



Archivos Venezolanos de Farmacología y  
Terapéutica  
ISSN: 0798-0264  
revista.avft@gmail.com  
Sociedad Venezolana de Farmacología Clínica y  
Terapéutica  
Venezuela

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Archivos Venezolanos de Farmacología y Terapéutica, vol. 39, no. 7, 2020

Sociedad Venezolana de Farmacología Clínica y Terapéutica, Venezuela

**Available in:** <https://www.redalyc.org/articulo.oa?id=55965388018>

**DOI:** <https://doi.org/10.5281/zenodo.4426267>

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# The role of phonological loop in working memory: a visual-related experiment

El papel del bucle fonológico en la memoria de trabajo: un experimento relacionado con lo visual

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DOI: <https://doi.org/10.5281/zenodo.4426267>  
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Received: 28 August 2020

Accepted: 15 September 2020

Published: 15 September 2020

## ABSTRACT:

The mixed methods study presented in this paper investigates the role of the phonological loop in working memory. This research article examines the effects of the phonological loop by using mental tasks among Master of Arts (MA) university students of different nationalities. The phonological loop has consisted of two components. The first is the phonological store which is associated with the perception of speech, and the second is the articulatory control process which is related to the production of speech. As a research tool, a visual-related task is used, including two lists of words A and B with various numbers of syllables. Through an iterative process, common concepts emerge that give rise to dominant emerging themes such as imagination, mental rehearsal, association, personal strategies, time, emotions, psychological factor. According to most of the participants, they rehearse the words several times from the list of words A which marks the existence of articulatory control in the phonological loop. However, this component of the phonological loop is not fulfilled in this experiment when the students started to perform the experiment from List B. The conclusion can be elicited that the phonological loop does not play a role in this case.

**KEYWORDS:** phonological loop, working memory, articulatory control.

## RESUMEN:

El estudio de métodos mixtos presentado en este artículo investiga el papel del bucle fonológico en la memoria de trabajo. Este artículo de investigación ejemplifica los efectos del bucle fonológico mediante el uso de tareas mentales entre estudiantes universitarios de maestría de diferentes nacionalidades. El bucle fonológico consta de dos componentes. El primero es el almacén fonológico que está asociado con la percepción del habla y el segundo es el proceso de control articulatorio que está asociado con la producción del habla. Como herramienta de investigación, se utiliza una tarea relacionada con lo visual que incluye dos listas de palabras A y B con varios números de sílabas. A través de un proceso iterativo, surgen conceptos comunes que dan lugar a temas emergentes dominantes como imaginación, ensayo mental, asociación, estrategias personales, tiempo, emociones, factor psicológico. Según la mayoría de los participantes, ensayan varias veces las palabras de la lista de palabras A que marca la existencia de control articulatorio en el bucle fonológico. Sin embargo, este componente del bucle fonológico no se cumple en este experimento cuando los estudiantes comenzaron a realizar el experimento de la Lista B. Se puede sacar la conclusión de que el bucle fonológico no juega un papel en este caso.

**PALABRAS CLAVE:** bucle fonológico, memoria de trabajo, control articulatorio.

## INTRODUCTION

In the second half of the 20<sup>th</sup> century, the interests of linguistics and psychology clearly have moved into the sphere of psycholinguistics, giving primary attention to working memory. Working memory includes coherent groups of cognitive functions. According to Baddeley and Hitch (1974), the phonological loop is the second group of functions in working memory that deals with spoken and written production and plays

a critical role as rehearsing the information when individuals memorize<sup>1</sup>. Phonological loop features a type of 'inner voice', consisting of two parts. The first is 'phonological store' which is linked to speech perception and keeps information in speech-based form for one or two seconds, and the second is 'articulatory control process' which is linked to speech production and acts like inner voice rehearsing information from the phonological store. However, it is striking how the role of phonological loop in working memory plays in a visual-related experiment<sup>2, 3</sup>. In this regard, the aim of this paper is to investigate the effects of the phonological loop by using mental tasks among MA university students. Drawing on it, the research question of the current study is the following: What is the role of phonological loop in working memory among MA university students?

## METHOD

### Instruments

The research method for this study was a mixed method research design that allowed us to examine students' effects of phonological loop by using an experimental task from a psychological book 'Psycholinguistics: A Resource Book for Student' created by John Field<sup>4</sup>. It includes two lists of words A and B. List A had twelve mono-syllable words: strange, brought, sparkle, dressed, though, station, glanced, squeeze, clothes, ground, bridge, please, scratch, flowers and list B had twelve polysyllabic words (caravan, imitate, cinema, visible, satisfy, animal, economy, educate, holiday, potato, family, occupy, another, musical). It is normally to assume that List B is harder to remember than List A because of various numbers of syllables. It can be seen that in List A is averagely two syllables, while in List B it rises up to three syllables, therefore, it is necessary to take more time and efforts to memorize the words from List B.

### Participants

The subjects were consisted of 20 students among which 10 females and 10 males were. They were from different nationalities: Hungarian, French, Russian, Azerbaijani, Spanish, Tunisian Brazilian and Chinese. Levels of education represented in the sample included MA degree. All these participants were equipped with an advanced level of English. In order to obtain more persuasive results, 20 participants were divided equally into two groups, one of which were first given List A and then List B, while the other were performed the opposite.

### Procedure

All words were put on the slides by arranging each word on each slide. The participants watched each word during two seconds. After finishing the list, participants were asked to write down all the words they remember, the same procedure was done with the second list of words. Then, the students were asked the question about what their experience was while they were looking at the words to memorize them. They should answer with a detailed description. The answers were transcribed and analyzed with the help of recording devices.

### Data Analysis

20 answers were chosen for this analysis. All the participants clearly understood the task, and they were very explicit and direct in their answers. With the help of qualitative content analysis, the collected data was coded manually following line-by-line scrutiny. The main key-words were examined in the context, and then the texts were systematically scrutinized to find all the words and phrases which had similar meanings. Through an iterative process, common concepts emerged that gave rise to dominant emerging themes. By taking into consideration the aim of this research, all the relevant information from the data was codified and used to identify the influence of phonological loop in working memory.

## RESULTS AND DISCUSSION

This section highlights the findings of the study. Unsurprisingly, all the participants exhausted themselves to memorize the tricky words, and they scored differently. The overall results are shown in the table below (see Table 1).

TABLE 1  
The number of remembered words from List A and List B

Participants	List A	List B
P1	5	11
P2	5	10
P3	6	12
P4	7	9
P5	6	7
P6	7	7
P7	8	3
P8	9	7
P9	7	9
P10	7	5
Total %	47,8%	57,1%
	List B	List A
P11	10	11
P12	8	10
P13	9	11
P14	8	9
P15	8	8
P16	2	3
P17	10	3
P18	9	9
P19	7	6
P20	8	5
Total %	56,4%	53,5%

The data was divided in two categories: List A and List B. The first category (when students started to perform the experiment from List A) includes the following emerging themes. These themes were obtained based on what students reported after they completed List A of the experimental tasks. They were specific in providing answers about the procedure which they used in order to recall the words. They indicated their emotional states and other important features that were useful to summarize and represent in this section.

It is noticeable that most of the students (7 participants) used their 'inner speech' to rehearse when they were trying to remember the words. The following responses indicate about this: "I repeated these words in my head and then read them once again in order to memorize very well", or "I formed sentences with the words in my head and I repeated them". The rehearsal process plays an important role and results in a limited capacity of working memory. The rehearsal process can be after a certain number of items or when the first item will fade before it can be rehearsed<sup>2</sup>. When an individual is trying to acquire knowledge, he needs to become familiar with it by using it in repeated occasions until it is really remembered and transferred into long term memory. Consequently, mental rehearsal techniques that the participants used in these experimental tasks could be attributed to mnemonic strategies which they have acquired during their study period<sup>3</sup>.

Moreover, participants reported that they depended on their mother tongue, due to its high efficiency. However, to the contrary, some of the students claimed that they tried to take the words in their original

forms as they thought it took more time to translate into the native language. Interestingly, Participant 5 added that she repeated in Russian when the words were easy for her, but in English when it came to difficult words, like the word 'scratch' that was an unfamiliar word to her, although, she could guess how to pronounce it. Under that circumstance, she attempted to rehearse in English and managed to write the word down. Logie (2003) considered that the ability to repeat an unfamiliar speech sound that is a feature of the phonological loop is important for acquiring vocabulary and other language skills <sup>4</sup>.

Based on the data acquired, it was found that the students made associations with some words in order to memorize them. Some of the participants reported that "I associate the words by finding relevance between them: sparkle-clothes", "I come up with some associations by adding some attributes, for example, beautiful clothes". These results are related to the fact that some students are accustomed to use mnemonic strategies that have been acquired as a learning strategy <sup>5</sup>. Van Blerkom (2009) found that the importance of a good working memory is determined when something new is learned, when logical connections are not yet formed, therefore, the working memory load is high <sup>5</sup>. When students have significant associations between the elements of a body of material, it is easier for them to remember familiar words because content can be logically organized into a coherent and cohesive structure <sup>5</sup>.

Special attention should be given to the emerging theme 'Imagination'. During the content analysis of the transcribed texts, some imaginary structures were identified. The students read the words one by one and created images for some of them in order to facilitate their memory retention. However, as this section is discussing participants who started to work from List A, it was found that the words from List A were more complex for the students to remember than List B. The words such as bridge, clothes, station and flower were associated with the images easily. These were some of the expressions that participants reported: "I looked at the word and immediately manage myself to generate a picture that represents that word", "I saw the word 'station', and I imagined myself at a bus station". The images are easier to remember than words that recall abstract concepts. According to Cytowic (2002), the memory can be enhanced with the help of the imagination. The images must be well defined, but we must also modify them and give them characteristics that can link them to the concepts we want to store <sup>6</sup>.

The results show that 2 students made use of some useful personal strategies that helped them to retain the words in their memory. They gave the following responses: "I divided the words in the categories by considering the first letter of each one", "I tried to remember the words by memorizing pair words which sound with the same rhyme, for example, satisfy-occupy, they sound the same tone". The findings are consistent with the study of McNamara and Scott (2001) that more strategic participants display better working memory task performance and better verbal and written skills <sup>7</sup>. In this study, Participant 12 and Participant 14 remembered the most number of the words, using their own strategies.

It was found that two students mentioned about limited time for memorizing words and their emotional state. It can be noticed that these students felt anxiety when they tried to memorize the words, and they worried that they lost control over assigned time. One of the respondents told "...for me time was short that I could not have the possibility to string everything". They experienced negative thoughts that they cannot remember the words in the lists correctly. The effect of emotional state influence on how individual processes information, or adapts, or exchanges it. Despite the adaptive role of emotions, it may impair the ability to monitor and comprehend the information that should be processed <sup>8</sup>.

Additionally, Participant 16 memorized only 2 words from List A and 3 words from List B, referencing on bad memory. However, the reason that the results of this participant are lower is Attention Deficit Hyperactivity Disorder. This psychological factor creates difficulties for the individual with ADHD in cognitive and academic activities. Difficulties arising from impaired working memory may interfere not only with working memory, but with rules to manage behavior, moral inferences and other skills <sup>9</sup>.

The second category, which contains 7 emerging themes, includes the data from List B, which was given the first and then List A. Among the most frequent participants' answers about the experience how students were performing the words in memory, it was identified that five participants created stories. Some of them reported that "I started to connect words from list B in order to create a story. For example, students are going in the caravan", "I created a scene or a story with the words from List B", "I tried to put words in the sentences and to build a logical story. In this case, it was easier to remember for me". The findings testify that creating a story line for some people what they wish to remember is a simple and powerful way of binding ideas together, in a way, that allows easy and quick to recollect the appropriate words. Moreover, it was found that imagination helped the participants to build the stories. Most of them added to their answers that they also imagined the words in their mind before to create a story. In this case, the results indicate that individuals are better to retrieve words from List B when they imagine them than individuals who pronounce the words inwardly.

It should be noted that the emerging theme 'Mental rehearsal' is lower than in the previous category. Only 3 respondents used inner speech. They pointed out that they repeated every word once or twice, but all mentally, no one spoke it out. The fact that 'mental rehearsal' is not dominant, it is possible to explain that most of the participants utilized a similar strategy. They used the methods such as making connection, or meaningful operation, or imagination in order to memorize the words.

As for the emerging theme 'Association', the results show that the students had similar features: "For me some words were associated with positive feelings such as holiday: fun and entertainment", "At the beginning I made a mistake instead of writing the word 'brought', I wrote the word 'breath' because I associated it with smell of the flowers, but then I have corrected myself", "The words from list B are associated with my students' life. The word 'animal' is a common word; 'economy' is something that I connect with the saving money because I have to do it because of my status as a student. The word 'holiday' is my favorite part of the semester; 'educate' associates with the word 'to study' and 'potato' is concerned with the vegetable because I always see how my roommates use it for cooking at the dormitory". It was proved that memory associations are closely connected with images that are conjured up by our own mind and they are usually mentally associated with the visual images which are created to each other on the basis of similar characteristics<sup>10</sup>.

Some students in this study mentioned that they knew which results they would get. The following answers were: "I know I am going to fail in this experiment because I have a bad memory", "I have a very good memory, because I have previous experience as a pharmacist student where I needed to memorize more challenging terms and symbols", or "Every time that I participate in a kind of memory test I just can remember 5 words as maximum". Given attention to these answers, it can be said that students' assumptions influenced their performance of the experimental task. Furthermore, the human performance and success depends on how they personally perceive a given task, for instance, negatively or positively. According to Bandura (1997), individuals' beliefs in their abilities can be better predictors of future performance than their prior skills or knowledge<sup>11</sup>.

As for emotions, two participants reported what they felt while they made the mental task. These were some of their answers: "I feel comfortable with the task, no pressure at all", "I felt very anxious during this task because I was trying to rehearse the words in my head, and I don't know why, maybe, I was afraid of forgetting the words". Moreover, two participants pointed out that the time pressure was interfering their performance. They reported: "I did not feel comfortable with this task because you were measuring the time in front of me", "Only two seconds for each word is not enough, I think if I have had more time I would do it better". Thus, negative emotion as anxiety was reported by the participants. They did not feel confidence as they knew that they could forget of the words, or they had limited time for doing the task. However, it is important to mention that there was the participant who felt confident and no pressure during the task.



## CONCLUSION

This empirical research aims to investigate the role of phonological loop in working memory. The phonological loop is consisted of two components. The first is the phonological store which is associated with the perception of speech and the second is articulatory control process which is associated with the production of speech. The obtained data showed that phonological loop plays an important role in the case of mental rehearsal of the words from List A because all the participants more rehearsed. It is possible to say that the first component of phonological loop is included in this experiment. The other fact is that few participants rehearse the words several times which marks the existence of articulatory control in phonological loop. However, this component of the phonological loop is not fulfilled in this experiment when the students started to perform the experiment from List B as imagination and associations plays a key role to remember the words. Thus, the conclusion can be elicited that phonological loop does not play a role in this case. All participants scored better in List B than List A despite of various numbers of syllables in the words and probably because of the different testing order. To sum up, this study falsifies the assumption that it is harder to remember the words from List B. Moreover, it was pointed that emotions, personal beliefs, time, and personal strategies play an important role in a performance of the task and influence working memory.

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