UNIVERSIDAD CATÓLICA DE LA SANTÍSIMA CONCEPCIÓN

FACULTAD DE EDUCACIÓN

PEDAGOGÍA EN EDUCACIÓN MEDIA EN INGLÉS

THE INFLUENCE OF WORKING MEMORY ON VOCABULARY LEARNING

Seminario de Investigación para optar al Grado Académico de Licenciado en Educación

Profesor Guía: **Mg. Mª Gabriela Valenzuela F.**

Estudiantes: **José Miguel Casanueva H.**

Camila Cuevas A.

Makarena Sánchez C.

Gary Torres T.

CONCEPCIÓN, AGOSTO DE 2016

Abstract

This study aimed to investigate the influence of working memory and frequency of exposure on vocabulary learning in monolingual (M) and upper intermediate users of English (UIUE). 105 university students (58 M and 47 UIUE) from Universidad Católica de la Santísima Concepción were divided into four different groups (M1, M2, UIUE1 & UIUE2). Participants were presented 15 novel words in English, in two different conditions: single and double training sessions. All this previous training was assessed with a semantic categorisation task. The performance of both Spanish monolingual (M) and upper intermediate users of English (UIUE) was measured in order to find a difference in accuracy in word learning and also a difference between one or two training sessions. Results showed a significant difference amongst participants in word learning. The semantic categorisation task showed a significant difference on accuracy in favour of UIUE. The frequency of exposure condition revealed an effect on accuracy in favour of both groups with double training sessions. These results suggest that vocabulary learning may be positively influenced by enhanced working memory, seen in upper intermediate users of English, and the amount of exposure of the new words, seen with double training sessions.

Resumen

Este estudio tiene como objetivo investigar la influencia de la memoria de trabajo y la frecuencia de exposición en el aprendizaje de vocabulario en monolingües (M) y usuarios intermedio-alto de Inglés (UIUE). 105 estudiantes universitarios (58 monolingües y 47 usuarios intermedio-alto de Inglés) de la Universidad Católica de la Santísima Concepción fueron divididos en cuatro grupos diferentes (M1, M2, UIUE1 & UIUE2). A los participantes se les mostraron 15 palabras inventadas en Inglés, en dos condiciones distintas: sesiones de entrenamiento simple y doble. Todo lo anterior fue evaluado con un test de categorización semántica. El desempeño de ambos monolingües-Español (M) y usuarios intermedio-alto de Inglés (UIUE) fue medido con el fin de encontrar una diferencia en precisión en el aprendizaje de vocabulario, y también una diferencia entre una o dos sesiones de entrenamiento. Los resultados mostraron una diferencia significativa entre los participantes en el aprendizaje de vocabulario. El test de categorización semántica mostró una diferencia significativa en precisión a favor de los UIUE. La condición de frecuencia de exposición reveló un efecto en precisión a favor de ambos grupos con dos sesiones de entrenamiento. Estos resultados sugieren que el aprendizaje de vocabulario puede ser positivamente influenciado por una memoria de trabajo desarrollada, rasgo propio de los usuarios intermedio-alto de Inglés, y la frecuencia de exposición de las palabras nuevas, como se ve con las sesiones de entrenamiento doble.

Table of Contents

Chapter 3 — Study

Chapter 4 — Discussion, conclusions, limitations and further studies

List of Tables

List of Figures

Acknowledgments

We would like to thank all those who have given us support and words of encouragement through this entire process.

We would like to express gratitude to professors María Teresa Villagra, Theresa St. John, Katiuska Santibañez, Jorge Lillo, Lorena Sáez and, our guide teacher María Gabriela Valenzuela, for their collaboration in our study. We would also like to thank Tío Carlitos, Maricel, Tío Juan Carlos, Erwin Blanco and Ana María Hurtado for their kindness and help when needed.

We dedicate this thesis to our parents Ana María, José Miguel, Melisa, Mario, Miriam, Pablo, Jacqueline and Nemesio, and siblings Ximena, Paulina, Alejandro, Billy, Melanie, Joaquín and Amanda.

Chapter 1 — The influence of working memory on vocabulary learning

1.1 Introduction

Language is a vital tool that allows people not only to communicate their thoughts, feelings or ideas but also to create and project their identity. Language is knowledge, and therefore, it is a key element for this increasingly globalised world, where acquiring a second or a third language entails a competitive advantage when compared to people who only speak their mother tongue. According to Bialystok (2009), bilingualism may affect other types of learning beyond the language system, leading to more development in cognitive abilities and flexibility in learning in general.

Learning vocabulary is the key element when acquiring a language, and therefore, essential to language teaching, because without sufficient vocabulary, students cannot understand others or express their own ideas. For this reason it is very important for people to have a large store of words and strategies from a very early age. Hamzah, Kafipour and Abdullah (2009) defined vocabulary learning strategies (VLS) as techniques students employ to learn new vocabulary. There are many strategies that language learners use in order to retain new words such as: creating lists of words; making translations; using synonyms; making an explanation, and using images (Stern, 1975). As important as strategies, there are factors that play an essential role in the learning of new words. Bolger, Balass, Landen and Perfetti (2008) divided these factors into three different groups: word factors (semantics and syntactic features of the word), text factors (context) and individual differences (own learners' abilities). In this study, text factors and individual differences are going to be considered. Contextual learning, based on constructivism, is a learner-centred approach in which learners use their previous

experiences and interpret their environment in order to construct meaning (Brown, 1998). Since teaching vocabulary is crucial for learning language, the use of different methods such as contextual learning takes an important role given that it improves the interest of students and it becomes more relevant for them, making new information meaningful (Parnell, 2001). For this study, regarding individual differences, age (children and adults) will be considered as the most important. In the case of children, Bloom (2001) asserted that they construct meaning by creating their own stories and theories, due to their lack of experiences in life. Also and given their need of communicating, children are forced to learn words to express themselves. In the case of adults, they learn through their existing knowledge; they connect life experiences, real life situations and problems to understand the new language. Moreover, adults have a bigger range of vocabulary than children, which makes it easier for them to learn the new language (Dirkx, Amey & Haston, 1999).

The foregoing relates to the process of learning a new language, however, the main difference when learning vocabulary between L1 and L2 is that the former is a natural, unconscious process, while the latter is a conscious learning process (Krashen, 1982). L1 is acquired and genetically triggered at the most critical stage of the child's cognitive development, when other crucial life-skills are also acquired innately. Conversely, L2 is learnt in an artificial rule-conscious setting, where learners are aware of grammar and vocabulary rules.

Working memory (WM), part of the executive functions, is defined by Baddeley (2003) as the brain system responsible for holding, processing, and manipulating information necessary for complex cognitive tasks such as language comprehension, learning, and reasoning. As supported by Daneman and Carpenter (1980; 1983) humans' working memory has different capacities, which may affect their performance during life on reading, writing,

listening and speaking, when learning a second language. Atkinson and Shiffrin (1968), suggested that human memory has three separate components: sensory memory, short-term memory and long-term memory. According to the scholars, sensory memory perceives and retains stimuli through the five senses. Brown (1958) established that in short-term memory new information is forgotten immediately if rehearsal does not occur. However, if rehearsal is done, the new information is stored permanently in the long-term memory (Ashcraft, 1994).

The following study analyses the influence that working memory has regarding vocabulary learning and frequency of exposure. Firstly, a complete theoretical background of what vocabulary learning is will be granted, followed by a clear review of types of memory, focusing on working memory.

A detailed explanation of the study conducted for this research will be presented, followed by its results, discussion, conclusions, as well as limitations and further studies.

1.2 Vocabulary learning

Schmitt and Carter (2000) conceived vocabulary as individual words; nevertheless, this belief may not be adequate, since words may consist of more than only one single lexical item. For example, compound verbs such as *take away*, which has two lexical items that convey one meaning; adjectives composed of two lexical items that have one meaning, such as *high-class*; and idioms such as *act the fool*, composed of three lexical items that refer to one specific idea: to behave in a silly way, often in order to make people laugh. Consequently, vocabulary, and more specifically words can be understood both as a single unit and as lexical phrases that convey one single meaning (Read, 2000). In fact, according to Lewis (1993) vocabulary, as we know it, comprises lexical phrases that can be both phrasal verbs and prefabricated expressions. Schmitt (2000) adopted, as many other contemporary scholars, the term lexical phrase and presented the question whether lexical phrases are stored in the mind as single units or not. These units can be either stored as chunks of language or affixes and stems.

Ertmer and Newby (1993) classified approaches of learning into three categories: behaviourism, cognitivism and constructivism. For this study it will be considered the constructivist approach. This method considers creating meaning from context. Based on this approach Brunner (1996) suggested contextual learning as an effective method to learn vocabulary, which states that people acquire new vocabulary by using their previous experiences. Teachers give students context to activate their previous knowledge, helping them make their own inferences.

Meara (1996) stated that one of the aspects that affect the way vocabulary is learnt is individual differences, being age the most important, since children and adults have different capacities, motivations and ways of learning. In relation to vocabulary learning, Meara (1996)

declared that no matter what language level a learner might have, the processes of learning both L1 and L2 words is the same.

1.2.1 Vocabulary learning in L1

Language development is a process that starts early in life. It is thought to proceed by ordinary processes of learning in which children acquire the forms, meanings and uses of words and utterances from the linguistic input. Various theorists attribute importance to different factors that explain how language development occurs in human beings.

For instance, one of the first theories proposed about language development is the Operant Conditioning Theory proposed by Skinner (1957). He asserts that the environment influences language acquisition. Children learn new words through operant conditioning; that is to say, they receive positive reinforcement when producing correct utterances and negative reinforcement when producing incorrect grammar, to prevent its use again. According to this theory, infants learn words by relating them to objects, actions, and situations. They also learn by imitating words and syntax from adults through behaviourist reinforcement, that is to say, associating words with meaning. Skinner highlights that children try and fail to use the correct language until they succeed, being helped by parents' gestures. This process is called operant conditioning.

Vygotsky's Social Development Theory (1962) explains that language development is a complex interaction between the child and the environment influenced by both cognitive and social development. As children develop language, they build a symbol system that helps them understand the world. Vygotsky stresses the importance of communication with others as a major factor in the development of a child's language which stimulates the development of thought. Children's learning is influenced by their knowledge of the social group. In addition,

social interaction plays an essential role in cognition because cognitive development relies on the zone of proximal development (ZPD), which suggests two levels: the first level in which children can learn by themselves; and the second level where children learn with the aid of an essential tool: language. The divergence between the first level and the second is what Vygotsky defines as the ZPD.

Chomsky (1965) presented the Universal Grammar Theory: this idea postulates that children are pre-programmed and have an innate ability to acquire language since they are born knowing grammatical categories, such as noun and verb, which facilitate the entire language development in children and overall language processing in adults. Infants' only task is to learn new words, since they instinctively know how to combine a noun (e.g. a boy) and a verb (to eat) into a meaningful, correct phrase (A boy eats) without receiving any formal instruction. This theory proposes a biological influence on language acquisition in which children are born with a language acquisition device (LAD) that helps them acquire the language when they are exposed to its particular grammar.

The emergentist theory proposes that language is a cognitive process that appears through the interaction of biological pressures and the environment (MacWhinney, 1999). This theory gives importance to nature and nurture, and postulates that both of these influences are equally needed for children to acquire a language. Learning through nature is an innate process, while learning through nurture is basically an acquired process based on environmental influences (Ceci & Williams, 1999).

When acquiring a language, learners follow certain steps that benefit the process of learning and make it effective. Brown and Payne (1994) identified five different steps L1 learners use in order to acquire vocabulary, listed as: a) availability of sources for finding new words; b) creating an image of the form of the word either visual, auditory or both; c) learning

the meanings of the new words; d) making a strong memory connection between both forms and meanings of the words; and e) using the word.

Learners are constantly adding new lexical information to their current L1. According to Graves (1986) the average of new words that learners learn every year since preschool is 3000 and this depends on two factors: the amount of text encountered by the learner and the learner's ability. Besides, Kuhn and Stahl (1998) believed the majority of these new words do not come in either texts or direct instructions at school, but incidentally, that is to say, learners learn them through context.

Leach and Samuel (2007) referred to the process of adding a word to the mental lexicon as lexical entry, which involves certain features such as word's input (phonological and orthographic), meaning (multidimensional and context-specific) and its syntactic role. Learner will often learn part of that information first and eventually the rest, slowly developing what both researchers call *configuration* of lexical entry. However, it is difficult to identify when and how a new lexical item is fully acquired. Gaskell and Dumay (2003) suggested that the lexicalisation of words includes lexical competition since it affects the activity in the mental lexicon.

The process of vocabulary acquisition involves two main factors that influence its appropriation, such as age and exposure of the language. That is the reason why it is curious how children naturally acquire features of language during their life and what remains remarkable is the fact that, since infants, they can notice specific elements of the spoken language in their environment (Childs, 1998).

In terms of exposure, Saffran, Aslin, and Newport (1996) declared that acquiring specific words, depends on the amount of encounters to a significant corpus of language input. Moreover, Goodman, Dale and Li (2008), mentioned the fact that the effect of exposure

depends on the interactive context. Therefore, some exposures can be more productive for learning than others. For instance, the more frequently a word is produced in speech, the earlier it will be learnt.

A study by Linebarger and Walker (2005), also exposed that individual differences affect the way learners develop their language, in terms of the amount and quality of the linguistic input. For example, as Stanovich (1986) proposed, learners who perform better at reading find large amounts of texts easier to understand in comparison to poor readers. In the case of good learners, when exposed to more words, they are capable of learning its meaning by context. On the contrary, poor learners are less able to understand or encounter the meaning as a result of their smaller reading vocabulary; hence, poor readers are not able to make efficient use of context, they are not likely to find the meaning of new words.

Read (2000) asserted that knowing a word implies not only being aware of only one of its meanings but also its other meanings, its associations with other lexical items, derivations, collocations, frequency, and grammatical rules.

1.2.2 Vocabulary learning in L2

Vocabulary knowledge is the most important component of second language (L2) learning, even more so than background knowledge and syntax (Laufer, 1997). Actually, most people are aware of the fact that learning a second language requires the process of learning a sufficient amount of new words, thus, there is an interest on how words in L2 are learnt and retained.

Language learning strategies and methods are the main factors that help determine how and how well students learn a second or foreign language. Language strategies refer to specific conscious actions used by students to improve their own learning. According to Oxford (1990)

language strategies can be classified into direct and indirect strategies with 6 categories, 19 strategies and 62 sub-strategies. Direct strategies involve *memory strategies*, which help the learner connect one L2 concept with another but without deep understanding; *cognitive strategies*, which allow the learner to manage the language material in direct ways; and *compensation strategies*, which cope with limitations in their language. Indirect strategies support and manage language learning without directly involving the target language, hence, they are in charge of the language learning business and include *metacognitive strategies*, that help learners understand the way they learn; *affective strategies*, which allow students to manage their emotions both positive and negative; and *social strategies*, which help the learner work with others and understand the target culture.

Regarding memory strategies, Stern (1975) proposed creating lists of words. The idea is that these lists with words in L2 include a translation into the L1; a synonym; a brief explanation of the L2 word; as well as an image that can be used to memorise the new word more quickly and efficiently. Nevertheless, Nation (1982) declared word lists not to be effective to acquire a great number of vocabulary in a short period of time.

In order to acquire a second language it is believed that a learner must make use of methods of learning. According to Bakken and Simpson (2011) mnemonic strategies refer to procedures that a learner applies for a specific lexical item, so it can promote its retention more effectively. These procedures mainly involve connecting unfamiliar words with familiar information, which are integrated with previous knowledge through visual or verbal aids.

A study conducted by Sagarra and Alba (2006) found that there are two most used methods for vocabulary learning, being these memorisation and the keyword method (both types of mnemonic techniques). The former is a type of vocabulary learning that consists of memorising the L1 meaning (e.g., pencil) of an L2 word (e.g., lápiz) through visual or verbal

rehearsal, where the learner involves little cognitive processing. In contrast to memorisation, the latter requires a much more intricate cognitive processing. This method implies joining the L2 word (e.g., lápiz) to an L1 keyword (e.g., large) that it seems or sounds like the L2 word, or both, and at that point assembling a mental image or a sentence to connect the keyword (pencil) with the L1 word (un lápiz largo). In the study, after this learning phase was completed, the L2 learner presented with the L2 word recalled the keyword. This multiple task process requires a depth processing, because it pushes the learner to make both associations through the L1 keyword as well as conceptual associations through the connection between the L1 keyword and the L1 translation.

A study conducted by Gu and Johnson (1996) aimed to establish the vocabulary learning methods used by Chinese university learners of English and the relationships between their strategies and outcomes in learning the language. Participants were 850 second-year students that were asked to complete a vocabulary-learning questionnaire, which was compared with results on a vocabulary size test at the College English Test, a national EFL test to examine the proficiency of Chinese students. Results showed students used a wide variety of vocabulary learning strategies amongst contextual guessing, skilful use of dictionaries, and note-taking, paying attention to word formation, contextual encoding, and activation of newly learnt word.

Haynes (2007) proposed five stages in the process of L2 learning. The first is called *Preproduction,* where learners gradually make their vocabulary up to 500 words approximately, but without producing it in speech. The second stage is *Early Production*, involving learners having about 1000 words acquired and the capacity of using words in short phrases. Then there is the third stage, *Speech Emergence*, where the amount of acquired words increases to 3000 and where learners should be able to speak short sentences and simple

phrases. At this stage learners should be prepared to participate in conversations and ask questions. In the fourth stage, *Intermediate Fluency*, learners have an active vocabulary of around 6000 words and the ability of constructing complex phrases in both spoken and written language. They also should have struggles with grammar but demonstrating excellent comprehension. And finally, the last stage *Advanced Fluency* learners are considered near-native speakers. Haynes (2007) pointed out that in order to reaching proficiency in L2 a learner requires from 5 to 10 years. This, however, highly depends on certain factors such as motivation and age of the learner.

It is important to mention that learning a new word takes time and practice to be efficiently acquired. Eckle and Garret (1998) and Channell (1988) supported the previous studies by remarking the importance of recognising the meaning of a word, then the capacity of recalling the word several times and finally, the ability of producing that certain word in speech.

Factors, as well as strategies and methods, are an important part of the process of learning vocabulary. Bolger, Balass, Landen and Perfetti (2008) classified them into three different classes: word factors (semantic and syntactic features of the word); contextual factors (context), and individual differences (own learner's abilities such as prior knowledge and age).

1.2.2.1 Contextual learning

According to Brown (1998) and based on the constructivist learning theory, contextual learning is defined as a learner-centred process by which people assign meaning to words through interacting and interpreting their own environment. In fact, the meaning of what people learn is constructed by themselves with the help of their previous knowledge, and it is directly linked to their life experiences and events (Dirkx, Amey & Haston, 1999). In this

manner, learning vocabulary becomes significant for learners since they can connect real-life situations to the new information (Parnell, 2001).

Contextual learning gives meaning, relevance and usefulness to learning; allows change to occur in the classroom and also allows teaching to be more fun and be understood by the students. Given the flexibility of this type of learning, teachers can design a learning environment that incorporates many different forms of experience, including social, cultural, physical and psychological (Crawford, 2001).

A study conducted by Rott (1999) suggested that vocabulary learning in L2 requires contextual clues so learners can infer the meaning of the target word; otherwise it becomes difficult to understand. Nonetheless, Beck, McKeown, and McCaslin (1983) asserted that a vast amount of context when learning new words may be unreliable, because some contexts might be clear, while others might be ambiguous; leading learners to deduce an inappropriate meaning of a word.

1.2.2.2 Language and age

Children and adults' construction of meaning becomes different regarding age. In the case of children, Bloom (2001) observed that considering their limited amount of experiences, infants own a limited vocabulary and therefore construct meaning by creating their own stories and theories. When learning a second language, young learners discover syntactical rules through repetitive exposure to models and corrective feedback. Young learners have a high intrinsic motivation due to their essential need to communicate, establish and maintain peer relationships as well as succeeding at school. They are also less self-conscious in attempting to speak the L2 because they are naturally eager to express themselves without any grammatical awareness (Ausubel, 1964). What is more, environment also plays an important role since

their natural settings such as home, neighbourhood and school provide them with a safe atmosphere to practice the language (Thorndike, 1925).

Adults, for their part, and thanks to their life experience, have a large amount of vocabulary and therefore they do not need to acquire thousands of new concepts (Dirkx, Amey & Haston, 1999). Besides, they construct meaning by connecting new information with their previous knowledge and real-life events and problems, producing a large native-like vocabulary that allows them to express their ideas with abstract concepts. When learning new grammar, adults can deliberately use grammatical generalisations and can explicitly apply them into suitable exemplars.

Meara (1996) suggested that learning L2 words involves the same process as in learning L1 words, regardless the age of the learner. However, opposite ideas are shown by Brown (2007), who stated that second language acquisition in adults differ significantly from the way children learn a new language. He explains that there is a biological period of time in which language can be acquired more easily. This stage occurs around puberty, and according to the author, once this stage is finished, the process of learning a second language becomes gradually difficult.

1.2.3 Vocabulary learning in foreign language (EFL)

Vocabulary learning has become one of the biggest challenges that foreign language learners have to deal with when learning a new language. It has been suggested that vocabulary learning should not consist only of teaching isolated words, but also to provide learners the necessary strategies to increase their vocabulary list and the appropriate input. Although, learners may be able to use more than one strategy, from which they are able to select the one they feel more comfortable with. He proposes a list of vocabulary learning

strategies, in which it is mentioned memory strategies that requires repetition and mechanical means in order to store and retrieve aspects of the target language.

As Ghazal (2007) stated, the process of learning a new language involves learning language strategies in order to facilitate the comprehension, storage, and retention of the new language. Vocabulary Learning Strategies (VLS) as Hamzah, Kafipour and Abdullah (2009) roughly defined are the actions taken by learners in order to aid the learning process of new vocabulary. He declares whenever language learners need to study words, they use one or many strategies in order to do so in a conscious or unconscious way. Schmitt's (1997) taxonomy, in addition, divides VLS into discovery and consolidation strategies. The former are those which contribute to the discovery of the meaning of new words, that is to say, learners gain knowledge of a new word whether by guessing from L1 cognate, using context, reference material or even asking someone else. Consolidation strategies, conversely, include memory strategies such as repetition of words through writing and speaking, using lists and also cards, and any other action learners use in order to facilitate retention of new words (Sanaoui, 1995). Barcroft (2009) observed learners also make use of metacognitive strategies in which language learners assess and manage their own vocabulary development.

According to Krashen's input hypothesis (1982), learners improve their knowledge of a certain language when they comprehend the input that is somewhat more advanced than their actual level. That is why, EFL learners might be fortunate because English input is widely available from different sources. Learners of other foreign languages may not have as much L2 input outside the classroom as the learners of English (Alharthi, 2014). Moreover, researcher Al-Seghayer (2001) discusses the advantages of presenting information using multimedia elements such as visual text, graphics, and videos on language learning. These formats are able to create an authentic language context for EFL learners.

Given that the process of acquiring a wide vocabulary in the classroom is highly challenging, researchers have been looking for successful techniques in order to achieve that goal. Most language teachers and language learners are convinced of the centrality of vocabulary knowledge in various pedagogical tasks, and understand that learning English involves acquiring and remembering a large number of words (Nation, 2001). McCarthy (1984) argued that vocabulary learning should involve two levels: learners primarily go from the situation in which they find a new word to the level where they can effectively and automatically employ it in a wide range of language contexts when the need arises. Therefore, vocabulary learning refers to both remembering the new vocabulary words and achieving a level of competence where learners can use this word in different contexts.

1.3 Types of memory

Since ancient times there has been a significant concern about memory and what its processes involve and consist of. Most importantly and according to Ashcraft (1994), some of the most important philosophers such as Aristotle, Plato, and Socrates, were aware of the nature of thought and memory. This is probably one of the main reasons for studying human mind and thoughts. In order to understand the human memory in a better way, it is important to clarify what the term memory refers to. For this study, memory is defined as "mental processes of acquiring and retaining information for later retrieval, and the mental storage system that enables these processes" (Ashcraft, 1994, p. 11).

Encoding is a biological event that starts with perception through the different senses. According to Craik and Tulving (1975) encoding is defined as the initial registration and learning of information through the sensory memory. Consequently, this new information goes beyond the sensory memory when it is retained in the short-term memory. It is here where depending on the interest the input is consolidated or it quickly disappears. Thus, when the new information is encoded and consolidated the input can be stored in the long-term memory. This process is called recalling or retrieval and it refers to the re-accessing of information from the past (Tulving, 1991). These replays of information are not quite identical to the original input since it differs between the genuine experience and the one that is remembered.

Scoville and Milner (1957) supported the idea that human beings have two separate systems of memory. There was one case of a male patient who suffered from amnesia as a result of brain surgery made to control epileptic problems. In this procedure, some parts of his brain were removed, causing the patient to be unable to acquire new information after the surgery. However, his immediate memory as well as his linguistic and intellectual skills were

not affected at all, and he was able to remember events from his childhood and happenings from two years before the surgery. In other words, the patient's past events were stored in the long-term system while the events that happened after the surgery were in the short-term memory.

Different studies made by Brown (1958), and Peterson and Peterson (1959) suggested the existence of two separate memory systems: a short-term store in which information is kept temporarily if rehearsal is prevented; and a long-term store in which information would be stored for a longer period of time (Baddeley, 1990). They found that new information is forgotten in seconds if rehearsal for retaining information is avoided (Brown, 1958; Peterson & Peterson, 1959).Thus, training increased the possibility of retaining the new vocabulary since it increases adults' brain activities in the medial superior frontal gyrus (Kirchhoff, Anderson, Barch, & Jacoby, 2011).

The Atkinson-Shiffrin model (1968) asserts that human memory has three separate components: Sensory memory, short-term memory, and long-term memory. This model suggests that the flow of information from sensory input to long-term memory must first pass through short-term memory. Information from the environment is registered by sensory receptors—visual, auditory, haptic (relating to touch), and others—and passed to short-term memory. Here it is rehearsed or otherwise manipulated before entering long-term memory; here also are strategies for retrieving information from long-term memory.

1.3.1 Sensory memory

Sensory memory is the first stage through which the perception of incoming information enters. This type of memory has an extremely limited storage capacity, and it is

able to keep information up to 300 milliseconds (Ashcraft, 1994). Sensory memory includes all the smells, sounds, sights and the stimuli received throughout life. On the same line, it can be seen as the entry point of memory (the initial stage). The stimuli detected by the different senses can be ignored or perceived in order to remain in our brain. The sensory memory is an unconscious way of discriminating which process information will be useful at a later date.

According to Neisser (1967) stimulation of human sense organs is initially represented in sensory memory for a brief period by a literal, changeable, and modality-specific neural copy. The term iconic memory stands for the initial representation of visual stimuli, and echoic memory is its counterpart for auditory stimulation of long-term memory. In fact, sensory memory is the shortest-term when talking about working memory. In addition, in this unconscious process the stimuli detected by the different senses can be ignored and disappears almost instantaneously or it can be perceived and enter to the sensory memory.

Human brain has been designed to process and store information but in order to do that the input needs to go through the sensory memory process. Moreover an important aspect to highlight is that unlike other types of memory, sensory memory cannot be preserved via rehearsal.

1.3.2 Short-term memory

The short-term memory, as the name implies, retains information for a brief period of time. Cowan (1995) proposed that short-term memory refers to information in a long-term memory that is activated at a certain limit. From that point, the activated information immediately comes back to an inactive state. Short-term memory is also referred to as a storage buffer, the capacity of which is determined by practiced skills and strategies, such as rehearsal and chunking (Conway, Cowan, Bunting, Therriault, & Minkoff, 2002).

People are often holding information during brief periods of time that can become insignificant sometimes. Ordinary situations involve remembering the phone number of a friend, the address of a place, the dates of meetings, etc. This capacity to store and manage that type of information in the short-term memory is remarkably important for the functioning of cognitive processes. According to Gathercole (1999), one of the most important factors influencing short-term memory capacity is age. In children, their short-term memory capacity increases considerably up to adolescence. Miller (1956), provides evidence for the capacity of short-term memory in adults: they can store between 5 and 9 items. According to Atkinson and Shiffrin (1971) the elements that human beings keep in their memory seem to be kept only between 15 and 30 seconds.

Gathercole (1999), explains the neuroanatomy of short-term memory. The cerebral cortex is divided into four lobes: frontal, parietal, temporal and occipital. Through childhood, the basic neuroanatomical structure is placed at birth: the human brain grows to about 1000g between birth and twelve months. Another characteristic is the rate of metabolism, which varies according to the cortical region. The activity in the temporal, parietal and occipital lobes reaches adult levels, since three to six months of age. Meanwhile, the frontal lobe activity increases later at around nine months and continues up to adolescence. Another key feature is the number of synaptic connections that take place in the cortex, which reach the top in the second year of life. The short-term memory capacity is provided with new information. This information is sent to long-term memory through rehearsal and other cognitive processes. Waugh and Norman (1965) estimated that rehearsal contributes to two purposes. First, it helps maintaining items in short-term store and secondly, it transfers the information about the items to a more permanent long-term storage. Craik and Watkins (1973), stated that the item's maintenance in long-term memory depends on the length of stay in the short-term store.

Everyday experience tells us that some types of auditory sensory information are retained for short periods of time and human beings rely on their short-term memory while performing different types of tasks such as remembering an address, or phone number. The more times an item is rehearsed, the more likely it is to be transferred to the long-term memory.

1.3.2.1 Frequency of exposure

Given the incremental nature of vocabulary acquisition in L2, studies that involve learners' encounters with words in certain contexts can provide insights into how learners approach vocabulary learning (Joe, 2010). Time of exposure is one of them since it is relevant in word retention, especially when learning a second language. As Lai, Zhu and Gong (2015) declared, frequency of exposure influences word learning in two ways: one is by increasing the possibility of a word to be noticed by the learner, and the other is by reinforcing the association between lexical stimuli (target words) and mental responses (cognitive processing).

Regarding syntactic, semantic and listening abilities of the language, Ellis (1995) reports that repeated exposure to phonological and orthographical features of words in spoken and written input helps learners to recognise and produce those forms. Moreover, Baddeley (1990) supported this idea by explaining that rote rehearsal is not as effective as deeper rehearsal for storing and processing knowledge. Research made by Durkin (1990) revealed a significant effect for exposure levels, in which more contextual exposures (frequency of exposure) produced better acquisition of unknown words. For instance, the more frequently a word is produced in speech the earlier it will be learnt.

Nowadays, the required amount of encounters to learn an L2 unknown word is not clear. A study conducted by Hulstijn, Hollander, and Greidanus (1996) found that there was a little difference amongst time of exposure to target words once or three times. According to Rott (1999), six encounters may be sufficient to learn a word, Saragi, Nation, and Meister (1978) suggested 10 encounters and Waring and Takaki (2003) reported that it may take more than 20 times of exposure to incidentally learn the meaning of a word.

1.3.3 Long-term memory

Ericsson and Kintsh (1995) introduced the expression long-term working memory. While reading, mental representations of sentences are generated in the short-term and working memory. Elements of that representation are connected to parts of the previous representations (already stored in the long term memory). This linkage creates a long-term working memory that gives direct access to relevant information.

Long-term memory refers to the large storage of information or the system which stores information on a permanent basis (Ashcraft, 1994). As explained before, the information stored in this type of memory is there due to efficient rehearsal, which helps retaining new information. Moreover, the most important feature of this system is that it holds an unlimited storage capacity; this is actually why people have the ability to remember events.

According to Tulving (1972) there are different types of long-term memory: The procedural memory is the unconscious memory of skills and how to do things, particularly the use of objects and movements of the body. These memories are typically acquired through repetition and practice, and are so deeply embedded that we are no longer aware of them. This type of memory is encoded and stored in the cerebellum, putamen, caudate nucleus and the motor cortex (motor control). Moreover, the episodic memory is the one that storages

experiences and specific events (times, places and emotions) in a chronological order allowing us to reconstruct events at any given point in our lives. This memory allows human beings to remember a specific event in a wider way including the emotional charge and the entire context of it. Finally the semantic memory is responsible for storing facts, meanings, concepts and knowledge about the external world that we have acquired. Despite this unlimited capacity of storing information for long periods of time, there have been debates as to whether people really forget certain information at all, or whether it just gets increasingly difficult to access this information as time passes. These two types of memory are encoded by the medial temporal lobe (hippocampus, entorhinal cortex and perirhinal cortex) but are consolidated and stored in the temporal cortex (Ashby & O'Brien, 2005).

Modern studies have shown that learning and memory are not necessary a unitary process, but a link of very distinct processes. To state the difference, learning can be considered as the process in which new information is acquired, while memory can be considered as the process involving the retention of that new information.

Bahrick, Bahrick and Wittinger (1975) conducted a research on what they called *very long-term memory*. They worked with nearly 400 participants aged 17 to 74, using types of tests that included a free recall test in which participants had to try to remember names of people in a graduate class. A photo recognition test, and a name recognition test for ex-school friends. The results of this study showed that participants within 15 years of graduation were about 90% accurate on identifying names and faces. Participants tested after 48 years were 80% accurate for verbal and 70% visual. Nevertheless, free recall was worse, where participants tested after 15 years were 60% and after 48 years they were 30% accurate.

Another study this time conducted by Wixted and Squire (2011) showed the relevance of long-term memory, and how it relates to the other sorts of memory in the process of

retaining information. The study showed that in fact, it requires short-term memory and working memory for the long-term memory to be efficient. If the new information to be learnt exceeds the working memory capacity and is difficult to recall, the production will depend on the long-term memory even when the retention interval is brief as in short-term memory. In addition to this, learners performing cognitive tasks require maintaining access to a large amount of information. For instance, a student reading a sentence in a text needs to recall previously mentioned actors, places, and objects to resolve references to pronouns (Ericsson & Kintsh, 1995).

1.4 Working memory

1.4.1 Working memory and vocabulary learning

Working memory is considered to be the main system of human cognition and it is also where human cognitive processes occur (Ashcraft, 1994; Harrington & Sawyer, 1992; Just & Carpenter, 1992). These cognitive processes are responsible for manipulating incoming information and storing it for a limited period of time during the performance of demanding cognitive tasks (Ashcraft, 1994). Studies made by Daneman and Carpenter (1980; 1983) stated that people's working memories have different capacities and at the same time, these capacities affect the way they perform all sorts of tasks during their life, even the ones including the four skills (reading, writing, listening and speaking). From this point of view it is crucial to say that working memory has a significant importance in the process of learning a language.

A better understanding of the nature of human working memory may have important implications for understanding why people differ in cognitive skills and abilities and why individuals have different degrees of success in their efforts to accomplish real-world goals. If we understood more precisely the components of working memory, and which aspects are the most critical for real-world cognitive success, we might be able to develop methods to train and exercise working memory in a manner that could improve its function, and consequently enhance a person's cognitive repertoire.

Ideas regarding the nature and function of working memory have evolved considerably during the last hundred years, changing from primary memory to short-term memory to working memory. However, working memory is not completely distinct from short-term memory.

For one thing, the Atkinson-Shiffrin model (1968) is essentially sequential: information passes through short-term memory before entering long-term memory. But neuropsychological data were showing that this assumption is not correct. Some patients with brain damage (typically to the parietal lobe) who showed drastic impairments in short-term memory, nevertheless were able to store new information in long-term memory in comparison to that of neurologically healthy people (Shallice & Warrington, 1970). This finding demonstrated that information can gain access to the long-term memory system even when the short-term memory system was dramatically impaired. The Atkinson-Shiffrin model could not account for this result: with a poorly functioning short-term memory, according to Atkinson-Shiffrin, long-term storage should also be impaired.

Baddeley and Hitch (1974) argued that there are multiple systems available for short-term storage and that these storage systems are coordinated by the actions of a central control system that flexibly handles memory allocation and the balance between processing and storage. Because these short-term stores are independent, there is greater flexibility in memory storage. Thus, even if one buffer is engaged in storing information, the other can still be utilised to full effectiveness. The supervision of these storage systems by a central executive suggests that information can be rapidly shuttled between the two stores and coordinated across them.

There are various ways in which the temporary information can be stored within a cognitive system. In 1974, Baddeley and Hitch proposed a three-component model of working memory. The initial Multicomponent Model of Working Memory had three functional components: the central executive, the phonological loop, and the visual spatial sketch. The most important, known as the *central executive* is a system for controlling attention and it is used to ensure that working memory resources are directed and used appropriately to achieve

the goals that have been set. This part of the model (1) determines when information is deposited in the storage buffers; (2) determines which buffer—the phonological loop for verbal information or the visuospatial sketchpad for visual—is selected for storage; (3) integrates and coordinates information between the two buffers; and, most important, (4) provides a mechanism by which information held in the buffers can be inspected, transformed, and otherwise cognitively manipulated. The central executive determines both how to expend cognitive resources and how to suppress irrelevant information that would consume those resources (Baddeley, 1986).

There are also two temporary storage systems that are controlled by the central executive: the *phonological loop* and the *visuospatial sketch*. The phonological loop holds speech-based information and it is considered to be in charge of the storage and maintenance of information in a phonological form. It has been proposed that the phonological loop involves two sub components: a *phonological store* and an *articulatory rehearsal process* (Baddeley, 1986). When visually presented verbal information is encoded, the information is translated into an *auditory-phonological* code (for auditory information, such as speech, initial access to the phonological store is automatic). Then, in order to prevent complete decay, the information is refreshed and this is where the loop comes in. The refreshment comes via articulatory rehearsal, as one voices internally the sounds heard internally (like the ability to *shadow*—repeat quickly something that we hear—an indication that the phonological loop may be involved in language learning). Once the verbal information is spoken internally in rehearsal, it can then be heard again by the mind's ear and maintained in the phonological store. In this way a continuous loop plays for as long as the verbal material needs to be maintained in working memory.

Given that working memory is flexible, if for some reason, the phonological loop component is unusable, the central executive and the visuospatial scratchpad appear, preventing disruption in the performance on verbal working memory tasks.

Behavioural studies have suggested that phonological and articulatory factors significantly affect verbal working memory performance. One example is the phonological similarity effect: when items simultaneously stored in working memory have to be serially recalled, performance is significantly worse when the items are phonologically similar (Conrad & Hull, 1964). The effect is thought to be caused by confusions that arise when similar sound-based codes are activated for the different items in the phonological loop.

The other effect this time present in the articulatory processing is reflected in the word-length effect. Performance on a recall task is worse when the items are long words, such as *university*, and *individual*, than short words, such as *cat*, and *item*. The key factor seems not to be the number of syllables per se, but rather the time it takes to pronounce them: performance is worse for two-syllable words that have long vowel sounds, such as harpoon and voodoo, than for two-syllable words with short vowel sounds, such as bishop and wiggle (Baddeley, Thompson, & Buchanan, 1975).

The second storage system holds visual and spatial information and it is responsible of the storage and maintenance of the visual and spatial details. As the compound nature of its name implies, information processed by the visuospatial scratchpad is of two sorts: spatial, like the arrangement of your room, and visual, like the face of a friend or the image of a favourite painting. The ability to develop, inspect, and navigate through a mental image is thought to be a cardinal function of visuospatial working memory. The subjective experience of moving the mind's eye from one spatial location to another also suggests the possibility that visuospatial working memory depends on brain systems that plan movements of the eyes (or

possibly other parts of the body), just as verbal working memory depends on brain systems involved with planning speech (Baddeley & Lieberman, 1980). From this perspective, they suggest visuospatial working memory may be composed of two distinct systems, one for maintaining visual object representations and the other for spatial ones.

Therefore, Baddeley (2000) added a fourth component to the model, the episodic buffer, which is assumed to form a temporary storage system that allows information from the subsystems to be combined with that from long-term memory into integrated chunks. This capacity system depends heavily on executive processing, but which differs from the central executive in being principally concerned with the storage of information rather than with attentional control. This new component in the working memory process adds three new features. Firstly, it links the working memory to the long-term memory; second, it integrates information from all the other systems into a unified experience; a third one, indicates that there is a small amount of extra storage capacity that does not depend on the perceptual nature of the input.

The role of memory in the process of learning a language, either first or second language, has caught the attention of many researchers as the years pass (Baddeley, 1999). People learn new words in different ways and memory capacity plays an important role in this process. However there are also external factors that can determine the right acquisition of information. Apart from the general context, it has been found that elements such as the learner's level of proficiency, the text, previous knowledge, the learning context, the L2, and the learner's features are significant factors to have in mind when learning a second language (Chamot & Rubin, 1994).

If, as suggested, working memory is a temporary storage system that underpins our capacity for thinking, it is clearly the case that it should have implications for language

processing, and that disorders in working memory may impact on language processes (Baddeley, 2003). While a huge amount of such language processing is relatively automatic, deficits within the phonological loop, and to a lesser extent, within other aspects of working memory, may seriously impair language processing. It can be said that success when learning a second language is strongly attributed to differences in memory capacity because people in general have different ways and strategies to acquire new information and different ways of using memory. Although it is known that the working memory is developed in the first years of life, it can be trained and improved with experience as the person grows up.

1.4.2 Working memory in monolinguals

As Aronin and Hufeisen (2009) stated, monolinguals are people who employ one language in their daily lives, and may be skilful at applying a number of different varieties of the language along with distinctive registers. According to the Oxford English Dictionary (2016), monolingualism is known as the condition that some people have to speak only one language. Monolinguals, known alternatively as monoglots, use only one language; however, they tend to be proficient at using the variations of the language and the different registers depending of the context (Aronin & Hufeisen, 2009).

Working memory in monolinguals becomes irregular when learning a first language. Studies demonstrate that people vary in their working memory capacity because it directly affects their performances on tasks involving reading comprehension (Daneman & Carpenter, 1980, 1983; Daneman & Green, 1986; Tomitch, 1995). Reading becomes relevant when explaining how working memory functions in monolinguals, since it is an essential source of new words to learn.

When memorising a new word, people use working memory to link images, sounds, and at the same time process this new information in memory slots. These slots go in several directions through synapses around sections in the brain, associating that new information with previous and related knowledge. If adults use the new information, nerve cells will connect tighter, making it difficult to forget (Morales, Calvo & Bialystok, 2013).

Ellis (1996) explained that learning vocabulary in native languages includes knowing the phonological features of it such as, categorical units, syllable structures and phono-tactic sequences. Furthermore, it is concluded that one important role of working memory is related to hold sequences of languages, so language acquisition relies on working memory. Besides, it is known that usual language assessments trust on previous language experience, which means that its result will depend on the exposure to the languages. Daneman and Carpenter (1980) explained that early studies in monolingual adults' attainments on verbal working memory tasks associated with reading or listening activities, present a decay on adults with smaller reading or listening spans for keeping information under attention, resulting in more errors than adults with larger spans. The same assumption is attributed to monolingual children; they, as well as adults, face comprehension problems due to their limited working memory skills.

In a study conducted by Kaushanskaya and Marian (2009), they proposed that monolinguals are not able to properly recall novel words, because they do not have the necessary mechanisms such as, suppression of irrelevant information, inhibitory control or inhibit-interference from the target language as in the case of bilinguals. The study consisted of having three different groups, twenty English-Spanish bilinguals, twenty English-Mandarin bilinguals and twenty English speaking monolinguals. In the vocabulary testing, participants heard the novel word, and then chose the correct English translation out of five options. The

results showed that monolinguals did not stand out from the other two groups, mainly because of their little exposure to another language since early in life.

1.4.3 Working memory in bilinguals

According to Bloomfield (1933), bilingualism is the ability to express oneself with ease in two languages. Bilingualism is a complex cognitive and linguistic phenomenon, which may differ amongst individuals, and even within individuals regarding their competence in the languages concerned (Romaine, 1995). Ervin and Osgood (1954) categorised bilingualism into two types: coordinate and compound bilingualism. The first one is described as a person's usage of two different independent linguistic systems, which means that the person constructs a series of correspondences between signifier and meaning in each language. Instead, in the compound bilingualism, the person owns one cognitive structure, meaning that the person uses two different words in two different languages to refer to the same object, connecting both to the same concept.

As previously stated, the working memory of a person includes the structures and processes associated with both the storage and processing of information over short periods of time. The bilingual brain is able to determine the language of heard or written speech, originate words in the selected language, and inhibit the production of words in the non-selected language (Crinion et al., 2006).

In addition, people in general are constantly learning and absorbing information from their surroundings. Since they are born, they start this unstoppable, constant process of learning. Regarding language, people get a start point for the phonological contours, grammars, and uses of the language by building up neural connections in the brain (Childs, 1998). Beliefs shown by previous researches have stated that individual differences in working

memory are highly predictive in consequence of cognitive behaviours. A study made by Ransdell, Barbier and Niit (2006) showed discrepancy by having monolingual, bilingual and multilingual university students from different cultural contexts. The task was to read and remember final words of different sentences in order to comprehend a reading span test in their native languages. This research found that bilingual and multilingual students have better metalinguistic awareness of their language skills in reading and working memory than monolingual students, mainly due to their exposure to the language.

Studies have evidenced the relation between cognitive skills, and working memory in bilinguals. Ransdell, Arecco and Levy (2001) stated that working memory could be analysed through writing tasks. In their study, they agreed that writing assignments depend on various cognitive processes, which means that the person needs to decide what to write, by coming up with sentences, and by editing what they have done. The study consisted in the analysis of the coordination of long-term working memory, whilst participants wrote in L1 and L2. Forty-two multilingual subjects were able to maintain native language writing characteristics and fluency in the presence of irrelevant speech while keeping a concurrent six digits memory load. The result was interpreted in terms of bilingual advantage in overcoming irrelevant information. According to Gutiérrez-Clellen, Calderón and Weismer (2004), working memory can help predict L2 proficiency in young learners by enhancing cognitive skills. Moreover, memory span appears to measure the number of discrete units over which the person can successively organise its attention and still distribute them into a working unit.

Another benefit of working memory lied on the capacity of performing at a larger level in mental tasks. As Cummins (1977) supported, bilingual learners were able to perform at a higher level in intellectual skills than monolinguals. Having access to two languages simultaneously can positively influence cognitive functioning, which could eventually lead to

a more accelerated development of intellectual tasks. This occurs differently for monolinguals, who did not have entrance to a variety of experiences in that case. Moreover, Marian and Shook (2012) stated that in the case of a bilingual adult using one language the other keeps active as well. For instance, if a person hears a word, it will not be completely heard at the beginning, instead, the vibrations will arrive gradually. Long before the word is finished, the brain's language system starts to presume what it might be by activating lots of words that ultimately match the perceived one, for example if they hear *ship*, they will activate words such as *sheep* and *cheap*.

In conclusion, the working memory of a monolingual person differs from the one of a bilingual person, basically in a way that the first has not the type of connections that are present in a person who speaks two or more languages. From the previous ideas it is remarkable to state that one type of memory is not better than the other, but that they work in different ways considering language learning. The process of learning a language is credited with assisting cognitive processes, as it constitutes an intellectual stimulus and includes new ways of thinking, learning and organising (ALS & ALAA, 1981).

1.4.4 Working memory in early and late bilinguals

The acquisition of two languages raises questions about the process and the outcomes. The most typical interrogation relies on the age when a certain language is acquired, since the onset age of bilingualism is determined as the period of time at which bilinguals begin using both languages on a daily basis. Furthermore, Portocarrero, Burright and Donovick (2007) established the distinction between early and late bilinguals. They explain that early bilinguals are those individuals capable of acquire the language before the age of 10, and late bilinguals are those who acquire language at age of 10 or later.

There is a common assumption that L2 achievement is primarily a function of age and that native-like performance is not accomplished unless the L2 is acquired during early childhood. In addition to this, the issue that children acquire their mother tongue more rapidly and more efficiently than adults when learning a second language has led to the hypothesis that infancy is a critical period for language acquisition, in which human beings are biologically skilled to learn languages. Basically, the earlier age of arrival, the greater the second language proficiency. Moreover, Lenneberg (1967) postulated that second language can be acquired only during a critical period which goes from the early infancy until adolescence. At the same time, Johnson and Newport (1989), agreed that language develops up to early in life, and then gradually descends when this period finishes. Consequently, if learners are not exposed to a first language during a maturational stage early in life, they will be unable to acquire any language fully later on.

Age in bilingualism appears to be highly important regarding proficiency, cognitive processes and working memory. According to Luk, De Sa and Bialystok (2011), late bilinguals, who became bilingual at an advanced age, may not only differ from early bilinguals regarding proficiency in both languages but also in neural organisation (Hernandez, Hoffman & Kotz, 2007). Kramer and Mota (2015) conducted an experiment demonstrating that early and late bilinguals were more efficient at storing, manipulating and repeating words more correctly than monolinguals. Recent studies of bilingualism have shown that early bilinguals and late bilinguals demonstrate enhanced attentional control in different tasks (Bialystok, 2001; Bialystok, Craik, Klein & Viswanathan, 2004).

This bilingual processing advantage is not constrained to linguistic tasks but has been found in a variety of cognitive processes (Bialystok & Martin, 2004). The exact nature of this superior control however is still debatable. The ability to store and maintain that information

active links with working memory and vocabulary learning. Park et al. (2002) explained that the ability to maintain information active for processing in working memory begins to decline at 20's and that it gradually declines through life. As people age, they have greater difficulty holding, manipulating and dealing with incoming information, especially on tasks involving performing all these together. In addition to this, according to Johnson and Newport (1989), there are differences in outcomes for both early and late bilinguals, which occur because late bilinguals do not acquire native-like proficiency levels in their L2 and, consequently, language competence does not increase at a steady level.

Studies conducted by Barber and Carreiras (2005) stated that general factors such as demands on working memory could stand an important factor regarding non-native-like performance in late bilinguals. The experiment was carried out with Spanish speakers and consisted of manipulations of sentences (between articles and nouns), resulting in late bilinguals struggling to maintain information and demanding working memory. These studies put bilinguals in a higher level considering working memory. Research made by Van Hell and Mahn (1997), showed that experienced learners outperformed novice language learners in both the number of retained foreign words, and in the speed of their retrieval. This bilingual advantage was existing independent of the learning method; however, bilingual learners seemed to benefit from the process of repeating the foreign word out loud during the research more than from associating the foreign word to a similar sounding key-word in the native language. Supporting this idea, Kroll, Michael, Tokowicz, and Dufour (2002), conducted an experiment that found that experienced English-Spanish and English-French bilinguals were better on reading span tasks involving working memory.

One of the considerations that needs to be taken into account is that acquiring a language depends on the age in which the language is learnt. When language is learnt in an early stage of life it is adjudged as early bilingualism. In opposition to that, when the time of acquisition occurs in the adulthood it is known as late bilingualism (Haugen, 1956; McLaughlin, 1984).

Chapter 2 — Problem statement and research proposal

2.1 Justification

Being bilingual in a globalised world has become increasingly common and practical. Scientists have begun to observe that the advantages of speaking more than one language are more significant than just speaking one. The field of vocabulary learning and working memory has not been deeply investigated considering second language is crucial in our educational system. One of the most fundamental pillars for communication is vocabulary learning, therefore, it is important to establish the cognitive advantages upper intermediate users of English (UIUE) have in order to acquire vocabulary. Also, it is relevant to understand the influence of short-term memory on vocabulary acquisition due to the fact that the process of it includes two main factors: age and exposure to the language. Notably, the role of short-term memory in vocabulary acquisition is affected by language knowledge. In addition, it is necessary to make the contrast between UIUE and monolinguals in word recognition task, because of the assumption that the earlier an individual is exposed to a second language, the most likely to improve learning later in life.

2.2 Research questions

- Do upper intermediate users of English outperform their monolingual peers in word learning?
- Do participants with double training sessions outperform learners with a single training session?

2.3 Objectives

2.3.1 General objective

- To investigate the influence of working memory and frequency of exposure on vocabulary learning.

2.3.2 Specific objectives

- To determine the influence of working memory on upper intermediate users of English and monolingual students on vocabulary learning.
- To determine the influence of single and double training sessions in word learning.

2.4 Variables

2.4.1 Independent Variables

- Monolinguals
- Upper intermediate users of English
- Frequency of exposure

2.4.2 Dependant Variable

- Accuracy

2.5 Hypotheses

- Upper intermediate users of English will perform better on semantic categorisation tasks than monolinguals in working memory processes.
- Learners with double training will outperform learners with single training in word learning.

Chapter 3 — Study

3.1 Introduction

This study attempts to investigate the effects of working memory and the influence of training in learning new vocabulary. In line with the previous experiment conducted by Ransdell, Barbier and Niit (2006), it can be inferred that upper intermediate users of English (UIUE) outperform monolinguals (M) in terms of working memory. Moreover, it was expected that participants with double training sessions would perform better than learners with a single training session in the learning of novel words (Channell, 1988).

The current study consisted of the presentation of fifteen novel words containing seven living and eight non-living nouns (Appendix 3.1). These words were presented in two training sessions and participants were tested in a semantic categorisation task.

3.2 Study

3.2.1 Method

Participants

The participants were 105 university students. 47 upper intermediate users of English (33 females; mean age 23.7 years, SD 4,05 and 14 males; mean age 22 years, SD 1,1; range, 21 to 39) with a B-1 level, according to the Common European Framework of Reference for languages (CEFRL), who had been studying English Pedagogy at the Universidad Católica de la Santísima Concepción for five years. 58 monolingual students (40 females; mean age 19.3 years, SD 1,5 and 18 males; mean age 19.2 years, SD 1.3; range, 17 to 23) with an English functional 1, which means they had received a minimum exposure to a second language, studying other majors at the same university. None of the participants presented a record of any language or vision disabilities. Two females failed to complete the test due to technical

problems; another female participant was not paying attention to the instructions; and two males and one female were excluded from the study because they did not arrive in time to the testing session. Finally, the remaining participants in the study were 69 females and 30 males, with 54 M and 55 UIUE.

Materials and design

A set of fifteen novel words in English (e.g. *telt, reck, prew*) were used in the study (see Appendix 3.1). They were obtained from the English Lexicon Project Web Site (http://elexicon.wustl.edu) according to the following criteria used in the study by Soto, Bravo, and Valdés (2013): Length (4 minimum and 7 maximum), Orthographic Neighbours (8 minimum and 12 maximum), and BG Mean frequency (2000 and 4000 maximum).

After having the results, thirty-six words were selected according to the following criteria: not ending in –ed, –er, –ing and –s, as words resembled real singular nouns were needed. Not starting in –h, –s, –c, and –z, for they were not properly recorded in the reading task. In order to select these items, an English native speaker (male from Norwich, England) was asked to read and record a list of thirty-six words in order to make sure the words had a regular pronunciation (see Appendices 3.1 and 3.2).

After reading and recording the 36 words, the English native speaker had to give feedback about their pronunciation and orthographic form, that is to say, if the novel words sounded real, and if they looked as real words. The novel words that were selected fit the criteria previously mentioned. Finally, fifteen words were selected distributed living/non-living and were given images.

The selection of images entailed 7 living creatures (extinct animals, exotic plants, amongst others) and 8 non-living elements (ancient instruments, medieval objects, amongst

others) (see Appendix 3.3). Images were associated with a novel word randomly; so novel words were linked to a picture of a living or a non-living thing so that participants learn their meaning. Once the association was made, images helped the creation of the sentence for each novel word (see Appendix 3.1). Subsequently, a male native speaker was recorded as he read aloud each of the fifteen novel words (see Appendix 3.1). The resulting audio files were edited using Audacity 2.1.1 (Mazzoni & Dannenberg, 2015) and were then added to a Power Point presentation to be used in the training session. Once the training version was ready, it was counterbalanced to cancel out possible order effects. The instruments were validated by a university professor.

Procedure

The study took place over one day. Firstly, participants received the training session (single or double) in which they were presented the training presentation and after a break, the testing session that consisted of a semantic categorisation task. For single training groups (M1 – UIUE1), the learning session lasted four minutes, and then participants had a break of ten minutes, to finish with the testing session that lasted two minutes and a half.

Alternatively, for double training groups (M2 – UIUE2), both learning sessions lasted four minutes with breaks of ten and fifteen minutes respectively in between, and finished with the testing session that lasted two minutes and a half. Participants were given breaks before the testing session in order to consolidate new words. The words that were presented were the same and in the same order than in the first training.

Training procedure

During the training, all participants went through the same conditions. The training was made in groups (M1, M2, UIUE1 and UIUE2) and all the participants began at the same time. Firstly the participants were presented to the entire list of fifteen novel words, all of them associated with images. The words were presented in (Times New Roman, 80). All audio files (spoken words) were presented for one second, and all sentences (Times New Roman, 49) stayed on for five seconds before moving automatically to the next slide (see Appendix 3.4).

This test consisted of a presentation of fifteen novel words with the written word, their respective image, pronunciation and context. That is to say, participants were asked to memorise those fifteen novel words using their own strategies. The training session was ordered as: a novel word appeared on the screen along with the image and its pronunciation in the first slide, and the novel word in context in the second, for five seconds each. Once the time was over, the next slide took place with another novel word, and so on, until the list of the fifteen words was completed. In order to have a clear understanding of how the sentences were presented during the training session, see Appendix 3.5.

The following is a graphical representation of the procedure of the training session. Figures 3.1, 3.2, 3.3 and 3.4 depict the format of the training session for all the participants.

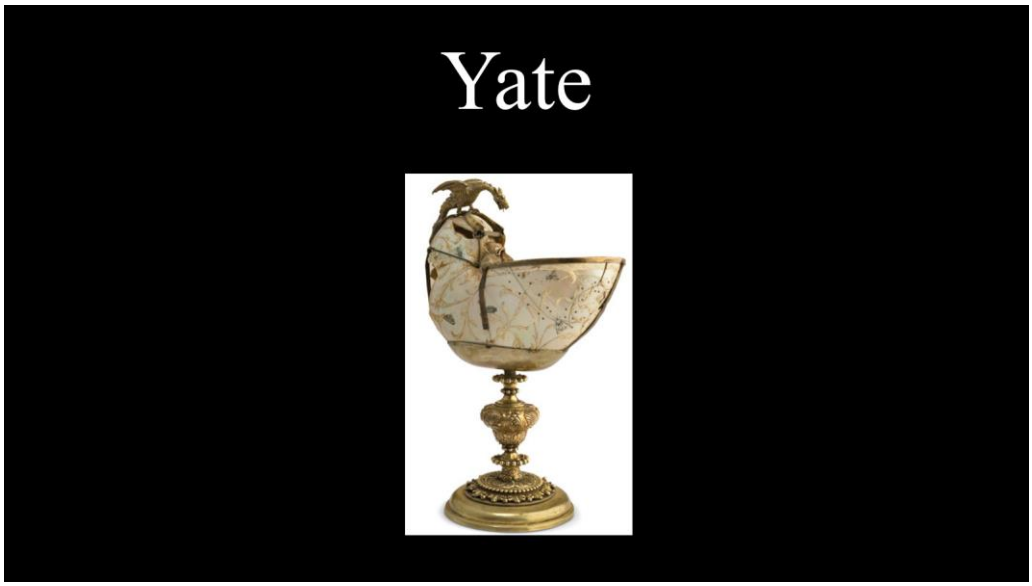

Figure 3.1 Image, written form, and audio of the novel word (Non-Living).

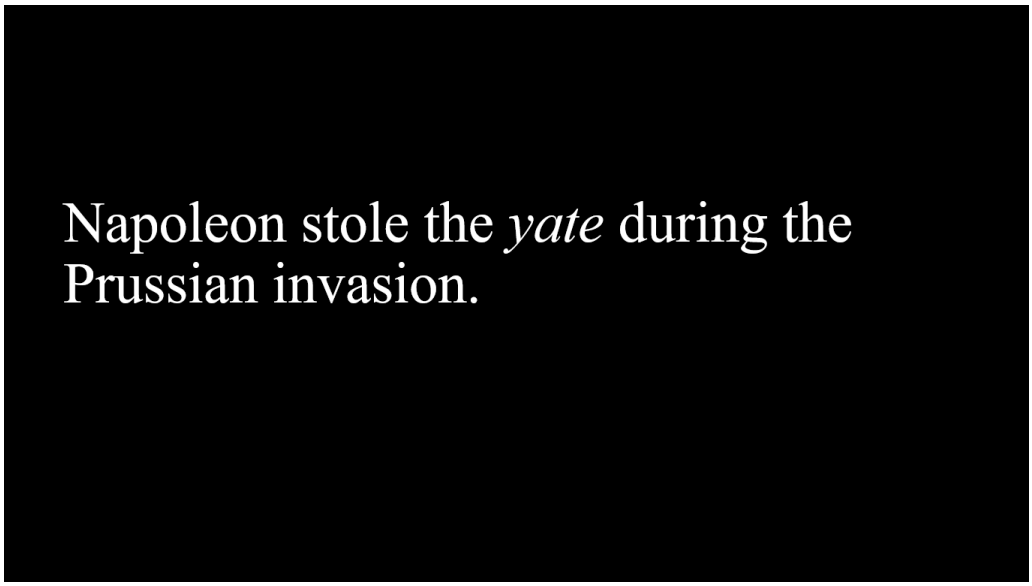

Figure 3.2 Presentation of a sentence during the training session (Non-Living).

Figure 3.3 Image, written form, and audio of the novel word (Living).

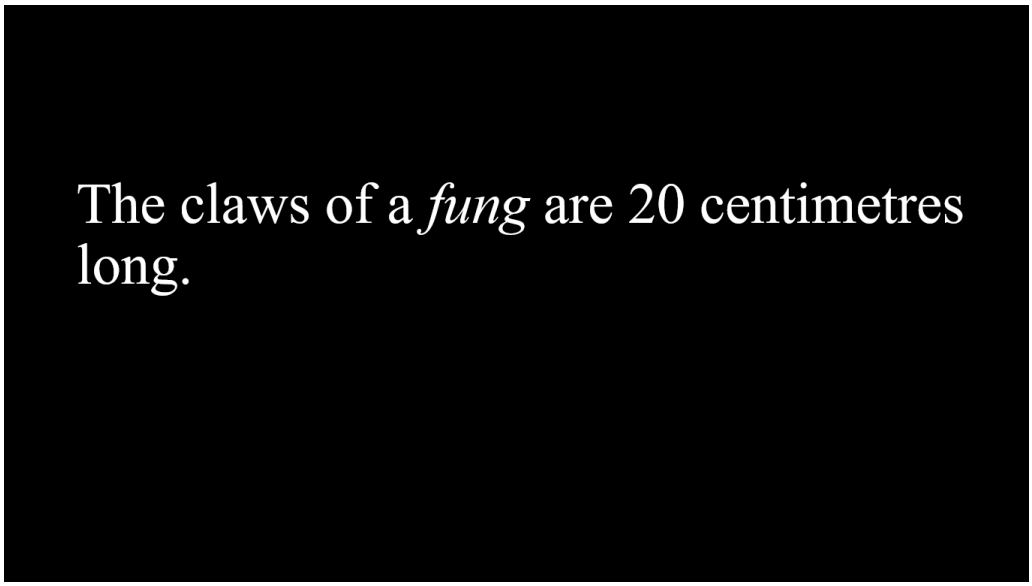

Figure 3.4 Presentation of a sentence during the training session (Living).

Testing procedure

The task consisted of a semantic categorisation, in which participants were presented the words disorderly and asked to identify whether the word that was shown in the presentation was associated to a living (L) or non-living (N-L) concept. Once the word was displayed, it automatically changed to the next one; therefore they had to answer immediately. Participants were given an answer sheet where they had to mark with a tick (✓) in the corresponding box (Appendices 3.6 and 3.7).

The study was run on Sentey CS1-1398 computers, with LG 20-inchscreen, with a resolution of 1280 x 800 pixels. This task also required headphones (Genius HS-500X) for each participant. Newly learnt words were randomly presented in white Times New Roman, 80 point, lower case font on black background (see Figure 3.5).

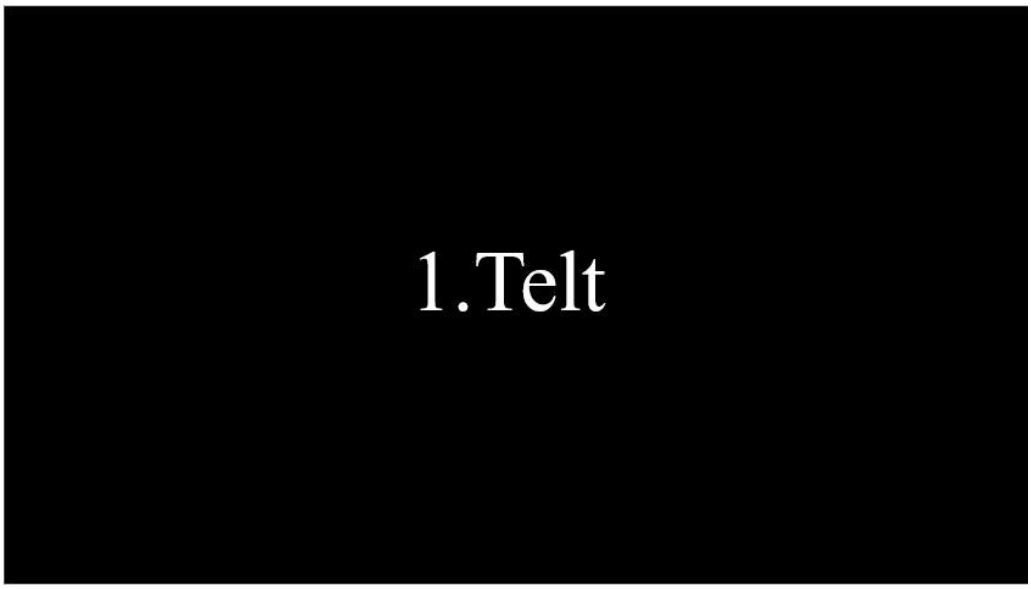

Figure 3.5 Written form of the novel word (Non-Living).

3.2.2 Results

The data analysis collected from the ninety-nine participants that took part in the study was analysed conducting a two-tailed *t*-test for independent samples with 95% confidence. The results were compared in terms of accuracy in single and double training sessions amongst two groups, monolinguals and upper intermediate users of English. Accuracy stands for the percentage of correct words that participants were able to identify into living and non-living. As previously stated, the range of correct words to be accepted as sufficient is 9 to 15.

Analysis 1 compared the means of the correct words recalled in a brief period of time by monolinguals and upper intermediate users of English in a single training session.

Vocabulary acquisition

Table 3.1: Mean accuracy

	Monolinguals 1	Upper Intermediate Users 1
Nº participants	16	12
(%)	57,14	42,85
Mean %	53,3	74,4
SD	1,89	2,03

An independent sample *t*-test reported significant difference on vocabulary acquisition *t(26) =-4,235, p=0,00.*

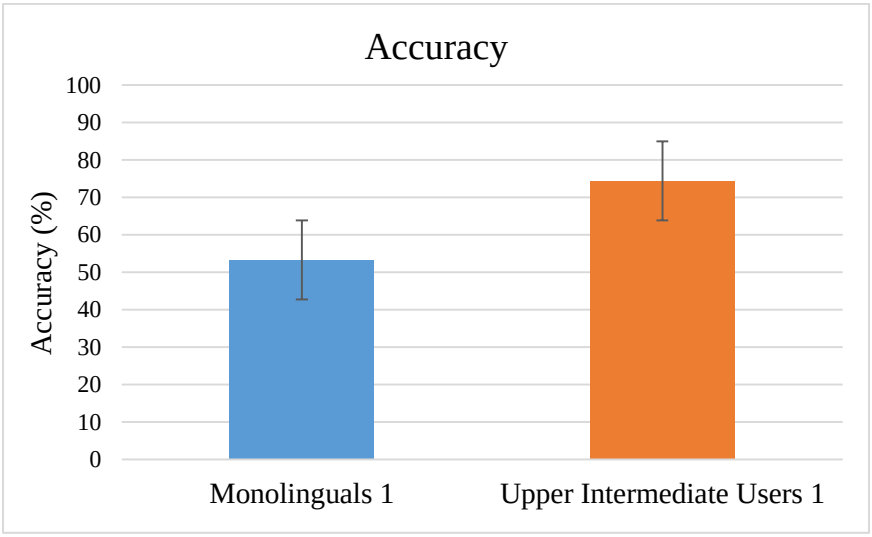

Figure 3.6 Accuracy, corresponding to the percentage of correct answers obtained by monolinguals and upper intermediate users of English in a single training session.

Analysis 2 compared the means of the correct words recalled in a short period of time by monolinguals and upper intermediate users of English in a double training session.

Vocabulary acquisition

Table 3.2: Mean accuracy

	Monolinguals 2	Upper Intermediate Users 2
Nº participants	38	33
(%)	53,52	46,47
Mean %	77,13	84
SD	2,04	2,16

An independent sample *t*-test reported significant difference on vocabulary acquisition *t(69) =-2,053, p=0,04.*

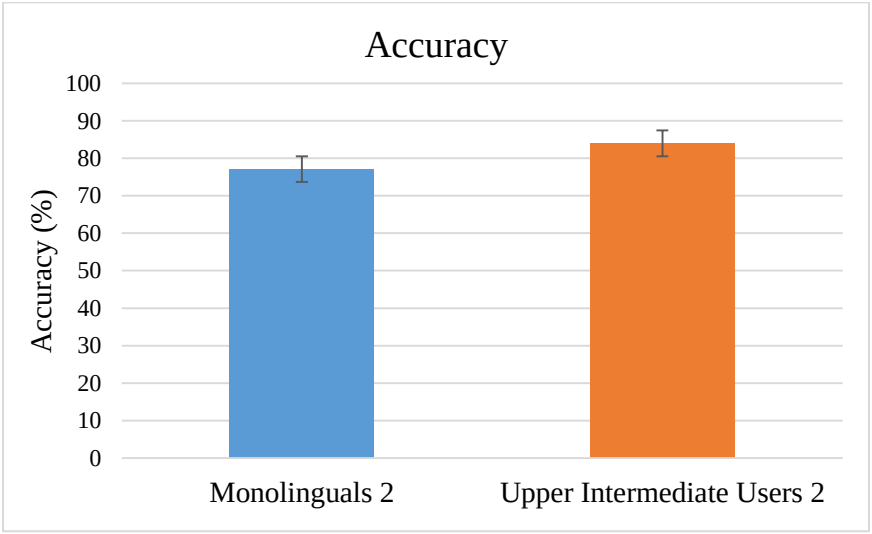

Figure 3.7 Accuracy, corresponding to the percentage of correct answers obtained by monolinguals and upper intermediate users of English in a double training session.

Analysis 3 compared the means of the correct words recalled in a brief period of time by monolinguals with single and double training sessions.

Monolinguals Vocabulary Acquisition

Table 3.3: Mean accuracy

	Monolinguals 1	Monolinguals 2
Nº participants	16	38
(%)	29,62	70,37
Mean %	53,3	77,13
SD	1,89	2,04

The results shown by an independent sample *t*-test provided significant difference between words learnt in single and double training sessions *t(52)=-5,98, p= 0,00.*

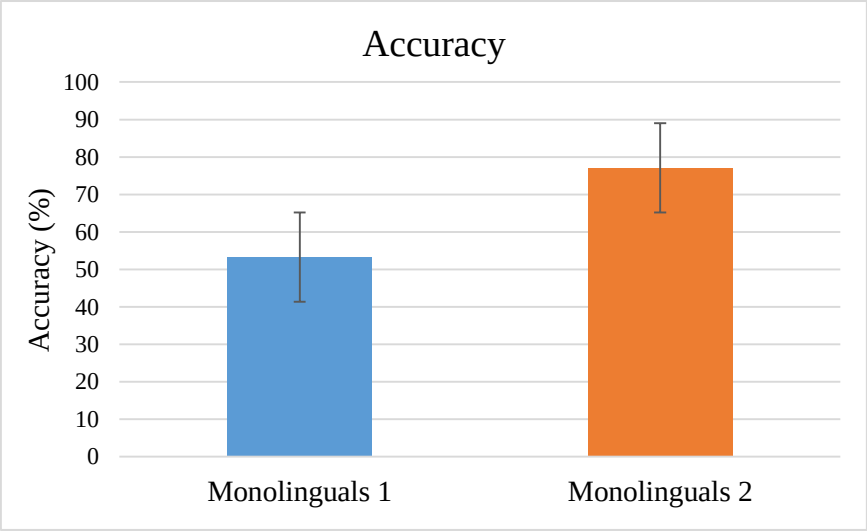

Figure 3.8 Accuracy results on monolinguals with single and double training sessions.

Analysis 4 compared the means of the correct words recalled in a brief period of time by upper intermediate users of English with single and double training sessions.

Upper Intermediate Users Vocabulary Acquisition

Table 3.4: Mean accuracy

	Upper Intermediate Users 1	Upper Intermediate Users 2
Nº participants	12	33
(%)	26,66	73,3
Mean %	74,4	84
SD	2,03	2,16

The analysis demonstrated significant results when comparing both learners groups *t(43)=-2,002, p=0,05.*

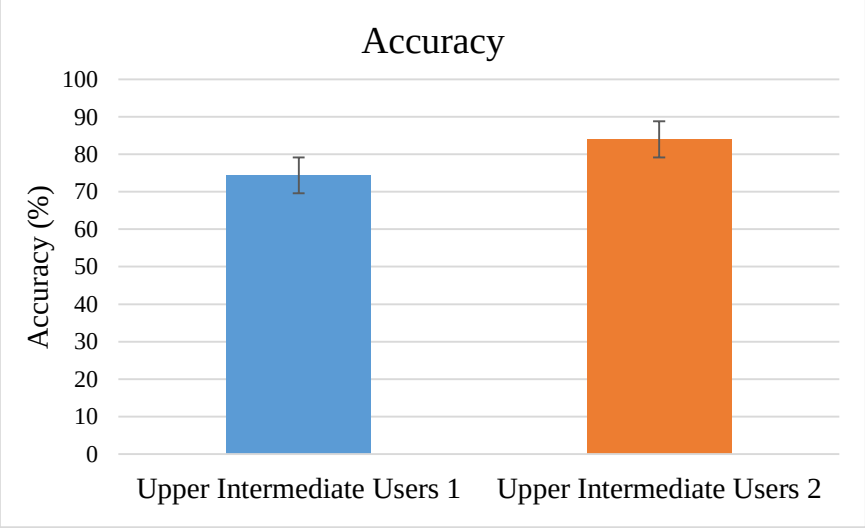

Figure 3.9 Accuracy results on upper intermediate users of English with single and double training sessions.

Chapter 4 — Discussion, Conclusions, Limitations and Further Studies

4.1 Discussion

The present study aimed to delve into the influence of working memory in learning novel words, which corresponded to living and non-living nouns. It also attempted to analyse the effects of training in the process of learning new vocabulary. The results of the task are discussed below.

Semantic categorisation

The study collected data from a semantic categorisation task that measured accuracy in a single training session. The hypothesis indicated that upper intermediate users of English (UIUE) perform better than their monolingual (M) peers in word learning. Results obtained through the independent sample *t*-test showed a *p* value statistically high; thus, our assumption was confirmed since there was a significant difference between both conditions, in which upper intermediate users had a better performance than monolingual subjects.

This result confirmed one of the hypotheses regarding working memory, since upper intermediate users of English were able to recall and recognise more words than their monolingual peers. This idea is supported by Kaushanskaya and Marian (2009), who explain that bilingualism facilitates word learning in adults, and they suggest a general bilingual advantage for novel word learning. Sixty participants were recruited for the study: twenty English-Spanish bilinguals, twenty English-Mandarin bilinguals, and twenty English-speaking monolinguals. Firstly, participants heard the novel word pronounced twice over headphones

and saw its written English translation on the computer screen. Subjects were instructed to repeat the novel word and its English translation out loud three times. Each pair was presented twice during the learning phase. After that, participants' memory was tested immediately after learning and after a week delay, using recall and recognition tasks. During recognition testing, participants heard the novel word and chose the correct English translation from five options that were listed on the computer screen. The results suggested a bilingual advantage, with both bilingual groups outperforming the monolingual group. The findings indicated that both experienced with Spanish and experienced with Mandarin facilitated novel-word learning and increased memory-storage capacity relative to monolinguals. Also, this experiment concluded that monolinguals do not recall properly new words due to their lack of memory skills. These results can be related to ours, since in both experiments monolinguals obtained lower results compared to UIUE.

This idea goes in line with Baddeley (1999), and Daneman and Carpenter (1983) which explain that people's working memory has different capacities that affect the way they perform all sorts of tasks during their lives because, in general, they have both different ways and strategies of using memory and acquire new information. One of the advantages of learning a second language can be seen in the ability of performing in a higher level in mental tasks. Therefore, our results reflect how cognitive processes are more sophisticated in UIUE and the manner in which it improves their performance in intellectual assignments (Cummins, 1977). In terms of accuracy, the results obtained from the semantic categorisation task were higher in favour of UIUE, not only for their developed cognitive skills, but also because of the design of the experiment which allowed the recency effect to happen.

Another factor that influenced upper intermediate users of English's performance was vocabulary strategies. Ghazal (2007) suggests learning a second language involves acquiring learning strategies to simplify the process of comprehension, storage and retention of the new language. In addition, participants used mnemonic strategies in order to learn the fifteen novel words of the experiment by using different learning techniques such as: connection mnemonic and image mnemonic (Sanaoui, 1995). Moreover, as Nation (2001) and Schmitt (1997) stated, knowing a word includes being aware of its spelling, pronunciation and context, which we followed while conducting our experiment in order to activate previous knowledge. Monolingual students may not have being developing as many strategies as upper intermediate users of English (Alharthi, 2014).

Frequency of exposure

The data was obtained through the variable of frequency of exposure that measured accuracy. Our hypothesis stated that participants with double training outperform the ones with a single training session in both M and UIUE groups. The results retrieved from the independent sample *t*-test showed a *p* value statistically high.

During the testing process, it was observed that students with double training sessions outperformed the ones with a single training session. The number of times participants were exposed to the novel words influenced significantly on their accuracy. These agreed with the study conducted by Kirchhoff, Anderson, Barch, and Jacoby (2011) who explained that when a novel word is exposed more, there is a higher brain activity in the prefrontal and left temporal regions. Thus, there is interdependence amongst higher recognition of novel words and training.

In relation to training, the performance of monolinguals and upper intermediate users of English were benefited regarding accuracy of learnt words by double training sessions which enhanced time of exposure. The main reason for these results can be supported by Brown (1958), who indicates that new information is not likely to be retained if rehearsal is not done. For this reason, training sessions are important, since the more times an item is rehearsed, the more likely it is to be transferred to the long-term memory (Wixted & Squire, 2011).

The results obtained are a reflection of the time of exposure condition not only on the experiment itself, but also during life. Monolinguals are constantly learning new words in their native language, while upper intermediate users of English do the same, but in two languages.

4.2 Conclusions

According to the results of this study, it can be established that upper intermediate users of English (UIUE) outperform their monolingual (M) peers in working memory processes at the moment of learning new vocabulary. These findings answered the first research question, due to UIUE's advanced cognitive processes, which resulted in a better retention of the fifteen novel words.

The second research question was answered, since the categorisation of the novel words into living or non-living was improved by the input through the exposure to aids such as images, context, audio and frequency of exposure, which was an additional variable that suggests that the more stimulus is exposed, the better it will be recalled.

As shown above, working memory contributes to transfer the new vocabulary from short term memory to long term memory allowing the categorisation of new words. It can also be concluded that training plays an important role for both M and UIUE in the process of learning a language due to their improvement when having double training sessions. Our findings demonstrate to be important for EFL teachers, since they show upper intermediate users of English do not need excessive teaching, that is to say, teachers should consider the cognitive abilities of an upper intermediate student. Although the results showed an inclination in favour of upper intermediate users of English, more research is needed.

These results lead to conclude that teaching vocabulary should be the focus of EFL teachers, since it is the most important aspect of learning a language because it allows learners to convey meaning in texts, which at the same time, contributes to the development of reading comprehension skills. For instance, the last *Simce* evaluation showed a low performance in

reading tasks where 80% of Chilean students did not understand English because they did not manage the sufficient amount of vocabulary. In order to overcome this situation EFL teachers should consider firstly, making use of cognitive processes such as memory, which contributes to transfer the new vocabulary from short term memory to long term memory. Besides, vocabulary should be taught through repetition, since the more times learners are exposed to the new language, the more likely they will be to learn it. Secondly, it is important for teachers to make use of methods and strategies which are elements that help determine how students learn a foreign language, for example, the use of context and imagery helps them understand the meaning of the word, also mnemonic strategies are efficient procedures learners use for a specific lexical item through visual or verbal aids.

Therefore, knowing vocabulary is the key element for understanding and consequently producing the language. If we want learners to understand a foreign language, we need to provide them the appropriate tools and different methods in order to accomplish this task.

4.3 Limitations

The study was affected by some limitations that were noticed after the experiment was conducted. The first limitation was not testing the reaction time between the monolingual and upper intermediate users of English groups. Many studies have considered reaction time as an important element to investigate during memory research, hence, the study would have had more variables to analyse and compare between the two groups.

Another important limitation was not to have gathered more information about the participants of the study, such as: previous English studies, background information of the subjects, and if they had travelled abroad to an English speaking country. This would have helped us to have more certain information about the participants in case one of them had a higher level of English than the one needed.

4.4 Further studies

The research that has been undertaken for this study has enlightened working memory and vocabulary learning, on which further research would be favorable.

More variety of activities needs to be considered when setting an experiment, such as putting the word in sentences with high and low context, given that researches state that a word in high context is stored in a better way. Also, training sessions could be designed differently by putting novel words, their images, audio and sentences separately rather than presenting all of those together. For the testing session, activities like: matching the novel words with images or free recalling could be included depending on the aim of analysis.

More research with school children is needed, considering that vocabulary learning starts at a very early stage in life. Furthermore, learning a second language is a complex process that differs depending on the age in which it is learnt. Task-switching is another area for further research, given that there are a large number of studies that consider bilingualism closely related with changing between tasks. Moreover, knowing one language or more may be beneficial at the moment of shifting attention from one activity to another.

References

Al-Seghayer, K. (2001). The effect of multimedia annotation modes on L2 vocabulary acquisition: A comparative study. *Language learning technology, 5*(1), 202–232.

Alharthi, T. (2014). The impact of attrition on vocabulary knowledge among Saudi teachers. *English language teaching, 7*(4), 111–118.

ALS & ALAA (Australian Linguistics Society & the Applied Linguistics Association of Australia). (1981). Languages in a core curriculum –a set of statements from the profession–. *Babel, journal of the Australian federation of MLTA 17*, 2–3.

Aronin, L., & Hufeisen, B. (Eds.). (2009). *The exploration of multilingualism: Development of research on L3, multilingualism and multiple language acquisition* (Vol. 6). John Benjamins Publishing.

Ashby, F. G., & O'Brien, J. B. (2005). Category learning and multiple memory systems. *Trends in cognitive sciences, 9*(2), 83–89.

Ashcraft, M. H. (1994). *Human memory and cognition*. New York: Harper Collins.

Atkinson, R. C., & Shiffrin, R. M. (1968). Human memory: A proposed system and its control processes. *Psychology of learning and motivation, 2*, 89–195.

Atkinson, R. C., & Shiffrin, R. M (1971). *The control of processes of short-term memory.* Stanford University.

Ausubel, D. P. (1964). Adults versus children in second language learning: Psychological considerations. *The modern language journal, 48*(7), 420–424.

Baddeley, A. D. (1986). *Working memory*. Oxford, England: Clarendon Press.

Baddeley, A. D. (1990). *Human memory: Theory and practice*. Hove, UK: Lawrence Erlbaum Associates Ltd.

Baddeley, A. D. (1999). *Essentials of human memory*. East Sussex: Psychology Press.

Baddeley, A. D. (2000). The episodic buffer: a new component of working memory? *Trending cognitive sciences, 4*(11), 417–423.

Baddeley, A. D. (2003). Working memory and language: An overview. *Journal of communication disorders, 36*(3), 189–208.

Baddeley, A. D., & Hitch, G. (1974). Working memory. *The psychology of learning and motivation, 8*, 4–89.

Baddeley, A. D., & Lieberman, K. (1980). Spatial working memory. In Nickerson, R. S. (Ed.), *Attention and performance, 8*, 521–539. Hillsdale, NJ: Erlbaum.

Baddeley, A. D., Thomson, N., & Buchanan, M. (1975). Word length and the structure of short-term memory. *Journal of verbal learning and verbal behavior*, *14*(6), 575–589.

Bakken, J. P., & Simpson, C. G. (2011). Mnemonic strategies: Success for the young-adult learner. *Journal of human resources & adult learning*, *7*(2).

Bahrick, H. P., Bahrick, P. O., & Wittinger, R. P. (1975). Fifty years of memory for names and faces: a cross-sectional approach. *Journal of Experimental Psychology: General, 104*, 54–75.

Barber, H., & Carreiras, M. (2005). Grammatical gender and number agreement in Spanish: *An ERP comparison. Journal of cognitive neuroscience*, *17*(1), 137–153.

Barcroft, J. (2009). Strategies and performance in intentional L2 vocabulary learning. *Language awareness*, *18*(1), 74–89.

Beck, I. L., McKeown, M. G., & McCaslin, E. S. (1983). Vocabulary development: All contexts are not created equal. *The elementary school journal*, *83*(3), 177–181.

Bialystok, E. (2001). *Bilingualism in development: Language, literacy, and cognition*. Cambridge University Press.

Bialystok, E. (2009). Bilingualism: The good, the bad, and the indifferent. *Bilingualism: Language and cognition*, *12*(1), 3–11.

Bialystok, E., Craik, F. I. M., Klein, R., & Viswanathan, M. (2004). Bilingualism, aging, and cognitive control: Evidence from the Simon Task. *Psychology and aging*, *19*, 290–303.

Bialystok, E., & Martin, M. M. (2004). Attention and inhibition in bilingual children: Evidence from the dimensional change card sort task. *Developmental science*, *7*, 325–339.

Bloom, P. (2001). Précis of How children learn the meanings of words. *Behavioral and brain sciences*, *24*(6), 1095–1103.

Bloomfield, L. (1933). *Language.* NY: Holt, Rinehart, & Winston.

Bolger, D. J., Balass, M., Landen, E., & Perfetti, C. A. (2008). Context variation and definitions in learning the meanings of words: An instance-based learning approach. *Discourse processes*, *45*(2), 122–159.

Brown, B. L. (1998). Applying Constructivism in Vocational and Career Education. *Information Series, 378.*

Brown, C., & Payne, M. E. (1994). *Five essential steps of processes in vocabulary learning.* Paper presented at the TESOL Convention, Baltimore, MD.

Brown, D. H. (2007). *Principles of language learning and teaching.* NY: Pearson Education.

Brown, J. (1958). Some tests of the decay theory of immediate memory. *Quarterly journal of experimental psychology, 10,* 12–21.

Bruner, J. S. (1996). *The culture of education*. Harvard University Press.

Ceci, S. J., & Williams, W. M. (1999). *The nature-nurture debate: The essential readings.* Oxford: Blackwell.

Chamot, A. U., & Rubin, J. (1994). Comments on Janie Rees-Miller's 'A critical appraisal of learner training: theoretical bases and teaching implications': Two readers react. *TESOL Quarterly, 28*(4), 771–776.

Channell, J. (1988). Psycholinguistic considerations in the study of L2 vocabulary acquisition. In R. Carter & M. McCarthy (Eds.), *Vocabulary and language teaching*, 83–96. London and New York: Longman.

Childs, M. R. (1998). Academic journal article from *Journal of prenatal & perinatal psychology & health, (13)*2.

Chomsky, N. (1965). *Aspects of the theory of syntax*. Cambridge, Mass.: MIT Press.

Conrad, R., & Hull, A. J. (1964). Information, acoustic confusion and memory span. *British journal of psychology*, *55*(4), 429–432.

Conway, A. R., Cowan, N., Bunting, M. F., Therriault, D. J., & Minkoff, S. R. (2002). A latent variable analysis of working memory capacity, short-term memory capacity, processing speed, and general fluid intelligence. *Intelligence, 30*(2), 163–183.

Cowan, N. (1995). *Attention and memory: An integrated framework*. Oxford: Oxford University Press.

Craik, F. I., & Tulving, E. (1975). Depth of processing and the retention of words in episodic memory. *Journal of experimental psychology: General*, *104*(3), 268.

Craik, F. I., & Watkins, M. J. (1973). The role of rehearsal in short-term memory. *Journal of verbal learning and verbal behavior*, *12*(6), 599–607.

Crawford, M. L. (2001). *Teaching contextually: Research, rationale, and techniques for improving student motivation and achievement in mathematics and science.* Waco, Texas: CORD.

Crinion, J., et al. (2006). Language control in the bilingual brain. *Science, 312*(5779), 1537–1540.

Cummins, J. (1977). *The cognitive development in bilingual children: A review of recent research.* Edmont, Canada: Center of Study of Mental retardation.

Daneman, M., & Carpenter, P. A. (1980). Individual differences in working memory and reading. *Journal of verbal learning and verbal behavior, 19*(4), 450–466.

Daneman, M., & Carpenter, P. A. (1983). Individual differences in integrating information between and within sentences. *Journal of experimental psychology: Learning, memory, and cognition, 9*(4), 561.

Daneman, M., & Green, I. (1986). Individual differences in comprehending and producing words in context. *Journal of memory and language*, *25*(1), 1–18.

Dirkx, M. J., Amey, M. and Haston, L. (1999). Teacher beliefs and subject matter boundaries: The struggle for curricular transformation among teachers of adults. *40th Adult education research conference proceedings*, Dekalb, IL, 97–102.

Durkin, D. (1990). Reading instruction in kindergarten: A look at some issues through the lens of new basal reader materials. *Early childhood research quarterly*, *5*(3), 299–316.

Eckle, P. & Garrett, M. (1998). Lexical retrieval stages of momentarily inaccessible foreign languages words. *Ilha do Desterro, 35*, 157–184.

Ellis, N. C. (1995). Consciousness in second language acquisition: A review of field studies and laboratory experiments. *Language awareness*, *4*(3), 123–146.

Ellis, N. C. (1996). Working memory in the acquisition of vocabulary and syntax: Putting language in good order. *The quarterly journal of experimental psychology: Section A, 49*(1), 234–250.

Ericsson, K. A., & Kintsch, W. (1995). Long-term working memory. *Psychological review*, *102*(2), 211.

Ertmer, P. A., & Newby, T. J. (1993). Behaviorism, cognitivism, constructivism: Comparing critical features from an instructional design perspective. *Performance improvement quarterly*, *6*(4), 50–72.

Ervin, S. M., & Osgood, C. E. (1954). Second language learning and bilingualism. *Journal of abnormal and social psychology*, *49*(4), 139–146.

Gaskell, M. G., & Dumay, N. (2003). Lexical competition and the acquisition of novel words. *Cognition*, *89*(2), 105–132.

Gathercole, S. E. (1999). Cognitive approaches to the development of short-term memory. *Trends in cognitive sciences*, *3*(11), 410–419.

Ghazal, L. (2007). Learning vocabulary in EFL contexts through vocabulary learning strategies. *Novitas-Royal*, *1*(2), 84–91.

Goodman, J. C., Dale, P. S., & Li, P. (2008). Does frequency count? Parental input and the acquisition of vocabulary. *Journal of child language*, *35*(3), 515.

Gutiérrez-Clellen, V. F., Calderón, J., & Weismer, S. E. (2004). Verbal working memory in bilingual children. *Journal of speech, language and hearing research*, *47*(4), 863.

Gu, Y., & Johnson, R. K. (1996). Vocabulary learning strategies and language learning outcomes. *Language learning*, *46*(4), 643–679.

Graves, M. F. (1986). Vocabulary learning and instruction. *Review of research in education*, *13*, 49–89.

Hamzah, M. S. G., Kafipour, R., & Abdullah, S. K. (2009).Vocabulary learning strategies of Iranian undergraduate EFL students and its relation to their vocabulary size. *European journal of social sciences*, *11*(1), 39–50.

Harrington, M., & Sawyer, M. (1992). L2 working memory capacity and L2 reading skill. *Studies in second language acquisition*, *14*(1), 25–38.

Haugen, E. I. (1956). *Bilingualism in the Americas*. American Dialect Society.

Haynes, J. (2007). *Getting started with English language learners: How educators can meet the challenge*. Alexandria, Virginia: Association for Supervision and Curriculum Development.

Hernandez, A. E., Hofmann, J., & Kotz, S. A. (2007). Age of acquisition modulates neural activity for both regular and irregular syntactic functions. *Neuro Image*, *36*(3), 912–923.

Hulstijn, J. H., Hollander, M., & Greidanus, T. (1996). Incidental vocabulary learning by advanced foreign language students: The influence of marginal glosses, dictionary use, and reoccurrence of unknown words. *The modern language journal*, *80*(3), 327–339.

Joe, A. (2010). The quality and frequency of encounters with vocabulary in an English for academic purposes programme. *Reading in a foreign language*, *22*(1), 117.

Johnson, J. S., & Newport, E. L. (1989). Critical period effects in second language learning: The influence of maturational state on the acquisition of English as a second language. *Cognitive psychology*, *21*(1), 60–99.

Just, M. A., & Carpenter, P. A. (1992). A capacity theory of comprehension: individual differences in working memory. *Psychological review*, *99*(1), 122.

Kaushanskaya, M., & Marian, V. (2009). The bilingual advantage in novel word learning. *Psychonomic bulletin & review*, *16*(4), 705–710.

Kirchhoff, B. A., Anderson, B. A., Barch, D. M., & Jacoby, L. L. (2011). Cognitive and neural effects of semantic encoding strategy training in older adults. *Cerebral cortex*, *22*(4), 788–799.

Kramer, R., & Mota, M. B. (2015). Effects of bilingualism on inhibitory control and working memory: A study with early and late bilinguals. *Gragoatá*, *20*(38).

Krashen, S. (1982). *Principles and practice in second language acquisition* (Vol. 2). Pergamon: Oxford.

Kroll, J. F., Michael, E., Tokowicz, N., & Dufour, R. (2002). The development of lexical fluency in a second language. *Second language research*, *18*, 137–171.

Kuhn, M. R., & Stahl, S. A. (1998). Teaching children to learn word meanings from context: A synthesis and some questions. *Journal of literacy research*, *30*(1), 119–138.

Lai, C., Zhu, W., & Gong, G. (2015). Understanding the quality of out-of-class English learning. *TESOL Quarterly*, *49*(2), 278–308.

Laufer, B. (1997). The lexical plight in second language reading: Words you don't know, words you think you know, and words you can't guess. In J. Coady & T. Huckin (Eds.), *Second language vocabulary acquisition: A rationale for pedagogy*, 20–34. Cambridge: Cambridge University Press.

Leach, L., & Samuel, A. G. (2007). Lexical configuration and lexical engagement: When adults learn new words. *Cognitive psychology*, *55*(4), 306–353.

Lenneberg, E. (1967). *Biological foundations of language.* New York: Wiley.

Lewis, M. (1993). *The lexical approach*. Hove, England: LTP.

Linebarger, D. L., & Walker, D. (2005). Infants' and toddlers' television viewing and language outcomes. *American behavioural scientist*, *48*(5), 624–645.

Luk, G., De Sa, E. R. I. C., & Bialystok, E. (2011). Is there a relation between onset age of bilingualism and enhancement of cognitive control? *Bilingualism: Language and cognition*, *14*(04), 588–595.

MacWhinney, B. (1999). *The emergence of language*. London, England: Taylor & Francis.

Marian, V., & Shook, A. (2012). The cognitive benefits of being bilingual. *In cerebrum: The Dana forum on brain science*. Dana Foundation.

Mazzoni, D., & Dannenberg, R. (2015). *Audacity: A free audio editor and recorder.* (Version 2.1.1). [Computer software].

McCarthy, M. J. (1984). A new look at vocabulary in EFL. *Applied linguistics*, *5*(1), 12–22.

McLaughlin, B. (1984). *Second language acquisition in childhood.* Hillsdale, NJ: Lawrence Erlbaum Associates.

Meara, P. (1996). The classical research in L2 vocabulary acquisition. *Words, words, words: The translator and the language learner*, 27–40.

Miller, G. A. (1956). The magical number seven, plus or minus two: some limits on our capacity for processing information. *Psychological review*, *63*(2), 81.

Morales, J., Calvo, A., & Bialystok, E. (2013). Working memory development in monolingual and bilingual children. *Journal of experimental child psychology*, *114*(2), 187–202.

Nation, I. S. P. (1982). Beginning to learn foreign language vocabulary: A review of the research. *RELC Journal*, *13*(1), 14–36.

Nation, I. S. P. (2001). *Vocabulary learning in another language.* Cambridge: Cambridge University Press.

Neisser, U. (1967). *Cognitive psychology.* East Norwalk: Appleton Century-Crofts.

Oxford, R. L. (1990). *Language learning strategies: What every teacher should know*. Rowley, MA: Newbury House.

Oxford English Dictionary (2nd Ed.) (2016). Oxford: Oxford University Press.

Park, D. C., Lautenschlager, G., Hedden, T., Davidson, N. S., Smith, A. D., & Smith, P. K. (2002). Models of visuospatial and verbal memory across the adult life span. *Psychology and aging*, *17*(2), 299.

Parnell, D. (2001). *Contextual teaching works!* Waco, TX: CCI Publishing.

Peterson, L. R., & Peterson, M. J. (1959). Short-term retention of individual verbal ítems. *Journal of experimental psychology, 58,* 193–198.

Portocarrero, J. S., Burright, R. G., & Donovick, P. J. (2007). Vocabulary and verbal fluency of bilingual and monolingual college students. *Archive of clinical neuropsychology, 22*(3), 415–422.

Ransdell, S., Arecco, M. R., & Levy, C. M. (2001). Bilingual long-term working memory: The effects of working memory loads on writing quality and fluency. *Applied psycholinguistics, 22*(1), 113–128.

Ransdell, S., Barbier, M. L., & Niit, T. (2006). Metacognitions about language skill and working memory among monolingual and bilingual college students: When does multilingualism matter? *International journal of bilingual education and bilingualism, 9*(6), 728–741.

Read, J. (2000). Assessing vocabulary. Cambridge: Cambridge University Press.

Romaine, S. (1995). *Bilingualism*. Oxford: Blackwell.

Rott, S. (1999). The effect of exposure frequency on intermediate language learners' incidental vocabulary acquisition and retention through reading. *Studies in second language acquisition, 21*(4), 589–620.

Saffran, J. R., Aslin, R. N., & Newport, E. L. (1996). Statistical learning by 8-month-old infants. *Science*, *274*(5294), 1926–1928.

Sagarra, N., & Alba, M. (2006). The key is in the keyword: L2 vocabulary learning methods with beginning learners of Spanish. *The modern language journal, 90*(2), 228–243.

Sanaoui, R. (1995). Adult learners' approaches to learning vocabulary in second languages. *The modern language journal, 79*(1), 15–28.

Saragi, T., Nation, I. S. P., & Meister, G. F. (1978). Vocabulary learning and reading. *System*, *6*(2), 72–78.

Schmitt, N. (1997). Vocabulary learning strategies. *Vocabulary: Description, acquisition and pedagogy, 199227*.

Schmitt, N. (2000). *Vocabulary in language teaching.* Cambridge: Cambridge University Press.

Schmitt, N., & Carter, N. (2000). Lexical phrases in language learning. *The language teacher 24*(8), 6–10.

Scoville, W. B., & Milner, B. (1957). Loss of recent memory after bilateral hippocampal lessions. *Journal of neurology, neurosurgery, and psychiatry, 20*(1), 11–21.

Shallice, T., & Warrington, E. K. (1970). Independent functioning of verbal memory stores: A neuropsychological study. *The Quarterly journal of experimental psychology*, *22*(2), 261–273.

Skinner, B. F. (1957). *Verbal behavior.* Acton, MA: Copley Publishing Group.

Soto, J., Bravo, G., & Valdés, M. (2013). *Vocabulary learning: Interaction between contexts and images* (Unpublished undergraduate thesis). Universidad Católica de la Santísima Concepción, Concepción, Chile.

Stanovich, K. E. (1986). Matthew effects in reading: Some consequences of individual differences in the acquisition of literacy. *Reading research quarterly*, 360–407.

Stern, H. H. (1975). What can we learn from the good language learner? *Canadian modern language review, 31*, 304–318.

Thorndike, E. (1925). The improvement of mental measurements. *The journal of educational research*, *11*(1), 1–11.

Tomitch, L. M. B. (1995). *Reading: Text organization perception and working memory capacity* (Doctoral dissertation, Universidade Federal de Santa Catarina).

Tulving, E. (1972). Episodic and semantic memory 1. Organization of memory. *London: Academic*, *381*(4), 382–404.

Tulving, E. (1991). Concepts of human memory. *Memory: Organization and locus of change*, 3–32.

Van Hell, J., & Mahn, A. (1997). Keyword mnemonics versus rote rehearsal: Learning concrete foreign words by experienced and inexperienced learners. *Language learning, 47*(3), 507–546.

Vygotsky, L. S. (1962). *Thought and language.* Cambridge MA: MIT Press.

Waring, R., & Takaki, M. (2003). At what rate do learners learn and retain new vocabulary from reading a graded reader? *Reading in a foreign language, 15*, 1–27.

Waugh, N. C., & Norman, D. A. (1965). Primary memory. *Psychological review*, *72*(2), 89.

Wixted, J. T., & Squire, L. R. (2011). The medial temporal lobe and the attributes of memory. *Trends in cognitive sciences*, *15*(5), 210–217.

Appendices

Appendix 3.1

List of the fifteen novel words used in the study.

Foon	Dene	Geat
Telt	Prew	Reck
Lond	Fung	Dist
Yate	Dind	Vink
Kend	Eall	Nean

Appendix 3.2

List of the phonological pronunciation for each word.

/fu:n/	/di:n/	/gi:t/
/telt/	/pru:/	/rek/
/lɒnd/	/fʌŋ/	/dɪst/
/jeɪt/	/dɪnd/	/vɪŋk/
/kend/	/i:l/	/ni:n/

Appendix 3.3

Set of images used in the study.

Appendix 3.4

List of sentences used in the study.

1. Architects use a *foon* to draw and design maps.
2. A *telt* is a stick used for royal ceremonies.
3. The Asian rainforest is the habitat of the *lond*.
4. Napoleon stole the *yate* during the Prussian invasion.
5. A *kend* can see colours that people can't.
6. People use a *dene* to massage their feet.
7. The most interesting characteristic of a *prew* is its shell.
8. The claws of a *Fung* are 20 centimetres long.
9. A *dind* is made of pure bronze.
10. An *eall* can swim 200 kilometres per hour in the sea.
11. A *geat* has a humid skin.
12. Doctors use a *reck* to check your heart rhythm.
13. The Maya civilization used a *dist* in their religious ceremonies.
14. The *vink* has big eyes and long fingers.
15. Cleopatra used a *nean* to look at herself in the morning.

Appendix 3.5

Examples of images of living and non-living things with their names chosen randomly.

Dind

A *dind* is made of pure bronze.

Eall

An *eall* can swim 200 kilometres per hour in the sea.

Dist

The Maya civilization used a *dist* in their religious ceremonies.

Vink

The *vink* has big eyes and long fingers.

Appendix 3.6

Testing session worksheet

THE INFLUENCE OF WORKING MEMORY ON VOCABULARY LEARNING

TEST

Gender: Male ☐ Female ☐ Group: _____

Age: _____

Instructions:

- You will only see the written form of the fifteen words on the screen.
- Categorise the words as Living or Non-Living, by putting a tick (✓) in the corresponding box.

WORD	LIVING	NON-LIVING
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		
11.		
12.		
13.		
14.		
15.		

Appendix 3.7

Testing session answer key

THE INFLUENCE OF WORKING MEMORY ON VOCABULARY LEARNING

TEST

Gender: Male ☐ Female ☐ Group: _____

Age: _____

Instructions:

- You will only see the written form of the fifteen words on the screen.
- Categorise the words as Living or Non-Living, by putting a tick (✓) in the corresponding box.

WORD	LIVING	NON-LIVING
1.		✓
2.	✓	
3.		✓
4.		✓
5.	✓	
6.		✓
7.		✓
8.	✓	
9.		✓
10.	✓	
11.		✓
12.	✓	
13.		✓
14.	✓	
15.	✓	