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# WORKING MEMORY AND L2 VOCABULARY LEARNING: A STUDY WITH YOUNG LEARNERS

Dissertação submetida ao Programa de Pós-Graduação em Inglês da Universidade Federal de Santa Catarina para a obtenção do grau de Mestre em Inglês: Estudos Linguísticos e Literários.

Orientadora: Profa. Dra. Mailce Borges Mota.

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Amarildo Lemes de Souza

**WORKING MEMORY AND L2 VOCABULARY LEARNING: A STUDY WITH YOUNG LEARNERS**

Esta dissertação foi julgada adequada para a obtenção do Título de "Mestre em Inglês", e aprovada em sua forma final pelo Programa de Pós-Graduação em Inglês: Estudos Linguísticos e Literários.

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Florianópolis, 01 de junho de 2015.

*To my parents*
*João Lemes de Souza and Paulina de Souza*
*and my beloved family*
*with love and gratitude*

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## ABSTRACT

WORKING MEMORY AND L2 VOCABULARY LEARNING: A STUDY WITH YOUNG LEARNERS

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2015

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Among the cognitive systems that underlie learning and use of a second language (L2), working memory emerges as one of the most studied and influential over the past 35 years (Dehn, 2011). Working memory is the system responsible for temporary storage and processing of information during the performance of complex activities such as language comprehension, learning and reasoning (Baddeley & Logie, 1999). The present study investigates the influence of working memory capacity (Baddeley & Hitch, 1974) in L2 vocabulary learning in 24 young learners aged 11-14 years attending the 6th grade of elementary school. The method used was quasi-experimental and mainly quantitative and correlational. The first stage of the study consisted of the assessment of participants' working memory capacity through the Automated Working Memory Assessment - AWMA (Alloway, 2007) and assessment of vocabulary knowledge through a pre-test in English as an L2. The second stage of the study consisted of an intervention for explicit instruction of 10 lexical items in the L2. The third and final stage consisted of an immediate post-test to evaluate the retention of the lexical items which were the object of instruction. The results indicated statistically significant correlations between verbal working memory's performance vocabulary post-tests, showing that individuals with average or high performance on verbal working memory tests presented better performance in recalling vocabulary words than individuals with low verbal working memory performance. This suggests that verbal working memory does in fact influence the acquisition of L2 vocabulary by young learners. These results are discussed in the light of Baddeley's working memory model (Baddeley, 2012).



**Keywords:** Working memory. Vocabulary. Second Language (L2).
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## RESUMO

A MEMÓRIA DE TRABALHO E APRENDIZAGEM DE VOCABULÁRIO EM LÍNGUA ESTRANGEIRA: UM ESTUDO COM CRIANÇAS

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UNIVERSIDADE FEDERAL DE SANTA CATARINA

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Orientadora: Dr. Mailce Borges Mota

Entre os sistemas cognitivos que fundamentam a aprendizagem e uso de uma língua segunda língua (L2), a memória de trabalho figura como um dos mais influentes e estudados dos últimos 35 anos (Dehn, 2011). Este é um sistema responsável pelo armazenamento e processamento temporário de informações durante a realização de atividades complexas tais como a compreensão da linguagem, a aprendizagem e o raciocínio (Baddeley & Logie, 1999). O presente estudo investiga a influência da capacidade de memória de trabalho (Baddeley & Hitch, 1974) na aprendizagem de vocabulário em segunda língua (L2) em 24 crianças na faixa etária de 11 a 14 anos, cursando o 6º ano do ensino fundamental. O método usado foi quase-experimental e predominantemente quantitativo e correlacional. A primeira etapa do estudo consistiu na avaliação da capacidade de memória de trabalho dos participantes por meio do *Automated Working Memory Assessment* – AWMA (Alloway, 2007) e de um pré-teste de vocabulário em inglês como L2. A segunda etapa do estudo consistiu de uma intervenção para instrução explícita de 10 itens lexicais na LE. A terceira e última etapa consistiu em um pós-teste imediato para avaliação da retenção dos itens lexicais objeto de instrução. Os resultados obtidos indicaram uma correlação estatisticamente significativa entre o desempenho da memória de trabalho verbal e os pós-testes de vocabulário, indicando que indivíduos com melhor desempenho da memória de trabalho verbal apresentaram melhor desempenho na memorização de palavras do vocabulário do que indivíduos com baixo desempenho da memória de trabalho verbal. Isto sugere que a memória de trabalho verbal de fato influencia a aprendizagem de vocabulário em L2 por crianças. Estes resultados são discutidos à luz do modelo de memória de trabalho de Baddeley (BADDELEY, 2012).

**Palavras-chave:** Memória de trabalho. Vocabulário. Segunda Língua (L2).
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## LIST OF ABBREVIATIONS

L2 – Second Language
SLA – Second Language Acquisition
EFL – English as a Foreign Language
L1 – First Language
rs – Spearman's correlation coefficient
M – Mean
SD – Standard Deviation
Mdn – Median
Min. – Minumum number of scores
Max. – Maximum number of scores
Z – Standard Score

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# CHAPTER I

# INTRODUCTION

## 1.1 PRELIMINARIES

Second Language Acquisition (SLA) is considered an interdisciplinary field that can be studied by psycholinguists, linguists, sociolinguists and pedagogues, for example. According to Mota (2011), SLA has been an active field of research. Studies in the field have dealt with the fundamental issues discussed in the national and international scenario and have done it using a variety of conceptual approaches and research methodologies (e.g. interaction, grammar acquisition, effects of instruction, interlanguage phonology, speech production, and classroom processes) (p. 9). Considering that SLA is already internationally grounded in solid research and is acknowledged as a flourishing field of inquiry in Brazil, it is important to consider studies that cover themes in the contemporary research on the mechanisms and processes involved in the acquisition of a non-primary language (Mota, 2011).

Thus, studies that address issues related to cognition and neurocognition of SLA bring substantial contributions to recent trends in the field. Within the field of SLA there are various researchers (e.g.,Altman, 1980; Skehan, 1989; Larsen-Freeman and Long, 1991 as cited in Ellis, 1994) who acknowledge the existence of individual differences between learners. These individual differences include cognitive, affective, cultural or social variables and may influence the acquisition[1] of a second language (L2) (Dörnyei & Skehan, 2008).

In 2012 I had the privilege of attending Prof. Mailce Mota's Second Language Acquisition class at the Federal University of Santa Catarina (UFSC), which explored a variety of theories about second language acquisition, the relationship between first and second language acquisition, individual differences on second language acquisition,

[1] In this study, the terms "learning" and "acquisition" will be used interchangeably. Though I am aware of the difference between these two concepts as stated by Krashen (1982), I agree with Ellis (2008, p. 14), who argues that this distinction is still problematic and therefore I prefer to use the two terms interchangeably. They will be placed inside inverted commas if used in their distinctive senses. Additionally, and for the same reason, still following R. Ellis, unless otherwise stated, I will not make a distinction between the terms second language (L2) and foreign language (FL).

among other topics. This class, along with my own experience as an English teacher, motivated me to pursue a better understanding of the cognitive processes that support second language acquisition/learning which, ultimately, led me to the study on the influence of working memory on L2 vocabulary learning.

Among the cognitive systems that underlie the learning and use of a second language (L2), working memory has been considered one of the most important human cognitive aspects over the last 35 years (Dehn, 2011). Working memory is a system responsible for temporary storage and processing of information during the performance of complex cognitive activities such as comprehension, learning, and reasoning (Baddeley & Logie, 1999). Since it was first proposed by Baddeley and Hitch (1974), this construct has been one of the most intensively studied areas in cognitive psychology and neuro-cognitive research (Juffs & Harrington, 2011).

Educational and psychological research on working memory over the past 20 years has demonstrated that working memory processes are at the basis of individual differences in learning ability, and therefore play a critical role in the learning process (Dehn, 2011). Over the years, various studies (Ellis & Sinclair, 1996; Gathercole & Alloway, 2004; van den Noort, Bosch, & Hugdahl, 2006; Kormos & Safar, 2008) have demonstrated that individuals with more efficient working memory capacity (higher spans) perform better on cognitive complex tasks related to second language, whereas individuals with lower working memory capacity (lower spans) have a poorer performance on the same tasks. Similar results have also been found in studies conducted in Brazil, with a Brazilian adult population of L2 learners (Mota, 1995, published as Fortkamp, 1999; Fortkamp, 2000; Mendonça, 2003; Bergsleithner, 2007; Finardi, 2009; Prebianca, 2009; Guará-Tavares, 2005; Xhafaj 2006; Fortkamp, 2008).

To the best of my knowledge, I was not able to find any research that has been conducted on the influence of working memory in the acquisition of L2 English vocabulary among young learners, speakers of Portuguese. Hence, along with my personal motivation to pursue such line of enquiry, there sprung up the necessity of studies related to that specific population and line of research.

## 1.2 THE PRESENT STUDY

The present study aims investigating the influence of working memory in the learning of L2 English vocabulary by young learners

currently attending the 6th grade at a public school located in the Florianopolis metropolitan area, all native speakers of Portuguese. In order to achieve that, working memory will be assessed by means of the Automated Working Memory Assessment (AWMA, Alloway, 2007). Vocabulary acquisition will be assessed by means of a vocabulary acquisition test designed for the purposes of the present study. The present investigation pursued to answer the following research question:

1. What are the effects of working memory on the acquisition of L2 vocabulary by 6th graders?

## 1.3 SIGNIFICANCE OF THE RESEARCH

Over the years, various studies (Ellis & Sinclair, 1996; Gathercole & Alloway, 2004; van den Noort, Bosch, & Hugdahl, 2006; Kormos & Safar, 2008) have demonstrated that individuals with more efficient working memory capacity (higher spans) perform better on cognitive complex tasks related to second language, whereas individuals with lower working memory capacity (lower spans) have a poorer performance on the same tasks. Similar results have also been found in studies conducted in Brazil, with a Brazilian adult population of L2 learners (Mota, 1995, published as Fortkamp, 1999; Fortkamp, 2000; Mendonça, 2003; Bergsleithner, 2007; Finardi, 2009; Prebianca, 2009; Guará-Tavares, 2005; Xhafaj 2006; Fortkamp, 2008). However, to the best of this researcher's knowledge there has not been enough research concerning the influence of working memory in the acquisition of L2 vocabulary by young learners. This dearth of research, combined with the importance of this subject, represents an attempt to better understand working memory processes in general and their influence in L2 vocabulary acquisition in particular.

In addition, various studies (Alloway, T.P., Banner, G., & Smith, P., 2010*;* Leseman et al., 2010; St Clair-Thompson & Sykes, 2010; Messer, Leseman, Boom, & Mayo., 2011) point out working memory as an excellent predictor of young learners' educational attainment, future academic success, vocabulary learning and language skills. Thus, it is hoped that this study may contribute with new data to theoretical and pedagogical issues specifically concerning the influence of working memory in the acquisition of English vocabulary as an L2 by young learners speakers of Portuguese.

For these reasons, this study might be of some contribution to SLA field specially in language acquisition researching.

## 1.4 ORGANIZATION OF THE THESIS

The present thesis is organized into five major chapters. Chapter I has presented the introductory chapter. Chapter II presents the review of literature, subdivided into four subsections: working memory and working memory capacity, theories and models of working memory including Baddeley's model of working memory, the working memory of children, and L2 vocabulary acquisition.

Chapter III details the objectives, research question and hypothesis upon which the present study is based. In addition, it describes the methodology and general procedures adopted for the study, a detailed description of the participants, design, instruments of data collection, analysis and pilot study.

Chapter IV reports and discusses the results obtained in this research, including the descriptive and inferential statistical analysis of participants' performance on working memory and vocabulary tests. Then, it readdresses the research question.

Chapter 5 presents the final conclusions from this study. Firstly, it portrays a summary of the main findings of the study. Then, it describes some limitations of the study and proposes some suggestions for further research. Finally, it concludes with the methodological and pedagogical implications of the present study.

# CHAPTER II

# REVIEW OF LITERATURE

This chapter presents the theoretical background for this study and is organized into five major sections. Section 2.2 presents the concepts of working memory (WM) and working memory capacity (WMC). Section 2.3 presents the theories and models of working memory and section 2.4, discusses aspects of working memory of children. Finally, Section 2.5 reviews the concepts involving L2 vocabulary acquisition and section 2.6 address the relationship between working memory and vocabulary acquisition.

## 2.1 WORKING MEMORY AND WORKING MEMORY CAPACITY

### 2.1.1 Working memory and second language learning

The importance of memory can be traced back to the ancient times. However, the study of human memory focused on models and measurements is quite recent, becoming more prominent with the advent of psychology as a science by the end of the nineteenth century (Kim, 2008). In fact, the most significant theories, maps and models of memory did not emerge until the mid-twentieth century, more specifically after the 1950s (Baddeley, Eysenck, & Anderson, 2009). With the rise of cognitive psychology in the 1960s there was a significant shift in researchers' opinion from the assumption of a unitary memory system based on stimuli and responses associations towards a more complex concept that memory was formed by multiple constructs (Baddeley, Eysenck, & Anderson, 2009).

Though much controversy has surrounded the WM concept since its outset by Baddeley and Hitch (1974), an increasing amount of cognitive psychologists have accepted WM as a multi-component system that includes both domain-specific storage mechanisms and domain-general executive functions (Miyake & Shah 1999; Baddeley 2012; Wen 2014). Such a fractioned view of WM has become evident in distinct strands of WM language research, where two contrasting research paradigms have emerged (Fortkamp, 2003; Wen, 2012).

WM researchers following the European tradidion have sought to establish the critical role played by the phonological component

(phonological loop) of WM (e.g., (Baddeley, 1986; 1992; 1999; 2001; 2012) in vocabulary learning and grammar development (Wen, 2014). In contrast, many cognitive psychologists based in North America have tended to emphasize the executive functions associated with the WM concept (central executive) and focus on isolating the implications of its attention-regulating mechanisms for language learning and processing (Fortkamp, 2003; 2008; Wen 2014).

Research on WM and language has been carried out since the inception of Baddeley and Hitch's working memory model (1974). Their research has been primarily concerned with first language processing, but since the early nineties, studies on the role of WM on second language learning and processing has also been developed (Mota, 2011). In the past decades, specially since the 50's, according to Mota (2011), SLA has been an active field of research. Studies in the area have dealt with the main issues and have done so from a variety of conceptual approaches and research methodologies (p. 9). In the first moment, psychologists have developed several appropriate methods of measuring and discussing WM among first language (L1) speakers, and SLA researchers have quickly applied these methods to the study of WM among second language (L2) learners (Wen, Z., Mailce M. B., & McNeill A, 2015). Then, further studies have indicated that WM in fact plays a very active role in the language learning process. More Specifically, WM has demonstrated strong correlations with L2 proficiency levels (Wen, Z., Mailce M. B., & McNeill A, 2015). Such interesting and intriguing representation of the WM-SLA association have motivated an increasing number of empirical studies exploring the potential effects of WM in several aspects of SLA (Juffs & Harrington 2011; Wen, 2014).

In the context of WM, it is also necessary to address other related memory systems. In the next section short-term memory system and long-term memory system will be addressed.

### 2.1.2 Short-term memory and long-term memory

From the beginning of the 20th century until 1950 memory was generally viewed as a unified system, with short-term memory being a part of what is now considered long-term memory (Dehn, 2011). Even though the terms *short-* and *long-term memory* are very popular (Cowan, 2005) it is not clear when these terms were first used. Literature shows evidence they were used by Thorndike as early as 1910 (Cowan, 2005).

The term short-term memory (STM) refers to the process of storing small amounts of information for a short period of time (Atkinson & Shiffrin, 1968; Cowan, 2001; 2005; Baddeley, Eysenck & Anderson, 2009). STM capacity is domain specific, passively holding verbal and visual information (Baddeley, Eysenck, & Anderson, 2009). Also, STM retains information coming from the environment, it is able to operate independently of long-term memory and can automatically activate information stored in long-term memory (Dehn, 2011).

The approach used in this study regarding STM reflects a multicomponent account of WM (Baddeley & Hitch, 1974) that relies on STM as a subsystem of WM, responsible for verbal and visual STM, as posed by predominant theories of working memory (Cowan, 1988; 1995; Kail & Hall, 2001), which is the my point of view in this study. The distinction between STM and WM will be presented on the next subsection (2.2.3).

The term long-term memory (LTM) can be understood as a storage system which has the capacity to store unlimited amounts of information over long periods of time (Atkinson & Shiffrin, 1968; Cowan, 2005; Klingberg, 2008; Baddeley, Eysenck, & Anderson, 2009). Long-term memory is a complex storage system that complies various different types of storage distributed throughout the brain (Baddeley, Eysenck, & Anderson, 2009). Long-term memory can be classified in two main types: (1) declarative (or explicit) memory, and (2) implicit (or procedural) memory. Declarative memory can be further sub-divided into: (1) semantic memory, and (2) episodic memory (Squire, 1992**;** Baddeley, Eysenck, & Anderson, 2009). Explicit or declarative memory consists of knowledge the individual is aware of and can consciously manipulate, based on recollecting personal events or facts (Squire, 1992**;** Baddeley, Eysenck, & Anderson, 2009). In contrast, implicit or procedural memory refers to stored information or knowledge that the individual is not aware of and retrieve through explicit conscious recall or recognition (Squire, 1992**;** Baddeley, Eysenck, & Anderson, 2009). As part of the declarative memory, semantic memory is primarily a verbal form of memory that includes all the general knowledge an individual possess and is of crucial importance for academic learning, as it involves memory for facts, concepts, principles and rules (Baddeley, Eysenck, & Anderson, 2009; Dehn, 2011). On the other hand, episodic memory is essentially visual, autobiographical, and contextual. It is focused on remembering specific events or episodes (Baddeley, Eysenck, & Anderson, 2009). Episodic memory contains information

that is associated with the specific time and place information is learned (Leahey & Harris, 1989).

Regarding this study, I also thought to be relevant to discuss the reciprocal processing of information in STM, LTM and WM memory systems through processes of *encoding*[2], *retention*[3] and *retrieval*[4]. STM, defined as the passive storage of verbal and visuospatial information, can bypass working memory and automatically encode information into long-term memory, as well as automatically activate long-term memory representations. All of the separate components of STM and WM systems encode information in LTM (Dehn, 2011 p. 73). Memories are encoded into long-term storage through a chain of biochemical and cellular processes (Klingberg, 2008, p. 36). STM transforms sensory data into a representational code, such as a phonological code, that can efficiently be stored in LTM (Torgesen, 1996).

Encoding can be either automatic or effortful, however, automatic encoding tends to be more shallow and insufficient for semantic coding required for academic learning (Hasher & Zacks, 1979; Dehn, 2011). Elaborative rehearsal – associating meaning while rehearsing the information – is a type of meaning-based encoding conducted by WM (Swanson, 1992). Those with high WMC spend more time encoding because they can keep more information simultaneously activated (Kyllonen & Christal, 1990). If information cannot be maintained temporarily, then it cannot be registered in a longer-term store (Brown & Hulme, 1996). For example, new vocabulary cannot be stored directly in long-term memory. WM must first create a representation of a new word that can interact with existing related vocabulary so that storage of the new word can interact with existing related vocabulary so that storage of the new word is consistend with current long-term organization, such as derivations of a root word being stored together (Gathercole & Baddeley, 1993; Brown & Hulme, 1996, pp. 133-134; Gathercole, et al., 1999).

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[2] *Encoding* is the process of creating codes or representations for long-term storage in the brain (Dehn, 2011 p. 73)

[3] Based on Cambridge Online dictionary which defines *retention* as the "ability to keep or continue having something" (retrieved in May 9, 2014, from http://dictionary.cambridge.org/dictionary/american-english/retention?q=retention), for the sake of this study, retention is assumed to reflect the abilities learners have to continue keeping information in their long-term memory.

[4] *Retrieval* refers to the process of recovering a target memory based on one of more cues, subsequently bringing that target into awareness (Baddeley, Eysenck, & Anderson, 2009, p. 165).

The retention of information in LTM following a learning experience depends on a combination of factors (Estes, 1999). Fisrtly, total memory load determines how much information will be retained. Second, it is assumed that as the time of a retention interval increases, the accuracy of recognition or recall of information is predicted to decrease or decay. Third, loss of learning can result from changing the context between the learning and the recalling of information (Estes, 1999, pp. 76-77). Fourth, at least as far as learning a foreign language is concerned, a study conducted by Bahrick (1984) has suggested that the overall retention of knowledge of a foreign language, including vocabulary, is determined by the level of initial learning (p. 1).

For the most part, WMC is important only in cases of effortful controlled retrieval from long-term memory and not in cases of automatic retrieval activation (Conway & Engle, 1994). A controlled, strategic long-term memory search seems to be supported specifically by WM, as there is a significant relationship between WM span and directed retrieval from long-term memory. As Conway and Engle (1994) state "WM capacity and the amount of activation available to LTM are equivalent" (p. 355). Compared to those with low WM spans, high-span individuals retrieve more items and clusters, and larger sized clusters, more often and efficiently ( Rosen & Engle, 1997). Evidently, WMC influences the effectiveness of conscious long-term memory retrieval (Cantor & Engle, 1993).

After discussing the reciprocal influence of working memory, short-term and long-term memory regarding the processes of *encoding*, *retention* and *retrieval*, the next subsection will present the disctinction between short-term memory (STM) and working memory (WM).

### 2.1.3 Distinguishing short-term memory from working memory

The perspective adopted in this study considers STM as part of the larger WM system, following Baddeley's model of WM (Baddeley & Hitch, 1974). In the multicomponent WM model proposed by Baddeley and Hitch (1974) STM is responsible for simply storing verbal and visuo-spatial information without manipulating it mentally (Gathercole & Alloway, 2008; Baddeley, Eysenck, & Anderson, 2009).

Verbal STM stores material that can be expressed in spoken language, such as numbers, words, and sentences, and is supported by structures in the left hemisphere of the brain. On the other hand, visuo-spatial STM can hold images, pictures, information about locations and is located in the right hemisphere (Gathercole & Alloway, 2008, p. 10).

Visuo-spatial STM have been proposed as part of the visuo-spatial sketchpad, a component of WM, while verbal STM is part of the phonological loop, another component of WM, that is a counterpart of the visuo-sketchpach (Baddeley, Eysenck, & Anderson, 2009, p. 39). The *phonological loop* and the *visuo-sketchpad* components or WM will be discussed in detail in section 2.3.

WM is a comprehensive term for the larger system of which STM is a part. In activities that occur in WM tend to be more complex than STM tasks, involving not only the storage of information, but also either its mental transformation or being engaged in other effortful mental process (Gathercole & Alloway, 2008).

Short-term memory (STM) and working memory (WM) are both main constructs in modern theories of memory and cognition, but only recently their relation has been examined by researchers (Kail & Hall, 2001). Cowan (1988, 1995) proposed a theory in which STM refers to information in long-term memory that is activated above some kind of threshold. In this case, activated information quickly returns to an inactive state unless it becomes the focus of limited-capacity attentional processes, as claimed by Baddeley (e.g., 1986; 1992; 1999; 2001).

Campbell, Hill and Podd (2013) assert that WM is distinguished from STM due to its active component. STM involves simple rehearsal and is sometimes labelled as a ‘passive store’ (Swanson, 1994). On the other hand, WM is an active store involving rehearsal and processing of stimuli (Campbell, Hill & Podd, 2013, p. 19).

According to Kail and Hall (2001), WM includes STM as well as the atentional processes used to keep STM contents in an active state. In a similar way, Engle, Kane, and Tuholski (1999) assert that WM is “a system consisting of (a) a store in the form of long-term memory traces active above threshold, (b) processes for achieving and maintaining that activation, and (c) controlled attention” (p. 104). Thus, in both views (Kail & Hall, 2001; Engle, Kane & Tuholski, 1999), STM is a subcomponent of WM.

Kail and Hall (2001) investigated the distinction between short-term memory and working memory in two studies with children ranging in age from 7 to 13 years. Specific tasks were administered to assess STM as well as WM. Both exploratory and confirmatory factor analyses distinguished STM tasks from WM tasks, providing additional evidence concerning the distinction between WM and STM. Kail and Hall (2001) evidenced that working memory and STM although related, are in fact distinct. They equate, “WM = STM + attention,” working memory equals Short-Term memory plus attention.

Finally, according to both Baddeley, Eysenck, and Anderson (2009) and Gathercole and Alloway (2008), the term 'short-term memory' has become a source of confusion because STM has lately become part of everyday language, and it is most of the times used to mean something different than psychologists' definition. To the general public, the STM refers to remembering things over a few hours or days. To psychologists, however, these are long-term memory (LTM) processes. Remembering over a few minutes, hours, or a few years all seems to depend on the same long-term memory system. The contents of STM indeed usually last for no more than seconds (Baddeley, Eysenck, & Anderson, 2009, p. 19; Gathercole and Alloway, 2008, p. 13).

In the following section, I will move on to present information about working memory and working memory capacity is provided.

### 2.1.4 Working memory and working memory capacity

The definition of working memory has evolved from the concept of a unitary short-term memory system (Baddeley, 1992). During the 1960s there was a major controversy whether human memory should be considered as a single unitary system or whether it should be divided into various distinct components (Baddeley, 1992). Then, with the advance of research, mainly based on studies of brain-damaged patients, strong evidence was presented in favor of memory as a system with two or more components instead of a unitary memory system (Baddeley, 1992). Consequently, most researchers agreed that memory was formed by at least two constructs: (1) short-term memory (STM),which can be defined as "the storage of small amounts of information over brief periods of time" (Baddeley, Eysenck, & Anderson, 2009, p. 39), and (2) long-term memory (LTM), which has been conceptualized as "a system or systems assumed to underpin the capacity to store information over long periods of time" (Baddeley, Eysenck, & Anderson, 2009, p. 10).

According to Richardson (1996), the term "working memory" was first applied, but not further elaborated, by Miller, Galanter, and Pribram (1960) in their book *Plans and the Structure of Behavior*. During the 1960s, STM was generally understood as the subject's working memory. Based on this premise, STM and working memory were considered the same construct and both terms were used interchangeably. However, as new evidence came along resulting from studies in STM (Shallice & Warrington, 1970; Vallar & Shallice, 1990, as cited in Baddeley, Eysenck, & Anderson, 2009) some researchers

came to the conclusion that working memory and STM are in fact distinguisheable constructs (Baddeley, Eysenck, & Anderson, 2009) – which is the perspective adopted in this study as well.

Working memory has been traditionally conceptualized as an active memory system that is responsible for the temporary maintenance and simultaneous processing of information (Bayliss, Jarrold, Gunn, Baddeley & Leigh, 2005). WM is "the term used by psychologists to refer to the ability we have to hold and manipulate information in the mind over short periods of time" (Gathercole & Alloway, 2008, p. 2). Similarly, working memory is viewed as a construct responsible for "selecting and operating strategies, for rehearsal, and generally serving as a global workspace" (Baddeley, Eysenck, & Anderson, 2009, pp. 41-42). Overall, working memory is seen as a comprehensive system that unites various short- and long-term memory subsystems and functions responsible for the management, manipulation, and transformation of the information drawn from either short-term or long-term memory (Dehn, 2011).

In spite of its importance, Cowan (2005) points out that working memory is limited in its capacity. Likewise, Dehn (2011) advises researchers to be cautious when dealing with the concept of working memory in order to avoid classifying everything that goes into the mind as working memory, thus diminishing its usefulness.

An early account of working memory limitations is the classic article '*The Magical Number Seven Plus or Minus Two*' (Miller, 1956), in which George Miller stated that working memory capacity (WMC) is limited up to seven items. Thus, in spite of individual differences, working memory capacity is quite limited, even in individuals with normal working memory resources (Dehn, 2011). For instance, Cowan (2001) states that the typical individual can only manage about four chunks of information at a time. However, in spite of its limitation, due to the crucial role played by working memory in cognitive processing and learning, successful learning is mainly a function of the individual's WMC (Dehn, 2011).

## 2.2 BADDELEY'S MODEL OF WORKING MEMORY

Since working memory has been one of the most intensively studied areas in cognitive psychology and cognitive neuroscience, an array of different working memory models have been presented since the early years (see Miyake & Shah, 1999, for a review). However, due to space constraints, this subsection will focus only on the

multicomponent framework (Baddeley & Hitch, 1974) that will be used in this study.

In 1974 the British psychologists Baddeley and Hitch proposed the multiple-component model of working memory (Baddeley & Hitch, 1974), defining working memory as "a system for the temporary holding and manipulation of information during the performance of a range of cognitive tasks such as comprehension, learning, and reasoning" (Baddeley, 1986, p. 34). Baddeley and Hitch's working memory model originally consisted of three systems: (1) a phonological loop, (2) a visuo-spatial sketchpad, and (3) a central executive that supervises and controls the other two subsystems, also called slave systems. Later on, Baddeley (2000; 2001) added a third subsystem called the episodic buffer.

The phonological loop is a subcomponent or slave system, originally called the *articulatory loop*, where all speech-like or phonemic information is stored. The characteristic function of this component is to serve as a buffer store, which is responsible for keeping verbal responses until they can be emitted (Baddeley, 1986; 1992; 1999; 2001; 2012; Richardson et al., 1996). The phonological loop is divided into two subcomponents: the phonological input storage (Verbal STM) and an articulatory rehearsal system. The phonological loop is basically used for speech control. Here, the phonological input store briefly holds the incoming oral information which decays within a couple of seconds unless the articulatory rehearsal encodes the decaying information to be stored in long-term memory (Baddeley, 1986; 1992; 1999; 2001).

The second slave system of Baddeley's working memory model is the visuo-spatial sketchpad. This component is responsible for the short-term storage of visual and spatial information, such as objects and their locations, colors and shapes (Baddeley, 1986; 1992; 2001; 2012). Similarly to the phonological loop, the visuo-spatial sketchpad also consists of a passive short-term store and an active rehearsal process. Decay in the temporary visuo-spatial store is likely to happen as fast as phonological decay, which occurs in a few seconds. Then, the visuo-spatial sketchpad needs to rely on its active rehearsal process to avoid information loss, which can be refreshed through eye movement, manipulation of the image or some type of visual mnemonic (Baddeley, 1986).

The third WM system presented by Baddeley & Hitch (1974) is the central executive, which according to their working memory model is considered the heart of working memory. It is responsible for controlling the other two subsystems, coordinating all the cognitive

processes that take place in working memory performance, such as allocating limited attentional capacity. The central executive controls functions like an chief executive for the WM, controlling attention resources, selecting strategies, and integrating information from many different sources (Baddeley, 1986; 1992; 2001; 2012). Even though the central executive is deemed to be the supervisor of the other subsystems and the most important system, its operating characteristics are still much less-clearly defined and have been more difficult to investigate experimentally (Richardson et al., 1996).

Finally, 25 years later, Baddeley (2000; 2001) added a new subcomponent to the WM model, called the episodic buffer. This subcomponent was included in an attempt to explain the long-term memory's impact on the contents of working memory. The episodic buffer is assumed to be a limited-capacity temporary storage system that is capable of integrating information (e.g. episodes and scenes) from a variety of sources and is consciously accessible, binding information from the subsidiary systems and from long-term memory into a unitary episodic representation (Baddeley, 2000; 2001).

## 2.3 THE WORKING MEMORY OF CHILDREN

There is evidence suggesting that working memory capacity in children is lower than that of adults. This evidence comes from studies that demonstrated that working memory capacity increases across the childhood years (Baddeley et al., 2009; Gathercole & Alloway, 2008; Gathercole, Pickering, Ambridge, & Wearing, 2004). Generally, the memory capacity of adults is between two and three times greater than those of young children (Gathercole & Alloway, 2008). One of the reasons for the increase in working memory capacity as children grow older is that they become more efficient at carrying out mental processes. Another possible reason is that older children have considerably more knowledge of various subjects, thus enhancing memory performance by enabling them to relate new knowledge to relevant stored knowledge (Gathercole & Alloway, 2008; Baddeley et al., 2009).

Gathercole, Pickering, Ambridge, and Wearing (2004) reported a thorough and influential investigation of developmental changes in the three original components of working memory as described by Baddeley (e.g. 1986; 2000; 2001; 2009): the central executive, the phonological loop, and the visuo-spatial sketchpad. The study was carried out with

boys and girls between the ages of 4 and 15 who performed a range of memory tasks relevant to working memory.

In summary, Gathercole et al. (2004) found that there was a progressive increase in working memory capacity year-by-year in all three components of the working memory system. There was a marked working memory capacity growth between 4 and 11 years of age, followed by small but significant increases up to 15 years when adult levels are reached. Also, according to Gathercole et al. (2004), the structure of working memory remains fairly consistent through the childhood years, providing substantial evidence that the three main components of the Baddeley and Hitch (1974) model of working memory are in place by 6 years of age. Later on, Alloway and Gathercole (2006) suggested that all working memory components are already in place by 4 years of age, meaning that as early as 4 years of age it is possible to measure working memory as a modular structure.

After conceptualizing the WM of children, the next section will address the importance of vocabulary in L2 acquisition.

## 2.4 L2 VOCABULARY ACQUISITION

This section intends to provide a theoretical overview on the importance of vocabulary acquisition to second language (L2) learning. It also aims to provide the theoretical background for the role of WM in the acquisition of L2 vocabulary. It is divided into four parts that respectively deals with (1) the concept of “word” and “vocabulary”, (2) what involves knowing a word and vocabulary knowledge, (3) strategies learners use to learn vocabulary, and (4) L2 vocabulary teaching.

*Vocabulary acquisition* is an area within applied linguistics that has been neglected throughout the years. This neglect becomes even more striking as learners admit that they face considerable difficulties with vocabulary in the early stages of a second language acquisition, even identifying vocabulary acquisition as their greatest source of problems as an L2 learner (Meara, 1980).

However, since the late 1990s, there has been an increasing interest in the study of L2 vocabulary acquisition among researchers and theorists involved in second language learning (Coady & Huckin, 1997). Some authors have argued that vocabulary learning plays a vital role in second language acquisition. For instance, Zimmerman (1997) points out that “vocabulary is central to language and of critical importance to the typical language learner. […] the teaching and learning of vocabulary have been undervalued in the field of second language

acquisition" (p.5). Hunt and Beglar (2005) emphasize that adequate second language vocabulary acquisition is important particularly for learners of English as a foreign language (EFL) which is probably true for other languages as well. Lewis (2000, as cited in Pérez & Ruiz, 2007) has gone even further in stating that "the most important task facing language learners is acquiring a sufficient large vocabulary" (p.8). Once the importance of vocabulary to second language has been established, the next subsection will discuss the conceptualization of "vocabulary" and "word", which are key terms to be understood in the context of vocabulary acquisition.

### 2.4.1 The concept of vocabulary/word

To conceptualize the term *word* is not an easy task as it seems, either in theoretical terms or for various applied purposes (Read, 2000). A word can be understood both as a single lexical item or as larger lexical items containing more than one lexical unit (compound verbs, compound nouns, phrasal verbs) but conveying one single meaning, since its meaning is often unpredictable from the meanings of its components (Read, 2000; Trask, 2007). For instance, the compound verb *believe in* or the phrasal verb *make up*, despite having two lexical items, conveys only one meaning and are considered only one word (Read, 2000; Trask, 2007).

As pointed out by both Schmitt (2010) and Barcroft, Sunderman, and Schmitt (2011), a basic characteristic of vocabulary is that meaning and form do not always have a one-to-one correspondence. For example, the items *die, expire, pass away, bite the dust, kick the bucket and give up the ghost* are synonymous, all with meaning 'to die' (Schmitt, 2000, p. 1). However, many of the items contain more than one word. Especially in English, meanings can be represented by multiple words operating as single units. Therefore, in this study, in order to accommodate the fact that both single and multi-word units can realize meaning, I will use the terms *lexical item* and *word* interchangeably, both defined as 'an item that functions as a single meaning unit, regardless of the number of words it contains' (Schmitt, 2010, p. 50)

On the other hand, v*ocabulary*[5] is more popularly and commonly known as a set of words known and used by a particular person, or the group of words that are part of a particular language (Read, 2000; Lessard-Clouston, 2013). Until a certain point, that is correct because vocabulary in fact deals with words. However, this belief is not adequate because vocabulary encompasses much more than just single words (Read, 2000; Nation, 2001; Lessard-Clouston, 2013).

Recent vocabulary studies rely upon an understanding of *lexis*, from the ancient Greek for 'word', that in English "refers to all the words in a language, the entire vocabulary of a language" (Barcroft, Sunderman, & Schmitt, 2011, p. 571). In these terms, vocabulary no longer consists of individual words only, but also includes *lexical chunks*, phrases of two or more words, such as *Good morning* and *Nice to meet you*, which research suggests are usually learnt as single lexical units (Lessard-Clouston, 2013). Phrases like these involve more than one word but have a clear, conventional usage, and they form a significant portion of spoken or written English language (Read, 2000; Lessard-Clouston, 2013).

Moreover, in spite of SLA linguists having developed their own conceptual approaches regarding *word/vocabulary* there are several Brazilian linguists (e.g., Biderman, 1998; Ferrarezi Jr & Teles, 2008; Henriques, 2011; Antunes, 2012; Batista, 2011) that have substantially broaden and deepened the conceptualization of *word* and *vocabulary*. For instance, according to Biderman (1998) *words* are not simply labels of things; but they are a way of registering the knowledge of the universe since there is a process of nominalization of reality which enables humans to label entities, appropriating the real. In other words, to the author, "the generation of the lexis is processed through successive acts of cognition of reality and categorization of the experience, crystallized into linguistic signs: the words (p. 92). Thus, the statement above implies that the lexis carries in its meaning important aspects of the world view that individuals have. According to the author, the words that are generated by the system of lexical-grammatical categories of a language are labels by which humans interact cognitively with their environment (Biderman, 1998, p. 91).

Finally, taking into account the brief conceptualization of the terms word and vocabulary, another correspondent aspect involves

[5] According to Cambridge Dictionary, vocabulary refers to "words used by a particular person or all the words that exist in a particular language or subject". Retrieved May 7, 2014, from http://dictionary.cambridge.org/dictionary/american-english/vocabulary?q=vocabulary.

knowing what it means to know a word and consequently what it means to have vocabulary knowledge. With that in mind, the next subsection will discuss what it means to know a word and to know a vocabulary.

### 2.4.2 What it means to know a *word/vocabulary*

One of the most relevant issues to be dealt with relating to second language vocabulary acquisition concerns understanding what it means to know a word. Read (2000) and Nation (2001) state that knowing a word not only implies being able to recognize the written and spoken form of the word and being able to associate a meaning with this form, for instance, knowledge of pronunciation, spelling and word parts; form-meaning connection and its associations with other lexical items, derivations, collocations, frequency, constraints and grammatical rules (Nation, 2001, p.159). These aspects of word knowledge were comprised into three essential aspects learners need to be aware of and focus on, which are *form*, *meaning*, and *use* (Lessard-Clouston, 2013).

According to Nation (2001), the *form* of a word involves its pronunciation (spoken form), spelling (written form), and any word parts that form this particular item (such as a prefix, root, and suffix). An example for word parts can be seen with the word *uncommunicative*, where the prefix *un-* means *negative* or *opposite*, *communicate* is the root word, and *–ive* is a suffix denoting that someone or something is able to do something, and when it is put together it refers to someone or something that is not able to communicate, hence *incommunicative* (Lessard-Clouston, 2013). Moreover, the concept of *meaning* provided by Nation (2001) encompasses the way that form and meaning work together, which means, the concept and what items it refers to, and the associations that come to mind when people think about a specific word or expression. Finally, Nation (2001) states that *use* involves the grammatical functions of the word or phrase, collocations that normally go with it, and also the constraints on its use, either in terms of frequency or level, for instance. Furthermore, Nation (2001) declares there is both a receptive (reading and listening) and productive (speaking and writing) dimension for each of the three aspects involved in knowing a word.

At the same time, vocabulary knowledge and use corresponds to knowing the words and phrases correctly in any and all of these different components (Lessard-Clouston, 2013). Thus, the concept of vocabulary knowledge is intertwined with the concept of knowing a word and all its related aspects, involving much more than just

memorizing the meaning of a word, but also involving the capacity of putting that knowledge into use (Read, 2000). This can be enhanced with the assistance of a teacher and also relying on learning strategies, which are the subjects of the next two subsections.

### 2.4.3 L2 vocabulary learning

Learning strategies are the particular approaches or techniques that learners use to try to learn an L2 (Ellis, 1997). There have been various attempts to discover which strategies are important for L2 acquisition. Nation (2007) advises that a well designed language course should divide its time into four main strands, which are: (1) meaning-focused input, (2) meaning-focused output, (3) language-focused learning, and (4) fluency development. Due to space constraints, the four strands will be only briefly mentioned here, focusing more on the third strand which is more related to this study.

Meaning-focused input involves learning receptively, either through listening or reading. Thus, the learner's main focus and interest in this strand should be on understanding, and enhancing knowledge through listening and reading L2 activities. Because of this, great amounts of input are necessary for this strand to work efficiently (Nation, 2007, p. 02). Meaning-focused output strand involves learning through production of language, either through speaking or writing. Activities that are typical of this strand include talking in conversations, delivering a speech or lecture, writing a letter or telling a story. In this strand, many spoken activities will mix meaning-focused input and meaning-focused output, because one person's output can be another person's input.

The language-focused learning strand involves intentional learning of language features such as pronunciation, spelling, vocabulary, grammar and speech. This strand has received other names in literature, such as form-focused instruction (FFI) Spada (1997), which has been proposed in the area of grammar, but can be easily adapted to vocabulary as well (Laufer, B. 2010), focus on form (FonF), deliberate study and deliberate teaching, learning as opposed to acquisition, and intentional learning, just to name a few (Nation, 2007, p. 05). The term language-focused learning is preferred by Nation because terms such focus on form and form-focused instruction are misleading in a way that they can involve a deliberate focus on meaning as well as form, and do not need to involve instruction but can be the focus of individual autonomous learning. Some examples of deliberate learning activities

are guessing from context, using dictionary or word cards, intensive reading, translation and getting feedback about writing (Nation, 2007, p. 06).

There is consistent evidence that vocabulary that is deliberately learnt can result in large amounts of well retained useable knowledge (Nation, 2001: 296-316). Also, there is evidence from L2 learning studies that deliberate learning is effective on learning of multiword expressions, such as collocations and idiomatic expressions (Boers et al ., 2006). In addition, evidence from vocabulary learning shows that very large amounts of learning can occur within limited amounts of learning time, although it becomes more effective if the learning sessions are more spaced apart (Nation, 2007, p. 06).

Finally, the fluency development strand should involve all the four skills of listening, speaking, reading and writing. In this strand, the learners are assisted to make the most effective use of what they already know. Like the meaning-focused input and output strands, the fluency development strand is also meaning-focused. That is, the learner's aim is to receive and convey messages. Some examples of typical activities include speed reading, skimming and scanning, listening to easy stories and so on (Nation, 2007, p. 06). This section discussed L2 learning strategies and the next subsection will present suggestions of L2 vocabulaby teaching.

### 2.4.4 L2 vocabulary teaching

Vocabulary has always been a fundamental component of language teaching, and after a long period of relative neglect, it is now extensively acknowledged as such (Schmitt, 2010). This subsection will concentrate on the necessary conditions for vocabulary learning and then it will give examples of activities that may underpin the retention of new vocabulary in an L2.

According to Nation (2001), there are three important conditions needed for vocabulary learning. These comprise (1) noticing, (2) retrieval, and (3) creative or generative use. The first process to encourage learning is noticing, that is giving attention to an item (Nation, 2011), or the conscious awareness of something (Schmidt, 1990). This means that learners need to notice the word and become aware of it as a language item (Schmidt, 1990). According to Nation (2001, p. 72), noticing may occur if words appear in important parts of the written input in a given task. It is possible to increase the chances of a word being noticed by pre-teaching, highlighting the word in the text

by using underlining, italics or bold letters (Nation, 2001). For example: in order to be noticed by learners, the target word strawberry appears underlined in the following context: "Strawberry ice cream is delicious".

The second major process that may lead to a word being remembered is retrieval (Baddeley, 1990:156). If a word that was noticed is subsequently retrieved during the task then the memory of that word will be strengthened (Nation, 2001). Moreover, Baddeley (1990) suggests that each retrieval of a word strengthens the path that links form to meaning making subsequent retrieval easier. Retrieval may be receptive or productive (Nation, 2001). Receptive retrieval complies perceiving the form and having to retrieve its meaning when the word is encountered in listening or reading (Nation, 2001). Productive retrieval involves the communication of the meaning of a word when speaking or writing, by retrieving its spoken or written form (Nation, 2001). One effective way to encourage retrieval is through repetition. Recalling or retrieving a word is a more effective way of learning than simple exposure or just seeing a word several times (Nation, 2001; Sökmen 1997, as cited in McCarten, 2007). This can be accomplished either through repetition of the same story or by serializing a longer story (Nation, 2001).

The third major process that may lead to a word being remembered is generation. Generation or generative processing occurs when words that were encountered before are subsequently met or used in different ways from the previous meeting with the word (Nation, 2001; Wittrock, 1974; 2010). Generative processing can also be receptive or productive. The receptive form involves meeting a word being used in new ways in listening or reading. On the other hand, in its productive form, it involves producing new ways of using the wanted vocabulary in different contexts from those met before (Nation, 2001; Wittrock, 1974; 2010). The activity proposed to prompt generative processing is called 'the second-hand cloze' (Laufer & Osimo, 1991), (Appendix Q). This activity consists of a summarized version of the text of the second retrieval activity with the target words deleted (Appendix N). The learner has to fill in the missing words in the text blanks. The learners are helped to recall the target words by being given a list of L1 words equivalent of the target words they have to translate into L2, and then use to supply the blank spaces. Laufer and Osimo (1991) tested the procedure with native speakers of Hebrew and Arabic and found that 'second-hand cloze' can result in a significant improvement in retention of words. The second-hand appears to have added a generative element to learning (Nation, 2001).

After outlining the conditions for L2 vocabulary learning to occur and the correspondent activities to enhance L2 vocabulary retention, the next section will deal with the issue of how working memory is related with vocabulary acquisition.

## 2.5 WORKING MEMORY AND VOCABULARY ACQUISITION

A relevant theoretical aspect of the present study is the relationship between WM and second language vocabulary acquisition. As already mentioned, researchers in educational and psychological areas have acknowledged that working memory plays a vital role in learning. As a result, working memory capacity may determine the degree and extent of learning (Dehn, 2011). researchers in educational and psychological areas have acknowledged that working memory plays a vital role in learning. A study conducted by Ellis and Sinclair (1996) demonstrated that working memory is well-involved in vocabulary acquisition by mediating the reciprocal interaction between long-term and short-term memory. Their study investigated the role of phonological rehearsal of foreign language (FL) utterances in the process of language acquisition. It compared the acquisition of FL Welsh between individuals who repeated the utterances and those who were prevented from doing so. The results revealed that learners who repeated utterances clearly performed better than those who were prevented from doing so. They concluded that "individual differences in STM and working memory can have profound effects on language *acquisition*" (p.247) [emphasis in the original].

Mendonça (2003) investigated the relationship between working memory capacity and L2 vocabulary acquisition. The study was conducted with seventeen Brazilian graduate students. The participants' working memory capacity was assessed by means of a speaking span test, and vocabulary acquisition was assessed by productive and receptive tasks. Statistical results demonstrated that WMC correlates with L2 vocabulary acquisition. The results suggested that individuals with higher spans are more capable of comprehending and producing new vocabulary items than lower span individuals, indicating also that people with higher spans possess more efficient phonological processing than those with lower spans.

Another study that hints at the role of WMC in L2 vocabulary acquisition was conducted by Bergsleithner (2007) who studied the relationship between WMC, noticing of L2 forms, and L2 speech production. The study found that individuals with a larger WMC noticed

more L2 formal aspects and presented better performance in L2 oral tasks, while conversely individuals with poorer WMC noticed fewer L2 formal aspects and had lower performances on L2 oral tasks.

In a more recent study, Engel de Abreu and Gathercole (2012) claimed that executive processing is a crucial factor that links the WM system to higher order language abilities. They showed that phonological STM makes specific contributions to second language learning activities, including vocabulary learning. The study was conducted with children of 8 to 9 years old experiencing multilingual education. Results indicated that phonological STM was uniquely linked to vocabulary in L1 and the structurally similar L2; executive processes were related to grammar across languages, reading comprehension, and spelling; phonological processing abilities appeared to be critical for acquiring the sound structure of a new language whereas executive processes share more general links with higher order linguistic abilities in second language learners.

Wen (2014) also suggests that the phonological working memory component with its associated cognitive mechanisms is most closely related to the acquisition and developmental aspects of language-learning domains such as vocabulary and formula acquisition and grammar development.

To conclude, even though various research results were presented, the literature on the relationship between WMC and vocabulary acquisition is still scarce, and what there is, is mainly related to adult acquisition. Consequently, there is considerable space for research involving WM and vocabulary acquisition by young learners as it has been proposed here.

# CHAPTER III

# METHOD

The present chapter is organized into 9 major sections outlining in detail the methodological procedures adopted in the present study. Section 3.1 presents the objectives, research question and hypotheses of the research. In section 3.2, the general design is described. Section 3.3 presents information regarding the participants who volunteered for this research. The instruments of data collection are presented in section 3.4. Section 3.5 portrays the general procedures for data collection and section 3.6 presents the data analysis. Finally, the pilot study carried out prior to the current study will be described in section 3.7.

## 3.1 OBJECTIVES, RESEARCH QUESTION, AND HYPOTHESES

The method used in this study was quantitative, quasi-experimental[6] and correlational (Brown, 1988). The main objective of this study was to investigate the effects of working memory on the learning of L2 vocabulary in a population of 24 young learners of English who, at the time of data collection, were attending the 6th grade of a Brazilian public school in the city of Florianópolis. All participants were native speakers of Portuguese.

In order to fulfill the main objective of the present study, the following research question was proposed to be investigated:

1. What are the effects of working memory on the learning of L2 vocabulary by 6th graders?

From this research question, and given that individual performance on working memory tasks is expected to be distinct, this research question generated the following hypotheses:

1. The phonological loop has a significant effect on the acquisition of L2 vocabulary by 6th graders.

This hypothesis follows from the fact that, as presented in Chapter 2, Ellis and Sinclair (1996) and other researchers (e.g., Engel de Abreu & Gathercole, 2012; Wen, 2014) have provided evidence that the phonological loop has a significant role on the acquisition of L2

6 Quase-experimental groups are similar to experimental groups but use subjects not randomly assigned since they naturally belong to one group or the other (Brown, 1988).

vocabulary. Also, in my own experience as an English teacher, I have observed that repetition (Nation, 2001; 2013) is required for L2 vocabulary learning. Repetition occurs with assistance of the phonological loop.

2. The central executive has a significant effect on the acquisition of L2 vocabulary by 6th graders.

This hypothesis is based on the study reported by Gathercole et al. (2004) and Wen (2012) in which they indicate the strong association between the central executive and the phonological loop.

3. The visuo-spatial sketchpad does not affect the acquisition of L2 vocabulary by 6th graders.

This hypothesis is based on studies (e.g., De Benit et al., 2005; Tsai, 2014) that have provided evidence that the visuo-sketchpad does not significantly affect L2 vocabulary acquisition. Also, the this hypothesis follows from the view that, due to the nature of the visuo-spatial sketchpad (Baddeley, 1986; 1992; 2000; 2001; 2012), this slave system of working memory should not significantly affect L2 vocabulary acquisition.

## 3.2 GENERAL RESEARCH DESIGN

In order to test the hypotheses previously mentioned, the present study was conducted in three phases, as follows:

1 – Phase 1: Assessment of working memory and English vocabulary pre-tests.

2 – Phase 2: Treatment consisting of the teaching of ten words related to food.

3 – Phase 3: Vocabulary post-tests.

## 3.3 PARTICIPANTS

The present study was approved by the Ethics Committee of the Universidade Federal de Santa Catarina, according to protocol CAAE: 34049314.0.0000.0121 and approval letter number 772.086 issued on August 29, 2014. In addition, a written form of consent was obtained from all participants (Appendix B and C).

The investigation was conducted at Escola Estadual Getulio Vargas (EEGV), in Florianopolis, state of Santa Catarina, with one experimental group of 24 participants. At the time of data collection, all participants were currently attending the 6th grade. From this number, 17 participants were female and 7 participants were male, all Brazilian

native speakers of Portuguese with low English vocabulary knowledge, according to the Vocabulary Levels Test (VLT), Nation (1983, 2001). No control group was formed because my objective was to investigate participants' learning of new vocabulary on a pre-post-test basis and correlate this learning to their working memory capacity. All participants were young learners (ages ranging from 11 to 14, with an average age of 12 years. All of them agreed to participate voluntarily in the present study.

In order to be part of the experimental group, participants should be in the 6th-grade and should be attending a public school. A public school was chosen because I believed that considering that most of the participants were part of a low socio-economic group, I hoped to find more participants with working memory deficits. The 6th grade was chosen because this is the first school year in which they have English classes as a curriculum subject, thus having more control over their L2 English vocabulary knowledge. In addition, all participants should have low vocabulary knowledge in English. In order to test their English profiency, they should score less than 85% on the 2000 words level of the Vocabulary Levels Test (VLT). The total number of students in Class 62 at Escola Estadual Getulio Vargas was 26. However, 2 students were excluded from the study because they did not perform the working memory test. Hence, the final pool of participants in the experimental group consisted of 24 students (7 male and 17 female).

## 3.4 INSTRUMENTS

The present study had a pre-test, treatment, post-test design. The materials and procedures were tested through a pilot study in order to verify whether the selected design was adequate to the purposes of this study.

Seven instruments of data collection were used in this study: a personal information and language background questionnaire prior to the first phase of the study, the Automated Working Memory Assessment (AWMA), two pre-tests, a Word Recognition test and the Vocabulary Levels Test (VLT) were used in the first phase of the study and two post-tests on the third and last phase of the study. The second phase consisted of instructional treatment through six different planned activities whose results were not reported in results and discussion.

*(1) Personal Information and Language Background Questionnaire*. This questionnaire (Appendix D) consisted of four questions concerning participants' age, gender, and educational

background, as well as their previous knowledge and use of English. The general background questionnaire was filled out individually by each participant.

*(2) Automated Working Memory Assessment.* Participants' working memory capacity was assessed by means of the *Automated Working Memory Assessment* (AWMA, Alloway, 2007) provided by Pearson Assessment UK, in its standardized version in Portuguese for research purposes.

The AWMA (Alloway, 2007; Alloway et al., 2006, 2004) was developed with the purpose of identifying significant working memory impairments in individuals between 4 and 22 years of age, based on studies conducted with more than 700 children in the United Kingdom. The AWMA tests the three components of working memory proposed by Baddeley and Hitch (1974). The tests tap four different aspects of memory: the verbal short-term memory corresponding to the phonological loop; the visuospatial short-term memory corresponding to the visuospatial sketchpad; and both the verbal working memory and visuospatial working memory corresponding to phonological loop processing and visuospatial sketchpad processing, simultaneously testing the central executive performance (Alloway, 2007, p. 13).

The AWMA is originally composed of 3 different versions: (1) AWMA Screener, (2) AWMA: Short Form, and (3) AWMA: Long Form. For the purposes of the present study, only the AWMA Screener version was utilized. This version comprises 2 tests, subdivided into two subtests each. The verbal portion or the test was divided into two subtests: listening recall and listening recall processing. The visuospatial portion of the test was also divided into two subtests: spatial recall and special recall processing. AWMA Screener version is considered suitable for screening either typical individuals or individuals with suspected working memory difficulties. Considering that the tests would be applied on a typical population of young learners who had not been suspected of having working memory problems, the AWMA Screener version was considered adequate. The first test, the *Listening Recall*, comprised two subtests called listening recall and listening recall processing, which tests the verbal working memory (phonological loop) and the central executive respectively. In this test, the participant listens to a series of spoken sentences and has to verify if the sentence is "true" or "false" (listening recall). The participant, then, has to recall the last word of each sentence presented, in the exact order of presentation (listening recall processing).

The trials begin with a block of one sentence, and increases to a block of six sentences until the participant is unable to recall three correct trials. The one-sentence trial contains six sentences. The two-sentence trial contains twelve sentences subdivided in six sets of two sentences each. The three-sentence trial contains eighteen sentences subdivided in six sets of three sentences each and so forth until a maximum of a six-sentence trial containing thirty-six sentences subdivided into six sets of six sentences each. The participants should recall the last word of each sentence after all the sentences for each trial have been presented. This means that in a three-sentence trial, they would repeat the last word of each sentence after the third sentence had been presented. The following is an example of the AWMA subtests Listening Recall and Listening Recall processing:

(1) Os cachorros têm quarto patas. (Verdadeiro)
*Última palavra da frase:* patas.

(2) As maçãs jogam bola. (Falso)
Os livros têm capa. (Verdadeiro)
*Últimas palavras das frases:* bola e capa.

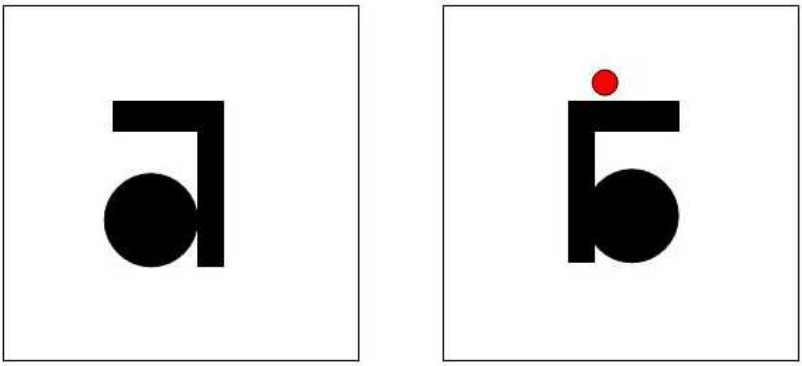
The second test, the *Spatial Recall*, was also divided into two subtests (spatial recall and spatial recall processing) to test the visuospatial working memory and the central executive respectively. In this test the participant views a picture of two shapes, where the shape on the right has a red dot on top of it, and it can be rotated in three possible directions. First, the participant has to identify whether the shape on the right is the same or opposite of the shape on the left (visuospatial recall). At the end of each trial, the participant is expected to recall the location of each red dot on the shape in the correct order, by pointing to a picture with three possible positions marked (visuospatial recall processing).

The test begins with a block of one set of shapes and increases to a block of seven sets of shapes or until the participant is unable to recall three correct trials. The one-shape trial contains six shapes. The two-shape trial contains twelve shapes subdivided in six sets of two shapes each. The three-shape trial contains eighteen shapes subdivided in six sets of three shapes each and so forth until a maximum of a seven-shape trial containing forty-two shapes subdivided into six sets of six shapes each. The participants should recall the correct order of dots of each series of shapes after all the shapes for each trial have been presented.

This means that in a three-shape trial, they would repeat the dot of each shape after the third shape had been presented. The AWMA subtests Spatial Recall and Spatial Recall processing are illustrated next:

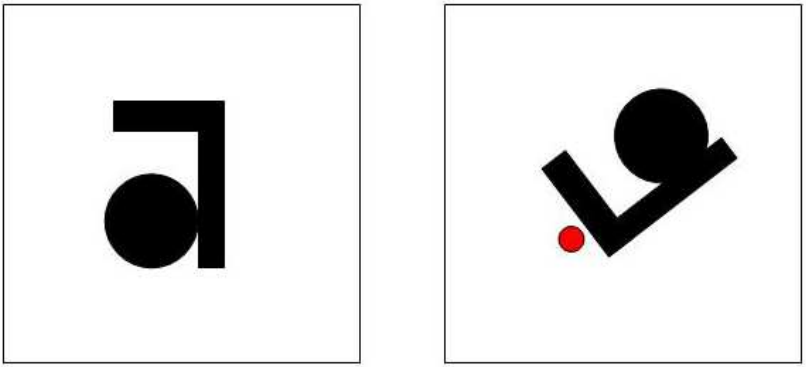
*Spatial Recall*

Trial 1



Response 1 = ‘opposite’

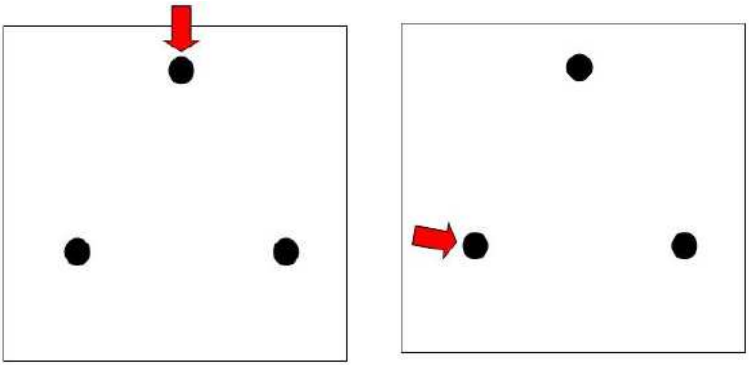
Trial 2



Response 2 = ‘opposite’

*Spatial Recall Processing*

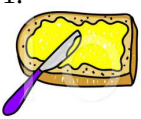
Recall1 Recall 2



*(3) Word Recognition Test.* The Word Recognition test (Appendix E) was developed in the Laboratory of Language and Cognitive Processes (*LABLING - Laboratório da Linguagem e Processos Cognitivos*) at Universidade Federal de Santa Catarina in order to verify if the words chosen for pre-test 1 and pre-test 2 were part of their vocabulary in Portuguese. The Word Recognition test consisted of a series of pictures in which participants had to write the words in Portuguese that corresponded to each picture. The following is an excerpt of the Word Recognition test used in the present study:

*Word Recognition test* (Appendix E).

Escreva em português o nome das figuras:

1. 

2. 

3. 

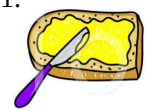
4. 

_____ _____ _____ _____

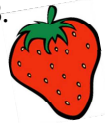
*(4) Pre-test 1.* Pre-test 1 – Picture Matching (Appendix F) was developed in the Laboratory of Language and Cognitive Processes (*LABLING - Laboratório da Linguagem e Processos Cognitivos*) at Universidade Federal de Santa Catarina, in order to assess participants' vocabulary knowledge to find out which words related to food these participants were familiar with. Unknown words were selected to be addressed on the second phase of the study. The pre-test 1 was designed to assess participants' knowledge of 40 food vocabulary words in English and it was applied to all 24 participants of the experimental group. The pre-test 1 consisted of a multiple-choice test in a matching format in which participants had to choose the right picture to go with each word. The following is an excerpt of the pre-test 1 used in the present study:

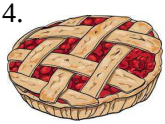
Pre-test 1 - *Picture matching test* (Appendix F).

Escreva a alternativa que corresponde à figura:

1. 
( ) Strawberry

2. 
( ) Cookie

3. 
( ) pie

4. 
( ) Butter

*(5) Pre-test 2.* Pre-test 2 – Translation (Appendix G) consisted of a translation format with 40 supposedly unknown words in the L2 (English) to be translated into the L1 (Portuguese). Then, 10 words out of the 40, none of which the participants had answered the correct meaning in pre-test 2 were selected as target words to be taught to the participants in the second phase. Similar translation tests were used in studies on second language where they tested the receptive and productive vocabulary size of non-native speakers (Bouangeune, 2009; Nurweni and Read, 1999; Mendonça, 2003; Prince, 1996). Nation (2001; 2013) also argues that "the use of first language to convey and test word meaning is very efficient" (p. 351; 544). Thus, translation test was considered adequate for the purpose of this study.

The translation pre-test was designed with isolated words (Mendonça, 2003; Prince, 1996; Seibert, 1930) rather than words in phrase or sentence contexts. Ruhl (1989, as cited in Nation, 2001, p. 51) argues that there are two major sources of meaning when we

comprehend a word: (1) its inherent lexical meaning (what it means as an isolated word), and (2) the inferential meaning that is drawn from the contiguous context and from our world knowledge. In this case, isolated words were chosen because all the selected words were concrete nouns that have one main inherent lexical meaning. The selection of the words also took into consideration the participants' low proficiency in the target language.

The criteria for choosing the words for pre-tests were: each word should have one main translation equivalent in Portuguese which was clear and unambiguous; the word should be concrete, referring to a type of food, and the word should have a high probability of being unknown to the participants.

Pre-test 2 - *Translation Test* (Nurweni and Read, 1999; Mendonça, 2003; Prince 1996) (Appendix G).

**Traduza as seguintes palavras para o Português.**

1. Strawberry _____
2. Cookie _____
3. Butter _____
4. Pie _____
6. Grape _____

*(6) Vocabulary Levels Test (VLT).* Also as part of the first phase of the study, a paper-based Vocabulary Levels Test (VLT) (Appendix H), originally designed by Nation (1983) and revised by Schmitt et al (2001) to measure both first and second language learners' written receptive vocabulary size in English, was used in order to find the learners' current level of vocabulary knowledge in general, thus controlling their lexical proficiency.

The original monolingual VLT has already been translated to several languages. However, at this point there was no version available in Portuguese. Thus, for the purposes of this study the monolingual version was translated from English into Portuguese by the researcher following the guidelines provided by Nation (2004): Four levels were chosen for testing – the 2nd 1,000 word level, the 3rd 1,000 word level, the 5th 1,000 word level, and the 10th 1,000 word level. The second level (2nd 1,000 word level) contains the second most frequent 1,000 word families in English, the third level contains the third most frequent 1,000 words and so on.

A representative sample of 60 words was taken from each of the four levels. Sample representativeness guarantees that a learner's score at each level represents the proportion of all the words known at that specific level. For instance, if a learner scores 15 out of 30 on the 2nd 1,000 level, it means that the learner knows 50% or 500 out of 1,000 words at that level. The 60 words at each level were grouped into blocks of six words according to part of speech (e.g., noun, adjective, etc.). Then, the words in each block were checked to make sure that they were not similar in form or related in meaning. This was done so that the distractors in each block were not distracting, meaning that if the learners had partial knowledge of a word they should be able to choose the correct answer. Three words in each block of six were randomly selected as the words to be tested. The other three in the block were the distractors. Learners were required to match target words with their corresponding definitions as illustrated below:

**Teste de níveis em vocabulário: Versão 1**

Este é um teste de vocabulário. Escolha a palavra certa para cada significado. Escreva o número da palavra na linha do significado correspondente. Como no exemplo:

| | | |
|---|---|---|
| l | business | |
| 2 | clock | _____Uma parte da casa |
| 3 | horse | _____Um animal com quatro patas |
| 4 | pencil | _____Algo usado para escrever |
| 5 | shoe | |
| 6 | wall | |

Você pode responder da seguinte maneira:

| | | |
|---|---|---|
| l | business | |
| 2 | clock | __6__Uma parte da casa |
| 3 | horse | __3__Um animal com quatro patas |
| 4 | pencil | __4__Algo usado para escrever |
| 5 | shoe | |
| 6 | wall | |

As indicated above, there are 3 words to be chosen by the learners. However, learners who are taking the test need to know 6

words because they should check every word against the definitions in order to make correct matches.

*(7) Post-test 1 – Picture Matching.* This test (Appendix I) consisted of the same multiple-choice in a matching format test described for Pre-test 1 in which participants had to choose the right picture to go with each word. It was administered seven days after the last treatment session.

*(8) Post-test 2 - Translation.* Post-test 2 (Appendix J) consisted of the same translation format with 40 supposedly unknown words in the L2 (English) to be translated into the L1 (Portuguese) as described for Pre-test 2. It was also applied seven days after the last treatment session.

Both Post-test 1 and Post-test 2 consisted of with 40 words where 30 words were distractors and only the 10 target words that were taught in the second phase were the focus of the study. The score was considered only for the 10 target words.

### 3.4.1 The instructional treatment - teaching of vocabulary

The treatment phase consisted of teaching vocabulary. In the second phase of the present study, participants received explicit instruction related to the 10 unknown L2 vocabulary words selected after pre-tests. It is important to point out there was no prediction here, because the tasks administered during treatment were developed specifically for this study and had not been previously evaluated. The pedagogical strategy selected to teach vocabulary for the purposes of this study was proposed by Nation (2001;2013). According to him, there are three important general processes that may help the learner remember a word: (1) noticing, (2) retrieval, and (3) creative (generative) use. Seven different activities involving the target words were used during the instructional treatment phase for teaching of vocabulary. Each of these activities is detailed within the following subsections.

#### 3.4.1.1 Noticing

The chances of a word being noticed may be increased by pre-teaching or highlighting the word in the text by using underlining, italics, or bold typography (Nation, 2001; 2013).

The first activity, Food Pyramid, (Appendix K) involving the *noticing* process was designed to encourage noticing by underlining the

target words to be noticed during the activity. The participants received a food pyramid picture with the target words underlined. The second activity (Appendix L) used to prompt *noticing* was designed to encourage noticing by asking participants to choose the right food group for the foods listed with the target words to be noticed in bold print.

#### 3.4.1.2 Retrieval

The second major process that may lead to a word being remembered is *retrieval* (Baddeley, 1990:156). If a word that was noticed is subsequently retrieved during the task then the memory of that word will be strengthened (Nation, 2001).

Four activities were used to stimulate retrieval process. The first activity was used to stimulate retrieval processing by giving learners a list of the same words from the previous activity to match the target word with the right picture shown on the right of the word list (Appendix M).

In the second activity used to stimulate retrieval processing, participants were presented a short dialogue with the target words which the learners had to retrieve by answering a questionnaire after reading the dialogue (see Appendix N for dialogue and questionnaire).

The third activity used to stimulate retrieval processing was an activity where participants had to write the names of the foods presented in the pictures according to their food group (Appendix O).

The fourth and last activity used to stimulate retrieval processing was a food bingo (Appendix P) in which participants received bingo cards with food pictures. Then the researcher called out the names of randomly selected foods one by one as students crossed them off their bingo cards. The game continued until a participant completed their full bingo card and shouted out BINGO!

#### 3.4.1.3 Generative processing

The third major process that may lead to a word being remembered is *generation*. Generation or generative processing occurs when words that were encountered before are subsequently met or used in different ways from the previous encounter with the word (Nation, 2001; Wittrock, 1974; 2010).

The activity of the instructional treatment to stimulate generative processing was called ‘the second-hand cloze,’ (Laufer & Osimo, 1991) (Appendix Q) proposed to prompt generative processing during the

treatment. This activity consists of a summarized version of the text of the first retrieval activity with the target words deleted. Learners had to fill in the missing words in the text gaps. The learners were helped to recall the target words by being given a list of L1 words equivalent of the target words they had to translate into L2, and then use to fill in the blanks.

## 3.5 PROCEDURES

The first procedure that was followed for this study was to ask for the authorization from the Escola Estadual Getulio Vargas (EEGV)'s principal through a letter of consent (Appendix A) to have the data collection in the school.

In order to recruit these participants, this researcher talked to the English school teacher and visited classes, talked about the research project and distributed consent letters. As all participants were underage, they received a consent letter (Appendix B) addressed to their parents and participants received another consent letter (Appendix C) which they could sign by themselves to accept to become volunteers of this study. Through these letters (Appendices B and C), the participants were invited to participate in the study and were given information about it. The procedures, the voluntary nature of participation, the assurance of confidentiality, and the contact with the researcher were provided in these documents. These letters also emphasized that the aim of the study was to collect data for academic purposes and not to evaluate their performances during the tests or grading them.

No control group was used for this study, as the objective was to contrast performance results achieved by each student on a pre- and post-test basis. Data collection was carried out in a 6$^{th}$ year group at Escola Estadual Getulio Vargas, in the city of Florianopolis. All participants were regularly enrolled in the 6$^{th}$ grade. The total number of participants was of 26 volunteers; young learners between the ages of 11 and 14, 17 female and 7 male students. However, 2 students were excluded from the study, because they did not perform the working memory tests. The tests and activities were performed in different days by the whole group, except the AWMA which was applied individually, at a different time set with this researcher.

On the first day of meetings, the participants were required to fill in the personal information and language background questionnaire (created in the LabLing), which was the first procedure of the research in the classroom. It took the participants about 15 minutes to answer the

questionnaire. Subsequently, on the same day, participants attended an introductory class aiming to get them acquainted with the classroom coexistence rules (e.g., focus on the importance of getting involved in and performing all proposed activities, not spending time on conversations away from the topic, etc.); to explain the main objectives of the project and the English classes; and to introduce basic vocabulary in English for common situations in the classroom (e.g., I don't understand, excuse me, please, can I go to the bathroom, etc.). The whole session lasted about 45 minutes.

On the second day of meetings, participants were required to perform the Vocabulary Levels Test (VLT) in order to verify the learners' current level of vocabulary knowledge in general, thus controlling for previous knowledge of English vocabulary. After that, participants were invited to take the word recognition test, aiming to verify if the words selected for pre-test 1 and pre-test 2 were part of their vocabulary in their native language. Subsequently, participants performed pre-test 1 and pre-test 2 in order to assess their knowledge of 40 vocabulary words in English related to food. The class was then organized in two halves. Pre-test 1 was applied to one half of the class while the other half of the class was performing pre-test 2 and vice versa. Unknown words were selected to be addressed in the second phase of the study (i.e., bread, butter, carrot, garlic, jam, lettuce, onion, pineapple, plum and rice). These three tests (VLT and pre-tests 1 and 2) were carried out in the second meeting with all 24 participants in the same classroom.

During the first phase of the study participants were also required to perform two working memory tests of the *Automated Working Memory Assessment* (AWMA, Alloway, 2007a), in its Portuguese version which was adapted to Portuguese (Santos & Engel, 2008) with permission from Pearson Education Ltd (© Copyright Pearson Education Ltd, 2007) on a standard personal computer. The administration and scoring was fully automated and results were saved once the tests had been administered. AWMA tests were performed by participants individually in a separate classroom at a different time set by this researcher.

The following step was to apply five treatment sessions of 45 minutes each. Each one happened in a new meeting, on different days, during a period of 2 weeks. During this period of 2 weeks, participants received instruction on noticing, retrieval and creative use of vocabulary through the activities described in subsection 3.4.1.

Finally, after the five treatment sessions, two new meetings were set with the participants with the purpose of having them take both post-test 1 and post-test 2, seven days after the last treatment session. In addition, participants were administered again both post-test 1 and post-test 2 twenty one days after last treatment session. Participants and the researcher had 9 meetings to carry out the procedures of the research.

## 3.6 DATA ANALYSIS

The results from data collected from the six tests (Verbal WM, Visuo-spatial WM, pre-test 1, pre-test 2, post-test 1 and post-test 2) were entered onto a spread sheet of the Microsoft Excel program in the form of a data bank and submitted to statistical treatment. First of all, a descriptive analysis of all data was conducted; it provided an overview of the group's performance on the measures of variables of the six tests previously mentioned. The mean values of general results for each of the measures, and the standard deviation were provided by the descriptive analysis.

Firstly, the scores on the working memory tests, pre- and post-, were compared to one another and the descriptive statistics were run. From the descriptive statistics, mean, median, minimum, maximum, lower quartile, upper quartile, standard deviation (SD) and standard error (SE) for the sample group were analyzed, in order to check for the distribution of the data. In addition, both graphs of histograms and of boxplots, as well as the normality tests of Kormogorov-Smirnov and of Shapiro-Wilk were run with the purpose of checking the distribution of the data.

As neither of the data for the tests presented a normal distribution according to the tests described above, non-parametric tests of Spearman correlation were performed in order to analyze the inferential statistics to verify significant correlations between working memory and vocabulary post-tests.

The data analyses of the present study were performed quantitatively using software STATISTICA® 8.0 and IBM® SPSS® Statistics Version 20 for Windows. The alpha level was set at $p<0.005$, the standard coefficient of significance for linguistic experiments.

The results and the discussion for this data analysis are presented in Chapter 4.

## 3.7 PILOT STUDY

In order to test the instruments selected for the present study, a pilot study was carried out over four days. The participants were 5 students of the 6th grade from the counter-shift of the Escola Estadual Getulio Vargas (EEGV). Their age ranged from 11 to 14 years old, with a mean of 12.

On the first day of the pilot study, the participants' working memory was assessed using AWMA and the results indicated that participants would need more time to perform the AWMA tests than was expected. The standard time for students to perform the AWMA tests according to the AWMA manual was 5 – 7 minutes, but students of the pilot study were taking approximately 15 – 20 minutes to perform the tests, which meant that I would have to set longer appointments with the experimental group than I had anticipated.

On the second day of the pilot study, the consent letter, the personal and language background questionnaire, the Vocabulary Levels Test (VLT), the word recognition test, pre-test 1, pre-test 2 were carried out with the group of five participants. The analysis of the results of this first day of the pilot study showed that: (1) no changes were necessary in the consent letter to address the parents of underage participants who could be recruited for the final data collection; (2) the personal and language background questionnaire was adequate to gather the information needed regarding their previous knowledge and use of English as well as their personal information such as age, gender, and educational background and there was no need for changes; (3) The word recognition test was considered adequate and no changes were needed. The VLT had been properly translated and well fit for the purposes of finding out the learners' current level of English vocabulary knowledge in general and no changes were necessary; (4) pre-test 1 (picture matching) needed to be redesigned in a way that the answers could be more accurate. Pre-test 2 was considered adequate for the purpose for which it was designed and there was no need for changes.

On the third day of the pilot study, participants performed the treatment activities for noticing and two activities relating to retrieval of vocabulary. The results for this third day of the pilot study showed that the activities ran properly and no changes were necessary.

On the fourth day of the pilot study, participants performed two more activities related to retrieval, as well as post-test 1 and post-test 2. The results for this fourth day showed that the activities were adequate and no changes were needed.

The next chapter presents and discusses the results of the present study.

# CHAPTER IV

# RESULTS AND DISCUSSION

This chapter aims at presenting and discussing the results of the present study, whose objective was to investigate the relationship between working memory and the learning of vocabulary in English as a second language (L2) by a population of young learners attending the 6th grade.

The data was analysed by means of statistical tests. The significance level considered for the statistical analyses was 0.05, with a 95% confidence interval. The statistical tests were non-parametric since the sample size was not large enough to be normally distributed. In this case, the central limit theorem states that a sample size where $n<30$ may be too small to produce a normal distribution of sample means. Kolmogorov-Smirnov with Lilliefors correction and Shapiro-Wilk's normality tests were run in order to assure the confidence of data.

The results are discussed in the light of important existing studies in the field of working memory and L2 vocabulary learning (see chapter 2). Section 4.1 is devoted to the descriptive statistics for verbal and visuo-spatial working memory capacity tests as well as for vocabulary tasks (pre-test 1 - Picture Matching test and pre-test 2 - Translation test respectively). Section 4.2 presents inferential statistical analyses and discussion of the results obtained in the performance of the working memory tests and vocabulary tests. Finally, in section 4.3, the research question will be readdressed.

The data analyses were performed using software STATISTICA® 8.0 and IBM® SPSS® Statistics Version 20 for Windows.

## 4.1 DESCRIPTIVE ANALYSES

### 4.1.1 Normality tests

For the present investigation, statistical tests were applied in order to verify whether the data fit the assumptions that are necessary to perform either parametric or non-parametric statistics. The output shown in Table 4.1 gives the results for both the Kolmogorov-Smirnov

(with the Lilliefors correction) as well as the Shapiro-Wilk normality tests used to test whether distribution was normal. Ricci (2005) states that the Shapiro-Wilk test is the most powerful test for small sample sizes (under 50).

***Table 4.1*** *– Tests values of Kolmogorov-Smirnov (and Lilliefors) and Shapiro-Wilk's normality tests.*

| Experiment Phases | Variables | Kolmogorov-Smirnov | Shapiro-Wilk |
|---|---|---|---|
| | **Age** | d=0,318, p<0,05<br>Lilliefors p<0,01 | W=0,813<br>p=0,0005 |
| Verbal WM | **Listening Recall** | d=0,165, p> 0.20<br>Lilliefors p<0,10 | W=0,925<br>p=0,075 |
| | **Listening recall processing** | d=0,113, p>0.20<br>Lilliefors p> 0.20 | W=0,937<br>p=0,146 |
| Visuo-Spatial WM | **Spatial recall** | d=0,177, p> 0.20<br>Lilliefors p<0,10 | W=0,923<br>p=0,069 |
| | **Spatial recall processing** | d=0,142, p>0 .20<br>Lilliefors p> 0.20 | W=0,942<br>p=0,189 |
| Pre test | **Picture Matching Test** | d=0,122, p> 0.20<br>Lilliefors p> 0.20 | W=0,952<br>p=0,309 |
| | **Translation** | d=0,194, p> 0.20<br>Lilliefors p<0,05 | W=0,805<br>p=0,0003 |
| Post Test 1 (7 days) | **Picture Matching Test (Target Words)** | d=0,287, p<0,05<br>Lilliefors p<0,01 | W=0,756<br>p=0,000 |
| | **Translation (Target Words)** | d=0,216, p<0,20<br>Lilliefors p<0,01 | W=0,816<br>p=0,001 |
| Post Test 2 (21 days) | **Picture Matching Test (Target Words)** | d=0,219, p<0,20<br>Lilliefors p<0,01 | W=0,884<br>p=0,012 |
| | **Translation (Target Words)** | d=0,253, p<0,10<br>Lilliefors p<0,01 | W=0,83<br>p=0,001 |

As can be seen in Table 4.1, most variables analyzed report a *p*-value smaller than the significance level determined for the data analyses ($\alpha$ =0.05). This indicates that these variables are not normally distributed. Furthermore, following statistical assumptions proposed by Field (2009), and taking into account the central limit theorem, which states that a sample size where n<30 may be too small to produce a normal distribution of sample means, the data distribution was considered not normally distributed. Therefore, all further analyses were

run using non-parametric statistical tests even in those cases in which the normality tests indicated normal distribution.

### 4.1.2 Mann-Withney test (gender difference)

The sample unit consisted of both males and females; therefore a Mann-Withney test was applied to verify possible gender difference. As can be seen in Table 4.2, no gender difference was found ($p$>0.05). Since there was no gender difference, all statistical analyses and correlations were performed considering males and females equally as one single group.

***Table 4.2*** *– Test values of Mann-Whitney test comparing gender (males and females):*

| Experiment Phases | Variables | U | Z | p-level |
|---|---|---|---|---|
| | **Age** | 37,50 | 1,397 | 0,162 |
| **Verbal WM** | **Listening Recall** | 45,00 | 0,921 | 0,357 |
| | **Listening recall processing** | 52,50 | 0,445 | 0,657 |
| **Visuo-Spatial WM** | **Spatial recall** | 54,50 | 0,318 | 0,751 |
| | **Spatial recall processing** | 58,50 | -0,064 | 0,949 |
| **Pre Test** | **Picture Matching Test** | 49,00 | 0,67 | 0,50 |
| | **Translation** | 38,50 | 1,33 | 0,18 |
| **Post Test 1 (7 days)** | **Picture Matching Test (Target Words)** | 49,50 | 0,11 | 0,92 |
| | **Translation (Target Words)** | 37,00 | -0,25 | 0,80 |
| **Post Test 2 (21 days)** | **Picture Matching Test (Target Words)** | 33,50 | 1,50 | 0,13 |
| | **Translation (Target Words)** | 53,00 | 0,41 | 0,68 |

### 4.1.3 – Age, working memory, and vocabulary pre- and post-tests

**Table 4.3** *Descriptive analyses for the verbal (Listening Recall) and visuo-spatial (Spatial Recall) working memory tests, pre and post vocabulary tests.*

| | | Valid N | Mean | Median | Minimum | Maximum | Lower Quartile | Upper Quartile | Std.Dev. | Standard Error |
|---|---|---|---|---|---|---|---|---|---|---|
| **Age** | | 24 | 12,25 | 12 | 11 | 14 | 12 | 13 | 0,9891 | 0,20189321 |
| VERBAL WM | **Listening recall** | 24 | 92,683 | 92,7 | 63,7 | 116 | 82,1 | 111,8 | 16,974 | 3,46485286 |
| | **Listening recall processing** | 24 | 84,75 | 86,85 | 65,6 | 97,2 | 78,8 | 91,7 | 9,4734 | 1,93375807 |
| VISUO-SPATIAL WM | **Spatial recall** | 24 | 96,392 | 98,4 | 57,5 | 126,2 | 89,95 | 109,95 | 19,062 | 3,89092179 |
| | **Spatial recall processing** | 24 | 97,104 | 95,8 | 69,1 | 126,3 | 86,6 | 111,8 | 16,717 | 3,41234693 |
| PRE-TEST | **Pre-test Picture Matching** | 24 | 0,4061 | 0,388 | 0,1 | 0,8 | 0,2125 | 0,55 | 0,2159 | 0,04407798 |
| | **Pre-test Translation** | 24 | 0,1823 | 0,163 | 0,025 | 0,525 | 0,075 | 0,2625 | 0,1295 | 0,02643007 |
| POST -TEST 7 DAYS | **Post-test Picture Matching** | 24 | 0,8 | 0,95 | 0 | 1 | 0,7 | 1 | 0,2735 | 0,05582062 |
| | **Post-test Translation (Target Words)** | 24 | 0,675 | 0,8 | 0 | 1 | 0,45 | 1 | 0,3492 | 0,07128479 |
| POST -TEST 21 DAYS | **Post-test Picture Matching** | 24 | 0,7021 | 0,8 | 0 | 1 | 0,5875 | 0,875 | 0,2731 | 0,05573774 |
| | **Post-test Translation (Target Words)** | 24 | 0,6667 | 0,8 | 0,1 | 1 | 0,4 | 0,9 | 0,3144 | 0,06417443 |

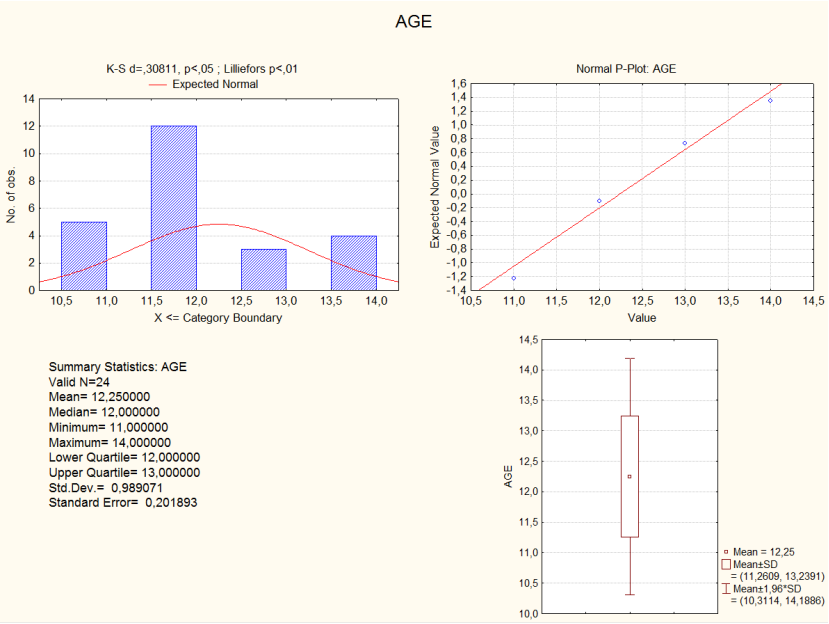
Table 4.3 presents the descriptive analyses for the verbal (Listening Recall) and visuo-spatial (Spatial Recall) working memory capacity tests of the current study. Also, it presents the descriptive analyses for vocabulary pre-tests (pre-test 1 – Picture Matching and pre-test 2 – Translation test) and vocabulary post-tests after seven and twenty one days (post-test 1 - Picture Matching, and post-test 2 – Translation test) respectively, reporting the mean, median, minimum, maximum, lower quartile, upper quartile, standard deviation (SD) and standard error (SE) for the sample group. Results presented in Table 4.3 are expressed by the number of correct answers divided by 100, where 1 = 100% (1:100). The number of participants in this study was twenty

four. The maximum age was 14 and the minimum was 11, with a mean of 12.25. In addition, Table 4.3 only presents the results of the tests applied, but no comparison between participants with low/high performance in working memory capacity tests were presented here.

After presenting the descriptive analyses for the verbal (Listening Recall and Listening Recall processing) and visuo-spatial (Spatial Recall and Spatial Recall processing) working memory tests, pre- and post-vocabulary tests, next subsections will present data distribution for each variable individually (i.e., Listening recall, Listening recall processing, Spatial recall, Spatial recall processing, Pre-test 1 – Picture Matching, Pre-test 2 – Translation test, Post-test 1 – Picture Matching and Post-test 2 – Translation test after 7 days, Post-test 1 – Picture Matching and Post-test 2 – Translation test after 21 days), beginning with variable age:

Figure 4.1 presents data distribution for variable age:

Figure 4.1 Age



### 4.1.4 Working memory tests

In the Verbal WM tests (Listening Recall and Listening Recall processing), as well as in the Visuo-Spatial WM test (Spatial Recall and Spatial Recall processing), the highest standard score participants could reach on the Automated Working Memory Assessment (AWMA) program was 150. The maximum standard score reached by the participants was 116, and the minimum was 63,7, with a mean of 92,683 for the Listening Recall test. For the Listening Recall Processing test, the maximum was 97,2, with a minimum of 65,6 and a mean of 84,75.

Figures 4.2 and 4.3 present the data distribution for Listening Recall and Listening Recall Processing:

Figure 4.2 Listening recall subtest

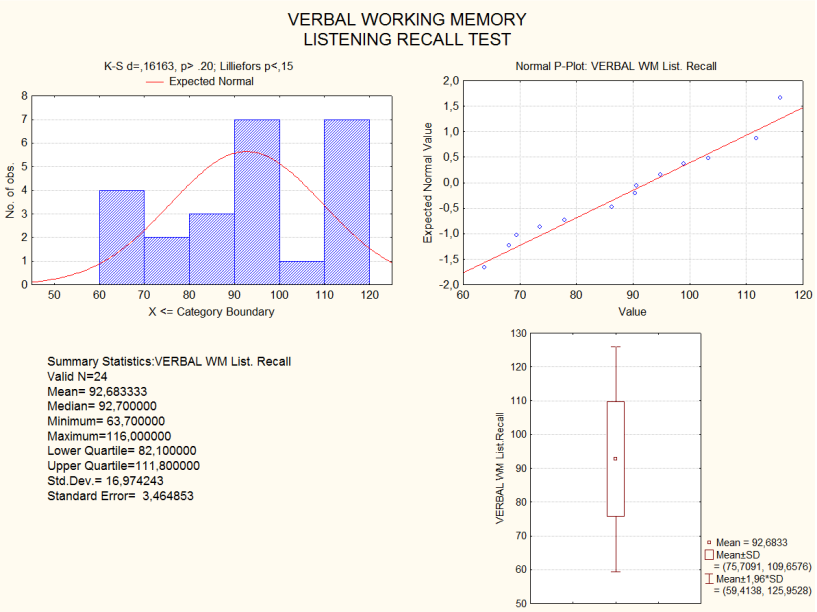
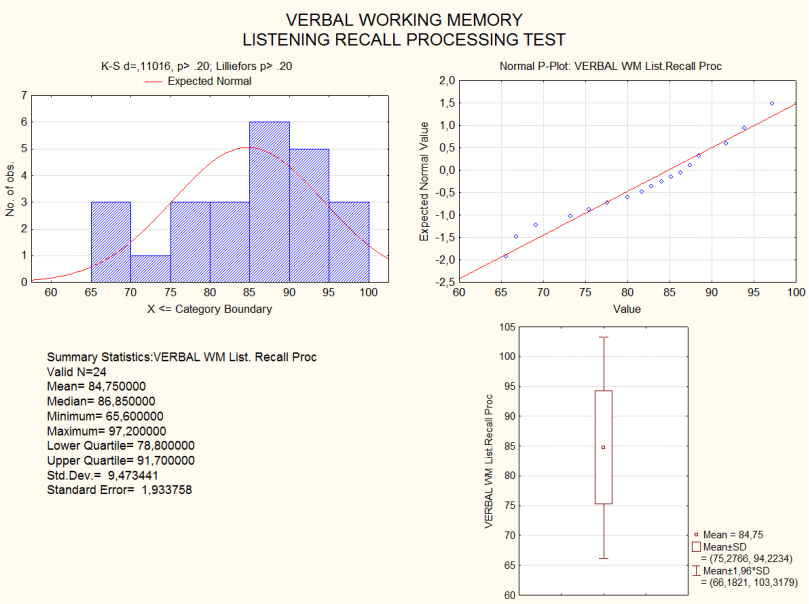


Figure 4.3 Listening recall processing subtest




Regarding verbal working memory assessment, participants had to listen to a series of spoken sentences and verify if the sentence was “true” or “false”. The participant then had to recall the last word of each sentence presented in the exact order of presentation. The trials began with one sentence, and continued with additional sentences, with a maximum of six sentences, until the participant was unable to recall three correct trials. The program automatically would credit a correct trial with a score of 1. Then the raw scores were converted into standardized scores.

The highest standard score participants could reach was 150. Standard scores of 90 and higher reflect working memory that is typical for that particular group. Standard scores between 81 and 89 represents low average working memory scores. Finally, standard scores of 80 and less represent working memory deficits.

As can be seen in Figure 4.2, in the Listening Recall test, six participants scored 80 or less, representing the group with verbal working memory deficits. Three participants scored between 81 and 89 representing the low average group (poor verbal working memory) and

fifteen participants scored 90 or above, representing the above average level of performance (typical or good verbal working memory).

As can be seen in Figure 4.3, in the Listening Recall Processing test, seven participants scored 80 or below, nine participants scored between 81 and 89 and another group of nine participants scored 90 or above. On the basis of their performance on working memory tests, the AWMA identified whether the individual had poor working memory skills that could subsequently impair vocabulary learning. The correlation between the Listening Recall test and vocabulary post-tests (English vocabulary learning) will be shown in section 4.2 (inferential analyses).

Regarding the Visuospatial WM assessment, participants reached a maximum of 126,2, and a minimum of 57,5 with a mean of 96,392 for the Spatial Recall test. For the Spatial Recall Processing test, the maximum was 126,3, with a minimum of 69,1 and a mean of 97,104. Figures 4.4 and 4.5 present the data distribution for Spatial Recall and Spatial Recall Processing tests:

Figure 4.4 Visuo-spatial recall subtest

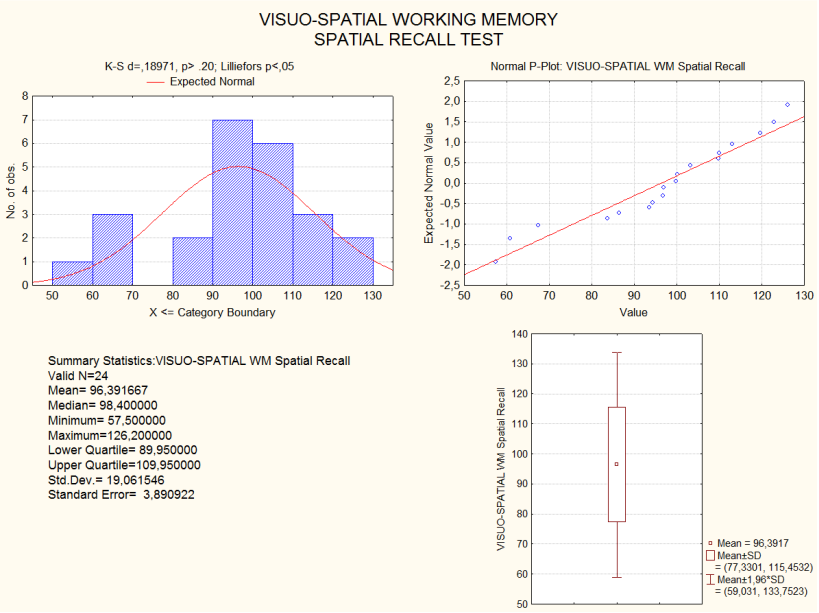
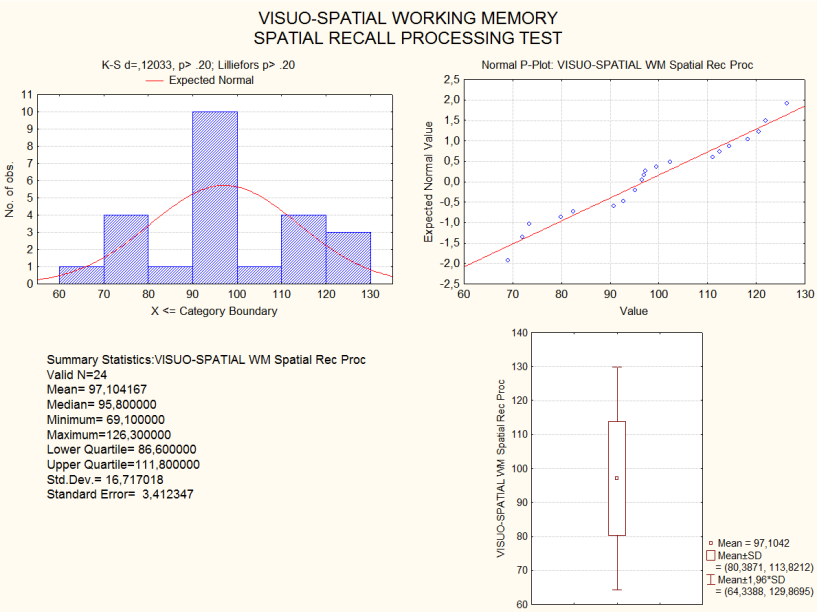


Figure 4.5 Visuo-spatial recall processing subtest




In the Spatial Recall working memory test participants viewed a picture of two shapes where the shape on the right had a red dot above it, and it could be rotated in three possible positions. Participants, then, had to identify whether the shape on the right was the same or opposite of the shape on the left. At the end, participants had to recall and point the location of each red dot on the shape in the correct order, by pointing to a picture with three possible positions marked. The trials began with one set of shapes and increased to a block of seven sets of shapes until the participant was unable to recall three correct trials. The program automatically would credit a correct trial with a score 1. Then the raw scores were converted into standardized scores.

The highest standard score participants could reach was 150. Standard scores of 90 and higher reflect working memory that is typical for that particular age group. Standard scores between 81 and 89 represents low average working memory scores. Finally, standard scores of 80 and less represent working memory deficits.

As can be seen in Figure 4.4, in the Visuo-spatial Recall test, four participants scored 80 or less representing the group with visuo-spatial working memory deficits. Two participants scored between 81 and 89

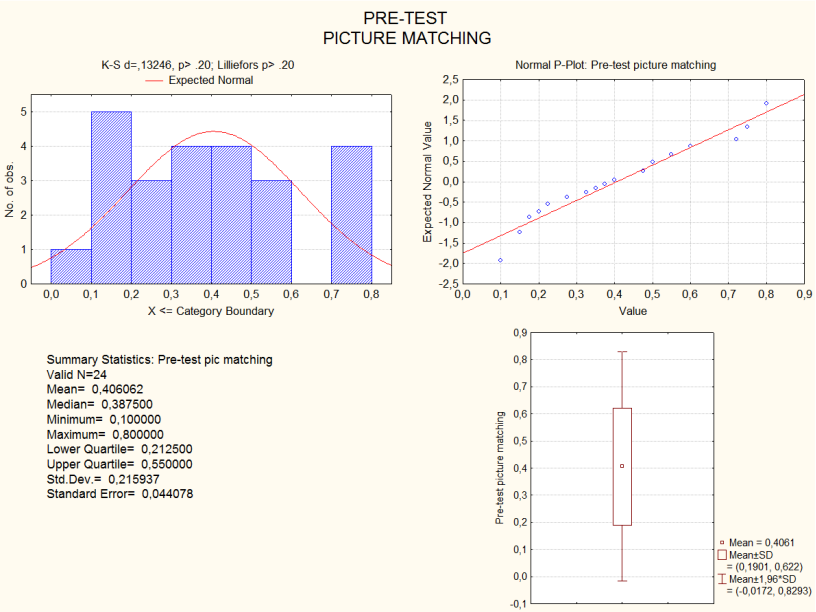
representing the low average group (poor visuo-spatial working memory) and eighteen participants scored 90 or above, representing the above average level of performance (typical or good visuo-spatial working memory).

As can be seen in Figure 4.5, in the Visuo-spatial Recall Processing test, five participants scored 80 or below, one participant scored between 81 and 89 and another group of eighteen participants scored 90 or above. The correlation between Visuo-spatial Recall test and vocabulary post-tests (vocabulary learning) will be shown in section 4.2 (inferential analyses).

### 4.1.5 Vocabulary pre-test 1 (picture matching)

The pre-test picture matching measured how many words were familiar to the participants. In the test, participants should be able to match the pictures with their correspondent English words. The total number of words in the test was forty. Each correct answer scored 1 with a maximum score of 40. The maximum score reached by the participants in the pre-test picture matching was 80%, and the minimum was 10%, with a mean of 0,406 (40,6%). Figure 4.6 presents data distribution for the pre-test picture matching.

Figure 4.6 Pre-test 1 – picture matching



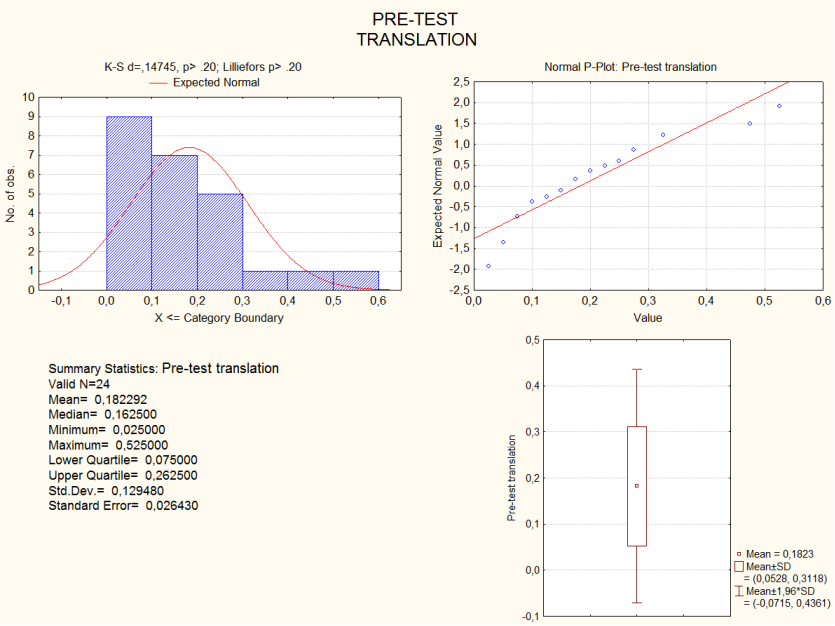

As can be seen in Figure 4.6, in the pre-test 1 picture matching, nine participants were able to correctly match between 4 and 12 pictures with their corresponding English words, indicating that 37% of participants were familiar with a range of 4 to 12 words out of 40. Eleven participants correctly matched between thirteen and twenty-four pictures with their corresponding English words, indicating that about 46% of the participants were familiar with a range of 13 to 24 words out of 40, and 4 participants correctly matched between 25 and 32 pictures with their corresponding English words, indicating that about 17% of participants were familiar with a range of 25 to 32 words out of 40.

### 4.1.6 Vocabulary pre-test 2 (translation)

The second pre-test consisted of a test of translation which aimed at assessing how many words were unfamiliar to participants, though it required stronger knowledge of each word than on the picture matching test. In this test, participants should be able to translate English words into Portuguese. The total number of words in the test was forty. Each correct answer scored 1 with a maximum score of 40. Results expressed

by the number of correct answers divided by 100, where 1 = 100% (1:100). The maximum score reached by participants in the pre-test translation was 0,525 (52,5%), and the minimum was 0,025 (2,5%), with a mean of 0,182 (18,2%). Figure 4.7 presents data distribution for the pre-test translation.

Figure 4.7 Pre-test 2 – translation




As can be seen in Figure 4.7, in the Pre-test 2 – Translation, 21 participants were able to correctly translate between zero and twelve words from English into Portuguese, indicating that 87% of participants were familiar with a range of 0 to 12 words out of 40 and 3 participants were able to correctly translate between 13 and 24 words from English into Portuguese, indicating that 13 percent of participants were familiar with a range of 13 to 24 words out of 40.

Considering that the translation test required stronger knowledge of the words than the picture matching test, and that in the picture test 4 participants had at least partial knowledge of 32 words, the ten words to be taught during the treatment phase were selected out of the 16 words none of the participants had translated correctly into Portuguese (i.e.,

bread, butter, carrot, garlic, jam, lettuce, onion, pineapple, plum and rice).

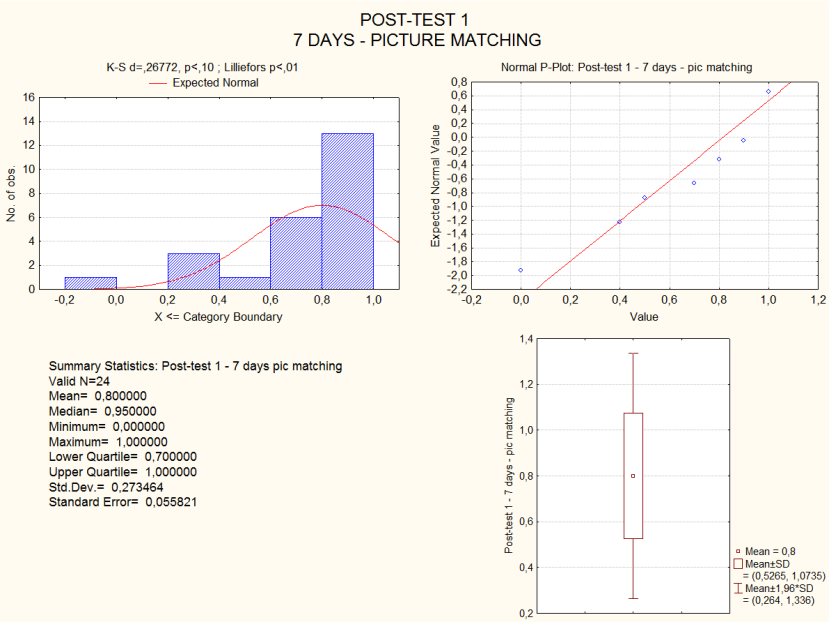
### 4.1.7 Vocabulary post-tests

This section presents the results of the two vocabulary post-tests (Picture Matching and Translation) which participants performed to test their L2 vocabulary learning after treatment sessions. The post-tests were performed 7 days after last treatment session (Post-test 1 - Picture Matching (7 days) and Post-test 2 – Translation test (7 days)) and were repeated 21 days after last treatment session Post-test 1 - Picture Matching (21 days) and Post-test 2 – Translation test (21 days)) in order to ensure the consistency or the results.

#### 4.1.7.1 Vocabulary post-test 1 - picture matching (7 days)

In the Post-test 1 - Picture Matching (7 days), the highest score participants could reach was 10, which was the number of English target words they had to recall and match with their correspondent picture. It was administered 7 days after the last treatment session. Each correct answer scored 1 with a maximum score of 10. Table 4.1 presents the results expressed by the number of correct answers divided by 100, in which 1 = 100% (1:100). The maximum score reached by participants in the Post-test 1 - Picture Matching (7 days) was 100%, and the minimum was 0,00%, with a mean of 0,8 (80%). Figure 4.8 presents data distribution for Post-test 1 - Picture Matching (7 days):

Figure 4.8 Post-test 1 – picture matching – 7 days



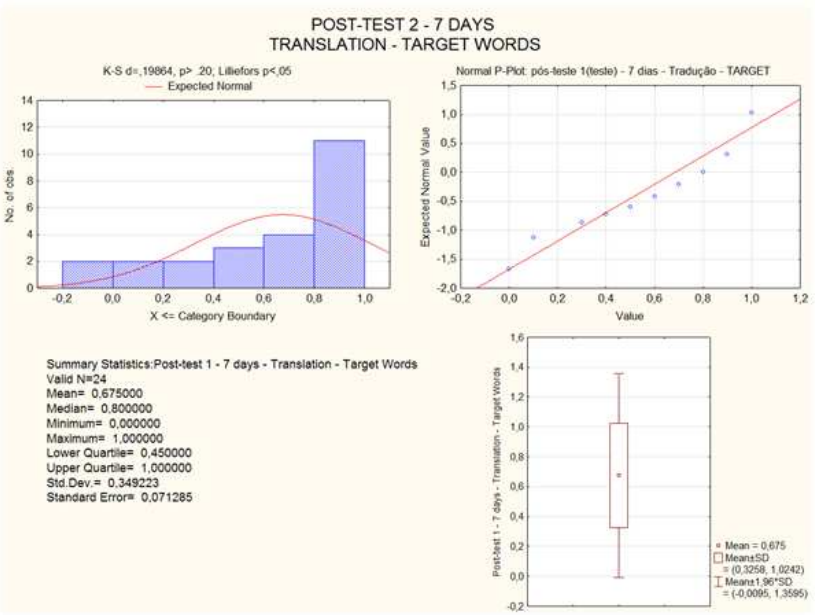

As can be seen in Figure 4.8, in the Post-test 1 - Picture Matching (7 days), 5 participants were able to correctly match between 0 and 6 English words with their corresponding pictures, indicating that 21% of participants were able to recall up to 60% out of 10 new words they had been taught during treatment session, 7 days after the last treatment session. Nineteen participants correctly matched between 7 and 10 English words with their corresponding pictures, indicating that 79% of participants were able to recall up to 100% of the 10 new English words they had been taught during the treatment session, 7 days after the last treatment session.

4.1.7.2 Vocabulary post-test 2 – translation (7 days)

The Post-test 2 - Translation (7 days) assessed how many English target words participants were able to recall and translate into Portuguese. It was administered 7 days after the last treatment session. The total number of words in the test was 10. Each correct answer scored 1 with a maximum score of 10. Results are expressed by the

number of correct answers divided by 100, where 1 = 100% (1:100). The maximum score reached by participants in the Post-test 2 – Translation test was 100%, and the minimum was 0,00%, with a mean of 0,675 (67,5%). Figure 4.9 presents data distribution for the Post-test 2 – Translation test:

Figure 4.9 Post-test 2 – translation – 7 days

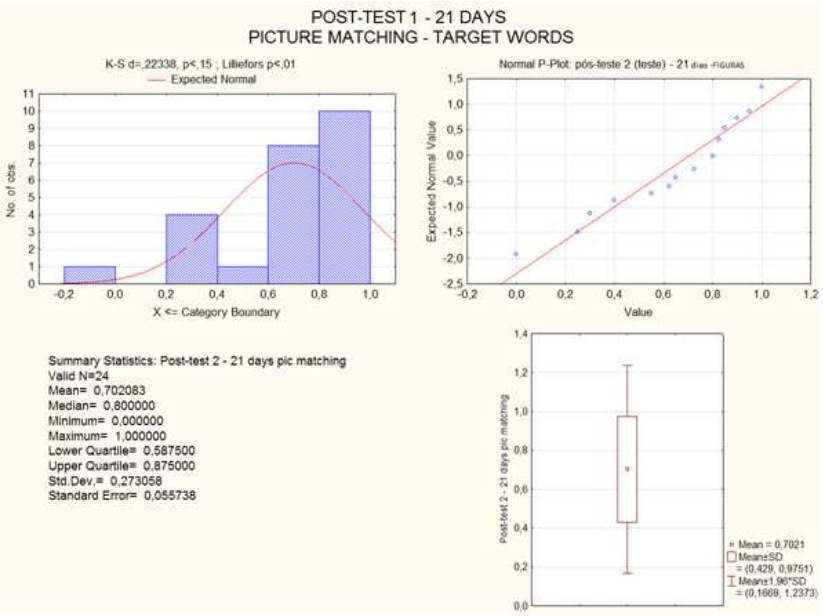



As can be seen in Figure 4.9, in the Post-test 2 - Translation test (7 days), 9 participants were able to correctly translate between 0 and 6 words from English into Portuguese, indicating that 37.5% of participants were able to recall and translate up to 60% out of ten new English words 7 days after the last treatment session. Fifteen participants were able to correctly translate between 7 and 10 new English words from English into Portuguese, indicating that 62.5% of participants were able to recall and translate from 70% to 100% out of ten new English words 7 days after the last treatment session. The next two sections will present the results of the Post-test 1 - Picture Matching and Post-test 2 - Translation tests repeated 21 days after last treatment session.

4.1.7.3 Vocabulary post-test 1 - picture matching (21 days)

In the Post-test 1 - Picture Matching (21 days), the highest score participants could reach was 10, which was the number of English target words they had to recall and match with their corresponding picture. It was administered 21 days after the last treatment session. Each correct answer scored 1 with a maximum score of 10. Results are expressed by the number of correct answers divided by 100, where 1 = 100% (1:100). The maximum score reached by participants in the Post-test 1 - Picture Matching (21 days) was 100%, and the minimum was 0,00 (0%), with a mean of 0,702 (70,2%). Figure 4.10 presents the data distribution for Post-test 1 - Picture Matching (21 days):

Figure 4.10 Post-test 1 – picture matching – 21 days



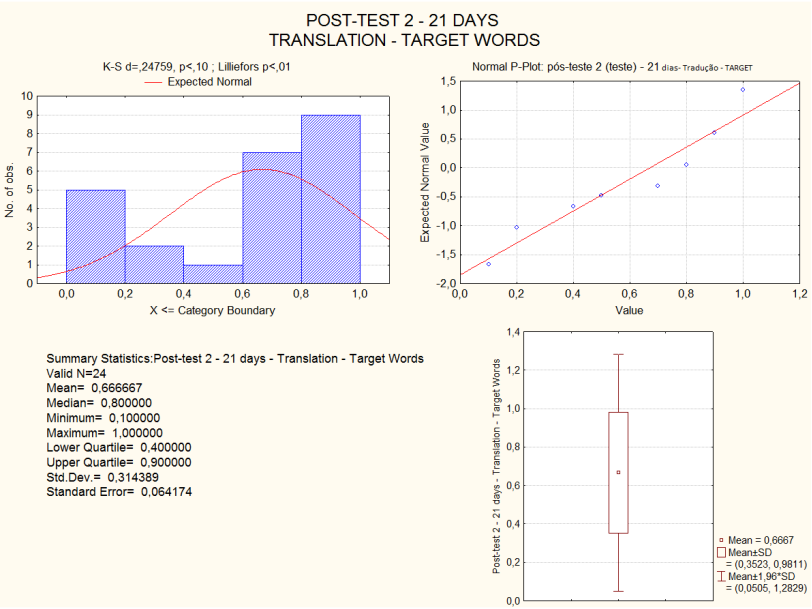

As can be seen in Figure 4.10, in the Post-test 1 - Picture Matching (21 days), 6 participants were able to correctly match up to six English words with their corresponding pictures, indicating that 25% of participants were able to recall up to 60% out of 10 new English words they were taught during the treatment phase, 21 days after the last

treatment session. Eighteen participants correctly matched up to 10 English words with their corresponding pictures, representing that 75% of participants were able to recall up to 100% out of 10 new English words they were taught during the treatment phase, 21 days after last treatment session.

4.1.7.4 Vocabulary post-test 2 – translation (21 days)

The Post-test 2 – Translation (21 days) measured how many English target words participants were able to recall and translate into Portuguese. It was administered 21 days after the last treatment session. The total number of words in the test was 40 (10 target and 30 non-target words). The score was considered only for the target words. Each correct answer scored 1 with a maximum score of 10. Table 4.1 presents results expressed by the number of correct answers divided by 100, where 1 = 100% (1:100). The maximum score reached by the participants in Post-test 2 Translation was 100%, and the minimum was 0,00%, with a mean of 0,666 (66,6%). Figure 4.11 presents data distribution for Post-test 2 - Translation (21 days):

Figure 4.11 Post-test 2 – translation – 21 days




As can be seen in Figure 4.11, in the Post-test 2 Translation, 8 participants were able to correctly translate up to 6 words from English into Portuguese, indicating that 33% of participants were able to recall and translate up to 60% out of ten new English words they were taught during the treatment phase, 21 days after the last treatment session. Sixteen participants were able to correctly translate up to 10 new English words from English into Portuguese, indicating that 67% of participants were able to recall and translate up to 100% out of ten new English words they were taught during the treatment phase, 21 days last treatment session.

Finally, having reported the results of the descriptive statistical analyses for the gender difference test, working memory tests, data normality tests, pre and post vocabulary tests applied in the present study, the next session brings up the inferential analyses for a deeper examination of the data in order to verify whether or not these findings are statistically significant.

## 4.2 INFERENTIAL ANALYSES

For the present study, in conformity with relevant statistical assumptions, non-parametric Spearman correlation was performed in order to examine the relationship between working memory and vocabulary post-tests. Table 4.4 presents Spearman's rank correlation coefficient (ρ), working memory tests' scores and the percentage of correct answers in post-test. The numbers with asterisks on top indicate that significant correlations were found ($p<0.05$).

***Table 4.4.****Spearman's rank correlation coefficient (ρ) between working memory tests and vocabulary post-tests (Post-test 1 and Post-test 2)*

| | Post-tests | Verbal WM | | | | | Spatial WM | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | *Listening recall* | | | *Listening Recall Processing* | | *Spatial recall* | | *Spatial recall processing* | |
| | | N | Spearman R | p-level | Spearman R | p-level | Spearman R | p-level | Spearman R | p-level |
| Post- Test 1 (7 days) | Picture Matching Test | 24 | 0,507 | * 0,011 | 0,555 | * 0,005 | 0,501 | * 0,013 | 0,523 | * 0,009 |
| | Translation (Target Words) | 24 | 0,436 | * 0,033 | 0,478 | * 0,018 | 0,543 | 0,067 | 0,563 | * 0,031 |
| Post- Test 2 (21 days) | Picture Matching Test | 24 | 0,611 | * 0,002 | 0,404 | * 0,046 | 0,282 | 0,193 | 0,258 | 0,234 |
| | Translation (Target Words) | 24 | 0,536 | * 0,007 | 0,451 | * 0,027 | 0,439 | * 0,032 | 0,445 | * 0,029 |

The results presented in Table 4.4 show statistically significant correlations between the performance on verbal working memory tests (i.e., listening recall and listening recall processing) and all vocabulary post-tests. These results might indicate that individuals with average or high performance on verbal working memory tests, as measured by the AWMA program, presented better performance in recalling L2 English vocabulary words that were taught during the treatment phase than individuals with low working memory performance or with working memory deficits. This suggests that verbal working memory does in fact have influenced the acquisition of L2 vocabulary in 6$^{th}$ graders as it was predicted by hypothesis 1.

Considering that the phonological component (i.e. the phonological loop as was originally conceived by Baddeley and colleagues) is the most widely researched component of WM in terms of its effects on language learning (Gathercole 2006), the findings of the present study add evidence to the claim that verbal working memory influences the acquisition of L2 vocabulary as presented in the Review of Literature.

For instance, the results of the present study are in agreement with Ellis and Sinclair (1996), who demonstrated that verbal working

memory is well involved in vocabulary acquisition by mediating the reciprocal interaction between long-term and short-term memory. Their study investigated the role of phonological rehearsal of foreign language (FL) utterances in the process of language acquisition and compared the acquisition of FL Welsh between individuals who repeated the utterances and those who were prevented from doing so. The results revealed that learners who repeated utterances clearly performed better than those prevented from doing so. Considering that phonological rehearsal of utterances is specifically supported by verbal WM, the present study is in agreement with Ellis and Sinclair (1996) in that there were statistically significant correlations between verbal working memory performance and all vocabulary post-tests.

Another study (Engel de Abreu & Gathercole, 2012) shows that phonological processing abilities make specific contributions to vocabulary learning. Their study, conducted with children of 8 to 9 years old, indicated that phonological processing abilities appeared to be critical for acquiring the sound structure of a new language. Finally, Wen (2014) suggests that the phonological WM component with its associated cognitive mechanisms is most related to the acquisition and developmental aspects of language-learning domains, such as vocabulary and formula acquisition and grammar development.

On the other hand, as can be seen in Table 4.4, according to Spearman's rank correlation coefficient *(ρ)*, the results regarding the influence of visuo-spatial working memory on the acquisition of L2 English vocabulary by $6^{th}$ graders were not conclusive. There were significant correlations between Visuo-spatial WM subtests (i.e., spatial recall and spatial recall processing) and Post-test 1 - Picture Matching (7 days); between Spatial recall processing subtest and the Post-test 2 – Translation (7 days), but no correlation was found between the Spatial recall subtest and the Post-test 1 - Translation (7 days). Furthermore, a significant correlation was found between all Visuo-spatial WM subtests (i.e., spatial recall and Spatial recall processing) and Post-test 2 – Translation (21 days), but no significant correlation was found between Visuo-spatial WM subtests (i.e., spatial recall and spatial recall processing) and Post-test 2 - Picture Matching (21 days).

The results of the present study concerning the influence of the spatial component of WM are partially in agreement with empirical evidence that support the hypothesis that visuo-spatial WM plays an important role in integrating information from texts and pictures in illustrated texts (Gyselinck et al., 2002). The results showed a significant correlation between Spatial WM tests and Picture Matching

Post-test 1. However, no significant correlation was found between Spatial WM tests and Picture Matching Post-test 2. To further explore this relationship, a deeper and more detailed investigation would be needed.

Furthermore, in another study with thirty learners of Japanese as a foreign language, Tsai (2014) used cloze tests, similar to the ones administered in my study, and the results showed no correlation between visuo-spatial WM tests and reading proficiency. However, Tsai (2014) found a small correlation between verbal WM tests and reading proficiency (p.101). There were at least a couple of reasons, presented by Tsai (2014), for why visuo-spatial WM tests did not have a relationship with cloze tests, which I considered could be applied to my study as well. The first one is that the type of skills needed to complete the tests for assessment were not visuo-spatial in nature and may not have required strong visuo-spatial memory. Another possible reason for why the visuo-spatial WM did not have a relationship with the tests used in the study is that visuo-spatial WM plays little to no role in learners' English vocabulary acquisition.

Finally, in another study, De Benit et al., 2005 investigated whether processing spatial and non-spatial texts involves visuo-spatial WM and verbal WM. The results add other possible explanations for why visuo-spatial WM did not have influenced vocabulary acquisition in this study. In De Beni et al's study (2005), the results demonstrated that the visuo-spatial WM is selectively involved in spatial texts, implying in constructing a representation of spatial, non-illustrated descriptions. Furthermore, in De Beni et al's study (2005) the results also evidenced that visuo-spatial WM is involved in the construction of the spatial model, which makes implicit information about landmark positions explicit. While listening, participants mentally follow the route described in the text as if they were actually navigating it. The visuo-spatial WM plays a special role in constructing and updating this sort of representation (De Beni et al., 2005, p. 93)

In the present study, the vocabulary words did not involve any type of spatial information because the words referred to food only. Thus, that could be a reasonable explanation for why the visuo-spatial WM played little or no role in learners' English vocabulary acquisition.

### 4.2.1 Post-tests comparison

The first session of post-tests, Post-test 1 – Picture Matching and Post-test 2 – Translation were administered 7 days after last treatment

session and repeated 21 days after last treatment session in order to ensure consistency of the results and to verify whether the effects of L2 English vocabulary learning still remained after 21 days.

Figures 4.12 and 4.13 present participants' percentage of correct answers in the Post-tests - Picture Matching and the Translation (target words) 7 days and 21 days after the last treatment session.

Figure 4.12 Percentage of correct answers of all participants in the picture matching and translation tests (target words) 7 days after the last treatment session. Data are expressed as mean and S.E.M. values.

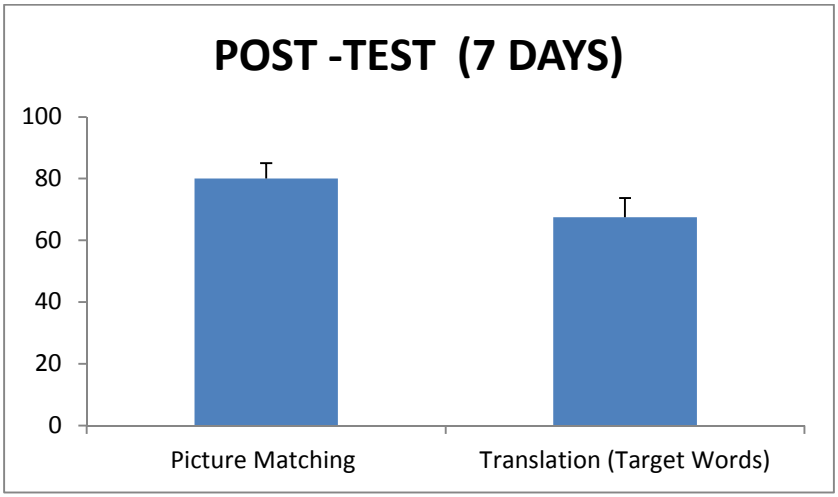


Figure 4.13 Percentage of correct answers of all participants in the picture matching and translation tests (target words) at 21 days after the last treatment session. Data are expressed as mean and S.E.M. values.

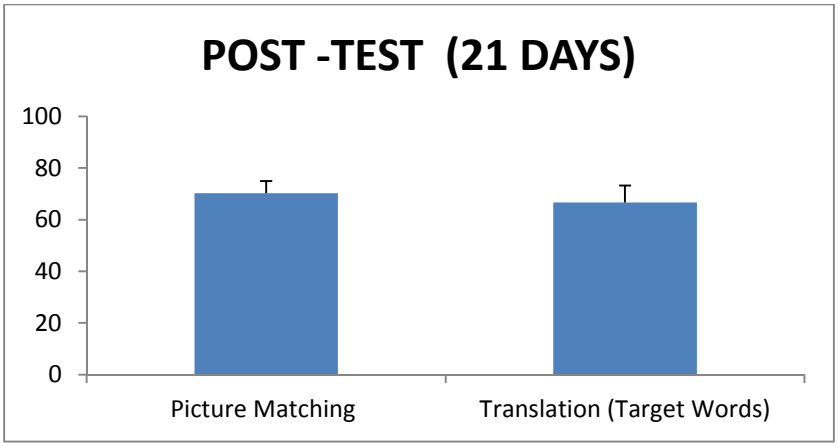
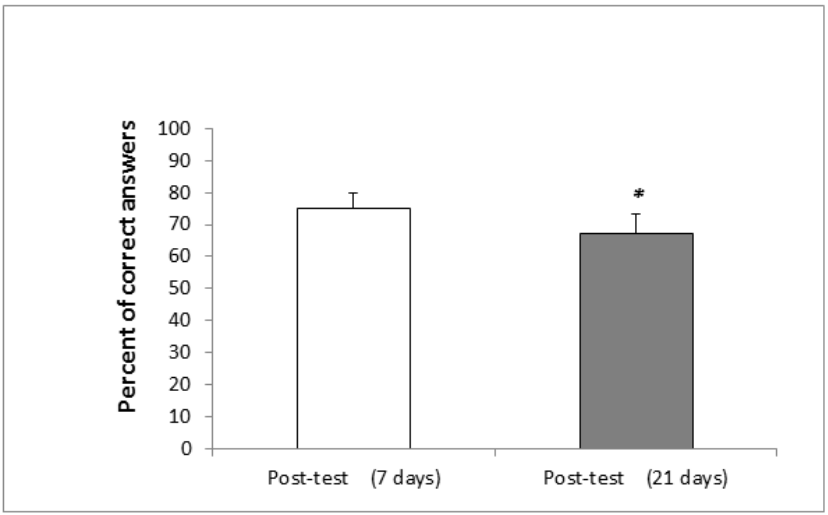



Figure 4.14 Comparison between results for all participants in picture matching and translation test (target words) combined 7 days and 21 days after last treatment session. Data are expressed as mean and S.E.M. values.



Comparing the performance on Post-tests (7 days) with Post-tests (21 days), Wilcoxon test demonstrated that the students did not maintain the same Total score in the post-tests (Z= 3,49; p = 0,0004) when comparing Post-tests (7 days) with Post-tests (21 days), as shown in the Figure 4.14.

As a final conclusion, there were statistically significant correlation between Verbal WM performance and L2 vocabulary learning. These results might indicate that individuals with average or high performance on verbal working memory tests, as measured by the AWMA program, are also more prone to learn L2 vocabulary than individuals with low working memory performance or with working memory deficits. This suggests that verbal working memory does in fact influence L2 vocabulary learning.

The next section will readdress the research question and correspondent hypotheses in the light of the results obtained in the present study.

## 4.3 READDRESSING THE RESEARCH QUESTION

In this section, the research question for the present study is readdressed.

**Research question 1:** What are the effects of working memory on the acquisition of L2 vocabulary by 6$^{th}$ graders?

This research question generated the following hypotheses:

**Hypothesis 1:** The phonological loop has a significant effect on the acquisition of L2 vocabulary by 6$^{th}$ graders.

The answer is yes. The phonological loop is responsible for short-term storage and processing of verbal material (i.e., the verbal working memory). The results of the Listening Recall test show statistically significant correlations between phonological loop performance and all vocabulary post-tests. These results might indicate that individuals with average or high performance on Listening Recall test, as measured by the AWMA program, were also more prone to recalling vocabulary words that were taught during treatment phase than individuals with low performance on Listening Recall test. This suggests that verbal working memory in fact influences the acquisition of L2 vocabulary by the 6$^{th}$ grade participants.

The aim of this study was to determine the influence of verbal WM and acquisition of L2 vocabulary by 6$^{th}$ graders. It was hypothesized that verbal WM would have a strong influence with vocabulary acquisition. The findings of the present study support and

add evidence to the claim that verbal WM influences the acquisition of L2 vocabulary as presented in the Review of Literature. As I have discussed in the previous section, the results of the present study are in agreement with Ellis and Sinclair (1996) study where they demonstrated that verbal working memory is well-involved in vocabulary acquisition. It compared the acquisition of FL Welsh between individuals who repeated the utterances and those who were prevented from doing so. The results revealed that learners who repeated utterances clearly performed better than those prevented from doing so. The phonological rehearsal of utterances is specifically supported by verbal WM. Thus, Ellis and Sinclair (1996) study is in agreement with my study that showed statistically significant correlations between verbal working memory performance and all vocabulary post-tests.

Another study (Engel de Abreu and Gathercole, 2012) shows that phonological processing abilities make specific contributions to vocabulary learning. Their study conducted with children of 8 to 9 years old indicated that phonological processing abilities appeared to be critical for acquiring the sound structure of a new language. Finally, Wen (2014) suggests that the phonological WM component with its associated cognitive mechanisms is most related to the acquisition and developmental aspects of language-learning domains such as vocabulary and formula acquisition and grammar development. Furthermore, the results found in this study corroborate my personal opinion and experience as an L2 teacher that verbal WM in fact influences vocabulary acquisition and development.

**Hypothesis 2:** The central executive has a significant effect on the acquisition of L2 vocabulary by 6$^{th}$ graders.

The answer is yes. Gathercole, Pickering, Ambridge, and Wearing (2004) indicate a strong association between the central executive and the phonological loop. According to Baddeley and Logie (1999), the complex memory span task *Listening Recall* demands both on the central executive and the phonological loop. Thus it is possible to assume that due to deeply involvement in controlling the processes that take place in the phonological loop, a satisfactory performance (average or high) on verbal working memory test would be possible only with the support of the central executive. The Listening Recall test involved both verbal storage (phonological loop) and processing (central executive). The results presented for Listening Recall Processing indicate a statistically significant correlation between central exective and all

vocabulary post-tests. This suggests that central executive in fact also influences the acquisition of L2 vocabulary by 6th graders.

The executive component of WM (i.e., the central executive as was originally conceptualized by Baddeley and colleagues) is considered the most important but the least understood component in Baddeley's early WM model (Wen, 2012). There are at least two main reasons for why the central executive influences the acquisition of L2 English vocabulary according to the results presented in this study. Firtly, the nature of the tests used for assessment of participants' working memory capacity through the Automated Working Memory Assessment - AWMA (Alloway, 2007), included the assessment of the central executive component as well. The second reason is based on both Gathercole et al. (2004) and Wen (2012), in which different components of WM (phonological loop and central executive in particular) are found to be highly correlated with different aspects of L2 performance and development (vocabulary, grammar acquisition).

**Hypothesis 3:** The visuo-spatial sketchpad does not affect the acquisition of L2 vocabulary by 6th graders.

The results regarding the influence of visuo-spatial sketchpad on the acquisition of L2 vocabulary by 6th graders was not conclusive. Some of the results on the test used to tap the visuo-spatical sketchpad (i.e., spatial recall) indicate that the visuo-spatical sketchpad is not involved in verbal processing, which is typically required for vocabulary acquisition. Spearman's rank correlation coefficient ($\rho$) presented a small correlation between the Visuo-spatial WM subtests (i.e., Spatial recall and Spatial recall processing) and Post-test 1 - Picture Matching (7 days), and between the Visuo-spatial WM subtests (i.e., Spatial recall and Spatial recall processing) and Post-test 2 – Translation (21 days). On the other hand, no significant correlation was found between Spatial recall subtest and Post-test 1 – Translation (7 days) and between Visuo-spatial WM subtests (i.e., Spatial recall and Spatial recall processing) and Post-test 1 – Picture Matching (21 days). These inconclusive results suggests that visuo-spatial sketchpad in fact does not significantly influence the acquisition of L2 vocabulary by 6th graders.

In the previous section I have discussed the results of the present study concerning the influence of the spatial component of WM and the acquisition of L2 vocabulary. This study was unable to present conclusive evidence if visuo-spatial WM influences the acquisition of L2 vocabulary. To further explore this influence, a deeper and more detailed investigation would be needed.

However, the results found in this study tend to corroborate with results a recent study where Tsay (2014) showed no correlation between visuo-spatial WM tests and reading proficiency. In addition, the results in this study also tend to corroborate with the results presented by De Benit et al. (2005) where visuo-spatial WM is only selectively involved in spatial texts, implying in constructing a representation of spatial, non-illustrated descriptions and in the construction of the mental spatial model. In the present study, the vocabulary words did not involve to any type of spatial information because the words referred to food only. Thus, that could be a reasonable explanation for why the visuo-spatial WM played little or no role in learners' English vocabulary acquisition.

In the next chapter, the final remarks of the present study will be reported including the limitations and suggestions for further research, and pedagogical implications.

# CHAPTER V

# FINAL REMARKS

The main objective of this study was to investigate the role of working memory in the acquisition of L2 vocabulary. More specifically, the present study aimed at administering WM and vocabulary tests and investigating the performance of 24 low English proficient young learners, all native speakers of Portuguese, who were attending the 6th grade at a public school located in the Florianopolis metropolitan area.

The investigation was organized as follows: Chapter I presented the introduction of the study. Chapter II provided the review of literature, with theoretical framework related to adults' WM, children's WM and vocabulary acquisition. Chapter III was devoted to the method adopted in the present study, in order to collect and analyze the data generated. The results and discussion are presented in Chapter IV including the answer for the research question pursued in the study. The main purpose of this chapter, Chapter V, is to summarize the results, present the limitations of the study, bring suggestions for further research and present the pedagogical implications of the findings.

## 5.1. CONCLUSIONS

The most relevant results obtained from data analysis in the current study were:

1. The phonological loop has a significant effect on the acquisition of L2 vocabulary by young learners.

These results might indicate that individuals with average or high performance on verbal working memory tests, as measured by the AWMA program, are also more prone to vocabulary learning than individuals with low performance on verbal working memory tests. This suggests that verbal working memory in fact influences the acquisition of L2 vocabulary by young learners.

2. The central executive has a significant effect on the acquisition of L2 vocabulary by young learners.

The results presented for Listening Recall Processing indicate a statistically significant correlation between central executive and all vocabulary post-tests. This suggests that central executive in fact also

influences the acquisition of L2 vocabulary by 6th graders. According to Baddeley and Logie (1999), the complex memory span task *Listening Recall* demands both on the central executive and the phonological loop. Thus, a satisfactory performance (average or high) on verbal working memory test would be possible only with the support of the central executive.

3. Considering the weak correlation found between the visuo-sketchpad and vocabulary post-tests, the visuo-spatial sketchpad might not affect the acquisition of L2 vocabulary by 6th grade participants.

The results regarding the influence of visuo-spatial sketchpad on the acquisition of L2 vocabulary by young learners were not conclusive. Some of results on the tests used to tap the visuo-spatial sketchpad (i.e., spatial recall and spatial recall processing) indicate that the visuo-spatical sketchpad is not involved in verbal processing, which is typically required for vocabulary acquisition. Spearman's rank correlation coefficient (ρ) presented only significant correlation between some of the visuo-spatial WM subtests and vocabulary post-tests not for all of them as it occurred in the case of the verbal WM. These inconclusive results suggest that visuo-spatial sketchpad might not significantly influences the acquisition of L2 vocabulary by young learners.

Overall results suggest that the phonological loop and the central executive have a significant effect and the visuo-spatial sketchpad might not affect the acquisition of L2 vocabulary by young learners.

## 5.2. LIMITATIONS AND SUGGESTIONS FOR FURTHER RESEARCH

The current research was carried out to investigate whether working memory influenced the acquisition of L2 vocabulary by young learners. Due to the nature of the present study, the results gathered from this investigation are to be seen as suggestive rather than conclusive. Despite the fact that it has been methodologically and theoretically guided by related literature, the present study suffered from limitations. In this section, some limitations of this study followed by some suggestions for further research will be presented.

Firstly, the present study was limited in relation to the number of participants. Although all participants went through the same working memory tests, being comparable in educational and language background aspects, and presented no gender difference, no generalizations can be stated since the data collected represented just a

small sample of L2 young learners. In addition, the statistical tests were non-parametric since the sample size was not large enough. Further research should consider the possibility of gathering more participants and attempt to work with a larger and more expressive sample.

Secondly, the present study explored the influence of working memory on L2 vocabulary learning with a young population of learners who were attending the 6th grade at a public school located in Florianopolis. In addition, participants were all low-level L2 English vocabulary knowledge. Because of the small size and homogeneous composition of the participants' population, this study did not uncover many participants with marked working memory deficits. Further research should consider investigate a larger and more diverse population.

Finally, during the present study there was no control of participants' physiological or emotional aspects before taking the tests, such as quality of sleep, daily diet, use of stimulants or prescription drugs, level of stress, drug addiction, etc. Further research should consider participants' physiological and emotional factors that might affect performance on working memory and vocabulary tests.

The next section will provide the implications that can be addressed from the results obtained in the present study.

## 5.3. PEDAGOGICAL IMPLICATIONS

In this section, some pedagogical implications of the present research will be presented.

Firstly, according to the results of this study and in line with other related research, working memory has a relevant effect on L2 vocabulary learning. According to St Clair-Thompson and Sykes (2010) the AWMA predicts children's educational attainment in grade school. The results with children aged 7-8 years tested on five measures of working memory revealed that AWMA scores were excellent predictors of children's achievement. Thus, it is important for teachers to become aware and consider the role played by working memory skills related to L2 learning and learning in general when planning classroom activities which were not a subject of the present study but could be a subject for further research.

Secondly, another important pedagogical implication of this study is related to L2 classrooms. In this context, teachers encounter a great variety of students with different learning aptitudes, distinct levels of motivation and working memory capacity. Although working memory

tests are not applied at schools, teachers must be aware of learners' individual differences in these aspects and specially working memory, and how this may influence their L2 learning capacity. Considering that working memory capacity has been established as an excellent predictor of educational attainment (Alloway & Alloway, 2010), including L2 learning as it was investigated in this study, one suggestion would be to broadly use AWMA to measure working memory in schools to identify children with working memory deficits as early as possible.

In sum, the findings of the present study also underscore the notion that working memory skills should be taken seriously because it is a great estimate of young learners' L2 learning abilities and likelihood of future academic success. Despite conceptual and methodological limitations, such as sample size and non-parametric data analysis, the present research provokes us to further reflect on the use of working memory tests in our schools as a great predictor for academic success and how to deal with learners' working memory deficits in order to improve their working memory skills or minimize its effects on the learners' academic career in the long run.

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## APPENDIX A - Letter of Consent from Institution

**Escola de Educação Básica Getúlio Vargas**
Rua João Motta Espezim, 499 – Saco dos Limões – Florianópolis/SC

(48)3333-6098

### DECLARAÇÃO

Eu Maristela Bernadete Degering Roesner, declaro para os devidos fins e efeitos legais que, objetivando atender as exigências para a obtenção de parecer do Comitê de Ética em Pesquisa com Seres Humanos, e como representante legal da Instituição **ESCOLA DE EDUCAÇÃO BÁSICA GETÚLIO VARGAS**, tomei conhecimento do projeto de pesquisa: **A MEMÓRIA DE TRABALHO E APRENDIZAGEM DE VOCABULÁRIO DE LÍNGUA ESTRANGEIRA POR ESTUDANTES DO ENSINO FUNDAMENTAL,** e cumprirei os termos da Resolução CNS 466/12 e suas complementares, e como esta instituição tem condição para o desenvolvimento deste projeto, autorizo a sua execução nos termos propostos.

Florianópolis, ...../...../.....

**ASSINATURA:**.....

**NOME:**.....

**CARGO:**.....
.
**CARIMBO DO RESPONSÁVEL:**

**APPENDIX B - Letter of Consent Addressed to Parents**

Universidade Federal de Santa Catarina – UFSC
Centro de Comunicação e Expressão
Pós-Graduação em Inglês – Estudos Linguísticos e Literários
Instrumentos de Pesquisa
Pesquisa: **A MEMÓRIA DE TRABALHO E APRENDIZAGEM DE VOCABULÁRIO DE LÍNGUA ESTRANGEIRA POR ESTUDANTES DO ENSINO FUNDAMENTAL**
Mestrando: Amarildo Lemes de Souza
Orientadora: Drª Mailce Borges Mota

**Consentimento Livre e Esclarecido**

Pesquisa: **A MEMÓRIA DE TRABALHO E APRENDIZAGEM DE VOCABULÁRIO**

**DE LÍNGUA ESTRANGEIRA POR ESTUDANTES DO ENSINO FUNDAMENTAL**

Senhores Pais

Eu, Amarildo Lemes de Souza, aluno de Mestrado do Programa de Pós-Graduação em Inglês – Estudos Linguísticos e Literários, sob orientação da professora Dra. Mailce Borges Mota na Universidade Federal de Santa Catarina – UFSC, em colaboração com A Escola de Educação Básica Getúlio Vargas em Florianópolis, venho por meio deste informar que seu/sua filho/a está sendo convidado a colaborar com minha pesquisa.

O objetivo geral dessa pesquisa é investigar o papel da capacidade da memória de trabalho na aprendizagem de vocabulário em língua estrangeira (inglês) em crianças da faixa etária de 11 a 14 anos, em ambiente de sala de aula, ou seja, durante a aprendizagem escolar.

Gostaríamos de convidar seu/sua filho/a para participar como voluntário/a deste estudo, com seu consentimento. Seu filho será solicitado a realizar as seguintes atividades:

**Alguns testes para avaliar a capacidade de Memória de Trabalho:**

São atividades curta duração adequadas à faixa etária.

**Alguns testes de conhecimento da língua estrangeira:**

São atividades aplicadas em língua materna (português brasileiro) de conhecimento de palavras da língua inglesa.

**Aulas para o ensino de vocabulário da língua estrangeira:**

Serão ministradas aulas visando ensinar novas palavras em inglês.

A realização destas atividades não representa qualquer risco ou desconforto para seu filho que pode desistir a qualquer momento sem prejuízo de qualquer natureza para ele.

A participação de seu/sua filho/a não implicará em prejuízos ou divulgação de nomes ou identificação dos participantes de qualquer forma (ainda que eles precisem colocar o nome e a idade nas folhas das tarefas, mas que tem única e exclusivamente função de controle do pesquisador para não misturar as folhas dos alunos).

Informo que o Sr (a) tem a garantia de acesso, em qualquer etapa do estudo, a qualquer esclarecimento sobre o estudo. Se tiver alguma consideração ou dúvida sobre a pesquisa, entre em contato pelo e-mail: amarildo10@hotmail.com; ou pelo fone (48)9918-9160/(48)9167-0808 (período vespertino), ou pessoalmente na própria escola no período vespertino.

Como informado acima, há garantida a liberdade da retirada de consentimento a qualquer momento e seu filho pode deixar de participar do estudo, sem qualquer prejuízo ou punição.

Garanto que a identidade dos participantes deste estudo será mantida em sigilo e, de modo algum, será revelada. Os dados obtidos dos participantes serão analisados em conjunto. Não existirão despesas ou compensações pessoais para o participante em qualquer fase do estudo.

Eu me comprometo a utilizar os dados coletados somente para pesquisa e os resultados serão apresentados na forma de Dissertação de Mestrado e veiculados através de artigos científicos em revistas especializadas e/ou em encontros científicos e congressos, após a aprovação do estudo pelo Programa de Pós Graduação em Inglês – Estudos Linguísticos e Literários.

Anexo está o consentimento livre e esclarecido para ser assinado caso não tenha ficado qualquer dúvida.

**Termo de Consentimento Livre e Esclarecido**

Concordo voluntariamente em permitir a participação do (a) meu (minha) filho (a) na pesquisa **A MEMÓRIA DE TRABALHO E APRENDIZAGEM DE VOCABULÁRIO DE LÍNGUA ESTRANGEIRA POR ESTUDANTES DO ENSINO FUNDAMENTAL,** de autoria de Amarildo Lemes de Souza.

E poderei retirar o meu consentimento a qualquer momento, antes ou durante a pesquisa, sem penalidade, prejuízo ou perda de qualquer benefício que eu possa ter adquirido. Esses dados são apenas para certificação de quem está assinando é efetivamente responsável pela criança.

_____ Data _____/_____/_____
Assinatura do pai (mãe) ou responsável

Nome: _____
RG. Ou CPF:_____
Fone: ( )_____

_____ Data _____/_____/_____
Assinatura do (a) pesquisador (a)

Nome da criança:_____

## APPENDIX C - Letter of Consent to Participants

**Termo de Consentimento Livre e Esclarecido para os alunos**
**Caro estudante**

Convite:

Você está sendo convidado a participar de uma pesquisa de estudo de mestrado intitulada **A MEMÓRIA DE TRABALHO E APRENDIZAGEM DE VOCABULÁRIO DE LÍNGUA ESTRANGEIRA POR ESTUDANTES DO ENSINO FUNDAMENTAL**. Essa pesquisa tem por objetivo descobrir o papel de um tipo de memória, chamada de memória de trabalho, na aprendizagem de vocabulário em língua estrangeira (inglês). Como vamos descobrir isso? Contando com a sua participação na pesquisa.

O que você vai precisar fazer?

1- Alguns exercícios que envolvem a memória. Por exemplo, um monitor vai apresentar algumas palavras ou números e você precisa se lembrar delas para falar em voz alta em seguida.

2- Você vai ouvir algumas frases e responder se a frase está correta.

3- Você vai ver algumas figuras em um monitor e precisa lembrar-se da posição onde elas se encontravam e se estão na posição correta.

4- Você vai aprender novas palavras da língua inglesa.

As tarefas são simples, mas você pode se sentir cansado(a), se isso acontecer, você pode parar para descansar um pouco. O seu nome não será divulgado no final da pesquisa. Você não terá gastos para participar da pesquisa. Você não será prejudicado caso não queira mais participar das atividades por algum motivo ou se achar que não tenha realizado bem alguma das tarefas.

**Você será um grande colaborador** do Prof. Amarildo Lemes de Souza e para a ciência.

_____ Data _____/_____/_____
Assinatura e nome do (a) participante

_____ Data _____/_____/_____
Assinatura do (a) pesquisador (a)

**APPENDIX D - Personal Information and Language Background Questionnaire**

**QUESTIONÁRIO – LEVANTAMENTO DE PERFIL DOS PARTICIPANTES**

Universidade Federal de Santa Catarina – UFSC
Centro de Comunicação e Expressão
Pós-Graduação em Inglês – Estudos Linguísticos e Literários
Instrumentos de Pesquisa
Pesquisa: **A MEMÓRIA DE TRABALHO E APRENDIZAGEM DE VOCABULÁRIO DE LÍNGUA ESTRANGEIRA POR ESTUDANTES DO ENSINO FUNDAMENTAL**
Mestrando: Amarildo Lemes de Souza
Orientadora: Drª Mailce Borges Mota

Instruções: Por favor, responda todas as questões.

Nome completo:_____
Idade:_____ Sexo: ( )M ( )F Repetente: ( )Sim ( )Não

1) Você gosta da língua inglesa? Se sim, o que você mais gosta? Falar, ouvir, ler ou escrever?

_____

2) Instrução em Língua inglesa:
Você frequentou aulas de inglês em um curso de línguas?
( )Sim ( ) Não
Se 'sim' quanto tempo você frequentou as aulas (um mês, um ano, etc.)?

_____

3) Você ainda frequenta aulas de inglês em um curso de línguas? ( ) Sim ( ) Não
Se 'sim', qual o seu nível?

_____

4) Você usa o inglês fora da sala de aula? ( ) Sim ( ) Não
Se ‘sim’, assinale todas as alternativas que se aplicam ao seu caso.
( ) lendo livros e revistas
( ) navegando na internet
( ) jogando vídeo-game
( ) assistindo filmes

Sinta-se à vontade para citar outros contextos em que você usa o inglês:

---

_____ _____, ____/____/_____
Assinatura do participante

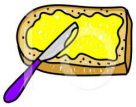
_____
Assinatura do (a) pesquisador (a)

**APPENDIX E - Vocabulary Test (Word Recognition)**

Universidade Federal de Santa Catarina
Teste de Vocabulário – Reconhecimento de palavras

Data: __/__/__ Nome do participante:_____ Turma: ____

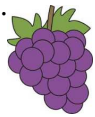
**Instrução:** Escreva em português o nome das figuras:

1.  _____

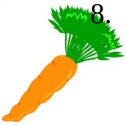
2.  _____

3.  _____

4.  _____

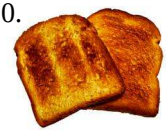
5.  _____

6.  _____

7.  _____

8.  _____

9.  _____

10.  _____

11.  _____

12.  _____

13.  _____

14.  _____

15.  _____

16.  _____

17.  _____

18.  _____

19.  _____

20.  _____

21. 

22. 

23. 

24. 

25. 

26. 

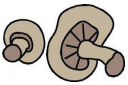
27. 

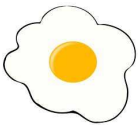
28. 

29. 

30. 

31. 

32. 

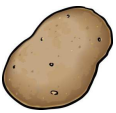
33. 

34. 

35. 

36. 

37 

38. 

39. 

40. 

**APPENDIX F - Vocabulary Pre-Test 1 (Picture Matching)**

Universidade Federal de Santa Catarina
Pré teste de Vocabulário

Data: _____/_____/_____

Nome do participante:_____ Turma: ____

**Instrução:** Escreva a alternativa que corresponde à figura:

1. 
( ) Strawberry

2. 
( ) Cookie

3. 
( ) pie

4. 
( ) Butter

5. 
( ) Grape

6. 
( ) Carrot

7. 
( ) Cake

8. 
( ) Pea

9. 
( ) Pineapp

10. 
( ) Toast

11. 
( ) Bread

12. 
( ) Wine

13. 
( ) Flour

14. 
( ) Pancake

15. 
( ) Jam

16. 
( ) Candy

17. 
( ) Pepper

18. 
( ) Rice

19. 
( ) Honey

20. 
( ) Garlic

21. 
( ) Corn

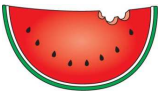
22. 
( ) Peach

23. 
( ) Melon

24. 
( ) Tomato

25. 
( ) Onion

26. 
( ) Lettuce

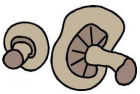
27. 
( ) Watermelon

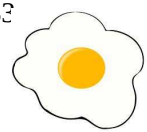
28. 
( ) Cucumber

29. 
( ) Mushroom

30. 
( ) Pear

31. 
( ) Plum

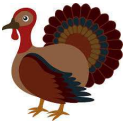
32. 
( ) Blackberry

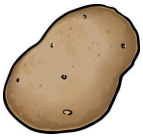
33. 
( ) Sugar

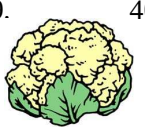
34. 
( ) Beef

35. 
( ) Egg

36. 
( ) Chicken

37. 
( ) Avocado

38. 
( ) Potato

39. 
( ) Turkey

40. 
( ) Cauliflower

**APPENDIX G - Vocabulary Pre-Test 2 (Translation)**

Universidade Federal de Santa Catarina
Teste de Vocabulário

Nome do participante:_____
Turma: _____

Instrução:

**Traduza as seguintes palavras para o português.**

1. Strawberry _____
2. Cookie _____
3. Butter _____
4. Pie _____
5. Grape _____
6. Carrot _____
7. Cake _____
8. Pea _____
9. Pineapple _____
10. Toast _____
11. Bread _____
12. Wine _____
13. Flour _____
14. Pancake _____
15. Jam _____
16. Candy _____
17. Pepper _____
18. Rice _____
19. Honey _____
20. Garlic _____
21. Corn _____
22. Peach _____
23. Melon _____
24. Tomato _____
25. Onion _____
26. Lettuce _____
27. Watermelon _____
28. Cucumber _____
29. Mushroom _____
30. Pear _____

31. Plum _____
32. Blackberry _____
33. Sugar _____
34. Beef _____
35. Egg _____
36. Chicken _____
37. Avocado _____
38. Potato _____
39. Turkey _____
40. Cauliflower _____

## APPENDIX H - Vocabulary Levels Test


Universidade Federal de Santa Catarina – UFSC
Centro de Comunicação e Expressão
Instrumentos de Pesquisa
Mestrando: Amarildo Lemes de Souza
Pesquisa: **A MEMÓRIA DE TRABALHO E APRENDIZAGEM DE VOCABULÁRIO DE LÍNGUA ESTRANGEIRA POR ESTUDANTES DO ENSINO FUNDAMENTAL**

Orientadora: Drª Mailce Borges Mota

Nome do participante:_____
Turma: _____

**Teste de níveis em vocabulário: Versão 1**

Este é um teste de vocabulário. Escolha a palavra certa para cada significado. Escreva o número da palavra na linha do significado correspondente. Como no exemplo:

| | | | |
|---|---|---|---|
| l | business | | |
| 2 | clock | ____ | Uma parte da casa |
| 3 | horse | ____ | Um animal com quatro patas |
| 4 | pencil | ____ | Algo usado para escrever |
| 5 | shoe | | |
| 6 | wall | | |

Você pode responder da seguinte maneira:

| | | | |
|---|---|---|---|
| l | business | | |
| 2 | clock | 6 | Uma parte da casa |
| 3 | horse | 3 | Um animal com quatro patas |
| 4 | pencil | 4 | Algo usado para escrever |
| 5 | shoe | | |
| 6 | wall | | |

Algumas palavras estão no teste para aumentar o desafio. Você não precisa encontrar um significado para as outras palavras. No exemplo acima, as palavras de desafio são business, clock, shoe. Tente fazer todas as partes do teste!

**Versão 1 Nível das 2.000 palavras**

1 birth
2 dust _____ jogo
3 operation _____ ganhar
4 row _____ nascer
5 sport
6 victory

1 choice
2 crop _____ calor, frio
3 flesh _____ carne
4 salary _____ dinheiro pago regularmente por um trabalho feito
5 secret
6 temperature

1 cap
2 education _____ ensinar e aprender
3 journey _____ números usados para medir algo
4 parent _____ ir a um lugar distante
5 scale
6 trick

1 attack
2 charm _____ ouro e prata
3 lack _____ qualidade atraente
4 pen _____ não ter algo
5 shadow
6 treasure

1 cream
2 factory _____ parte do leite integral
3 nail _____ muito dinheiro
4 pupil _____ uma pessoa que estuda
5 sacrifice
6 wealth

1 adopt
2 climb _____ subir
3 examine _____ olhar de perto
4 pour _____ estar por todos os lados
5 satisfy
6 surround

1 bake
2 connect _____ juntar, unir
3 inquire _____ andar sem rumo
4 limit _____ manter algo em certo tamanho
5 recognize
6 wander

1 burst
2 concern _____ estourar
3 deliver _____ melhorar
4 fold _____ levar algo a alguém
5 improve
6 urge

1 original
2 private _____ primeiro
3 royal _____ não é público
4 slow _____ tudo somado
5 sorry
6 total

1 brave
2 electric _____ feito costumeiramente
3 firm _____ querer comida
4 hungry _____ não ter medo
5 local
6 usual

**Versão 1 Nível das 3.000 palavras**

1 belt
2 climate _____ ideia
3 executive _____ parte de dentro da mão
4 notion _____ faixa de couro usada na cintura
5 palm
6 victim

1 acid
2 bishop _____ sensação de frio
3 chill _____ animal de fazenda

4 ox _____ organização
5 ridge
6 structure

1 bench
2 charity _____ assento longo
3 jar _____ ajuda aos necessitados
4 mate _____ parte de um país
5 mirror
6 province

1 boot
2 device _____ oficial militar
3 lieutenant _____ um tipo de rocha
4 marble _____ tubo por onde o sangue flui
5 phrase
6 vein

1 apartment
2 candle _____ um lugar para morar
3 draft _____ chances de algo acontecer
4 horror _____ primeira versão de algo escrito
5 prospect
6 timber

1 betray
2 dispose _____ assustar
3 embrace _____ dizer publicamente
4 injure _____ machucar seriamente
5 proclaim
6 scare

1 encounter
2 illustrate _____ encontrar
3 inspire _____ implorar por ajuda
4 plead _____ fechar completamente
5 seal
6 shift

1 assist
2 bother _____ ajudar

3 condemn _____ cortar com precisão
4 erect _____ girar rapidamente
5 trim
6 whirl

1 annual
2 concealed _____ selvagem
3 definite _____ claro e preciso
4 mental _____ acontece uma vez ao ano
5 previous
6 savage

1 dim
2 junior _____ estranho
3 magnificent _____ maravilhoso
4 maternal _____ com pouca iluminação
5 odd
6 weary

**Versão 1 Nível das 5.000 palavras**

1 balloon
2 federation _____ balde
3 novelty _____ coisa incomum e interessante
4 pail _____ saco de borracha cheio de ar
5 veteran
6 ward

1 alcohol
2 apron _____ etapa de desenvolvimento
3 hip _____ estado de sujeira e desorganização
4 lure _____ peça usada na frente do corpo para proteger suas roupas
5 mess
6 phase

1 apparatus
2 compliment _____ expressão de admiração
3 ledge _____ instrumentos ou maquinário
4 revenue _____ dinheiro recebido por um governo
5 scrap
6 tile

1 bulb
2 document _____ cavalo fêmea
3 legion _____ grande grupo de soldados ou pessoas
4 mare _____ um pedaço de papel contendo informações
5 pulse
6 tub

1 concrete
2 era _____ forma circular
3 fibre _____ topo de uma montanha
4 loop _____ um longo período de tempo
5 plank
6 summit

1 blend
2 devise _____ misturar
3 hug _____ planejar ou inventar
4 lease _____ abraçar
5 plague
6 reject

1 abolish
2 drip _____ terminar algo com uma lei
3 insert _____ adivinhar o futuro
4 predict _____ acalmar ou reconfortar alguém
5 soothe
6 thrive

1 bleed
2 collapse _____ vir antes
3 precede _____ cair de repente
4 reject _____ mover-se com passos ou saltos rápidos
5 skip
6 tease

1 casual
2 desolate _____ com cheiro forte
3 fragrant _____ único
4 radical _____ bom para a saúde
5 unique

6 wholesome

1 gloomy
2 gross _____ vazio
3 infinite _____ sombrio, triste
4 limp _____ sem fim
5 slim
6 vacant

**Versão 1 Nível das 10.000 palavras**

1 antics
2 batch _____ comportamento tolo
3 connoisseur _____ um grupo de coisas iguais
4 foreboding _____ pessoa que conhece arte, música, etc.
5 haunch
6 scaffold

1 auspices
2 dregs _____ mistura confusa
3 hostage _____ líquido naturalmente produzido pela boca
4 jumble _____ partes mais inúteis de alguma coisa
5 saliva
6 truce

1 casualty
2 flurry _____ número de mortos ou feridos
3 froth _____ estar longe de outras pessoas
4 revelry _____ celebração barulhenta e feliz
5 rut
6 seclusion

1 apparition
2 botany _____ fantasma
3 expulsion _____ estudo das plantas
4 insolence _____ poça d'água
5 leash
6 puddle

1 arsenal
2 barracks _____ felicidade
3 deacon _____ situação difícil
4 felicity _____ ministro em uma igreja
5 predicament
6 spore

1 acquiesce
2 bask _____ aceitar sem protestos
3 crease _____ sentar-se ou deitar-se no calor
4 demolish _____ dobra em pano ou papel
5 overhaul
6 rape

1 blaspheme
2 endorse _____ escorregar
3 nurture _____ dar cuidados e alimentação
4 skid _____ falar mal de Deus
5 squint
6 straggle

1 clinch
2 jot _____ mover-se rapidamente
3 mutilate _____ causar dano ou ferimento
4 smoulder _____ queimar lentamente, sem criar chamas
5 topple
6 whiz

1 auxiliary
2 candid_____ de mau humor
3 luscious _____ cheio de si
4 morose _____ quem dá apoio e ajuda
5 pallid
6 pompous

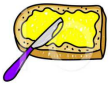
1 dubious
2 impudent _____ rude, grosseiro
3 languid _____ muito antigo
4 motley _____ de vários tipos diferentes
5 opaque
6 primeval

**APPENDIX I - Vocabulary Post-Test 1 (Picture Matching)**

Universidade Federal de Santa Catarina
Pré teste de Vocabulário

Data: _____/_____/_____
Nome do participante:_____
Turma: ____

**Instrução:**
Escreva a alternativa que corresponde à figura:

1. 
2. 
3. 
4. 

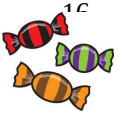
( ) Strawber ( ) Cookie ( ) pie ( ) Butter

5. 
6. 
7. 
8. 

( ) Grape ( ) Carrot ( ) Cake ( ) Pea

9. 
10. 
11. 
12. 

( ) Pineapple ( ) Toast ( ) Bread ( ) Wine

13. 
14. 
15. 
16. 

( ) Flour ( ) Pancake ( ) Jam ( ) Candy

17. 
18. 
19. 
20. 

( ) Pepper ( ) Rice ( ) Honey ( ) Garlic

21. 

( ) Corn

22. 

( ) Peach

23. 

( ) Melon

24. 

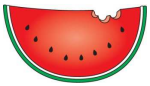
( ) Tomato

25. 

( ) Onion

26. 

( ) Lettuce

27. 

( ) Watermelon

28. 

( ) Cucumber

29. 

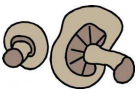
( ) Mushroom

30. 

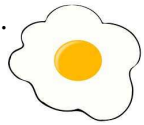
( ) Pear

31. 

( ) Plum

32. 

( ) Blackberry

33. 

( ) Sugar

34 

( ) Beef

35. 

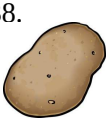
( ) Egg

36. 

( ) Chicken

37. 

( ) Avocado

38. 

( ) Potato

39. 

( ) Turkey

40. 

( ) Cauliflower

**APPENDIX J - Vocabulary Post-Test 2 (Translation)**

Universidade Federal de Santa Catarina
Pós-teste de Vocabulário

LabLing
Laboratório da Linguagem e Processos Cognitivos

Nome do participante:_____
Turma: _____ Data: _____/_____/_____

Instrução: **Traduza as seguintes palavras para o português.**

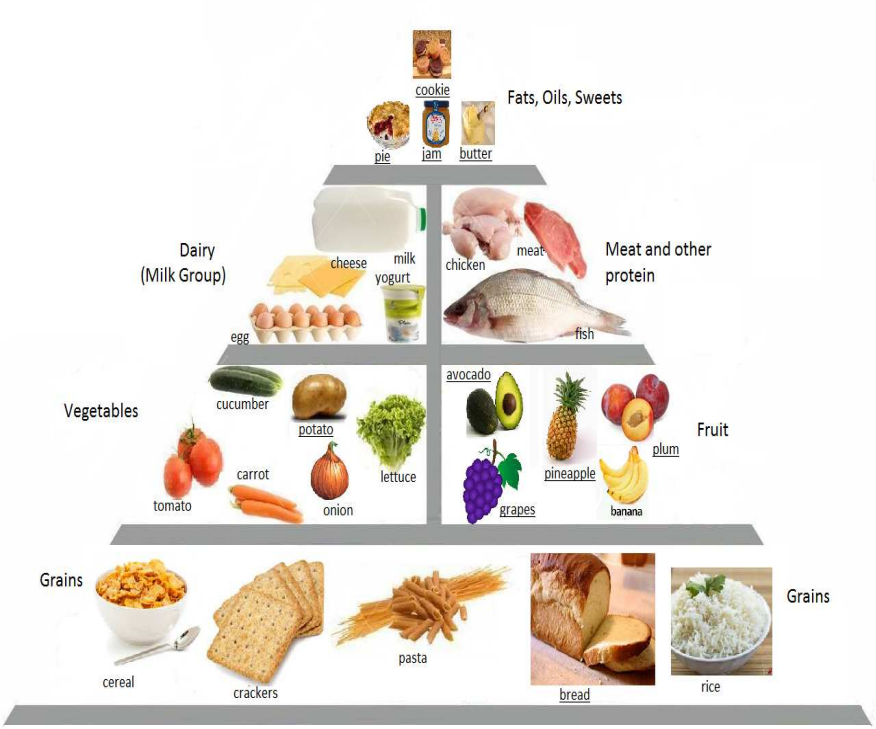
| | |
|---|---|
| 1. Strawberry _____ | 21. Corn _____ |
| 2. Cookie _____ | 22. Peach _____ |
| 3. Butter _____ | 23.Melon _____ |
| 4. Pie _____ | 24.Tomato _____ |
| 5. Grape _____ | 25. Onion _____ |
| 6. Carrot _____ | 26 Lettuce _____ |
| 7. Cake _____ | 27.Watermelon_____ |
| 8. Pea _____ | 28. Cucumber _____ |
| 9. Pineapple _____ | 29 Mushroom _____ |
| 10. Toast _____ | 30. Pear _____ |
| 11. Bread _____ | 31. Plum _____ |
| 12. Wine _____ | 32. Blackberry _____ |
| 13. Flour _____ | 33. Sugar _____ |
| 14. Pancake _____ | 34. Beef _____ |
| 15. Jam _____ | 35. Egg _____ |
| 16. Candy _____ | 36. Chicken _____ |
| 17. Pepper _____ | 37. Avocado _____ |
| 18. Rice _____ | 38. Potato _____ |
| 19. Honey _____ | 39. Turkey _____ |
| 20. Garlic _____ | 40. Cauliflower _____ |

## APPENDIX K - Noticing Activity 1 - Food Pyramid

**Escola de Educação Básica Getúlio Vargas**

LabLing
Laboratório da Linguagem e Processos Cognitivos

**Food Pyramid**
**English Class**



**APPENDIX L - Noticing Activity 2**

**Escola de Educação Básica Getúlio Vargas**
**English Class**
**Prof. Amarildo Souza**
**Data: ___/___/____**
**Exercício 1 – Tipos de Comida**

**Assinale a alternativa correta sobre o tipo de comida de acordo com a pirâmide de alimentos:**

1. Apple, **plum**, **pineapple**
( ) Fruit
( ) Vegetables
( ) Grains

2. Chicken, meat, fish
( ) Dairy (milk group)
( ) Meat and other protein
( ) Grains

3. Cookie, **jam**, **butter**
( ) Sweets
( ) Grains
( ) Fruit

4. Pasta, **bread**, **rice**
( ) Vegetables
( ) Fat
( ) Grains

5. Egg, cheese, milk
( ) Meat and other protein
( ) Fruit
( ) Dairy (milk group)

6. **Onion**, **lettuce**, potato, **carrot, garlic**
( ) Fruit
( ) Grains
( ) Vegetables

## APPENDIX M - Retrieval Activity 1

**Escola de Educação Básica Getúlio Vargas**
**Prof. Amarildo Souza**
**Data: ___/___/_____**

**Nome do(a) participante:**_____
**Turma: _____**

**Relacionar as colunas abaixo de acordo com o desenho correspondente:**

1. Carrot ( )
2. Pineapple ( )
3. Onion ( )
4. Plum ( )
5. Bread ( )
6. Lettuce ( )
7. Rice ( )
8. Garlic ( )
9. Butter ( )
10. Jam ( )










**APPENDIX N - Activity 2**

**Escola de Educação Básica Getúlio Vargas**
**English Class**
**Prof. Amarildo Souza**

**Leia atentamente o texto e responda as perguntas.**


**John:** What to you want for the picnic?
**Amanda:** Hmm. How about some **jam** sandwiches of **bread**, **butter** or **plum** fruit **jam**?
**John:** OK. But we also have some cookies, a **pineapple** pie and **rice**.
**Amanda: Rice?** I don't want **rice**.
**Amanda:** Do you have any drinks?
**John:** No, we need some.
**Amanda:** All right. Let's get some lemonade.
**John:** And let's buy some potato salad.
**Amanda:** Sure. Everyone likes potato salad.
**John:** The store doesn't have any potato salad.
**Amanda:** Well, we have lots of potatoes. Let's make some!
**John:** Ok. Do we have any mayonnaise?
**Amanda:** No, we need to buy some.
**John:** We need some **onions**, too.
**Amanda:** Oh, I don't want any **onions**. I hate **onions**!
**John:** Then let's get some **carrots** and **lettuce**.
**Amanda:** No, I don't want any carrots or **lettuce** in my potato salad. But let's put some **garlic** in it.
**John: Garlic** in potato salad? That sounds awful!

Adapted from: Interchange – Third Edition, Jack C. Richards
**Themes For Teaching –** www.t4english.ufsc.br
Picture: http://www.kitchendaily.com/read/picnic-food-ideas

**Retrieval Activity 2 – Questionnaire**

**Escola de Educação Básica Getúlio Vargas**
**English Class**
**Prof. Amarildo Souza**
**Data: ____/____/_____**

**Com base no diálogo e na pirâmide de alimentar apresentados, responda as perguntas a seguir em inglês.**

1. Aonde John e Amanda pretendem ir? O que eles pretendem levar?

2. Que tipo de salada John e Amanda querem levar? E o que estava faltando para fazer a salada?

3. Que vegetal Amanda desejava colocar na salada?

4. Releia o texto e escreva aqui as comidas que você já conhece em inglês. Responda em inglês.

5. Qual é o tema central do texto?

6. Quais comidas você mais gosta daquelas presentes no texto?

**APPENDIX O - Retrieval Activity 3**

**Escola de Educação Básica Getúlio Vargas**
**Data: ____/____/_____**

**Escreva os nomes das comidas em seus respectivos grupos de acordo com a pirâmide de alimentos:**

**Fruit**

_mangoes_____
_____
_____
_____

**Vegetables**

_____
_____
_____
_____

**Grains**

_____
_____
_____

**Fat, oil, and sugar**

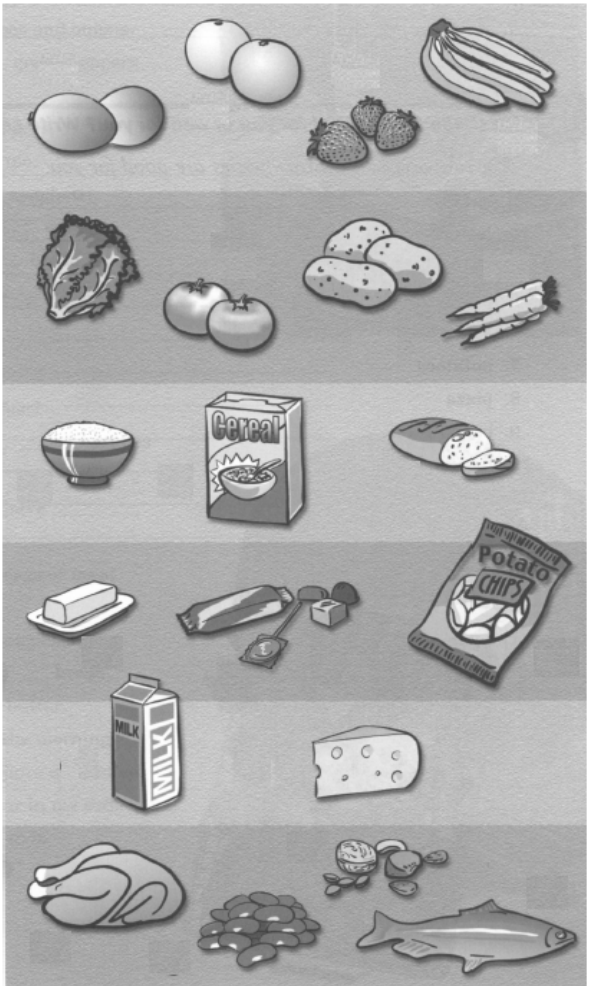
_____
_____
_____

**Dairy**

_____
_____

**Meat and other protein**

_____
_____
_____
_____




Adapted from: Interchange - Third Edition, Jack C. Richards

**APPENDIX P - Retrieval Activity 4 - Food Bingo**

**Escola De Educação Básica Getúlio Vargas**
**English Class**
**Prof. Amarildo Souza**
**Data: ____/___/_____**

**Solicite aos alunos que se dividam em grupos de três. Cada grupo de três alunos deverá receber uma cartela. O professor sorteia figuras de alimentos, pronuncia o nome e escreve no quadro enquanto os estudantes marcam as comidas sorteadas em seus cartões. Ganha o grupo que conseguir marcar todo o cartão primeiro.**

## Retrieval Activity 4 - Food Bingo Cards

**APPENDIX Q - Generative Processing Activity**

**Second-Hand Cloze**

**Escola de Educação Básica Getúlio Vargas**

**English Class**

**Prof. Amarildo Souza**

**Nome do participante:**_____

**Turma:**_____

**Preencha os espaços em branco com o nome dos alimentos em inglês. A lista abaixo do texto contém as palavras em português para ajudá-lo.**


1. **John:** What to you want for the picnic?
2. **Amanda:** Let's make some chicken sandwiches with _____, mayonnaise or _____, chicken and _____?
4. **John:** OK. But we also have a_____ pie and _____.
5. **Amanda:** Please, don't forget to pick up the _____ _____in the fridge.
7. **John:** By the way, we need some potatos and ____ for a potato salad.
9. **Amanda:** Oh, I don't want any _____. I hate _____!
10. **Amanda:** No, we need to buy some.
11. **John:** Then let's get some _____.
12. **Amanda:** No, I don't want any _____ in my potato salad either.
13. **Amanda:** But let's put some _____ in it.
14. **John:** _____ in potato salad? That sounds awful!

Adapted from: Interchange – Third Edition, Jack C. Richards

**Themes For Teaching –** www.t4tenglish.ufsc.br

Picture: http://www.kitchendaily.com/read/picnic-food-ideas

**Lista de palavras em português:**

| | |
|---|---|
| 1) CENOURA | 6) CEBOLA |
| 2) ABACAXI | 7) ARROZ |
| 3) ALHO | 8) GELÉIA |
| 4) AMEIXA | 9) MANTEIGA |
| 5) PÃO | 10) ALFACE |