 7 Master degree: 1 None: 0		College degree: 0 Bachelor degree: 5 Master degree: 3 None: 0		College degree: 2 Bachelor degree: 3 Master degree: 4 None: 1		College degree: 0 Bachelor degree: 5 Master degree: 5 None: 0	

Table 4: The descriptive statistics data of scores of working memory and word learning test

	Corsi test score	Word test score
Mean	5.2	8.8
Mode	5	9
Median	5	9
Max	9	15
Min	1	3
SD	2.3	3.7

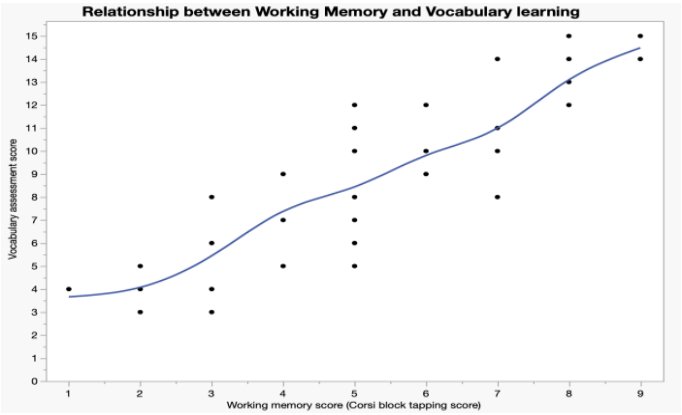

Figure 3: The scatterplot of the relationship between working memory and word learning.

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4. Conclusion

Regarding the test of the correlation between WM and word learning, the experiment could be improved in some aspects in addition to the number of participants in each representative group. Controlling the independent variables of educational and language backgrounds would be one way to do this. As Pliatsikas et al. [18] stated, WM is influenced by various factors, including gender, education and age. There are also some elements that affect new language acquisition, such as the level of proficiency, learning contents, previous knowledge and L2 [19]. Further, the time of exposure to vocabulary which is needed to strengthen the connection between target vocabulary and mental responses also plays a crucial role in word learning [20]. Therefore, to acquire the expectations taken from prior studies, more rigorous control of variables and conditions is necessary for this sort of experiment.

To summarize, concerning WM and word learning, an improved experiment may allow us to reach the expectation that the better the working memory, the more proficient the word learning. It is testified in many previous researches that the word learning process and temporary storage (WM) are closely related, and this paper would expect the results of an improved experiment to further verify this finding.

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