

# Games for Working Memory Training in Foreign Language Learning<sup>1</sup>

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## Abstract

The purpose of this case study was to examine the effects of games for working memory training to enhance language learning in low performance students given that a considerable body of research has demonstrated that, among other factors, working memory may account for individual differences in linguistic achievement. The population consisted of nine low performance language students (English as a foreign language) from second, fourth, and sixth semester in the English and French program at Universidad de Nariño, Colombia, who received working memory training games during a six-week period. The results showed general improvement in the subjects' overall language performance during the sessions and in class, which confirmed the premise that if students are given a set of strategies to exercise and improve their memory, they are likely to use and replicate them when training is not taking place.

## Resumen

El objetivo de este estudio de caso fue examinar los efectos de juegos para entrenar la memoria de trabajo con el fin de optimizar el proceso de aprendizaje de idiomas en los estudiantes de bajo rendimiento. El estudio se basó en diversas investigaciones que han demostrado que la memoria de trabajo puede explicar las diferencias individuales en el rendimiento lingüístico. La población consistió en nueve estudiantes de inglés como lengua extranjera de segundo, cuarto y sexto semestre del programa de Inglés y Francés de la Universidad de Nariño, Colombia, quienes recibieron sesiones extra clase en las que estuvieron expuestos a una serie de juegos para entrenar la memoria de trabajo durante un período de seis semanas. Los resultados mostraron una mejora en el desempeño lingüístico general de los sujetos durante las sesiones y en clase, lo que confirmó la premisa de que, si los estudiantes reciben un conjunto de estrategias para ejercitar y mejorar su memoria, es probable que las repliquen y las utilicen autónomamente en situaciones subsiguientes.

## Introduction

Given that one of the purposes of research in second language acquisition is to minimize the chances of failure and enhance learning, it is imperative to examine the factors that may intervene in the process; one of them without a doubt is memory. Memory, in a broad sense, plays a vital role in a wide variety of tasks we perform on a daily basis, and learning is one of the most complex ones. Learning, of any sort, demands memory use and the ultimate aim is for learners to store all the knowledge they acquired in their memory system so that this can be promptly retrieved for use when needed. One specific memory type that has been closely linked to learning is *working memory*.

Working memory is defined as the cognitive system that keeps important information stored in a highly active state so that it can be easily accessed and manipulated in the service of cognitive activities and behavior (Baddeley & Hitch, 1974; Baddeley, 1986, 2003).

Extensive research (Atkinson, & Shiffrin, 1968; Baddeley, 1992, 2000; St. Clair-Thompson & Holmes, 2008; Daneman & Carpenter, 1980; Shenfield, 2012) has proved that this construct is a crucial component of development in a wide variety of learning and high-level cognitive tasks, including language learning. In the field of second language acquisition, evidence suggests that working memory is an essential factor associated with language processing, word acquisition, reading, comprehension, and even oral fluency. Similarly, Baddeley (2007) explains that it is working memory that is in charge of binding new information from diverse sources and long-term knowledge about language, grammar, and the structure of sentences. That is, it connects new material with information already stored in long-term memory to create meaningful units. The role of working memory in second language acquisition has gained interest given that its capacity, which varies from individual to individual, is a determining factor in linguistic achievement, and may also account for learner differences regarding success in this process (Baddeley, 1999; Ellis, 2001).

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Despite the limited working memory capacity some learners may display, it is believed that this cognitive system can be trained. The games for memory training implemented in this case study are intended to assist those learners with working memory limitations in retaining the information necessary to move forward in the process of language learning.

### What is Working Memory?

Memory is an essential cognitive process that makes it possible for us to store information and skills, which are the building blocks of learning. Memory plays a crucial role in almost any task we perform on a daily basis, from the simplest to the most complex one, even if we are not aware of using it. There are said to be different types of memory, but it is *working memory* that has become a construct of particular interest in the field of cognitive psychology, second language acquisition (SLA), and more recently, foreign language learning.

The term *working memory* refers to a brain structure that provides temporary storage and manipulation of the information necessary to perform high-level cognitive tasks, such as written and spoken language comprehension, reasoning, problem solving, and ultimately learning (Baddeley & Hitch, 1974; Baddeley, 1986, 2003).

How working memory operates has been explained by different theoretical models that differ in their views on the nature, structure, and function of the memory system (Atkins & Baddeley, 1998; Atkinson & Shiffrin, 1968; Conway et al., 2007; Miyake & Shah, 1999). However, the model proposed by Baddeley and Hitch (1974) is possibly the most widely accepted and cited. Baddeley and Hitch's former model divided the working memory system into two subsystems: First, a storage-based system that consists of the phonological loop and the visuospatial sketchpad, also known as slave systems, and second, an executive-attentional system that controls information between the slave systems and long-term memory stores (Baddeley, 1986; Baddeley & Hitch, 1974).

**Phonological loop.** This working memory component is described as a storage system for speech-based information. That is, it enables individuals to remember small amounts of heard information over short periods. The phonological loop is divided into two further subcomponents.

**The phonological store.** It is the area of the system in which speech material is held for short periods. It is believed that no more than two seconds worth of speech-related material can be held, which implies that this fades rapidly if not rehearsed.

**The articulatory rehearsal mechanism.** This part of the system has the primary function of repeating, either mentally or verbally, the information that has been previously held in the phonological store. Given that speech-based material cannot be held for more than two seconds, the rehearsal mechanism acts like a tape loop that refreshes the information, giving the individual two more seconds to retain it, enhancing the capacity of phonological short-term memory (Baddeley, 1986; Baddeley & Hitch, 1974).

**The visuospatial sketchpad.** It is the second storage-based system whose primary function is to temporarily hold information that individuals perceive with their sight. As Baddeley and Hitch (1974) explained, the visuospatial sketchpad allows individuals to remember the constituent components of what is seen and its place in space.

**The Central Executive.** This component is responsible for determining (1) when information is deposited in the storage buffers; (2) which buffer, the phonological loop for verbal information or the visuospatial sketchpad for visual, is selected for storage; (3) the information integration and coordination between the two buffers; and, most importantly, (4) a mechanism by which information held in the buffers can be inspected, transformed, and cognitively manipulated (Baddeley, 2000). Executive processes are probably the ones that determine individual differences in working memory capacity (Daneman & Carpenter, 1980), which has shown to be a strong predictor of successful performance in a wide range of complex cognitive skills, ranging from reading comprehension to learning electronics (Daneman & Merikle, 1996).

The model described above was the one Baddeley and Hitch (1974) formerly proposed. The model was said to explain, at least to a certain extent, the mental processes involved in information storage. However, it was believed that it failed to account for the effects of long-term memory on the working memory system.

As a result, the model suffered a major adjustment, which was evident in the incorporation of a fourth component: the *episodic buffer*.

Episodic buffer. Baddeley (2007) refers to this part of the system as the one in charge of two main tasks: 1) putting together information held in the two storage components, namely, the phonological loop and the visuospatial sketchpad, and convert it into a meaningful unit called *episode*, and 2) serving as a link between the central executive and long-term memory so that individuals can access and utilize stored knowledge during ongoing memory and processing tasks. This function probably represents a key advancement that was missing from the original working memory model.

### Working Memory and Language Learning

Working memory plays a role in a wide array of tasks, ranging from simple daily life activities to those that require high cognitive involvement such as second language acquisition. It is in this area that working memory has become an issue of particular interest. It has proven to be associated with language processing and comprehension (Sagarra, 2012; Szmalec et al., 2012; Wen et al., 2015) as well as being involved in the process of binding new multi-source information and long-term knowledge about language, grammar, and the structure of sentences. Extensive research on the participation of working memory in language learning has also suggested that its capacity, which varies from individual to individual, may explain the differences among adults when learning a second language (Baddeley, 1999; Ellis, 2001). It can then be implied that second language learning may not be as challenging for those individuals with larger memory capacity as it may be for those who display limitations in this area (Atkins & Baddeley, 1998; Daneman & Hannon, 2007).

In this sense, the results yielded in a study conducted by Baddeley, Papagno, and Vallar (1988, cited in Martin & Ellis, 2012) proved that individuals with limitations to rehearse speech-based material were likely to lose the information they heard, and it was not likely to be retrieved, hindering the process of language learning. The authors determined that the phonological loop, which is in charge of rehearsal, might have an impact on language processing because it is integrated with language comprehension and production systems. They state that mentally rehearsing what has been previously heard may provide a means for helping learn new words via a linkage of sound and meaning.

Similarly, Service (1992) conducted a study with a group of Finnish speaking primary school children during a three-year period in order to determine how the implementation of a series of tasks (non-word repetition, non-word copying, and comparing syntactic-semantic structures) could be used as a predictor of success in learning English as a second language. The findings showed that vocabulary learning in a foreign language is closely attached to the ability to recognize and represent phonological information in working memory.

Along the same lines, Ellis and Sinclair (1996) examined a group of adults learning Welsh as a foreign language. After applying a series of tasks with an experimental and a control group, the researchers found that those adults who were prompted to verbally rehearse utterances in the foreign language outperformed those who were prevented from doing it in both vocabulary and grammar learning. The researchers concluded that verbal rehearsal of words and structures made it easier for the subjects to learn and comprehend structures in the foreign language.

By the same token, Martin and Ellis (2012) analyzed how phonological short-term memory and working memory are linked to vocabulary and grammar learning. The authors initially measured the participants' working and phonological memory capacity and then tested the participants on their ability to recall vocabulary, and to infer and generalize grammar rules in an artificial language. From the results, it could be inferred that there was a strong correlation between working memory capacity and vocabulary and grammar comprehension and production. The researchers further explain that vocabulary learning depends on an individual's capacity to store vocabulary whereas grammar depends on the ability to not only store but also process more complex information, which is the role of working memory.

The previously cited evidence leads us to infer that there is a clear connection between working memory and second language acquisition. It is said that the latter is largely reliant on the working memory capacity because it is a process that involves retaining incoming information and processing it. If this is a fact, then it would be relevant to explore what this capacity depends on, and whether it can be somewhat manipulated to ease and enhance learning processes such as that of a language.

### Working Memory Problems

Considering the empirical evidence that backs up the vital role of working memory in language learning, it is pertinent to now tap onto the fact that a part of the explanation for individual differences regarding success in learning a second language is attributable to differences in the memory capacity. This is usually unknown or disregarded in the classroom; sometimes it is difficult to understand why learners, under same conditions, and in the same setting do not display similar levels of achievement, or in the worst-case scenario, do not show any signs of progress at all. This situation becomes a bit frustrating for both the learner and the teacher, who often are unable to identify the causes of the lack of improvement in language learning. Daneman and Merickle (1996) identified a variety of signs common among students with poor working memory:

1. Difficulty finishing tasks
2. Difficulty following verbal instructions
3. Shyness in class participation
4. Disengagement during class time
5. Difficulty responding verbally
6. Received information easily forgotten
7. Difficulty remembering vocabulary and structures
8. Difficulty reading some words
9. Skipping words when reading
10. Progress not observed.
11. Problems finding a pronoun's referent, resolving lexical ambiguity, and performing well on general comprehension (Daneman & Merickle, 1996).

Fortunately, there have been a number of studies identifying the sources of and the strategies to lessen the difficulties that arise from poor working memory. First, it is believed that the cognitive load influences the functioning of working memory. The amount of information, its nature, the speed of delivery, and previous knowledge are all important variables that influence the capacity and efficiency of processing of linguistic material. Thus, the first strategy to minimize the chance of learners failing on learning activities due to poor working memory has to do with how teachers deal with memory loads in the classroom. The storage demands of classroom tasks can be reduced by breaking down multiple step tasks into separate independent steps, repeating important information frequently in different ways, and using external memory aids such as notes on the teacher's board or useful spellings (Alloway, 2006; Gathercole & Alloway, 2004, 2007, 2008). The second strategy that could assist learners in processing task-related material has to do with presenting the information in short, simple sentences, and also with choosing content which learners may be familiar with (St. Clair-Thompson & Holmes, 2008). A third related approach involves exposing learners to information in depth, encouraging them to form links between existing and new knowledge, and completing one topic before moving on to the next (Reder & Anderson, 1980, as cited in St. Clair & Holmes, 2008).

The last alternative to deal with limited working memory is to tackle it directly. It can be done in two ways: by teaching learners to use strategies that allow them to use memory more efficiently, or by providing direct training and practice on working memory tasks. Chein and Morrison (2010) put forward *strategy training* as means to improve working memory. This type of training involves teaching learners a series of techniques to manipulate and store information to be later retrieved. Some examples include chunking (St Clair-Thompson, Stevens, Hunt, & Bolder, 2010, as cited in Morrison & Chein, 2011), creating a story with the information to be remembered (McNamara & Scott, 2001), and using imagery to make items more salient (Carretti et al., 2007, as cited in Morrison & Chein, 2011). The games for memory training implemented in this case study constitute some tools that can fall into the strategy training proposal; the purpose is to provide those learners with working memory limitations with a plethora of strategies they can use to retain information. The idea is that once they become familiar with these, they can transfer them into other language-related tasks, so that they make progress in the process of language learning, and ultimately improve their overall performance.

### Game-Like activities for Working Memory Activation

The following section presents a description of some games that can be adapted for the purpose of activating and training students' working memory to facilitate foreign language learning. Once again, these activities draw students' attention to some language related aspects such as vocabulary, grammar, or target culture, but are mainly intended to provide them with information processing strategies they can later use to recall information when engaged in other tasks.

**Proverbs.** According to Mieder (2004), a proverb can be defined as a short folk statement containing general truths. Even though they are thought to be outdated, they remain current in spoken language, and this makes them particularly useful in language teaching and learning when it comes to relying on authentic texts. In fact, teachers should incorporate proverbs in their lessons as they add authenticity and culture into the classroom, and can be used as standalone activities for teaching different aspects of the language (Akbarian, 2010). In terms of language aims, the idea is to analyze proverbs in the L2 that have an equivalent in the L1 in order to discuss cultural and linguistic aspects. Regarding working memory, by analyzing the message of the proverbs in depth, students are prompted to connect new knowledge to existing knowledge, and the long-term goal is to encourage them to create that link when presented with new content in future situations. This activity is suitable for learners at least at lower-intermediate level and up, as it is necessary that they have a basis to be able to discuss the meaning of the proverbs and not resort to translation straight away.

The implementation of this activity can be summarized as follows. In the preparation stage, the teacher decides on the proverbs to be used, which may also exist in the learners' L1 and can be easily represented by pictures to facilitate understanding; proverbs with their corresponding L1 equivalent were chosen to spur cultural debate and analysis in this particular situation (See Appendix 1). Then, having the proverbs printed, the teacher cuts them into halves and the first task for students is to work in groups and match the halves. After some minutes, teacher and students compare their matches and try to work out the meaning of the proverbs given. At this point, there is room to analyze the equivalent of the proverbs in the L1 and address some cultural aspects.

The competition stage consists of asking students in the group to write on the board the proverbs they can remember within three minutes; this stage focuses primarily on memory since the discussion regarding the meaning of the proverbs already took place. The student who is able to write the majority of them is the winner. Then a second stage in the competition is carried out in groups; one student from each group is chosen and his/her job is to take a proverb from a bag and make a drawing that represents it on the board. The other students must guess with proverb the drawing represents. The group that guesses the higher number of proverbs would be considered the winner.

As said before, the advantage of using proverbs lies in the fact that they can introduce different language activities that range from debates, presentations, composition, language analysis, and vocabulary learning all depending on the learners' proficiency level. Additionally, the conscious analysis of proverbs and the tasks that involve their manipulation may be beneficial for working memory activation. This analysis can then be transferred to other tasks that require learners to store information.

**Days of the week/months of the year.** When it comes to linguistic demands, the vocabulary this game includes may not represent a major challenge for learners; however, there are a number of aspects that can be tackled with this activity: learners may learn or consolidate vocabulary and practice proper pronunciation, which is sometimes problematic and taken for granted. Nevertheless, the main objective of this activity is to stimulate learners' attention, and therefore their working memory.

In this activity, students are asked to fill out a table provided by the teacher. Through this, they are asked to write the names of the days of the week and the months of the year (See Appendix 2). Once they have completed the table with the names in the common order they are used to, they have to fill out a second column in which the names should be written in alphabetical order, and then a third column in which the names should be written backwards, which means, they should be written from the last day or month name to the first one. After students have completed the table, they are asked to do the exercise orally. Here students are observed by the teacher who can assess the knowledge of the vocabulary items and the pronunciation of the words. At a later stage, the teacher can ask students to use their knowledge of the days of the week and months of the year in real communication situations. For example, they can be asked

to refer to pictures the teacher presents, so they talk about the day of the week depicted and/or the month of the year shown. In this way, students process the language they have stored in their working memory in a more communicative way.

**Identifying and using logos.** Logos have been used in many different Apps (e.g. Quiz: Logo game, Logo quiz, Logo quiz world). They can be used in the language classroom, at any level, as prompts to introduce various topics such as discussions related to the origin of the companies they represent, interesting facts around them, or even grammar. Concerning the memory-related aspects, it can be said that even though this activity revolves around the use of logos, the core purpose is to encourage the representation of information through images. In the long run, it is expected that learners use this technique to represent in mental images the information they are exposed to, and they need to recall. This technique is called *imagery* and has proved to be an effective tactic to store information (see Carretti et al. as cited in Chein & Morrison, 2010)

Regarding the procedure, first of all, it is worth mentioning that the logos that are chosen should be more or less familiar to students to facilitate their recognition process (See Appendix 3). This game starts with the teacher asking students to observe a logo and then identify the company it represents; this game is suitable for students at any proficiency level, but depending on that, the teacher may decide on the follow up activity at this stage, which can range from simple questions about the company to more elaborate discussions. The second stage is a logo bingo for which the teacher has previously created boards with different logo combinations on them for each student. To activate students' working memory, the teacher asks students to identify the logos that appear on the board. After that, the teacher draws a logo from a bag and calls out the name. Students cover on their board the logo that has been called out, and the one who covers them all first would be considered the winner. Finally, the teacher shows a sequence of logos for students to memorize it; they can see and study the sequence for 10 to 15 seconds, and then they are asked to say what the sequence was. As can be seen in this activity students manipulate the information in multiple ways: they use different senses with the purpose of first becoming familiar with the material, and then making a conscious effort to retain it and recall it, which are the roles of working memory.

**Word associations.** The term association refers to the connection or relation between words, concepts, or notions whose appearance in an individual's mind prompts the appearance of others (Sinopalnikova, 2003). The connection among words can be semantic (i.e. words whose meanings are connected or belong to a broader group), phonological (i.e. words that share phonological patterns), or experiential (i.e. links resulting from the learner's personal experience) (McCarthy, 1990).

In the field of psycholinguistics, Aitchison (1994) states that individuals do not learn lexical items in isolation but in association to other items that have some kind of relation. Learning a set of lexical items that are interrelated implies creating connections amongst them; therefore, one single item would have a link to many others. As a result, it is believed that an individual has better understanding of a word when it is associated with others (Jullian, 2002). It is also claimed that by creating associations, and therefore a context, the chances to recall a lexical item also increase (Jullian, 2002).

Now regarding the mechanics of this game, first, students are provided with a chart in which they find a list of words; their job is to come up with two associations for each word given (See Appendix 4). This game is intended for students at any level of proficiency; however, the words provided in the chart may vary depending on this basis and may also be selected taking the contents of the coursebook as a source. For beginners, however, the words provided are illustrated. In this way, students can easily identify the words and their meaning, and then make associations based on their prior knowledge. In terms of language learning, this activity can be implemented as a review of lexical items that have previously been taught, and as a starting point to broaden learners' lexis. As for memory-related outcomes, this activity seeks to train students in finding links between the information they already know and new information. With the necessary training, learners may be able to create links between words, concepts, or ideas.

**Using numbers to remember.** In this game-like activity, the main brain skill students use is concentration. Students are expected to remember numbers in a specific series. Concerning the learning potential of this activity, it can be affirmed that it may serve to "recycle" and "refresh" the information learners have already stored in their long-term memory; however, it is a perfect example of a working-memory training exercise

that may involve imagery, as learners need to see information, store it in their visual working memory system, and perform a writing task.

For this game, students are presented with a series of numbers. At the beginning, two numbers are provided for the students to remember. One by one, the teacher shows students a set of cards with the numbers written on them; they see each card for 10 to 20 seconds, and after they see each card, they write the numbers on piece of paper. As the game progresses, the series of numbers increase up to eight (See Appendix 6). The student who writes the correct series is the winner. This game is very similar to the one involving logos, but the degree of difficulty may be higher because in this activity, learners need to retain the information presented to subsequently write it down in the order they saw it, which is a task working memory is particularly in charge of. The objective of this task is to tackle working memory directly; since it is a very sensitive system, which keeps information for a short period, it is necessary to refresh it to keep it active.

**Using words to remember.** This activity is very similar to the previous one in that students are required to retain series, in this case, of words which they have previously studied. In terms of language learning, this activity serves as a review of vocabulary, and when it comes to memory, this activity encourages students to make mental connections so that they can retain and recall series of words in a specific order. The game entails showing learners sequences of words on cards, starting with two words and going up to eight (See Appendix 6). Students are given 10 to 20 seconds to look at each of the cards, one by one, with the words on them, and they are asked to write down the words after seeing them. The student who writes the sequences of words correctly or has the most correct answers is the winner.

After describing the games used in the study, it is important to emphasize on their purpose, which is none other than offering learners a range of options they can choose from to process information and improve their retention capacity, leading them to more efficient foreign language learning.

## **Methodological Aspects**

### Study

Given the evidence suggesting that working memory capacity may account for individual differences among second language learners, and that working memory can be trained this case study aimed to determine whether low performance students could make progress in the process of vocabulary retention at an intermediate level of English learning through the implementation of games for working memory training. For this training process, researchers identified the students who would need to improve not only their working memory but also their foreign language learning (FLL) process.

The process to select the students who participated in the study was based on close observation of students' oral production in class. After the identification of the nine students who were selected and voluntarily accepted to participate in the study, a period of training with the games for working memory took place. Since the students were selected from three different semesters, the activities designed for the working memory training were based on the notion that the purpose of the study was to train students to use their working memory as a means to use this device for future language items recall in communicative tasks.

The decision to work with these students as a group, even though they were part of three different levels, was taken on the basis of the study developed by Barrantes (2019), titled *Strategies for Mixed-Level Classes: Participation and Grouping The Learners, The Context: Defining the Mixed-Level Class and grouping*. In this study, Barrantes (2019) argued that it is common to find students who have different proficiency levels in ESL and EFL classes. One of her arguments is that teachers should prepare learning strategies and activities that engage these students with the same learning experiences and knowledge development. The games proposed in this study for the training of working memory permitted students to experience the same learning and knowledge development. In this way, the study provides students training that will benefit both level students.

Abbott (2018) also argued that when mixed level students work together in a second or foreign language class, the teacher's task is to provide an equilibrium in the teaching process that really caters to students' needs. Abbot's argument permitted the design of games to fulfill the needs of the students selected. These students had problems remembering content already studied in previous semesters. Therefore, by applying what Barrantes (2019) and Abbott (2018) claimed, these nine students could improve their working memory

recall capacity. Something these students have in common, though, is that they identified the need to develop their memory capacity to remember items of language. It is expected that with the games the students in this study would not only develop the ability to recall the activities designed, but also develop strategies for future recall processes in their communication classes.

Considering the population and characteristics of this research, it was deemed a case study. Case studies have been widely used in SLA research. Due to the characteristics of this study, this research approach is selected if we consider that:

*Case study research has played a very important role in applied linguistics since the field was established, particularly in studies of language teaching, learning, and use. The case in such studies generally has been a person (e.g., a teacher, learner, speaker, writer, or interlocutor) or a small number of individuals on their own or in a group (e.g., a family, a class, a work team, or a community of practice). The cases are normally studied in depth in order to provide an understanding of individuals' experiences, issues, insights, developmental pathways, or performance within a particular linguistic, social, or educational context. Rather than discuss constructs, hypotheses, and findings in terms of statistical patterns or trends derived from a larger sample or survey of a population of language learners, as in some quantitative research, a qualitative case study of a person presents a contextualized human profile (Duff, 2014, p. 1).*

Since this study aims at training students to improve their working memory, a qualitative process was followed. This qualitative data and analysis provided results obtained from the application of games during the case study developed with the 9 students who participate in this research.

### Participants

In order to conduct this study, three learners from the second, fourth, and sixth semesters from Licenciatura en Inglés-Francés were chosen for a total of nine participants. In the year in which this study was conducted, students were enrolled in even semesters. The researchers also considered that in the second, fourth, and sixth semesters, teachers could identify the low proficient students based on an assessment of the communication skills in English. The subjects were selected by the teachers who were in charge of an English communication courses.

### Procedure

After detailed observations were made during English communication lessons, learners who displayed general difficulties when using or understanding the target language were selected to receive strategies on working memory training for two hours a week during a six-week period. In each session, which was out of class, a different working memory game was implemented, and each of the learners' performance was kept track of by means of a matrix. The information collected in that instrument included the number of items learners were able to recall (Appendix 7). The number of items recalled were organized on a scale and were assigned a score for better coding: 1 meaning poor production recall (the student could use 1 or 2 items from the game); 2 meaning slightly improved production recall (the student could use 3 to 5 items from the game); 3 meaning average quality production recall (the student could use 6 to 7 items from the game); 4 meaning improved performance recall (the student could use 8 to 9 items from the game), and 5 meaning excellent quality recall (the student could use 10 items from the game). After all the rubrics were completed, the researchers designed a summary rubric in which the tallies of each student's production in each category of games was kept.

Score Value	Equivalence	Number of items recalled in game.
1	Poor = P	1 to 2
2	Slightly Improved = SI	3 to 5
3	Average Quality = AQ	6 to 7
4	Improved Performance = IP	8 to 9
5	Excellent Quality = EQ	10

Table 1: Scale and equivalent in terms of quality of performance



## Findings

The participants in the study participated in the games described for working memory training. The information collected during the application sessions was written down in tables. These tables helped the researchers interpret in a qualitative way what was found during the games such as those manifestations of recalling processes. These occurrences provided information on the working memory training aspects for FLL. To facilitate the explanation of findings, this section is divided into two main segments that present the whole study.

Initial observations. These observations took place as the first stage in the research process, in which as researchers, we could detect those learners who displayed certain difficulties related not only to the use of the language but also to their overall attitude in class. Some of the most common signs, based on the list provided by Daneman and Merickle (1996) were:

1. Shyness in class participation. Some students were reluctant to speak in the target language, even when asked to give a short response.
2. Difficulty responding verbally. They were usually unable to provide short coherent answers even after others had already given a model for the answer. This situation was especially evident in lower semesters. Students in the second semester did not answer questions orally, mainly due to shyness, lack of vocabulary, and proper command of structures. Students from fourth and sixth semesters had better production of the L2, but they still needed to work with language they were supposed to have learned from the previous semesters. It was interesting to note that they did have some knowledge of L2 vocabulary and structures from previous semesters. Nevertheless, they did not remember them. When the teachers told these students they had already studied the contents in previous semesters their response was "yes, but I do not remember" (student 9).
3. Difficulty following directions. After receiving written or spoken instructions, learners would usually turn to their peers for explanation in the mother tongue regarding what they were expected to do.
4. Difficulty remembering vocabulary and structures. They were unable to recall vocabulary or grammatical structures taught and studied in previous lessons.
5. Difficulty finishing tasks. Since it was difficult for learners to recall information or follow instructions, it was difficult for them to complete tasks, including fill-in the gaps exercises or communicative activities. These difficulties were observed in the classes the students attended in their corresponding semesters. This meant that even though students were at different proficiency levels, they displayed the same difficulty in tasks that were developed according to each student's level in their regular classes. These activities were the ones prepared for their normal English communication classes at their own proficiency level. In this case, what the researchers observed is that even though the format of the activities was the same, and the level was the one expected for the students in each class, students showed the same problems related to the recall of vocabulary, structures, and pronunciation patterns.
6. Progress not observed. During the observational weeks, students did not display major linguistic competence related progress.

The next section in this study, the implementation stage, had to do with the game activities to activate students' working memory for developing their production of English in communication classes.

### Implementation of games for working memory training.

In each training session, students were asked to perform one of the games previously specified in the description above. The sessions were developed in the following order.

- Session 1: proverbs
- Session 2: Days/months of the year
- Session 3: Logos
- Session 4: word associations
- Session 5: using numbers to remember
- Session 6: using words to remember

From the scores of each session, it could be inferred that their average scores ranged from 2 to 3 (AQ) with one score below this range (SI). None of the students achieved an average score of 4 or 5; that is, they were able to recall up to seven items from the game (AQ). This suggests that the low proficient students who participated in this study had problems mainly with remembering the items provided in the games. One of the students argued that remembering lists of words, or numbers, or idioms, or any other kind of language

in English in a specific order is difficult for them because they cannot remember what the teacher presents in class (Informal conversation with student 2).

To provide information on the qualitative results in this study, the following tables were designed since it was difficult to compare the production of each student in relation to what they expressed about their memory and retention problems when dealing with foreign language learning. Consequently, the researchers, based on the scores obtained in the games, proposed the tables below to analyze students' performance during the application of games, and to determine the usefulness of the games to trigger students' recall process.

Table 2 shows the scores per student in each session, taking into account the number of items recalled. It is worth pointing out that students were able to recall more items in the last sessions than in the initial ones.

	Student 1	Student 2	Student 3	Student 4	Student 5	Student 6	Student 7	Student8	Student 9
Session 1	1	2	1	1	2	3	1	1	2
Session 2	2	2	1	2	2	3	1	2	2
Session 3	2	3	2	2	3	3	2	2	3
Session 4	2	3	2	3	3	4	2	3	3
Session 5	3	3	3	3	4	4	2	3	3
Session 6	3	3	3	3	3	4	2	3	3

Table 2: Number of items recalled per student in each session based on the scale created for this study.

Table 2 describes the average number of items recalled by students in each session in which the games were applied. If we pay attention to students as a group, it is possible to argue that the number of items recalled by means of the games improved from session to session with the exception of sessions 5 and 6. In session 5, the average number of items recalled was 3.1, while in the game in session 6, the average number of items recalled was 3. This difference is not very significant since it corresponds to 0.1 item. It might have been due to the results obtained in the game *using words to remember*. In the game that implied sequences of words to recall, it was observed that the words were given in series that started with two words and the last series contained 10. For students, it was easy to remember the rows in which two and three words were listed in the order provided. Nevertheless, when the word series increased to four and above, it was difficult for students to remember the words in the exact series and provide the oral series as they were presented in the game. One student, though, was the exception in this game; this student was able to recall up to the row in which six words were presented in the series.

	Session 1	Session 2	Session 3	Session 4	Session 5	Session 6
Student 1	1	2	2	2	3	3
Student 2	2	2	3	3	3	3
Student 3	1	1	2	2	3	3
Student 4	1	2	2	3	3	3
Student 5	2	2	3	3	4	3
Student 6	3	3	3	4	4	4
Student 7	1	1	2	2	2	2
Student 8	1	2	2	3	3	3
Student 9	2	2	3	3	3	3
Average number of items recalled	1.5	1.8	2.4	2.7	3.1	3

Table 3: Students' scores per session.

The table shows the results obtained during the application of the games to the nine students who participated in this study. These accounts provide information for the researchers to follow with the next section in the discussion of what was found and the significance of the study for communication classes at the university in relation to working memory training.

## Discussion

In the light of the results of the study, this section discusses the findings provided by the application of games as working memory triggers. The first part in this discussion is related to students' attitudes to games as possibilities to increase their capabilities when trying to increase their working memory. The second part is related to the attitudes of students when going back to their communication classes in relation to the use of working memory strategies based on the games used during the intervention sessions in the study.

The purpose of this study was to observe the impact of games in the training of students who displayed low proficiency in English communication classes at the university level. The group of nine students participated in six different sessions in which the games for recall were played and students practiced the language in a way in which they were more interested in the achievement of the goal of the game than in the learning of the structure of English as a foreign language. By describing the reactions of students and the results in the memory capacity to recall language items, the researchers provide an insight into how useful the training of low proficiency students in working memory is for improving their English.

Students' reactions during training sessions. While receiving training, students expressed their willingness and effort to complete the tasks. They repeatedly communicated their desire to do their best, and displayed a sense of competence. Despite not doing well in some of the games, they did not seem to be discouraged. They also stated that the sessions were a good chance for them to interact, which is something they were not able to do during regular lessons due to their fear of failing in front of the whole class. They participated in each session and did what they were instructed to do.

The researchers asked students if they remembered the directions provided at the beginning of the sessions and were asked to repeat the stages to play the game. It is important to mention here that this repetition of stages was another opportunity provided to the students to reinforce their working memory and recalling processes. When one student was not able to remember the whole series of instructions, the other students participated to build up the whole set of directions already provided. At the beginning sessions, this forgetfulness occurred from the beginning of the directions provided. As sessions progressed, students were able to remember the whole set of directions provided to complete the games. Therefore, it can be argued that certain degree of repetition does lead to improvement and the use of directions at the beginning of the games became a practice students identified and got used to.

The analysis of the specific training procedure developed with the participants in the study showed improvement of the low proficient students in working memory tasks which in this research was the development of games. The improvement in working memory and recall processes for the English games developed was noticeable from one session to the next. The tables that provided space for the tally (See Appendix 7), showed the progress students made in the use of the language items practiced during the games. Since the study was developed in six sessions, it is possible to argue that with a longer period of practice with activities that train working memory, students can achieve good results when required to remember language items for communication activities in the classroom.

A factor that could influence the small increase in the structure and vocabulary retention is related to the game properties. For instance, students reported that when the sequence of words in a structure or the number of words in a series was bigger than three, the retention and recalling became difficult for them (Students 3, 6, 7, 9). The reverse was the case when recalling less than three items in a single attempt.

In relation to the input provided during the games with use of materials, it is possible to argue in favor of graphical tools to help students to remember the foreign language. The games proverbs (Appendix 1), logo (Appendix 3), and word associations (Appendix 4) have illustrations that, according to the students, helped them to remember and recall not only the English words or structures but also the associations among them. When students played the games days of the week/months of the year (Appendix 1), number sequences (Appendix 5), and word sequences (Appendix 6), they expressed that the information provided in the games in relation to the language items was not new, but when presented in the form of a game, recall was easier. The participants also commented on the importance of developing comprehension of the L2 based on games they already played in their L1. Students found the logo game easy to play, and one even said "Ahhh, this game... we have it in Spanish. It is easy" (Student 1). The logo game was chosen considering that students were familiar with the names of the logos. Therefore, students could remember the names more easily and keep the logos in their working memory for a longer time. Again, students' life experience forms an

important part of their working memory and recall processes (See Amin & Malik, 2014). Therefore, it is possible to see that the activation of the students' background knowledge is important for students to train their working memory.

Another important aspect observed and reported by the students during and after the games was the fact that the organization of the language items in fixed patterns like alphabetical order, and the backward order assigned to the days of the week and months of the year game spurred interest among students since it was the first time they engaged in an activity of this kind to learn these language items. The written task assigned in the game also helped them with the process to remember the language items and to correct their writing mistakes in relation to capitalization. A student expressed "it was fun to organize the days and months in the correct order and backwards" (Own translation from Spanish) (Student 5) and "I learned to write the days and months with a capital, something I had forgotten" (Own translation from Spanish) (Student 3).

When students approached the game related to number series and word series, they expressed they liked to use materials they could touch (Student 2). In these two games, students were provided with cards that contained the series they were going to use when participating in the game contest. Students got the cards they were able to recall for the activity. In this way, students were motivated to make their effort to remember the series of numbers and words to get the largest number of cards to be the winner of the competition.

Analyzing the results obtained in this case study, it can be inferred that the working memory games used yielded positive results not only in terms of language proficiency, but also in the attitude learners displayed after a relatively short training period. Regarding working memory, which was the main focus of this study, learners showed stable improvement in recall processes that was constant from session 1 to 5, slightly decreasing in the last session, which had to do with recalling numbers. The researchers think that this slight decrease in recalling the foreign language in the game has to do with the long series presented with numbers to be remembered since after the series number 3, students had to remember series of 5, 6, 7, 8, 9, and 10 words to complete the task in the game. Then it is possible to argue that the long series are part of the features students need to practice for working memory improvement and for recall to take place.

Considering the fact that students' improvement in recall activities was noticeable not only during training, but also during regular lessons, it can be said that this finding is consistent to what was proposed by St. Clair-Thompson and Holmes (2008), who stated that when learners receive strategies to train their memory, these can be transferred to situations in which training is no longer taking place.

### **Implications**

The study yielded important information for English communication courses. The researchers noticed positive changes in students' behavior and performance during the class time, providing them with insights into the importance to implement activities for working memory training that aim to improve retention and recall capacity. It is important to mention that by week 3 of the training period with games, noticeable changes could be observed in terms of attitude and recall. It was seen that students, especially those who were reluctant to talk when facing the whole class, started to participate without being prompted by the teacher.

Regarding recall and retrieval of the foreign language, it was possible to compare the progress during the observation weeks and the one depicted while on training sessions. A visible difference was perceived, especially in the use of grammatical structures and vocabulary. It was observed that students were better able to monitor the language they produced and were able to use more structures from the set they had studied in class, implying that they were able to retrieve them.

The study provides important information for foreign language teachers in relation to the possibility that by training foreign language students with activities that trigger the working memory functions, better performance in classes can be observed. Since this study aimed at training students in recall processes, it is possible to argue that with games, students not only had fun in working with the foreign language but also developed motivation for memorization and retrieval processes.

When a foreign language teaching and learning process is at stake, working memory is the part of memory that plays a role for students to participate in different tasks. Students rely on working memory for retention

and retrieval. For foreign language comprehension, students' working memory ties the expressions to their meanings by means of the long-term memory retrieval process. The decoding process of the foreign language that takes place in the brain happens owing to working memory. The same process happens when practicing the foreign language by the repetition of words that is developed by means of working memory as Conti (2015) stated. Therefore, the significance of studies like this one is of paramount importance for institutions in which low proficiency students are considered poor learners of the foreign language without taking into account cognitive factors that influence processes like retention, retrieval, and recall. If we consider the findings of the study, it is possible to draw some implications that can be taken into account for the FL classroom practices when classes are taught.

### Classroom Implications

This study has provided findings that bring important implications for the FLL classroom. Since the purpose was to improve students' recall processes for a later progress in their foreign language production, the researchers adapted some activities as games for working memory training. Working memory training is important for foreign language teachers to consider; if professors in undergraduate foreign language programs take into account that working memory and the processes underlying storing, retrieving, and recalling are part of the students' brain functioning that play a part in any learning process, they can benefit from activities that train working memory.

The main objective of the research was to motivate the low proficiency students so they could feel less stressed to participate in activities for working memory activation and recall and for foreign language practice. It is important to consider that the kind of activity the professor proposes for foreign language classes influences not only the student participation but also improves knowledge of the foreign language.

The use of games for recalling vocabulary that includes words, fixed patterns, numbers, and associations, among others, represent a very useful tool that helps students process the information provided in the foreign language. The format of the games and the level of competition immersed in them made students feel more relaxed during the activity and prompted them to participate the game actively.

Materials that are used for the games also provided information on the way in which games can be combined to promote working memory training for later recall. Foreign language students can benefit from pictures, cards, tables, and others. Materials play an important part when storage, retrieval, and recall are the purpose. It is advisable to start working with such materials and activities not only for foreign language practice but also to promote improvement in working memory. The background knowledge of the students is activated through working memory training. By doing this, a connection between prior and new knowledge is created, facilitating learning (See Dronjic & Park, 2018).

From the experience during the application of the games in the study, the researchers noticed that the use of clear directions, which sometimes need paraphrasing, helped students achieve the purposes of the games and improve their recall of information processes. Therefore, it is advisable for foreign language instructors to take into account that comprehension of directions is the initial stage in these classroom activities. Professors need to make sure students understand the instructions to be able to complete any kind of activity in the foreign language. If students do not understand the directions from the beginning, it is the teacher's job to provide additional explanation, so the main activity is successfully completed. Working memory also relies on the comprehension processes students employ in class for later recall. Foreign language items practiced and the ones that will be introduced to students in future language classes can also benefit from this kind of training; as it was observed in the study, the participants improved in the games developed and the items recalled as well as in the foreign language classes that followed the study. As Buschkuehl et al. (2008) argued, this training benefits not only the working memory tasks but in the long run those provided in foreign language classes.

### **Conclusions**

Working memory has been a widely studied construct for decades. Even though researchers have proved the close link it has with language learning, its actual role in the process is usually not common knowledge among teachers. Being aware of the intervening factors in the process of language learning should be almost compulsory for us as educators, since we are not only responsible for our teaching, but also for providing our students with the necessary tools to optimize their learning.

After acknowledging some of the underlying causes of success or failure in language learning, in this case limitations of working memory, it is possible to turn to solutions that can somehow facilitate and also enhance the language learning process. Game-like activities for working memory activation may be one of the multiple choices we have at hand to assist learners in training their memory and probably benefit their language achievement.

Game-like activities for working memory activation proved to be beneficial at least in the context involved in this study. Learners showed improvement in their performance during training sessions and in regular English lessons as well as a positive change in their attitude when it came to the use of the target language versus their mother tongue and initiative to participate. By providing learners with these tools and the information on how to use them, it is hoped that they learn to apply them outside the classroom, turning students into more active participants in their own learning process. In the long run, learners are expected to become more autonomous and aware of what they need to do in order to make progress in the target language. Moreover, the implementation of these games or other memory training strategies could also be incorporated in English lessons as a warm-up, lead-in, or wrap up activity since this practice might contribute to enhance learners' capacity to retrieve and learn the material presented in the English lessons.

Finally, it is worth highlighting that this study took a very small sample of L2 learners in a particular teaching and learning context. Consequently, these research findings should be looked at with caution for further implementation in EFL contexts. Besides, results might vary, or the strategies herein proposed might yield diverse outcomes. However, the findings seem to broadly demonstrate positive effects on learners' working memory capacity and their performance in general.







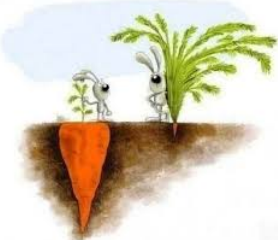



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### Appendix 1

#### Proverbs

<p>A bird in the hand is worth two in the bush</p>  <p>shutterstock.com • 227233411</p>	<p>A chip off the old block</p> 
<p>His bark is worse than his bite</p> 	<p>A taste of his own medicine</p> 
<p>A tiger doesn't change its stripes</p> 	<p>Actions speak louder than words</p> 
<p>All that glitters is not gold</p> 	<p>Practice what you preach</p> 
<p>My hands are tied</p> 	<p>Speaking of devil</p>  <p>www.creativecommons.org</p>



**Appendix 2**

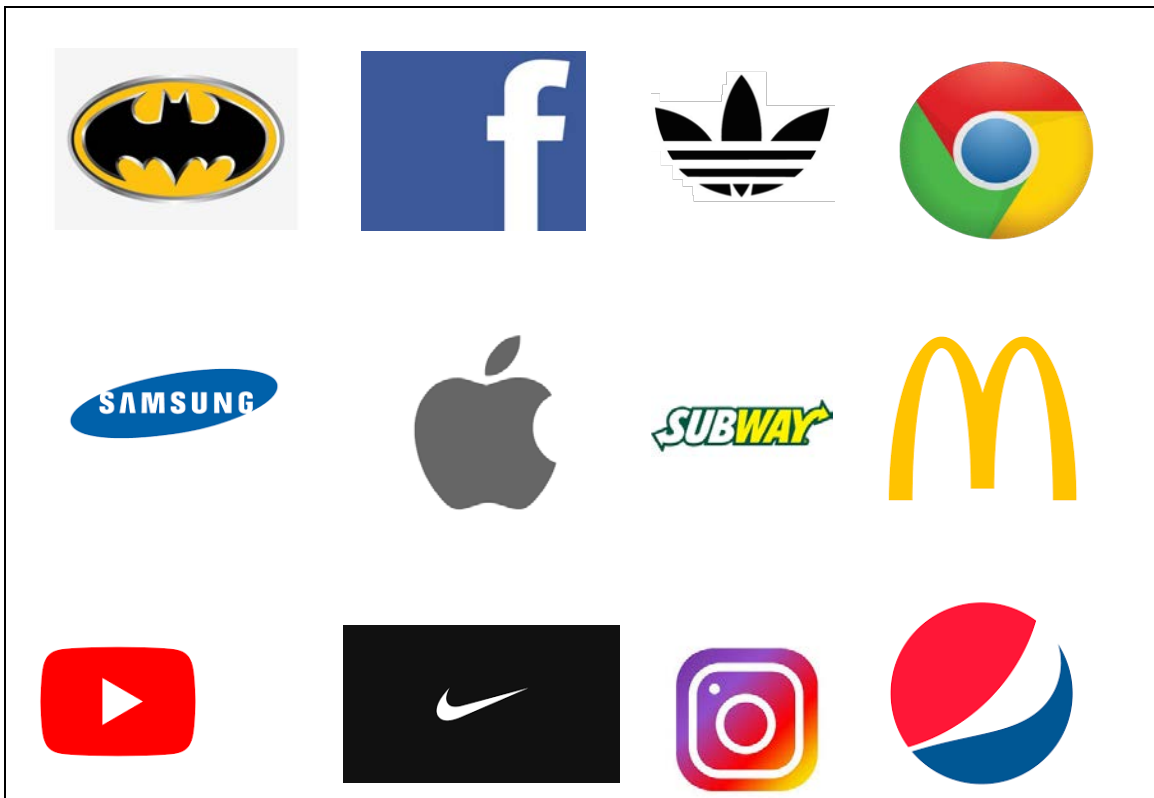
***Days of the week / Months of the year:***

***Chart for students to fill in***

Days of the week	Alphabetical order	Backwards	Months of the year	Alphabetical	Backwards











### Appendix 3

#### *Sample logo chart used for bingo*



**Appendix 4**

***Sample Word association chart***

<b>WORD</b>	<b>PICTURE</b>	<b>FIRST WORD ASSOCIATION</b>	<b>SECOND WORD ASSOCIATION</b>
<b>Kitchen</b>			
<b>Coffee</b>			
<b>Bread</b>			
<b>Spoon</b>			
<b>Lemon</b>			
<b>Child</b>			
<b>Apple</b>			
<b>Orange</b>			
<b>Notebook</b>			
<b>Tree</b>			

**Appendix 5**

***Each sequence is shown separately on a card***

2 - 9

4 - 7 - 9

0 - 3 - 1 - 4

4 - 2 - 9 - 7 - 8

6 - 2 - 1 - 5 - 0 - 9

3 - 1 - 7 - 6 - 2 - 8 - 0

5 - 2 - 4 - 8 - 1 - 0 - 7 - 6

8 - 4 - 2 - 0 - 6 - 5 - 1 - 3 - 7

3 - 8 - 7 - 6 - 5 - 9 - 4 - 2 - 1 - 0

## Appendix 6

***Each sequence is shown separately on a card***

dog - joy

cat - bed

sleep - rat - count

write - speak - live - hand

tomato - umbrella - parking - road - animal

walk - cat - take - tree - duck - desk -

pants - snake - talk - book - car - teacher - couch

make - comb - bed - dress - table - shirt - glass - door

flower - boy - school - run - hand - break - wall - glasses - picture

phone - shirt - vase - listen - paper - bin - pen - lamp - clock - scissors

### Appendix 7

#### Matrixes created for each of the games

LOGOS										
LANGUAGE ITEMS RECALLED										STUDENT NAME
1	2	3	4	5	6	7	8	9	10	

PROVERBS										
LANGUAGE ITEMS RECALLED										STUDENT NAME
1	2	3	4	5	6	7	8	9	10	

DAYS OF WEEK/MONTHS OF YEAR										
LANGUAGE ITEMS RECALLED										STUDENT NAME
1	2	3	4	5	6	7	8	9	10	

WORD ASSOCIATIONS										
LANGUAGE ITEMS RECALLED										STUDENT NAME
1	2	3	4	5	6	7	8	9	10	

USING NUMBERS SERIES TO REMEMBER										
LANGUAGE ITEMS RECALLED										STUDENT NAME
1	2	3	4	5	6	7	8	9	10	

USING WORDS SERIES TO REMEMBER										
LANGUAGE ITEMS RECALLED										STUDENT NAME
1	2	3	4	5	6	7	8	9	10	