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THE INFLUENCE OF READING EXPERIENCE AND WORKING MEMORY ON THE QUALITY OF L2 LEXICAL REPRESENTATIONS IN BRAZILIAN PORTUGUESE-ENGLISH BILINGUALS

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THE INFLUENCE OF READING EXPERIENCE AND WORKING MEMORY ON THE QUALITY OF L2 LEXICAL REPRESENTATIONS IN BRAZILIAN PORTUGUESE-ENGLISH BILINGUALS

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“There is nothing more deceptive than an obvious fact.”
– *Sir* Arthur Conan Doyle

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ABSTRACT

This study investigated the influence of L1 and L2 reading experience and of working memory capacity on the quality of L2 lexical representations of Brazilian Portuguese-English bilinguals during an L2 meaning decision task. In order to do so, the meaning decision task was built with L2 prime words, which were homonyms or non-homonyms and cognate or non-cognate words, followed by L2 target words, which could be related to the dominant meaning of the homonym prime or to the subordinate meaning, or could be unrelated. Also, cognate prime words could share the dominant or the subordinate meaning with the L1. Participants were 82 university students who completed six tasks: an L1 and L2 reading experience and reading habits questionnaire, a meaning decision task, a meaning recognition task, a reading span task, a language history questionnaire, and an L2 proficiency test involving grammar, vocabulary, and reading comprehension. They proficiency in English ranged from basic user to proficient user. Results for the meaning decision task alone showed that processing of target words related to the meaning of the prime word was confounded when these prime words were homonyms. This interference was diminished by the co-activation of meaning and form of cognate words across languages. In addition, the dominant meaning was easier to be accessed in any of the task conditions, especially when it was both shared across languages and primed by the target word. The higher frequency of the dominant meaning had more impact in target word recognition than cognate overlap across languages. Results from a linear regression model showed that the L1, L2 and bilingual reading habits scores predicted cognate and homonym effects in the performance in the meaning decision task, but the reading span total recall score did not. Discussion explains that these results lend support to a non-selective bilingual lexical access view as seen in the BIA+ Model and to the Lexical Quality Hypothesis.

Keywords: lexical quality hypothesis, bilingual lexical access, reading experience, working memory.

RESUMO

Este estudo investigou a influência da experiência leitora em L1 e em L2 e da capacidade de memória de trabalho na qualidade das representações lexicais em L2 de bilíngues Português Brasileiro-Inglês durante uma tarefa de decisão de significado em L2. Para tanto, a tarefa de decisão de significado foi construída com palavras-*prime* em L2, que eram homônimas ou não homônimas e cognatas ou não cognatas, seguidas por palavras-alvo em L2, que poderiam ser relacionadas ao significado dominante da *prime* homônima ou ao significado subordinado, ou poderiam ser não relacionadas. Além disso, as palavras-*prime* cognatas poderiam compartilhar o significado dominante ou o subordinado com a L1. Os participantes eram 82 estudantes universitários que completaram seis tarefas: um questionário de experiência leitora e hábitos de leitura em L1 e em L2, uma tarefa de decisão de significado, uma tarefa de reconhecimento de significado, uma tarefa de *reading span*, um questionário de histórico de uso de língua e um teste de proficiência em gramática, vocabulário e compreensão de leitura em L2. A proficiência deles em inglês variou de básica a proficiente. Os resultados, considerando-se apenas a tarefa de decisão de significado, mostraram que o processamento das palavras-alvo relacionadas ao significado da palavra-*prime* foi afetado negativamente quando as *primes* eram homônimas. Essa interferência foi diminuída pela coativação de significado e forma das palavras cognatas entre línguas. Ademais, o significado dominante foi mais facilmente acessado em qualquer condição da tarefa, especialmente quando ele era compartilhado entre línguas e também ativado pela palavra-alvo. A maior frequência do significado dominante teve um impacto maior no reconhecimento das palavras-alvo do que a sobreposição entre línguas das palavras cognatas. Os resultados de um modelo de regressão linear mostraram que os escores de hábitos de leitura em L1, em L2 e bilíngue puderam prever efeitos cognato e homônimo no desempenho na tarefa de decisão de significado, mas que o escore de recordação total da tarefa *reading span* não pôde. A discussão explica que esses resultados oferecem suporte a uma visão de acesso lexical bilíngue não seletivo como exposto no Modelo BIA+ e também à Hipótese da Qualidade Lexical.

Palavras-chave: hipótese da qualidade lexical, acesso lexical bilíngue, experiência leitora, memória de trabalho.

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1 INTRODUCTION[1]

Reading is everywhere, from the screens of our cell phones first thing in the morning, to books and (online) newspapers, billboards and signs in the streets during the day, ending with menus or the labels of products at night. From the moment we learn how to decode words, it is almost impossible not to read them. "Reading is one of the most important and complex cognitive skills within Western culture" (BADDELEY et al., 1985, p. 1). This essential skill may go unnoticed unless we are in an environment dominated by an unknown language. That is when the automatic understanding of words vanishes, and we experience the feeling of not being able to read again. For someone who is learning a second language (L2) later in life, this is a familiar sensation, especially because "[f]or many late L2 learners, reading is the first encounter with the L2 in the context of classroom instruction" (KROLL; GULLIFER; ZIRNSTEIN, 2016, p. 2). In the case of Brazilians, the school setting is the main – if not the only – circumstance for learning an L2. This highlights the importance of reading in the process of acquiring English as a second language by native speakers of Brazilian Portuguese.

The process of reading has been examined via many different approaches, such as using isolated letters, words or sentences as stimuli, measuring reaction times and error rates for specific reading components, focusing on the early stages of language learning, and also considering the impact of brain damage in language skills (BADDELEY et al., 1985). Research has also shown that there is permeability between the languages of a bilingual (KROLL; GULLIFER; ZIRNSTEIN, 2016). This means that the two languages are active in the bilingual brain. Moreover, the languages may influence one another in that L2 learning is based on L1 skills and on processes similar to L1 learning (SPARKS, 2012). Taken together, these brief findings illustrate the complexity of reading, especially when two languages interact.

According to Perfetti and Stafura (2014, p. 22), "[t]here is no theory of reading" since it is highly complex and has multiple components. It is suggested that fluent reading is at least two-fold: vocabulary and lexical access are needed (BADDELEY et al., 1985), and these are basically a combination of vast knowledge of words and fast word recognition. More recently, a study indicated that word knowledge and reading experience are the factors that explain

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reading in the L1 the most (TAYLOR; PERFETTI, 2016). These are some of the components which are thought to work together to guide the reading process.

One line of research which is centered in matters such as the ones presented above is the Lexical Quality Hypothesis (PERFETTI; HART, 2001, 2002; PERFETTI, 2007). According to it, words are composed of three strongly interconnected constituents: orthography, phonology, and semantics/morphosyntax. If these constituents are fully specified and phonologically redundant during reading, word identification becomes faster and easier, and thus of high quality. When each of these constituents receives detailed information and is specified, the quality of the lexical representation increases. For instance, lexical quality is higher when a reader knows both orthography and meaning of a word than when she knows only orthography; higher when phonology, orthography and meaning are known than when only phonology is known. These details can be found during reading; the more diverse and frequent is one's habit of reading, the more knowledge of words can be gathered. The consequence of such a fully-specified representation is a more automatic and faster lexical access, which in turn liberates superior resources for comprehension and inference generation, for instance (PERFETTI; HART, 2002; HAMILTON; FREED; LONG, 2016). Thus, this hypothesis essentially proposes that reading is driven by one's knowledge of words. But what happens when there are two languages represented in the brain?

For bilinguals, if lexical representations are of high quality – that is, if information of phonology, orthography, meaning, and grammar for a word are available and detailed –, this contributes to the process of lexical access as it does for monolinguals (PERFETTI; HART, 2001; LERVAG; AUKRUST, 2010; RAUDSZUS; SEGERS; VERHOEVEN, 2018). When two languages are known, there is permeability between them. This means that one language influences the other, and vice-versa, because they are activated in parallel. Concerning the recognition of words, access to the lexicon is language non-selective, and this lexicon is integrated between languages (DIJKSTRA; VAN HEUVEN, 2002). In other words, lexical items from both of the speaker's languages are activated during lexical access because the lexicons are integrated. The activation of two lexical representations at the same time may facilitate access if those representations share meaning between languages, as it is the case of cognate words (SCHWARTZ; KROLL; DIAZ, 2007; FRIESEN; HAIGH; JARED, 2014; POARCH; VAN HELL, 2014). Recognition of the word "accident", for instance, would be easier for Brazilian Portuguese-English bilinguals due to its orthographic and semantic similarity to the word "*acidente*". On the other hand, the activation of two representations that have different meanings across languages may hamper access to one of the representations

(HAIGH; JARED, 2007; FRIESEN; HAIGH; JARED, 2014; ARÊAS DA LUZ FONTES; SCHWARTZ, 2015). For homophone or homograph words – similar pronunciation or spelling, respectively – across languages, "late" may inhibit the recognition of "*leite*" (milk) as well as "role" may inhibit "*role*" (verb "roll"). These types of words may also cause this inhibition between words within the same language, as it is the case for monolinguals (PERFETTI; HART, 2001, 2002). These findings demonstrate that bilinguals activate representations from both languages during lexical access and that this co-activation may be influenced by lexical quality. But before this relationship is traced, there must be a robust foundation of word knowledge, which is built through reading.

Reading experience is considered a factor of individual difference when it comes to reading and language comprehension. For instance, individuals who read more frequently – and therefore are more experienced in reading – tend to demonstrate better text comprehension than less frequent readers. This is especially important when considering the literacy process in first or second language acquisition, as reading experience influences directly the quality of lexical representations in a readers' mind (PERFETTI, 2007). Exposure to a language through reading or conversations offers knowledge about lexical items and the opportunity to practice them. In other words, the use of a language works as lexicon practicing and growth. However, reading experience varies between people and, consequently, so do the characteristics of lexical representations:

> The profound differences in the amount of reading among individuals are sufficient to produce the degree of lexical quality differences observable at any given age. Such experience affects the quality of a given word and the number of words of a high quality. (PERFETTI; HART, 2002, p. 4)

These assumptions about reading experience from Lexical Quality Hypothesis have been tested. For instance, Taylor and Perfetti (2016) demonstrated that readers who were more experienced in reading and who had more knowledge about words and their constituents were able to use this knowledge in a more efficient way during reading. This efficiency was explained by higher lexical quality, which leads to more automatic and precise lexical access. Moreover, reading in both languages has an impact in L2 proficiency; namely, it is influenced by L1 reading volume and L1 print exposure (SPARKS, 2012). All these ideas emphasize the importance of reading habits and the need of access to diverse materials from both languages in order to improve vocabulary and reading skills.

Reading is also regulated by more general cognitive processes, such as working memory capacity, an executive function that plays a role in several everyday activities; this cognitive system is also responsible for processing and temporarily storaging information that

are used in complex cognitive tasks, such as reasoning, problem solving, and reading comprehension (BADDELEY, 2000, 2009; ENGLE, 2002, 2010; JUST; CARPENTER, 1992; RICKER et al., 2010; WATERS et al., 1987). Working memory depends on focus of attention and executive attention processes (COWAN, 1988, 1995; KANE et al., 2007), and relates to domain general processes, such as executive attention for enhancing or inhibiting information, and to domain specific processes, such as linguistic and phonologic ones (ENGLE, 2002). Some examples of its role in everyday activities include driving while at the same time talking to someone on the phone or in person; keeping a telephone number active in mind while looking for a piece of paper to write it down; and reading, which requires decoding linguistic signs and processing meanings.

Working memory capacity is also important for word recognition. It may aid bilinguals during disambiguation of words in sentences (ARÊAS DA LUZ FONTES; SCHWARTZ, 2011), and, in addition, may compensate for poor decoding ability (HAMILTON; FREED; LONG, 2016). Arêas da Luz Fontes and Schwartz's (2011) study demonstrated that bilingual participants with higher working memory capacity were able to reject more efficiently the irrelevant meaning of homonym words[2] across English and Spanish, while the ones with lower working memory capacity struggled during the same activity. Higher working memory capacity participants were faster in deciding which meaning of the homonym word was relevant for the sentence because they had more processing resources available during sentence comprehension. Moreover, Hamilton, Freed, and Long (2016) presented results which indicated that participants who had higher working memory capacity efficiently completed an inference generation task although they had lower word decoding ability, whereas lower working memory capacity participants who also had less word decoding ability exhibited difficulties during the task. Inference generation would be inhibited in a context of low decoding ability. However, higher working memory capacity was suggested to have compensated the word decoding limitation and allowed for inference generation through extra cognitive resources. These are some examples that illustrate the impact of working memory on reading by both monolinguals and bilinguals.

Considering the research topics discussed above, the focus of interest in this study is the lexical access of Brazilian Portuguese-English bilinguals and how this process may be influenced by related factors, namely reading experience and working memory capacity. More specifically, the main objective of this study is to investigate the influence of L1 and L2

[2] Homonym words are ambiguous words which have similar orthography but different meanings. Usually homonyms present two possible meanings, such as arms, which may mean "upper limbs" or "weapons".

reading experience and of working memory capacity on the quality of L2 lexical representations of Brazilian Portuguese-English bilinguals during an L2 meaning decision task. The first specific objective is to examine the influence of the L1 (Brazilian Portuguese) on the quality of L2 (English) lexical representations for homonym words, cognate or not with the L1. The second specific objective is to verify the effect of the L1 in the access to dominant and subordinate meanings of L2 homonym words. The third objective is to investigate the role of the L1 on the access to the meanings of L2 homonym words when these meanings are shared across languages (or not) and also primed (or not) by prime words. The fourth objective is to test the influence of reading experience in both the L1 and the L2 and of working memory capacity on the quality of L2 lexical representations for homonym words, cognate or not with the L1 as predictors of the performance in the meaning decision task. These goals and their respective hypotheses will be detailed in section 3.

2 THEORETICAL BACKGROUND

2.1 Lexical Quality Hypothesis

The LQH, in its origin, was based on a previous theory called Verbal Efficiency (PERFETTI, 1985). This theory stated that automatic word-level processes, that is, word identification skills, were the core of successful reading comprehension (PERFETTI; HART, 2001). Empirical support for that statement came from studies with children and adults, which linked lexical skills to reading comprehension. In general, Verbal Efficiency Theory predicts that "[most] problems in comprehension [arise] from ineffective lower level processes needed for the identification of words" (PERFETTI; HART, 2001, p. 67). This inefficiency may become clearer when considering the limitations of available processing resources as well. Verbal efficiency is the retrieval of a lexical item in a fast, easy, automatic, complete, and high-quality way. However, "[e]fficiency is not the same as speed" (PERFETTI, 2007, p. 359): it also involves the quality of the item being retrieved. This is explained by the LQH, which proposes that effective identification of words also depends on detailed lexical characteristics.

Lexical quality is defined as the reader's knowledge about orthographic, semantic, morphosyntactic, and pragmatic information of a word. Previously, Verbal Efficiency Theory included only semantic and phonetic information (PERFETTI; HART, 2001). Later, Perfetti and Hart (2001) presented three word constituents: the orthographic, phonological, and semantic-syntactic specifications. More recently, Perfetti (2007) explained that the quality of a lexical representation encompasses the quality of four features, or constituents – orthography, phonology, grammar, and meaning –, as well as the strength of a binding constituent. For a lexical representation to be high-quality, therefore, its four constituents must be precise, flexible, and well-bound to one another. These specifications sustain the stability of lexical representation and the coherence of its constituents. Thus, retrieval of a lexical item should be reliable and efficient. For example, knowledge about the word "cat" must be precise enough in order to differentiate it from "cap", but flexible enough to equate it to "four-legged meowing furry animal". The specification of every constituent increases the quality of representation of the word and, as a result, retrieval can be effective, that is, fast and encompassing all linguistic information available.

The importance of the specification of constituents can be illustrated with ambiguous words, which map onto more than one meaning, such as homonyms, homophones, and

homographs. Homonyms overlap in orthography and phonology (e.g. arms, which may mean "weapons" or "upper limbs"); homophones overlap in phonology (e.g. knight – night); homographs overlap in orthography (e.g. tear, which may mean "to pull apart" or "a drop of liquid from the eye" depending on the pronunciation). Using homophones, Perfetti and Hart (2001) constructed a meaning decision task to test the quality of lexical representations of less and more skilled readers. This task required participants to decide whether two words were related in meaning or not. For example, when presented with "king" and "royalty", participants should answer "yes"; when presented with "evening" and "royalty", they should answer "no". However, when presented with "night", which is a homophone with "knight", and "royalty", confusion is expected due to the phonological overlap between the words "night" and "knight" (PERFETTI; HART, 2001). The LQH predicts that skilled readers will suffer less interference from homophone words than less skilled readers.

Moreover, this hypothesis states that lexical quality depends on knowledge about words and also on practice with words, that is, reading activity. "[...] LQ depends on experience with words. A skilled comprehender has had more experience with a given word than has a less skilled reader, and this has important implications" (PERFETTI, 2007, p. 365). This may be applied to word frequency and word familiarity across readers, as well. Words vary in frequency of occurrence, and readers vary in their frequency of encountering words. This explains why a person who reads a lot may find and know more low-frequency words, and also high-frequency ones, than a person who does not read as much. Homophone words are a good example of the impact of frequency of words and of meanings. "Gate" is the high-frequency member of the pair "gate"-"gait". It can be expected that less skilled readers will suffer more interference from the low-frequency member, "gait", than skilled readers because of word frequency and reading experience. This illustrates the importance of frequency for processing ambiguity (PERFETTI; HART, 2001).

Perfetti and Hart (2001) used the meaning decision task coupled with a time-limited reading comprehension test to verify some of the predictions of the hypothesis. Participants were divided into two groups, according to their performance in the reading comprehension test. In general, less skilled readers reacted slower to both homophone and control words than skilled readers; they also showed confusion with both members of the pair of homophones. On the other hand, skilled readers suffered interference only from the low-frequency member of the word pair and earlier than less skilled readers. Target words were presented after prime words at three different stimulus onset asynchronies (SOAs): 150, 450, and 2000 ms. In the earliest SOA, skilled readers showed homophone confusion, which did not happen again.

However, less skilled readers demonstrated interference at 450 ms and release of confusion at 2000 ms. One interpretation of these results might be that activation and deactivation of competing forms is earlier and faster for skilled readers than for less skilled ones (PERFETTI; HART, 2001). This confirms the prediction that both word knowledge and word frequency have an effect in word processing.

Also according to Perfetti (2007, p. 377-8), high-quality lexical representations have consequences. These include accurate and fluent identification of words, the "resistance to form confusions, the ability to learn the meanings of new words, the retrieval of meanings of learned words, the stability of form representations, and the integration of words with text representations". Empirical evidence discussed below supports such predictions.

A recent study by Taylor and Perfetti (2016) used factor analysis to define how word knowledge and reading skills influence individual variability, and how this relates to reading behavior. In their first experiment, Taylor and Perfetti (2016) presented participants with text paragraphs, followed by true/false questions, and monitored their eye movements during reading. They also ran a factor analysis on the scores of a battery of 11 tests, including reading comprehension, decoding, reasoning, spelling, and reading history. Their goal was to identify individual differences related to reading behavior. Factor analysis resulted in five factors: reading experience, lexical knowledge, accuracy focus, learning and memory, and casual reading. The reading experience and the accuracy focus factors were associated to total length of viewing: more experienced readers presented shorter viewing times, and more attention to accuracy led to longer viewing times. Also, "the experience effect was stronger for the low accuracy focus readers" (TAYLOR; PERFETTI, 2016, p. 1082). Moreover, reading experience modulated the word frequency effect in that less reading experience increased total viewing times for low-frequency words. More experienced readers with higher lexical knowledge presented shorter fixation durations for high-frequency words, skipped words more frequently, and also re-read words less frequently.

In their second experiment, Taylor and Perfetti (2016) created a training paradigm with words in various levels of constituent specificity and frequency of exposure in order to define the contributions of each constituent to the lexical quality. The words which would be studied were rated according to familiarity and meaning. There were 6 training conditions: only orthography, only phonology, orthography and phonology, orthography and meaning, phonology and meaning, and orthography, phonology and meaning. Also, there were 3 exposure conditions: words were presented one, three, or five times during training. After training the words in isolation, participants read one sentence per studied word and had their

eye movements recorded. Orthography training increased first fixations for less-experienced readers, producing an exposure effect, that is, the higher the number of exposures, the stronger the influence on eye-tracking measures. This was not found for phonology and meaning training neither for more experienced readers. Phonology training was modulated by lexical knowledge and reading experience in that readers with low lexical knowledge or less experience were more benefited than readers with high-lexical knowledge or more experience, but only after multiple exposures. Meaning training was also modulated by experience: less experienced readers re-read words more frequently than more experienced readers, who also spent less time reading the words. The experience factor had different and limited effects; more experienced readers were more benefited from meaning training than less experienced readers, who were only benefited from a higher number of word exposure. The lexical knowledge factor seemed to be the most influential one, associated with phonology; as phonological training increased, eye movements became more efficient, that is, there were shorter fixations durations and less refixations. Overall, their results showed that, initially, word form information (orthography and phonology) slowed down first passes, but when meaning was added to the model the probability of re-reading a word decreased for more experienced readers. Also, less lexical knowledge influenced readers in that the addition of another constituent to the model slowed them down. Moreover, more experienced readers benefited more from the same number of word exposures than less experienced readers. Finally, the most influential factors on the reading behavior were reading experience and word knowledge. More experienced readers are quicker in the use of lexical information during reading and in the use of phonological information to improve lexical quality (TAYLOR; PERFETTI, 2016). All these results are in accordance with the idea that word knowledge is essential for reading and, consequently, with the LQH. They are evidence that more skilled readers are more accurate and fluent in their reading and are better in retrieving the meanings of learned words than less skilled ones.

Further evidence to LQH was presented by Burt and Jared (2015), who carried out two experiments with homophones to investigate how lexical expertise affects the processing of those words. In their first experiment, the authors asked participants to read homophonic and non-homophonic words and decide if they were words or not. Lexical experts were expected to activate more quickly both members of the homophone pair, and resolve any confusion more quickly than non-experts. In fact, lexical experts made decisions significantly faster than non-experts. Further, homophone effect was influenced by non-word naming and the spelling test scores. In the second experiment, participants had to decide if the words being visually

presented had a homophone counterpart or not. Once more, lexical experts were expected to be more accurate than non-experts, especially when the homophone was a high-frequency word. Precisely, lexical experts performed much better than non-experts when detecting homophones, with extra ease when the counterpart words were high-frequency ones. Moreover, non-experts also better identified homophones when their counterpart was a high-frequency word, but showed difficulty when rejecting a high-frequency control word. The study by Burt and Jared (2015) presents evidence that lexical experts are more accurate and more fluent readers than non-experts due to their lexical representations being more precise and more tightly bound together.

In another study, Brinchmann, Hjetland, and Lyster (2015) tested the effects of a word knowledge training program on poor readers' language and literacy skills. Third- and fourth-grade students participated in a 10-week intervention program taught by their teachers in their schools. There were 30 sessions of 60 minutes each, three times per week, with groups of 5 to 9 students. One theme subject, one short text, and three target words from the text were assigned to the sessions in each week. During the sessions, students read and discussed the text, completed semantic, syntactic, and morphological activities, and played games involving the three target words. Moreover, participants were assessed in terms of language, literacy and cognitive skills before and after the intervention program. The results indicated significant treatment effects for four measures: morphology, sentence formulation, vocabulary, and reading comprehension. However, there was no improvement or decrease in the decoding measure for any of the groups. The authors explained that word decoding was only partly taught by the morphology activities and that reading and discussing the texts may have led the treatment group to focus more on meaning. The study by Brinchmann, Hjetland, and Lyster (2015) corroborates the LQH in that instruction about word constituents may improve the learning and retrieval of new words.

On the same note, Oslund, Clemens, Simmons, and Simmons (2018) were interested in the direct and indirect influences of word reading and vocabulary in reading comprehension, more specifically through reading efficiency and inference-making. Participants were divided into struggling and adequate comprehenders and assessed on reading comprehension, vocabulary, word reading, inference-making, and silent reading tests. Vocabulary and word reading directly predicted reading comprehension in both groups. Vocabulary also presented the largest indirect effect on reading comprehension. Generally, vocabulary had a more important role for adequate comprehenders, while word reading influenced more struggling comprehenders. These results might be evidence that lexical

quality influences reading comprehension in different ways depending on the reader's individual characteristics.

Still on topic of word reading and reading comprehension, Andrews and Bond (2009) investigated top-down and bottom-up approaches to reading through the study of individual differences on written language expertise. Participants completed a reading comprehension test, two spelling tests, and a probe memory task based on Gernsbacher's materials (GERNSBACHER; FAUST, 1991; GERNSBACHER; ROBERTSON, 1995; GERNSBACHER; VARNER; FAUST, 1990). The task was composed of plausible and implausible sentences, ending in a homograph probe word, followed by a target word which could be congruous or incongruous, and related or not, to the meanings of the ambiguous probe word. Participants were instructed to decide whether the target word had appeared in the sentence or not. Good spellers suffered less interference from the related target word than poor spellers. Also, good spellers depended less on the context of the sentence to make decisions at the end of the sentence. On the other hand, poor spellers were slower in deciding on the target word because they relied more on sentence meaning. In addition, when sentences were presented at faster rates (150 ms), poor spellers demonstrated interference only for congruous target words. When sentences were presented at slower rates (300 ms), all participants suffered interference. These results are evidence of the LQH for they demonstrate that high-quality lexical representations contribute to accuracy and fluency in reading and to the integration of word meanings in a sentence.

At last, Martin-Chang, Ouellette, and Madden (2014) were interested in the hypothesis that lexical quality of orthographic representations was directly related to reading speed. Participants completed a spelling test, a word reading efficiency test, and a reading response time task with 20 words which were very hard to spell and 10 filler easier ones. After 7 days, participants took a spelling dictation test of the words presented in the task. Results demonstrated that words which were misspelled were also read more slowly than words which were correctly spelled, and that words which presented a more stable and coherent representation were read faster. Furthermore, spelling ability and reading rates were negatively correlated, which indicates better spellers really are faster in reading. The authors explained that this data illustrates how low-quality lexical representations can still be read and what the consequences are for a partially specified orthographic form.

As the previous studies showed, high-quality lexical presentations have positive consequences to the reading process. In sum, they help readers avoid confusion when they meet ambiguity, facilitate the learning of new words and retrieval of known ones, and work in

the integration of meanings in sentences and in texts (PERFETTI, 2007). Fully-specified and tightly-bound word constituents contribute to reading comprehension in that they automatize lexical access and free higher order resources, such as working memory, to work on more complex tasks, such as inference-making (PERFETTI; HART, 2001).

There is evidence demonstrating that the high quality of lexical representations diminishes interference from homograph words. Andrews and Bond (2009) explained that good spellers were less dependent on sentence context and top-down information when solving lexical ambiguity in a sentence as opposed to poorer spellers, who relied much more on context. These results corroborate with a prediction of the LQH that high-quality representations clear demands of higher order processes in order to solve ambiguity.

Additionally, low quality of lexical representations is suggested to increase interferences. Martin-Chang, Ouellette, and Madden's (2014) study showed that the words which participants were not able to spell correctly were also read more slowly than the ones spelled correctly. Thus, reading speed was considered a function of spelling accuracy. This depicts the importance of a fully-specified lexical constituent for efficient reading.

Moreover, lexical quality is shown to direct and indirectly predict reading comprehension. Oslund et al. (2018) demonstrated that vocabulary and word reading measures were able to directly predict reading comprehension for poor and for good comprehenders. Vocabulary was also the strongest indirect predictor of reading comprehension in their model. Similarly to Oslund et al.'s (2018) study with monolinguals, Lervag and Aukrust (2010) investigated monolinguals and bilinguals longitudinally in relation to the growth of their reading comprehension. Results showed that vocabulary and decoding skills predicted beginning reading comprehension skills both for monolinguals and bilinguals, although bilinguals' growth was slower than monolinguals' due to differences in vocabulary. Similarly, Raudszus, Segers, and Verhoeven (2018) presented evidence that both monolinguals and bilinguals' reading comprehension is indirectly, via syntactic integration, and directly predicted by lexical quality.

Although many aspects of the relationship between lexical quality and reading comprehension have already been investigated, most of them were tested on monolingual participants. Only two of the previously mentioned studies were interested in the effects that a second language may generate on the specification of word constituents. Lervag and Aukrust (2010) suggested that the growth of reading comprehension for bilinguals is slower than for monolinguals. However, this difference may be explained by the role that vocabulary plays in reading skills. Decoding skills are essential in the early stages of reading comprehension for

both monolinguals and bilinguals. As these skills are developed and automatized over time, vocabulary begins to play a more influential role instead. Usually, this is where monolinguals and bilinguals differ the most: vocabulary size. Due to a larger and richer vocabulary that allows more practice with reading, which in turn helps expanding the vocabulary, monolinguals reach a specific level of reading comprehension faster than bilinguals (LERVAG; AUKRUST, 2010). Furthermore, Raudszus, Segers, and Verhoeven (2018) showed that lexical quality, tested with vocabulary and decoding tests, is an indirect, via syntactic integration, and a direct predictor of reading comprehension for both monolinguals and bilinguals. They also found that L1 vocabulary has impact on L2 reading, which indicates that a richer vocabulary in L1 may help to learn new words (LERVAG; AUKRUST, 2010) and to acquire an L2. Bilinguals may fall behind in vocabulary and syntactic integration tasks in their L2 compared to monolinguals, but they are faster decoders, which may help vocabulary growth (RAUDSZUS; SEGERS; VERHOEVEN, 2018).

Another study concerning bilinguals was Pulido's (2007). She investigated whether intake, gain and retention of new vocabulary depended on the level of text comprehension and on topic familiarity. Participants read narrative passages about various topics and then wrote down everything they remembered about the texts. Some key words in these texts were replaced by nonsense words so that participants' intake, gain and retention, translation production and recognition could be tested. An L2 reading proficiency test and a topic familiarity rating questionnaire were also included. Results demonstrated that better passage comprehension, that is, recall of information and semantic propositions, indicated higher gain and retention of the nonsense words presented in those texts. Also, weaker readers recalled less nonsense words than better readers. Moreover, familiarity with the passage topic did not change the contribution of text comprehension for vocabulary gain and retention. These findings corroborate the idea that word knowledge depends on word frequency, which depends on reading experience. Better text comprehension is beneficial to the learning of new words or to the specification of word constituents, and vice-versa. Pulido (2007) demonstrated that this statement is also true for English-Spanish bilinguals.

Finally, the quality of lexical representations should be considered in both languages of a bilingual due to the co-activation of representations from L1 and L2 (DIJKSTRA; VAN HEUVEN, 2002; SCHWARTZ; KROLL; DIAZ, 2014). Just as homophones and homographs cause confusion for monolinguals, interlingual ambiguous words create interference during reading for bilinguals (ARÊAS DA LUZ FONTES; SCHWARTZ, 2015; DURLIK; SZEWCZYK; MUSZYNSKI; WODNIECKA, 2016). There are only a few studies

concerning the impact of language co-activation – through the use of cognate words or interlingual homographs and homophones – on the quality of lexical representations of bilinguals. There is a gap in research concerning cross-linguistic lexical quality since most studies on lexical quality investigated monolinguals and the ones which focused on bilinguals did not manipulate stimuli in a meaning decision task, for example, in order to verify the impact of language co-activation.

2.2 Bilingual lexical access

There is ample evidence that lexical representations of both languages in a bilingual are always active in word recognition. In other words, research has shown that bilinguals are not able to "turn off" one of their languages during reading and listening. This means that, unlike monolinguals, whose lexical representations refer to only one language, bilinguals co-activate representations of a lexical item from both languages during lexical access. This phenomenon is explained by the language non-selectivity hypothesis, which states that lexicons from both languages are interconnected or integrated in one lexicon (LAGROU; HARTSUIKER; DUYCK, 2015; TOKOWICZ, 2015; VAN HEUVEN; DIJKSTRA, 2010).

One of the first studies to present evidence that languages could be co-activated came from Spivey and Marian (1999 apud TOKOWICZ, 2015). They instructed Russian-English participants to move a series of objects to a different location. The objects were manipulated in a way that some had a name which began with a similar sound to the name of a competitor object in the other language. For instance, "marker" and "*marku*", which is Russian for "stamp". During the task, participants looked more at competitor objects than control objects although the entire testing session was held in only one language – English. The authors explained that the interference from the competitor item in Russian happened due to the parallel activation of the other language, more specifically the co-activation of phonological representations.

Language non-selectivity can be detected via the overlap between lexical items. Words across languages can share orthographic, phonological, and/or semantic representations. For example, interlingual homophones share pronunciation, interlingual homographs share spelling, and interlingual homonyms share spelling and meaning. Form representations can co-activate forms shared across languages (DIJKSTRA; VAN JAARSVELD; TEN BRINKE, 1998 apud DE BRUIJN; DIJKSTRA; CHWILLA; SCHRIEFERS, 2001) as well as semantic

representations can activate meanings which overlap across languages (DIJKSTRA; GRAINGER; VAN HEUVEN, 1999).

The processing of cognate words illustrates well the co-activation of languages (TOKOWICZ, 2015). Cognates share orthography, sometimes phonology, and especially meaning between languages. For instance, “piano”, “horror”, and “final” are cognates across English and Brazilian Portuguese because they perfectly share orthographic and semantic representations. The overlap across languages for cognate words provides advantages during their processing. Many studies demonstrate that words which share orthography and meaning facilitate lexical access (DIJKSTRA; GRAINGER; VAN HEUVEN, 1999; BRENDERS; VAN HELL; DIJKSTRA, 2011; POARCH; VAN HELL, 2014). This facilitation effect is suggested to be due to overlap between meaning and conceptual representations across languages (TOKOWICZ, 2015).

There is evidence of language co-activation in tasks of word naming, lexical decision, progressive demasking, sentence listening, and sentence reading. Most results point to cognate facilitation and homophone interference effects. However, there is conflicting evidence indicating homograph facilitation and interference, homophone facilitation, and absence of cognate facilitation effects. Generally, those effects add evidence supporting the language non-selectivity hypothesis. For instance, Dijkstra, Grainger, and van Heuven (1999) investigated the influence of the degree of overlap between English and Dutch cognate words and false friends on word recognition with Dutch-English participants. Words could share one or more of the following constituents: orthography, phonology, and meaning. The first experiment was a progressive demasking task and the second was a lexical decision task. Results from both experiments demonstrated that an overlap in semantics and orthography leads to a facilitation effect, while shared phonology causes interference. The authors emphasized that the results are in favor of a language non-selectivity account of word recognition because the three types of linguistic codes had an impact on reaction times. Moreover, they added that the effects of cross-linguistic similarity are task-independent. This conclusion was motivated by the similarity between regression equations for experiments 1 and 2, which used different tasks.

Similarly, Schwartz, Kroll, and Diaz (2007) were interested in whether the cognate effect could be influenced by the degree of overlap between lexical representations and by the language of production. They selected pairs of cognate words across English and Spanish which varied in graphemic similarity, verified through Van Orden’s (1987) algorithm. Also, a separate group of monolinguals rated the phonological similarity of the cognates across

languages. Bilingual participants named cognate and non-cognate words in English in one block of trials and in Spanish in the other block as fast as they could. The results indicated that participants named cognate words, which presented a high degree of orthographic similarity between languages, slower when those words had low phonological similarity than when they shared a higher number of phonological features. Also, this occurred for words in English and in Spanish. However, results for longer reaction times when there was low orthographic overlap but high phonological overlap were only a trend and were not significant. Still, the authors emphasized that this study is in agreement with others in the area in that this unbalanced overlap of orthographic and phonological representations may produce competition between representations. One consequence of this unbalanced activation is that the competition of representation will be dependent on the flow of activation, whether it comes from one language to the other and from one representation to the other (SCHWARTZ; KROLL; DIAZ, 2007).

Friesen, Jared, and Haigh (2014) were also interested in the co-activation of lexical representations and the language of production. They investigated the effects of the activation of a non-target language during word naming of cognates, interlingual homographs and homophones. In the first experiment, the authors tested whether there was a change in response times in naming words in one language after having named in the other. English-French participants had more difficulty naming homographs over control words when reading in the L1 and in the L2. Moreover, there were cognate and homophone facilitation effects only when participants named words in French. In the second experiment, French-English participants completed the same task as in experiment one. The results showed a small homograph interference effect, and cognate facilitation effects when naming in the L1. Also, there were both a homograph and a homophone interference effect when naming in L2. However, there was no cognate facilitation effect when reading in the L2; in fact, results pointed to a non-significant inhibition effect. The authors explain that this last outcome corroborates with Pivneva, Mercier, and Titone (2014) in that higher L2 proficiency seems to reduce the facilitation effect from cognate words. The strongest co-activation evidence was visible when participants named in their L2. The interference effect from homographs happened due to the overlap in orthography but not in meaning. On the other hand, the facilitation effect from cognates was due to overlap in orthography and also meaning. While interlingual homographs create competition between two different lexical representations, cognates should activate the similar representations. Nevertheless, according to the results in

Friesen, Jared, and Haigh's study, it is possible that this cognate facilitation occurs only to an L2 which is weaker than the L1.

A similar pattern concerning the cognate effect was found in Arêas da Luz Fontes and Schwartz's study (2015). In the first experiment, the authors examined the predictive power of homonym processing in the L1, working memory capacity, and sensitivity to cross-language form overlap on lexical ambiguity resolution in an L2. Spanish-English bilinguals participated in a primed lexical decision task in which the pairs of words were manipulated to fit one of the following conditions: cognate homonym (cabinet-KITCHEN), non-cognate homonym (chest-HAIR), cognate non-homonym (actor-STAGE), non-cognate non-homonym (breath-LUNG). Target words could be related to the dominant (chest-HAIR) or the subordinate[3] (chest-TREASURE) meaning of homonym words, or be unrelated to the prime. First, the ability to identify meanings related to the subordinate meaning of a homonym word in the L1 predicted the ability to identify meanings related to the subordinate meaning of a homonym word in the L2. Second, counterintuitively, a higher cognate effect, that is, a facilitation effect, was related to increased error rates. In the second experiment, the pairs of words used in the first experiment were inserted in sentence context to verify if the same effects would be observed. Sentences had a neutral context or a subordinate-biased context. The results indicated that the access to subordinate meanings of homonym words in the L1 strongly predicted the access to subordinate meanings in the L2 both in neutral and biased sentence contexts and for cognate and non-cognate words. Also, high span participants presented longer fixation durations on cognate words. The authors point that more accurate participants in experiment 1 and more efficient ones in experiment 2 had less impact from cognate facilitation effect. These findings are in consonance with the ones from Friesen, Jared, and Haigh (2014).

In addition, it is important to mention that, in the study by Arêas da Luz Fontes and Schwartz (2015), cognate words influenced the activation of subordinate meanings in sentences. Subordinate meanings of homonym words tend to occur less frequently than dominant meanings. Consequently, they take longer to be activated than dominant meanings. However, the study indicated that when subordinate meanings were shared across languages, their activation was stronger than when they were not shared. This more intense activation was able to create competition between subordinate and dominant meanings, which might not

[3] Homonym words usually have two different meanings: a dominant meaning, which is the most frequent one, and a subordinate meaning, which is the less frequent one.

have happened if only frequency of occurrence was considered. A similar result is expected in the present study. This will be detailed in section 2.5.

Still focusing on language co-activation with cognate words, Brenders, van Hell, and Dijkstra (2011) studied word recognition in Dutch children who were learning an L2 (English). The authors carried out two experiments with cognate words, and one with cognates and also false friends as stimuli. Participants were recruited from primary and secondary schools and their L2 proficiencies varied from beginning to advanced. In the first experiment, participants were divided in three groups according to L2 proficiency and were presented with cognate words, control words, and pseudo-words in English and had to decide whether they were a word in English or not. Results indicate cognate facilitation for all participants. In the second experiment, three new groups of participants completed the same task as in experiment 1. However, it was entirely in Dutch now. No cognate facilitation was found. In the third experiment, false friends were added to the task from experiment 1. Participants came from the fifth, seventh and ninth grades, and participants from the fifth grade were tested in three different times in a year, according to the beginning of their English instruction. The results from the cross-sectional analysis showed that both cognate words and false friends were recognized slower than control words. In addition, inhibition from cognates and false friends decreased as L2 proficiency increased. The results from the longitudinal analysis demonstrated that participants' performance on cognate words and false friends improved over time but that the magnitude of the inhibition did not decrease. Brenders, van Hell, and Dijkstra explained that the co-activation of lexical representations from L2 are comparable to effects found for adults and support the language non-selectivity hypothesis. The cognate facilitation seen in the first experiment became cognate inhibition as false friends were added to the task. A beginner L2 learner may treat both cognates and false friends with caution when they are present in the same item list. On the other hand, a more proficient bilingual may not need to pay extra attention to both cognates and false cognates due to greater experience with words (BRENDERS; VAN HELL; DIJKSTRA, 2011).

Turning from overlap in meaning to overlap in phonology, Carrasco-Ortiz, Midgley, and Frenck-Mestre (2012) examined silent reading of interlingual homophones using event-related potentials (ERPs). French-English bilinguals and English monolinguals read a list of English homophones, control, and filler words while their brain activity was being monitored. Results showed a reduction in the N400 amplitude only for bilinguals with homophones but not with control words. This N400 reduction was interpreted by the authors as an indication of greater ease of word processing. In other words, bilinguals activated phonological

representations in parallel even in silent reading, and this co-activation produced an advantage in the recognition of homophones. The authors explain that this could be caused by a high degree of phonological overlap between the homophones (76% overall) and, secondarily, by controlled-for orthographic overlap (40% overall). These results seem to corroborate the ones from Schwartz, Kroll, and Diaz (2007), although the latter reported only a trend. Considering the Bilingual Interactive Activation Plus Model (BIA+; DIJKSTRA; VAN HEUVEN, 2002), which will be addressed below, Carrasco-Ortiz, Midgley, and Frenck-Mestre hypothesized that the accumulation of similar units from each word constituent or code could have strengthened the activation of the critical stimuli.

The previously described studies present evidence in support of the language non-selectivity hypothesis, although there are some specific inconsistencies to solve. Some of these studies use the Bilingual Interactive Activation Plus Model (BIA+; DIJKSTRA; VAN HEUVEN, 2002) to explain their results. The BIA+ Model is an extension of the BIA Model (DIJKSTRA; VAN HEUVEN, 1998; DIJKSTRA; VAN HEUVEN; GRAINGER, 1998; VAN HEUVEN; DIJKSTRA; GRAINGER, 1998). The BIA+ Model differs from the BIA Model basically concerning the language nodes, the addition of a task/decision system, and the inclusion of phonological and semantic representations; its other features still fit into the BIA+ model.

The BIA model postulates the existence of one integrated lexicon between languages and that access to this lexicon is language non-selective. In other words, the activation of one lexical item in one language leads to the activation in parallel of a similar or competing lexical item in the other language. Originally, these assumptions were focused on orthographic representations. To solve this limitation, phonological and semantic representations were added to the BIA+, although the authors make it clear that the implementation of three word codes in a model is not simple (DIJKSTRA; VAN HEUVEN, 2002). The BIA and the BIA+ models were inspired in connectionist networks and they posit that visual word recognition starts with features which will activate letters which will activate words. Letters inhibit other letters for which those features were absent, and words inhibit words which do not fit the available description. Words, then, send activation to the language nodes. In the BIA model, the language nodes were responsible for four functions, two of which were linguistic and two non-linguistic. They could tag words with their respective language, collect activation globally for the whole language, act as a filter and modulate language activation during experiments, and collect activation from the context. In the BIA+ model, the language nodes lost the two non-linguistic functions and now are responsible for

controlling the language membership of lexical representations in the identification system and maintaining the global lexical activation of the language.

Figure 1 - The Bilingual Interactive Activation (BIA) model

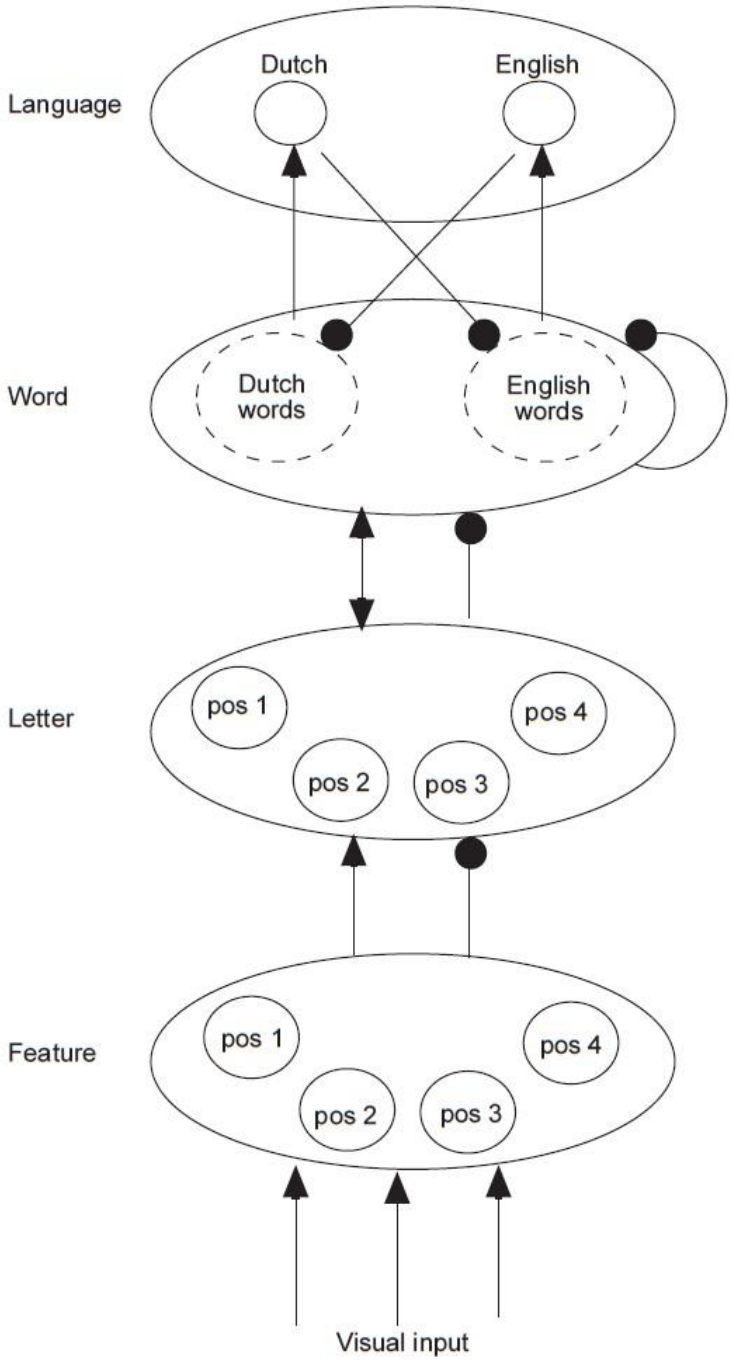

Figure 1. The Bilingual Interactive Activation (BIA) model for bilingual word recognition. Arrowheads indicate excitatory connections; black filled circles indicate inhibitory connections.

Source: Dijkstra and van Heuven (2002).

The BIA+ model also separates the word recognition system from a task/decision system. The latter was inspired in Green's (1998 apud DIJKSTRA; VAN HEUVEN, 2002) work with the Inhibition Control model and the task control which bilinguals should have when processing language in varied conditions. The word recognition system is responsible for dealing with linguistic context effects, such as sentence context information. Furthermore, the word recognition system can interact with semantic and syntactic information from the sentence context independently of language. In other words, word recognition can be influenced by word frequency and by semantic sentence constraint within and across languages. In sum, "syntactic and semantic effects are language non-selective, just as word recognition is language non-selective" (DIJKSTRA; VAN HEUVEN, 2002, p. 188). Conversely, the task/decision system tackles non-linguistic context effects, such as participants' expectations, instructions during a testing session, and also task demands. In addition, the BIA+ model states that non-linguistic information cannot influence activity in the word recognition system, but instead it guides the system into modifying the decision criteria. For example, considering that languages co-activate and cannot be voluntarily turned off, if there is a change in stimuli from one experiment to the other, the participant may have to modify their strategy, and an effect will be seen only in critical items. On the other hand, if the activation could be controlled, then the effect would be the same for control items too. Dijkstra and van Heuven (2002) emphasize that evidence points to the first possibility.

The activation of orthographic codes in the BIA+ model is dependent on mainly two factors: the degree of code overlap between input and lexical item in the mental lexicon, and subjective word frequency. Thus, many candidates may be initially activated, but only the ones which share the most features with the input. The rule of activation via code overlap also occurs across languages. For instance, homograph and cognate words share orthographic representations between languages. For this reason, they are recognized faster than non-homograph or non-cognate words even if the code overlap is partial. Moreover, subjective frequency has an influence on activation of orthographic codes due to its contribution to the resting level activation. This means that an orthographic form which is frequently encountered can be activated much easier as the minimum level of necessary activation is lower (DIJKSTRA; VAN HEUVEN, 2002).

Figure 2 - The BIA+ model for bilingual word recognition

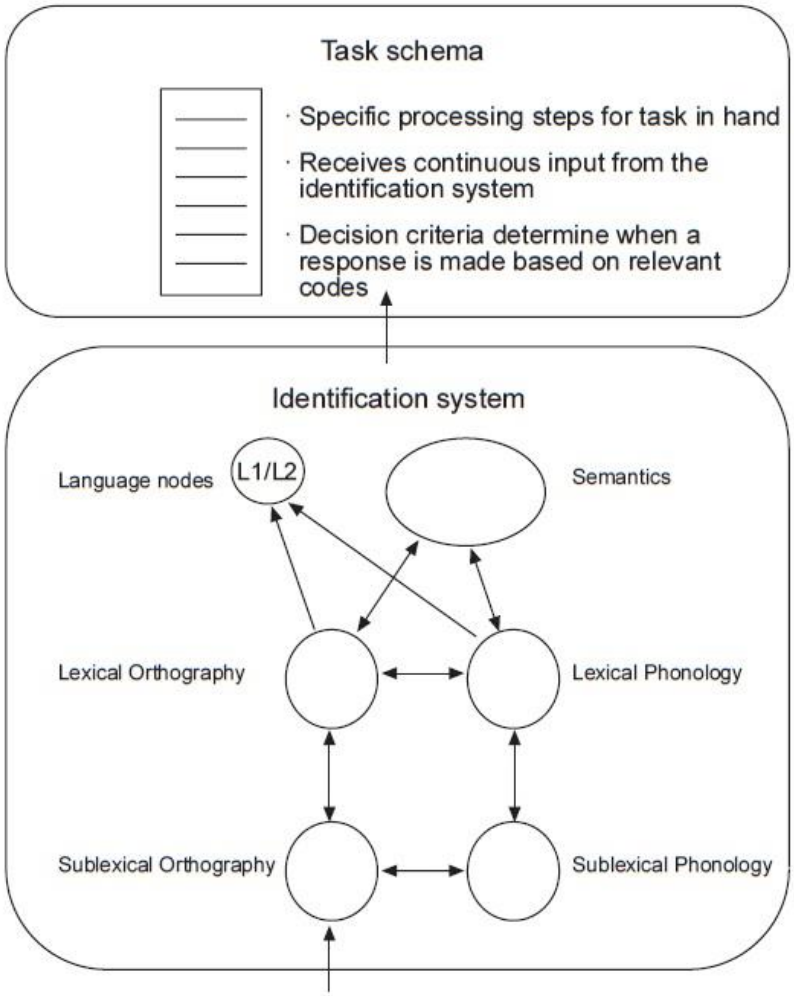

Figure 2. The BIA+ model for bilingual word recognition. Arrows indicate activation flows between representational pools. Inhibitory connections within pools are omitted. Language nodes could instead be attached to lemma representations between word form and meaning representations. Non-linguistic context only affects the task schema level.

Source: Dijkstra and van Heuven (2002).

Additionally, the BIA+ model states that the representation of interlingual homographs should hold two orthographic representations. If it was the case of only one orthographic representation, then frequency effects between interlingual homographs should be cumulative. However, evidence shows that this is not the case; frequency effects vary across the representations of interlingual homographs. Along with a special representation for homographs, the BIA+ model includes one for cognate words. For this model, it is the overlap in orthographic, semantic and sometimes phonological representations that make cognates so

unique (TOKOWICZ, 2015). There is one hypothesis which posits that cognates present a special morphological representation across languages. However, if that was the case, sentence constraint should not modify their processing. Tokowicz (2015) mentions the studies by Schwartz and Kroll (2006) and by van Hell and de Groot (2008), both of which indicated that the cognate effect was modulated by sentence semantic constraint. The view that cognate words have advantages during processing due to higher degree of overlap between their orthographic and semantic representations is in accordance with the BIA+ model in that shared information makes it easier to recognize their features and then to activate them.

The code overlap in cognates produces a facilitation effect, at least for beginner and intermediate L2 learners. Generally, homograph and homophone words are shown to produce an inhibition effect, but there is evidence of the opposite effect as well. Homograph and homophone words are one type of ambiguous words since they map onto two or more meanings. Polysemic and homonym words are other examples of ambiguity in that the former has multiple meanings related to one central meaning (e.g. point) and the latter has two mostly unrelated meanings (e.g. fast). Considering that one-to-two mappings can cause inhibition during word recognition, it is relevant to recover the idea that ambiguous words can be a risk to lexical quality (PERFETTI; HART, 2001). It is so because readers need to fully specify both mappings in order to hamper any interference during reading. Otherwise, two different semantic and orthographic or phonological representations may compete and slow down lexical access. When it comes to bilinguals, ambiguity happens within and also across languages. For instance, “bank” is both a homonym in English and a cognate between English and Brazilian Portuguese; it maps onto more than one meaning in both languages. Moreover, the frequency of occurrence of those meanings varies within languages and across them as well. The more frequent meaning is called the dominant one, while the less frequent one is named the subordinate one.

Although ambiguous words may cause problems during reading comprehension, bilingual readers are able to solve the mapping of many meanings. Cognate words, as in the previous example, usually help this resolution. However, there may be an interaction of factors involved in this process. As mentioned above, Arêas da Luz Fontes and Schwartz (2015) investigated how the access to subordinate meanings of L2 homonyms, cognate and non-cognate, could be influenced by the access to subordinate meanings of L1 homonyms, working memory capacity, and the strength of the cognate facilitation effect. A primed lexical decision task indicated that ambiguity resolution is underlined by the same mechanisms in the L1 and the L2, and showed that cognate words may lead participants to rely too much on

form, causing an increase in errors. However, when the same stimuli were inserted in subordinate-biased sentences, the cognate effect disappeared; in neutral sentences, only less efficient readers reflected the cognate effect. These findings showed that ambiguity resolution in an L2 is influenced by cross-language activation (i.e. cognate words), by access to meanings in the L1, context-biased sentences, and also working memory capacity.

Another factor was studied by Durlik, Szewczyk, Muszynski, and Wodniecka (2016). They examined the influence of L2 proficiency in the inhibition effect caused by interlingual homographs between English and Polish. The authors used the semantic relatedness judgment task, a paradigm developed by Macizo, Bajo, and Martin (2010 apud DURLIK et al., 2016) which requires participants to decide if the pairs of words were related in meaning or not. The task was entirely in English and was composed of two types of word pairs. Pair 1 contained two words unrelated in meaning in English, but the second word was also a homograph in Polish whose meaning was related to the meaning of the first word of the pair (e.g. cat-pies, "pies" means dog in Polish). The control pair 1 had no homograph (e.g. cat-art). Pair 2 contained two words related in meaning in English, but the second word was a translation into English from the previous Polish homograph (collar-dog). The control pair 2 had no translation from the previous homograph (e.g. collar-neck). Participants' L2 proficiency level was assessed via LexTALE. The authors expected longer reaction times for pairs containing homographs and also longer reaction times when comparing the homograph pair with the translation pair due to reactivation of the irrelevant Polish meaning. In fact, reaction to pairs with homographs was slower than to pairs without homographs. However, the comparisons between both the homograph-translation pairs and the homograph-non-translation pairs produced longer reaction times. Moreover, contrarily to expectations, L2 proficiency did not affect the inhibition effects. The authors included correlations between the results and working memory capacity, IQ, and non-linguistic cognitive control, none of which were significant. One possible explanation is that Durlik et al.'s (2016) participants were less balanced and less proficient in their L2 compared to previous studies, which observed the expected results. An alternative is that the homograph word activated a semantic category instead of only two meanings, and this semantic category accentuated the inhibition effect. These results corroborate the language non-selectivity hypothesis and also indicate that interlingual homographs may cause interference in a broader way, inhibiting semantic categories.

There is evidence for the influence of proficiency in co-activation of languages. Friesen, Jared, and Haigh (2014), as previously mentioned, showed that L2 proficiency seems

to modulate the cognate facilitation effect. In this case, participants who were highly proficient in their L2 did not present any facilitation from cognates, while less proficient participants did. This is in line with the findings from Pivneva, Mercier, and Titone (2014) in that higher proficiency is suggested to decrease the cognate facilitation effect, which should be taken into account in bilingual studies.

Contrarily to Durlik et al. (2016) and Friesen, Jared, and Haigh (2014), de Bruijn, Dijkstra, Chwilla, and Schriefers (2001) observed homograph facilitation effects during a semantic priming task using ERPs. They were interested in whether the semantic representation of homographs between English and Dutch was automatically activated during reading or whether this activation depended on context. Dutch-English participants completed a version of the Generalized Visual Lexical Decision Task with three words, in which they were required to answer "yes" if the three items were words either in Dutch or in English, and "no" if one of the items was not a word in any of those two languages. The first word of the triplets was either in English or Dutch and defined the context. The next two words were the homograph and a word related or not in meaning, so that the homograph would prime the related word. For instance, in "house-angel-heaven", "angel" would prime "heaven", while in "house-angel-bush", "angel" would not prime "bush". Also, if the activation of English meanings of homographs depended on context, then "zaak-angel-heaven" should elicit different reaction times (RTs) and N400 amplitudes compared to "house-angel-heaven". Results indicated significant RT and N400 semantic priming effects, which were not affected by the language of the prime words. The authors emphasized that this suggests that the activation of homographs mainly occurs via bottom-up processes, which is in line with the BIA+ model's assumptions.

Despite the many inconsistencies in the direction of homograph and homophone effects, indications about the access to ambiguous words can be drawn from the mentioned studies. As Arêas da Luz Fontes and Schwartz (2015) suggested, access to L2 items is predicted by access to L1 items. Resuming a discussion about the LQH, this approach would explain the influence of L1 word processing in L2 word processing through experience with words. Considering that such a result is evidence that the same cognitive mechanism underlies lexical access in the L1 and in the L2, and that an automatized bottom-up process is responsible for recognition of high-quality lexical representations, which depends on reading, it is also possible to admit the same rationale to access to L2 items. Moreover, Durlik et al. (2016) and Friesen, Jared, and Haigh (2014) indicated that cognate facilitation effects may be modulated by L2 proficiency. The automatization of recognition processes is part of a higher

efficiency in a language (PERFETTI; HART, 2002). Under the LQH view, an expert reader would not need to rely on overlap between languages provided by cognate words if they had efficient (and proficient) word recognition skills. Also, in accordance to Durlik et al. (2016), inhibition may spread to an entire semantic category and/or may be influenced by proficiency. This may be the case of confusion spreading due to low lexical quality of semantic representations. The inhibition caused by a related meaning which is not explicit in the task may have escalated to any similar meaning. This similarity may have produced an overlap in semantic representations, which were not well defined. Lastly, Carrasco-Ortiz, Midgley, and Frenck-Mestre (2012) and de Bruijn et al. (2001) suggested that word processing advantages may occur even when an ambiguous word maps onto two meanings. These results are not anticipated by the LQH. In fact, this approach would predict inhibition, unless all word constituents were fully-specified. However, this latter condition was not verified in the studies, and conflicting evidence remains.

The same problems which may arise from low lexical quality in monolinguals may happen for bilinguals, especially across languages. Considering the interference from homographs in sentence context observed by Andrews and Bond (2009), as mentioned in the previous section, one could wonder about the influence of the co-activation of a bilingual's languages on ambiguity resolution and ambiguous word recognition. The LQH and the BIA+ model seem to converge in many aspects of lexical access, thus they should be further studied together.

2.3 Reading experience

According to Perfetti (2007, p. 3), reading experience is the "effective practice" of the knowledge about word constituents. This concept is one of the factors which affect lexical quality. In other words, the quality of representations can vary across words and across readers due to differences in reading experience and in language experience (PERFETTI, 2007), which presents the readers with useful word knowledge (PERFETTI; HART, 2002). The variation in lexical quality depends on word frequency. A high-frequency word for a frequent reader will be easily accessed due to many encounters which contributed to fully-specified constituents. However, a low-frequency word for an occasional reader will cause confusion and disruption in reading. Perfetti and Hart (2001) observed these frequency effects for pairs of homophone words. Skilled readers demonstrated confusion only for the low-frequency member of a homophone pair, while less skilled readers were confused by both

members. Perfetti (2007) explained that form confusions, such as in homophone and homograph words, are caused by the relative frequencies of competition between forms, which are influenced by reading experience. These effects of frequency have an impact on word processing and disambiguation (PERFETTI; HART, 2001), as previously illustrated. Not only word frequency should be taken into account, but also familiarity or functional or relative frequency, which is the experience a reader has involving a given word. However, this experience varies across people and depends on "the amount of reading they have done" (PERFETTI; HART, 2001, p. 7). Reading experience contributes to the stability of word constituents, especially for high-frequency words.

There are few studies which address reading experience and lexical quality simultaneously. One of them, previously mentioned, is Taylor and Perfetti's (2016) investigation, which identified two highly influential factors on reading behavior: reading experience and word knowledge. These findings are evidence of the impact of the experience with words on lexical access. Other studies which also examine reading experience and bilingual lexical access can be discussed considering assumptions from the LQH. For instance, one important assumption in the LQH is that reading experience leads to improvement in word knowledge, that is, to a broader and more specified vocabulary, which in its turn automatizes word recognition processes.

In terms of reading experience in another language, Pratheeba and Krashen (2013) tested the relationship between L2 reading experience, operationalized as reading habits, and L2 vocabulary. They were also interested in the type of influence exerted by online reading materials on vocabulary. Participants were Indian students and spoke three L1s and English as an L2. They filled a 20-question questionnaire about their reading habits in English and a vocabulary test. Answers for the questionnaire were given according to a 5-point scale, where 0 stood for "never" and 5 for "always". The results from the vocabulary test and the answers for the questionnaire as a whole correlated positively and significantly. Considering subsets of the questionnaire, the book reading subset presented a moderate positive correlation with the vocabulary test. However, only one item from the computer reading subset, which was reading for pleasure, was positively associated with vocabulary. These findings support the assertion that reading experience is important to the quality of lexical representations since better scores on the vocabulary test were related to higher frequency of reading. A greater vocabulary leads to more reading, which in turn, leads to increase in vocabulary (PRATHEEBA; KRASHEN, 2013).

In addition to the idea that the more frequently someone reads, the broader is their vocabulary, Rudell and Hu (2010) examined the influence of reading experience in the recognition of words and of Gestalt figures. Participants were Chinese-English bilinguals, who were in the low English experience groups, and English monolinguals, who were in the high English experience group. Their task was to respond when an English word or a Gestalt figure appeared in the screen and to ignore background figures. English words were five-letter long, high frequency, and written in uppercase. Gestalt figures were images formed by one recognizable character repeated five times so that it could not be similar to any word from any language. Background images were formed by five different unrecognizable characters. Each participant was presented with twice more background images than words or Gestalt figures. Also, brain activity and ERPs were recorded. Monolinguals were faster to answer to words and to Gestalt figures than bilinguals and showed shorter recognition potential (RP) latencies for words than bilinguals. Bilinguals' responses to English words were longer than to Gestalt figures. However, there was no difference in RP latencies for Gestalt figures between groups. The authors explained that the monolingual group was much more exposed to the English language than the bilingual group and therefore had higher experience with the language. This difference between groups is likely to have facilitated the recognition of words for monolinguals. In fact, the groups did not differ in the experience with Gestalt figures, which was manipulated in the experiment. Thus, generally speaking, higher experience with words contributes to the speed of lexical access, which is in accordance with the LQH.

Moreover, Hamada and Koda (2008) investigated whether differences in participants' L1 orthographic background would influence L2 phonological decoding and whether L2 input improves L2 decoding. In the first experiment, their goal was to verify if Korean-English bilinguals were more efficient in phonological decoding than Chinese-English bilinguals when L2 proficiencies were equated. Participants completed a word naming task with English pseudowords which were regular or irregular in terms of orthography. Stimuli and original words' frequencies were controlled. Results showed that Korean-English bilinguals were faster and more accurate than Chinese-English bilinguals in naming pseudowords. This is likely due to the congruency between the Korean and English orthographic systems since both are alphabetic, comparatively to Chinese and English. Also, regular pseudowords were named faster and more accurately than irregular pseudowords. However, there was no interaction between L1 and L2 regularities, which the authors interpreted as a stronger influence from L2 input on L2 decoding than from L1 competences. In the second experiment, the goal was to examine whether differences in L1 orthographic system and L2 orthographic regularity may

affect L2 word learning. The same participants from experiment 1 executed a paired association learning task, which contained 16 random regular and irregular pseudowords from the previous material paired with 16 pictures. Then, participants completed three types of recall tests: spelling, picture recognition, and word recognition tasks. Results indicated that both orthographic congruence between languages and L2 orthographic regularity led Korean-English bilinguals to learn words more efficiently than Chinese-English bilinguals. The authors concluded that both L1 print exposure and features of L2 input have an impact on L2 decoding skills. These outcomes may be compared with Pratheeba and Krashen's (2013, p. 1) conclusion that "More exposure to print means more reading, and more reading results in more literacy development, including vocabulary". This is also in line with the LQH in that reading experience improves lexical quality and that word knowledge acquired through reading may affect word recognition (PERFETTI; HART, 2001).

In addition, Santos-Díaz (2017) was interested in the impact of reading experience on the L1 (Spanish) and the L2 (English or French) vocabularies. In order to measure the available vocabulary, the author used a task which required participants to write twenty words related to nine themes or centers of interest in everyday life. A specialized vocabulary test and a reading frequency measure based on the number of books read were added. Participants were graduate students. Generally, it was pointed out that participants who read more books identified more specific technical terms. As reading in English increased in frequency, the available vocabulary in English expanded too. However, the same did not occur with French. Results also showed a stronger correlation between reading frequency and active and passive vocabulary in foreign languages than in Spanish. This is explained by the similarity between participants' educational level, which likely equates participants' L1 vocabulary. Santos-Díaz concluded that L2 reading experience increased participants' lexical competence, operationalized by specialized vocabulary, and available vocabulary. These findings suggest that L2 reading experience contributes to vocabulary development.

Although most of the research on the LQH is focused on monolinguals, there are studies with bilinguals specifically addressing reading experience and reading habits, such as Pratheeba and Krashen (2013), Rudell and Hu (2010), Hamada and Koda (2008), and Santos-Díaz (2017). Unlike monolinguals, bilinguals have experience in reading with both of their languages. This may be an obvious fact. However, it is important to consider the effect of the amount of reading in both languages on bilinguals' lexical representations. Moreover, it is valid to examine the impact of bilingual reading on L1 and L2 lexical representations,

considering also the language non-selectivity hypothesis. Artieda (2007), Poarch and van Hell (2014), and Jared and Kroll (2001) studied some of these possibilities.

Artieda (2007) investigated whether L1 literacy and reading habits affected the L2 achievement of beginner and intermediate L2 proficiency adult bilinguals. In order to fulfill the objective, the author used L2 achievement, L1 reading comprehension, and L1 spelling tests, and a reading frequency and enjoyment questionnaire. Participants spoke Spanish and Catalan as L1s and English as L2, but some of them had low literacy in the L1. Results showed that L2 achievement correlated moderately with L1 reading comprehension only for beginner learners of English. First language spelling also had an impact on L2 achievement both for beginner and intermediate learners, even though the effect was weaker for intermediate learners. Finally, scores in the reading habits and enjoyment questionnaire affected only intermediate learners. These findings indicate that L1 literacy can function as a threshold for learning a second language and that L1 spelling is important for L2 achievement even for intermediate learners. In addition, it was suggested that, in the case of more advanced L2 learners, L2 reading habits may have improved L2 achievement more intensely than L1 spelling skills alone. Artieda's study adds evidence to the hypothesis that reading experience has an impact on word knowledge and, consequently, on L2 achievement.

In addition, Poarch and van Hell (2014) were interested in whether proficiency and immersion can affect the co-activation of languages in trilinguals. They examined the participants using L2 and L3 picture naming tasks with cognate words across two and three languages. Participants were L3-immersed Russian-English-German, L3-immersed German-English-Dutch, and non-immersed Dutch-English-German trilinguals. In the first experiment, L3-immersed German-English-Dutch participants named pictures in their respective L2 and L3. The tasks contained respectively triple cognates, double cognates (L1-L2 and L2-L3), and control words, and triple cognates, double cognates (L2-L3 and L3-L1), and control words. Results showed that in L2 naming triple cognates were named faster than double and non-cognates, while in L3 naming triple cognates were named faster than non-cognates and triple and double cognates were named more accurately than non-cognates. Participants may have been more influenced by their L3 than their L2 because of immersion in an L3 context and less proficiency in the L2. In the second experiment, non-immersed Dutch-English-German participants also named pictures in their respective L2 and L3. Results were similar to the ones in experiment 1. In L2 naming, triple cognates were named faster and more accurately than double and non-cognates; in L3 naming, triple and double cognates were named faster and more accurately than non-cognates. Here, participants' L2 seemed to have a stronger role

in the co-activation of words than their L3, which may be weaker than the L2. In the third experiment, L3-immersed Russian-English-German participants also named pictures in their respective L2 and L3. Results showed that triple cognates were named faster and more accurately than double and non-cognates in both L2 and L3 naming – while for the first group this varied between languages. This indicates a similar level of co-activation of all languages likely due to participants' active use of the L2 and the L3 in a daily basis. Further analysis of the results from the three experiments indicated that length of L3-immersion and self-assessed proficiency predict speed of lexical access in L3 naming and the magnitude of the cognate effect in L3 naming. The authors explained that three hypotheses can clarify these findings: the language co-activation view, a cumulative frequency view, and a learning-based view. More specifically, a cumulative frequency view agrees with the LQH in that the repeated activation of a word facilitates its access. Multiple encounters with a word increase the specification of its constituents, thus incrementing its quality, and high-quality lexical representations are accessed more easily and automatically. This is how reading and word experience may influence word recognition and likely word production.

Similarly, Jared and Kroll (2001) investigated whether bilinguals co-activated spelling-sound correspondences from both of their languages and what factors may influence this co-activation. They carried out four experiments using partial homograph words which shared word bodies (medial vowels and final consonants) across languages (e.g. "bait" in English and "fait" in French). These words were called word body neighbors and they could have consistent pronunciation in English ("bump") but not exist in French: the English friends; or they could have a different pronunciation in French ("fait"): the French enemies; or even they could have inconsistent pronunciation in English ("bead") but not exist in French: the English enemies. The task was composed of one block of experimental English words, one block of filler French words, and another block of experimental English words, and required participants to name the words. Participants were divided in two groups, one for higher proficiency and another for lower proficiency. Results showed that in the first block English enemies elicited longer naming latencies than English friends while French enemies did not. However, after naming French words, participants demonstrated longer latencies for French enemies than non-enemies. Moreover, more proficient participants manifested more interference from enemy words in the third block than less proficient ones. This is indication that either participants did not activate French spelling-sound correspondences in the first block or they did so, but weakly. Also, it suggests that naming French words which did not share word bodies with the critical stimuli was enough to activate those correspondences.

In the second experiment, the authors manipulated filler words by selecting words with the same word bodies from the critical stimuli. Results from the first experiment were replicated, with the addition of a stronger interference effect for both less and more proficient bilinguals when naming in the third block. In the third experiment, the authors tested if the effects observed would be the same if participants were naming in their L2. French-English participants were recruited, but materials remained the same. Results from experiments 1 and 2 were replicated when participants named words in English in the first block. However, no effect in French enemies was seen in the third block. The authors explained that the French-English bilinguals were immersed in an English context and that this may be the reason why they were able to inhibit French spelling-sound correspondences in the third block. In the fourth experiment, French-English participants who were less proficient in English were recruited to test the influence of proficiency level and immersion. In fact, results showed that, generally, naming latencies were significantly longer for French enemies than non-enemies and also in the third block, unlike experiment 3.

Jared and Kroll's study presents evidence of language co-activation during word naming, although other factors may have a role in naming latencies differences across blocks. The authors had explained the finding using the BIA model, specifically mentioning that the language nodes are responsible for inhibiting one of the languages. Nevertheless, the BIA+ model may explain these results through the task/design system, more specifically via strategies created by participants during the experiment. In addition, Jared and Kroll's (2001) results indicate that the co-activation of languages is modulated by proficiency and likely by frequency of language use, in this case in an immersive context. French-English participants from experiment 3 were highly proficient in English and were also using their L2 every day. The highly frequent usage of the language increases the experience with words to which these participants are exposed, and the higher word experience contributes to lexical representations of higher quality. Accordingly, higher lexical quality helps solving confusion between words which overlap within and across languages. In other words, the fact that participants were immersed and had higher experience with English words lead them to better inhibit activation from their L1 or to solve the confusion created by similarities between words. These results illustrate how reading experience and word experience in general influence lexical quality and, consequently, word recognition.

The studies just mentioned suggest that reading experience, which may include print experience, plays a role in word recognition and vocabulary development. This appears to hold both for L1 and L2 reading. On the other hand, in terms of amount of language exposure

for bilinguals, Whitford and Titone (2015) presented evidence in favor of the Frequency-Lag Hypothesis (GOLLAN; SLATTERY; GOLDENBERG; VAN ASSCHE; DUYCK; RAYNER, 2011). This view states that, since bilinguals have to divide language use by two languages, they end up using less of one language if compared to monolinguals. Consequently, bilinguals' usage of lexical items which are specific to one language is less frequent than for monolinguals. In other words, the frequency effect inflates for bilinguals, producing a larger disadvantage during the retrieval of low-frequency words (GOLLAN et al., 2011). Considering both the Frequency-Lag and the Lexical Quality Hypotheses, Whitford and Titone (2015) examined the influence of differences in current L2 exposure on L1 and L2 reading ability. They recorded participants' eye movements during a gaze-contingent moving window task. English-French and French-English participants read short sentences in English and in French silently and completed a language history questionnaire. Results showed that current L2 exposure modulated bilinguals' reading fluency and perceptual span. Participants who reported higher current L2 exposure demonstrated higher L2 reading fluency but lower L1 reading fluency. They were also more affected by decreases in window size during L2 reading but not during L1 reading. These findings corroborate the Frequency-Lag Hypothesis and add to the LQH in that higher current L2 exposure may have a detrimental effect on the quality of L1 lexical representations (WHITFORD; TITONE, 2015) since both are driven by frequency.

In sum, studies on reading experience have shown that scores on a vocabulary test are positively correlated to higher frequency of reading (PRATHEEBA; KRASHEN, 2013); higher reading experience speeds lexical access (RUDELL; HU, 2010); L1 and L2 orthographic congruity and features of L2 words influence L2 decoding skills (HAMADA; KODA, 2008); reading experience seems to be correlated with L2 achievement for intermediate L2 learners (ARTIEDA, 2007); L2 reading experience may contribute to active and passive vocabulary development (SANTOS-DÍAZ, 2017); length of L3-immersion predicts speed of lexical access in L3 naming and magnitude of cognate effect in L3 naming (POARCH; VAN HELL, 2014); L2-immersion increases inhibition of L1 activation and facilitates L2 ambiguity resolution (JARED; KROLL, 2001); and higher current L2 exposure implies lower current L1 exposure (WHITFORD; TITONE, 2015). Although these studies shed some light over these topics, one may still wonder about the effects of bilingual reading experience on the quality of L2 lexical representations combined with the co-activation of languages of a bilingual. Cross-language activation was shown through cognate and ambiguous words, which may cause facilitation or interference in the process of word

recognition. However, it is still not clear whether – and how – the habits and frequency of reading in an L1 and in an L2 may influence this co-activation and, consequently, lexical access. In addition, working memory, which has a role in reading, should also be accounted for here.

2.4 Working Memory

Working memory is a cognitive system which is responsible for maintaining information temporarily active in order to complete a processing task at the same time. It differs from short-term memory in that working memory emphasizes the fulfillment of cognitive tasks, mental work, and reasoning, together with temporary storage of information (BADDELEY; HITCH, 1974 apud BADDELEY, 2009). Working memory is considered to be used in various high-level cognitive activities, such as driving, playing chess, logical reasoning, and especially reading (BADDEKEY, 2009), which is one of the most complex cognitive processes (BADDELEY; LOGIE; NIMMO-SMITH, 1985) and a crucial part of linguistic achievement (LINCK; OSTHUS; KOETH; 2014).

There are several models which attempt to define and explain working memory. Three of the most famous models are Baddeley and Hitch's (1974; BADDELEY, 2000), Cowan's (2010), and Engle's (2002). Baddeley and Hitch's model is composed of three separate systems: the phonological loop, which is responsible for temporary auditory and verbal information storage; the visuospatial sketchpad, which functions similarly to the phonological loop, only with visual and spatial information; and the central executive, which controls the other systems and selects information to be processed. Later, Baddeley (2000) added to the model the episodic buffer, which integrates information from the other systems. Cowan's (2010) model maintains the idea of a central executive system, which controls the focus of attention on temporarily activated portions of the long-term memory. It is important to emphasize the central role given to attention in this model. Finally, Engle's (2002) model posits that working memory is the set of information which is activated in short-term memory and is available to immediate consciousness (ENGLE; CANTOR; CARULLO, 1992). This activation is created by executive attention processes, but can also be caused by domain-specific mechanisms, such as repetition and coding. In this study, we understand working memory as the capacity for manipulating and temporarily storing information simultaneously in order to execute a task, which also demands attention and inhibition processes.

Working memory is usually measured by its capacity. In other words, models predict processing capacity limits for working memory. Capacity is the maximum level of activation available in working memory for an element – which could be a word, a sentence, a proposition, etc. – so that processing and storage functions may be maintained (JUST; CARPENTER, 1992). There are various span tasks for measuring working memory capacity. Simple span tasks, such as the digit span and the word span tasks, are composed of a list of elements, digits or words, which are presented one by one to the participant, who should later recall them in presentation order. The addition of a second task, such as an acceptability judgement task or a mathematical operation, to the simple span forms a complex span task. The latter consist of the completion of two simultaneous tasks, for instance deciding if a sentence is acceptable, or solving a math equation, and memorizing words, letters, or digits. Complex span tasks demand both storage of elements and processing of information at the same time.

The first reading span task was devised by Daneman and Carpenter (1980) and it was composed of a series of independent sentences which should be read out loud. Also, as a concurrent task, the last word of each sentence should be memorized and recalled later in the test. However, Waters, Hildebrandt, and Caplan (1987), and Waters and Caplan (1996) argue that, although this task requires processing and storage of information, it only measures storage. Then, they suggested a modification in Daneman and Carpenter's task. Instead of only reading the sentences out loud, participants would be required to decide whether the sentence was acceptable in meaning or not, besides memorizing the last word of the sentences. These changes would ensure that the task measured storage as well as processing of information. The reading span task offers two measures for working memory capacity: the total span and the set size span. Respectively, they refer to the total number of words correctly recalled and the last set of sentences in which participants performed well (TOKOWICZ, 2015).

Many studies consider the influence of working memory in L2 acquisition and processing. Baddeley (2015) speculates that the separate components from his working memory model would each have different effects in the learning of a second language. The phonological loop, the most extensively studied part of this model, is shown to be essential for L1 acquisition. Consequently, it should be at least useful (BADDELEY, 2015) for L2 vocabulary learning and the transfer of information from short-term memory to long-term. Moreover, the use of the visuospatial sketchpad may depend on language script, as would be the case for Chinese and Arabic languages for instance. There is also little research on the

influence of the central executive. Despite that, the central executive should take part in second language learning since it is correlated with intelligence and it may influence comprehension through coherent connection of ideas. Finally, there is almost no research on the episodic buffer for speculations to be drawn from. In addition, Cowan (2015) emphasizes the importance of the focus of attention in working memory for the processing of an L1 or an L2. He explains that maintaining many verbal and visual items simultaneously activated in mind could generate conflict between types of information and cause a trade-off. Therefore, one should consider chunking of information and the quantity of chunks for monolingual and also bilingual speakers. These are initial thoughts for investigating individual differences in bilinguals.

One review on this topic was Juffs and Harrington's (2011), whose goal at the time was to identify areas of interest in the study of working memory and second language use and learning. They presented a brief theoretical background on the constructs and methods of measuring working memory and then proceeded with a summary of findings per research area. It was well established that working memory is only one of the individual differences factor which can influence L2 learning and processing. It plays a role in reading, solving ambiguities in sentence processing, vocabulary learning, and language production. Juffs and Harrington mentioned that most studies on sentence processing pointed to working memory's influence on L2 morpho-syntactic processing. However, a variety of other works failed to present evidence to this relationship, which should be due to methodological differences between studies. On the other hand, the ones which did suggest a correlation between working memory and syntactic processing actually indicated a moderate association, which explains a small part of the variance in individual performance. Also, the role of working memory seems to be mediated in most cases by L1 and pragmatics. Moreover, in self-paced tasks, effects were found mainly for accuracy measures of working memory instead of processing measures. The authors also observed that the importance of the phonological loop or phonological memory seems to be stronger for less proficient learners since its influence decreases as proficiency increases. In addition, there is a tendency for low L2 proficiency learners to use more top-down knowledge, fewer linguistic bottom-up, and fewer working memory resources than the ones with high proficiency. Similarly, production is suggested to be less accurate for bilingual participants with lower working memory capacity. This is explained by the need for inhibiting the influence from L1 and focusing on L2 forms at the same time. This indicates the importance of attentional systems and the suppression of competing information for bilinguals (JUFFS; HARRINGTON, 2011). In general, the

literature presented evidence that working memory is associated with many domains, from lexical access to sentence processing and language production. Also, the reading span task provided a higher number of correlations, which were stronger than simpler measures, such as word repetition tasks.

Taking Juffs and Harrington's (2011) review further, there is the work of Linck, Osthus, and Koeth (2014). Also considering studies which examined the association between working memory and second language processing, they presented a meta-analysis involving effect sizes and the influence of covariates on that relationship. They classified studies concerning complexity and content (verbal or non-verbal) of working memory measures, L2 proficiency measures, and participants L2 proficiency. Results showed larger correlations for working memory tests in the L2 than in the L1. The authors explained that, in this case, L2 proficiency is a confounding variable and may inflate the correlation between working memory capacity and L2 outcomes due to measurement of both constructs. In addition, significant stronger correlations were seen for complex span tasks compared to simple span tasks. This result is in accordance with Daneman and Merikle's (1996) meta-analysis, which emphasized that working memory is important for language comprehension and also indicated that task content (verbal or non-verbal) does not affect the predictive power of the test. However, in Linck, Osthus, and Koeth's meta-analysis, verbal working memory tasks presented a slightly higher correlation than non-verbal ones. Moreover, results showed that working memory is correlated with L2 proficiency, comprehension and production outcomes for both less and more proficient participants. Furthermore, the interaction between the language of the working memory task and its complexity was marginally significant. This effect may also be caused by the simultaneous measurement of L2 proficiency and working memory. Finally, results indicated that simple and complex span tasks are similarly correlated with L2 processing outcomes, while complex span tasks are more strongly associated with L2 proficiency outcomes. The authors concluded that even though there were some overlap in measures for L2 span tasks, there is no evidence suggesting that working memory should be separated for each language. Moreover, they reinforce the importance of attentional processes and conflict resolution for working memory and L2 outcomes. More specifically, working memory influences the solving of competition between representations (PERFETTI; HART, 2001) and the inhibition of a bilingual's first language (MICHAEL; GOLLAN, 2005 apud TOKOWICZ, 2015).

One of Linck, Osthus, and Koeth's (2014) meta-analysis results indicated that the verbal content of the span task led to slightly higher correlations with L2 outcomes than non-

verbal span tasks. This inflation seems to point to a confounding relationship between verbal working memory measures and L2 outcomes. On the other hand, Daneman and Merikle (1996) and Çeçen and Erçetin (2016) suggested the opposite. More specifically, in the latter, the authors were interested in whether the processing and storage functions, and explicit and implicit L2 linguistic knowledge, are associated to L2 reading comprehension. Bilingual participants completed reading span tasks in their L1 and L2, an operation span task, timed and untimed grammar judgement tests, a metalinguistic knowledge test, an elicited oral imitation test, and a TOEFL reading comprehension test. Main results showed that processing scores from the three working memory measures were correlated with one another and the storage scores were associated to one another. Storage and processing functions loaded on two separate factors. Moreover, significant variance in L2 reading comprehension was explained by processing scores in L1 and L2 reading span tasks and in operation span task. These results suggest that the predictive power of working memory measures does not depend on language or content. Çeçen and Erçetin (2016) interpret that this is due to the domain-general characteristic of the processing function of working memory. Considering these findings and Daneman and Merikle's, it seems that, at least partially, working memory requires domain-general functions during processing of information (ENGLE, 2010).

The majority of the previously mentioned studies addressed working memory together with sentence processing. Research has also focused on the influence of working memory on bilingual lexical access, reading experience, and the quality of lexical representations across languages. For instance, Arêas da Luz Fontes and Schwartz (2011) were interested in testing the role of working memory in the disambiguation of cognate homonyms by bilinguals in a semantic verification task. Spanish-English participants were presented with sentences with the last word (prime word) missing. When they were ready to read it, they pressed a button. Then, the prime word was presented, followed shortly by a target word. Participants' task was to decide if the target word was related to the meaning of the sentence. Prime words were manipulated to be ambiguous and cognate, ambiguous and non-cognate, unambiguous and cognate, unambiguous and non-cognate. Target words could be related or unrelated to the sentence. Participants also took a digit span test to assess their working memory. Results showed that participants who presented a lower working memory span had significantly more difficulty responding to target words which followed ambiguous primes. Also, low span participants were faster and less accurate in responding to cognate words. These results demonstrated that working memory capacity plays a role in the discrimination of competing

representations which share activation both within and across languages and it predicts processing of subordinate meanings of homonym words during the reading of sentences.

Working memory is also suggested to predict accuracy and efficiency in accessing subordinate meanings of homonym words in the L1 and L2, and it seems to influence inhibition of L1 competing information. Arêas da Luz Fontes and Schwartz's study (2015), which was described previously, had participants complete the Daneman and Carpenter's (1980) reading span task, a primed lexical decision task, and an eye-tracked sentence reading task. Participants who presented higher working memory capacity were more efficient when inhibiting competing meanings from cognate and non-cognate homonym words both within and across languages. High-span bilinguals accessed both meanings of the homonyms before low span bilinguals did, which demonstrates higher lexical access automaticity for high spans. Another finding was that high-span bilinguals presented generally better performance than low-span bilinguals but were less affected by cross-language activation of meanings caused by cognate words. The authors explained that it may be the case that the cognate facilitation effect decreases as L2 proficiency increases. In addition, Juffs and Harrington (2011) mentioned that working memory is suggested to influence the inhibition of L1 activation in bilinguals, which might modulate cognate facilitation during access of homonym meanings. At any rate, working memory plays a role in bilingual lexical access and ambiguity resolution.

Furthermore, Hamilton, Freed, and Long (2016) examined whether higher lexical quality frees up working memory during higher-level processing tasks, such as generating inferences, which is one of the predictions drawn from the LQH. Participants were monolingual English speakers and completed an inference generation task with text passages, alphabet and operation span tasks, non-word naming and phonological decision tasks. The inference generation task was composed of four-sentence passages which required an inference to connect two sentences. The passages were also followed by a target word, which could be related or not in meaning to the inference. Moreover, the last sentence of the passages could be written in Standard American English (SAE) or with pseudohomophone words. In total, there were three conditions: last sentence in SAE followed by related target, last sentence with pseudohomophones followed by related target, and last sentence in SAE followed by unrelated target. Results showed that participants responded faster to targets which were related to the inference in the passage than to unrelated targets. Also, this inference priming was stronger for last sentences written in SAE than with pseudohomophones. There was an interaction between decoding skill and working memory: poor decoders who presented low spans performed worse in the pseudohomophone condition

than poor decoders with high spans. Moreover, inference priming in pseudohomophone sentences was also modulated by working memory for poor decoders. These findings are in accordance to the LQH in that higher lexical quality leads to efficient low-resource lexical access (PERFETTI; HART, 2001). As Hamilton, Freed, and Long explained, poor decoding skills made it necessary to demand more from working memory in order to generate the inference which was needed in the passage. This study suggests that high working memory capacity compensates for low quality of lexical representations, at least for sentences. It should be verified if these results hold to the lexical level.

Considering working memory as a predictor of reading comprehension, Raudszus, Segers, and Verhoeven (2018) were interested in the influence of lexical quality and executive control on reading comprehension in children learning Dutch. Participants were 76 monolingual and 102 bilingual children. They completed vocabulary depth and breadth tests, word and pseudoword decoding tests, a grammar judgement task for syntactic integration, a backward digit span task for working memory, the Simon task, and a reading comprehension test. Results indicated that bilinguals performed better than monolinguals only in decoding tests. Participants did not differ in terms of executive control tasks. For monolinguals and bilinguals, vocabulary and decoding, that is, lexical quality, predicted reading comprehension indirectly via syntactic integration and also directly. Similarly, working memory indirectly predicted reading comprehension for both groups. However, inhibition was an indirect predictor only for L2 readers, who were also positively influenced by L1 vocabulary. Despite the fact that there were no differences in the executive control tasks between groups and that inhibition presented a marginally significant result, this study suggests that lexical quality has direct and indirect influences on reading comprehension while executive control affects it indirectly via syntactic processing.

The studies mentioned above demonstrate that working memory is implicated in reading comprehension and in language processing both in an L1 and in an L2. Although the effect of working memory on second language processing tends to be moderate, it is still shown to be influential (LINK; OSTHUS; KOETH, 2014). Moreover, it is suggested that working memory influences lexical access (HAMILTON; FREED; LONG, 2016) together with reading experience (TAYLOR; PERFETTI, 2014). There is still room for replicating such results and verifying these hypotheses about the interplay between working memory and lexical quality when considering Brazilian Portuguese-English bilinguals.

2.5 The present study

High quality of lexical representations, which is achieved by the specification of orthographic, phonological, semantic, and morphosyntactic components of words, increases efficiency of lexical access[4] (PERFETTI, 2007). Consequently, word recognition is more automatized, and higher order processing resources, such as working memory, are released from demand and are freed up to deal with more cognitively complex tasks, such as generating inferences (PERFETTI; HART, 2001). The importance of fully-specified lexical representations is illustrated when there is competition between representations, which causes confusion (PERFETTI; HART, 2001). This clash may occur within and across languages and can be observed through ambiguous words, which may have some degree of overlap between languages. In addition, these shared representations point to the simultaneous activation of both of a bilingual's languages (DIJKSTRA; GRAINGER; VAN HEUVEN, 1999). This hypothesis, of language non-selectivity, states that bilinguals cannot turn off one of their languages during lexical access. Thus, the activation of one language is able to influence the activation of the other, and the overlap in orthography, phonology or meaning between lexical items from different languages may affect access to these words (DIJSKTRA; VAN HEUVEN, 2002).

The quality of lexical representations may be increased through word experience and frequency (PERFETTI; HART, 2001). Frequency of exposure to words and reading experience is correlated with vocabulary (PRATHEEBA; KRASHEN, 2013) and L2 achievement (ARTIEDA, 2007). It was also shown to speed lexical access (RUDELL; HU, 2010) and to predict reading behavior (TAYLOR; PERFETTI, 2016). Word experience leads to more automatized lexical access processes, which allow the use of working memory in more complex tasks. Working memory capacity is correlated with measures of reading comprehension (LINCK; OSTHUS; KOETH, 2014). It was also shown to influence access to multiple meanings of ambiguous words within and across languages (ÂREAS DA LUZ FONTES; SCHWARTZ, 2011) and is suggested to compensate for low quality of lexical representations during inference generation (HAMILTON; FREED; LONG, 2016).

Considering the theoretical background presented above, this study's general objective is to investigate the influence of L1 and L2 reading experience and of working memory

[4] As an extension of this idea, in this study we are interested in investigating lexical access in order to predict lexical quality.

capacity on the quality of L2 lexical representations of Brazilian Portuguese-English bilinguals during an L2 meaning decision task.

The first specific objective is to examine the influence of the L1 (Brazilian Portuguese) on the quality of L2 (English) lexical representations for homonym words, cognate or not with the L1.

The second specific objective is to verify the effect of the L1 in the access to dominant and subordinate meanings of L2 homonym words.

The third objective is to investigate the role of the L1 on the access to the meanings of L2 homonym words when these meanings are shared across languages (or not) and also primed (or not) by prime words.

The fourth objective is to verify whether if reading experience in both the L1 and the L2 and working memory capacity can predict performance in the meaning decision task and, consequently, predict quality of L2 lexical representations of homonym words.

The first hypothesis is that the L1 will facilitate the recognition of homonym cognate words so that reaction times will be shorter in comparison to homonym non-cognate ones. It is also expected that non-homonym words will be easier to respond to than homonym ones because they map onto only one meaning, similarly to the results in Perfetti and Hart (2001).

The second hypothesis is that dominant meanings of homonym words will be accessed more easily and responded to faster than subordinate meanings due to their higher frequency of occurrence, which leads to higher lexical quality.

The third hypothesis is that when a meaning is shared across languages and also primed by prime words, it will be accessed more easily than when it is only shared or only primed. In other words, when a dominant meaning is shared and primed, it will be responded to faster than when it is only shared or primed. Also, it is expected that when a subordinate meaning is shared across languages and primed by prime words, its low frequency of occurrence will be overridden and its recognition will be facilitated compared to when the subordinate meaning is not shared across languages.

The fourth hypothesis is that reading experience in the L1, in the L2 and in both languages, and working memory capacity as well, will predict the performance in the meaning decision task in that higher reading experience and higher working memory capacity will predict better performance in the task.

3 METHODS

3.1 Experimental design

This study has a quasi-experimental, within participants, factorial design. There are four independent variables: the conditions in the meaning decision task, which are homonym status (2), cognate status (2), meaning shared (3), and target relatedness (4). Also, there are 2 variables which may predict variation in the independent variables: reading span test recall score (1); and reading habits questionnaire scores for L1, L2, and bilingual reading habits (3). These variables are operationalizing the following constructs respectively: lexical quality and language co-activation, working memory capacity, and L1, L2, and bilingual reading experience. Two dependent variables will be measured: reaction times and error rates in the meaning decision task.

The meaning decision task scores was be analyzed through two- and three-way Analyses of Variance (ANOVAs), t-tests, and Wilcoxon's Paired Ranks Test for non-normally distributed samples. Finally, the hypothesis that working memory capacity and the reading experiences would predict performance in the meaning decision task were verified through a linear regression analysis.

Box 1 – Scheme of independent variables and predictor variables

Independent Variables: Meaning Decision Task Conditions	
Primes	**Targets**
homonym cognate (dominant meaning shared)	dominant meaning related
	subordinate meaning related
	unrelated
homonym cognate (subordinate meaning shared)	dominant meaning related
	subordinate meaning related
	unrelated
homonym non-cognate	dominant meaning related
	subordinate meaning related
	unrelated
non-homonym cognate	related
	unrelated
non-homonym non-cognate	related
	unrelated

Predictor Variables
L1 reading experience
L2 reading experience
bilingual reading experience
working memory capacity

Source: Prepared by the author (2018).

3.2 Participants

Recruitment of participants was carried out through face-to-face and online invitations. Participants were college students, mostly from the Languages and Literature course. The researcher entered classrooms with authorization from Professors and invited the students to take part in the study after explaining briefly the objective and what tasks they would have to complete. The only participation requirement was that participants must speak Brazilian Portuguese as their first language and English as a second language. In addition, if they spoke any languages besides English, they must not be more proficient in those languages than in English. A total of 84 people volunteered; however, one person quit participation while in the middle of the testing session, and another one reported speaking German more fluently than English. Data from both of these participants was discarded, leaving an 82-participant sample.

Participants completed the online Language History Questionnaire (LI; ZHANG; TSAI; PULS, 2014). Their mean age was 23.33 years old (*SD* = 5.73, ranging from 17 to 49). Twenty-one of them were male. Participants mean of total years of use of English was 13.71 (*SD* = 6.40). The mean age of beginning of listening to English was 8.51 (*SD* = 3.65, ranging from 1 to 19), of speaking was 11 (*SD* = 4.14, ranging from 2 to 26), of reading was 10.56 (*SD* = 3.01, ranging from 4 to 18) and of writing was 11,21 (*SD* = 3.26, ranging from 4 to 21). The mean reported language learning skill was 5.13 (*SD* = 0.97, ranging from 3 to 7), in a scale in which "1" stands for "very poor" and "7" for "excellent". The mode for participants' current ability in English was 6 for listening, speaking, and reading skills, and 5 for writing skill, in a scale in which "1" stands for "very poor" and "7" for "native-like". The mode[5] for reported accent in English was 4, in a scale in which "1" stands for "none" and "7" for "extreme". The mode for daily hours of use of English in activities was zero for writing e-

[5] The mode is reported here because there was low variability in the answers. Then, the mode offers the best description of central tendency.

mails to friends, 1 for listening to the radio, reading for fun, reading for school or work, and writing for school or work, and 2 for watching TV. Mixing English and Brazilian Portuguese, or other languages, was reported by 62 participants, that is, 75.6% of the sample. The mode for daily hours of use of English in mental activities was 1 for calculating, 2 for remembering numbers, 3 for dreaming, and 5 for expressing emotions, thinking and talking to oneself.

Of the 82 participants, 53 (64.63%) reported having at least basic knowledge of languages other than Brazilian Portuguese and English, which is expected from students of the Languages and Literature course. Thirty three participants reported having knowledge of Spanish; 11, French; 6, German; 5, Italian; 5, Japanese; 3, Chinese; 2, Latin; 1, Flemish; 1, Hindi; and 1, Russian. In order to avoid strong influences from languages which could not be controlled for during the testing session, it was required that participants should be less proficient in the other languages compared to English. Not all participants reported their current ability in language skills for languages other than Brazilian Portuguese and English. According to the answers which were given about Spanish (33), the mode for current listening ability was 4, for speaking, 3, for reading, 4, and for writing, 2. According to the answers given about French (7), the mode for current listening ability was 6, for speaking, 4, for reading, 5, and for writing, 1. According to the answers given about German (3), the mode for current listening ability was 4, for speaking, 2, for reading, 2, and for writing, 2. According to the answers given about Italian (5), the mode for current listening ability was 3, for speaking, 3, for reading, 3, and for writing, 2. According to the answers given about Japanese (4), the mode for current listening ability was 3, for speaking, 4, for reading, 1, and for writing, 3. Current language abilities for Chinese, Hindi, Latin, and Korean were reported by only one participant.

Seventeen participants reported having been to an English speaking country and having stayed there for at least three months. The majority of participants (80) reported only starting using English at school during high school. All participants used Brazilian Portuguese during basic education.

Concerning participants' scores in the DIALANG proficiency test, their mean score in the placement test was 808.98 (*SD* = 128.08, ranging from 495 to 1000). In the reading test, 7% of the participants scored C2[6], 41% C1, 33% B2, 17% B1, and 1% A2. In the structures test, 19% scored C2, 30% C1, 42% B2, 6% B1, and 1% A2. In the vocabulary test, 6% scored C2, 31% C1, 59% B2, and 2% scored B1. These scores were used to describe participants' L2

[6] Scores in accordance with the Common European Framework of Reference (CEFR): A2 = basic user, B1 and B2 = independent user, C1 and C2 = proficient user (COUNCIL OF EUROPE, 2018).

proficiency with an objective measure while the scores reported in the questionnaire were a subjective description.

Participants also completed a reading habits questionnaire about their use of L1 and L2 for reading (PRATHEEBA; KRASHEN, 2013), which will be described in section 3.3.1. Forty four participants reported higher frequency of reading in their L1 than in their L2, while 37 participants reported higher frequency of reading in their L2 than in their L1.

3.3 Materials

All instruments were presented in participants' L2 (English) with the exception of the Informed Consent Form (Appendix A) in accordance with the Ethics Committee guidelines.

3.3.1 L1 and L2 Reading Experience and Reading Habits Questionnaire

This questionnaire intended to measure how frequently participants read in both of their languages and what types of texts they read. It was adapted from Pratheeba and Krashen (2013) and was composed of twenty questions about reading habits, involving printed and online materials, school and leisure contexts, and a variety of text genres. Answers were given using a six-point frequency scale ranging from never (zero) to always (five). Excerpts (1) and (2) are examples of questions and answers options.

(1) 1. Are you in the habit of reading daily newspapers in English?
( ) 0 ( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5
(2) 5. Are you in the habit of reading short stories in Portuguese?
( ) 0 ( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5

Participants completed this questionnaire in paper twice, once for Brazilian Portuguese reading habits and once for English ones. The complete questionnaire is in Appendix B.

3.3.2 Meaning Decision Task

This task was built according to descriptions from Perfetti and Hart (2001) using E-Prime software (PSYCHOLOGY SOFTWARE TOOLS, 2012). It requires participants to read a prime word for 300 ms on a computer screen, then a target word for up to 3000 ms,

and finally decide, pressing yes (L) or no (A) on the keyboard, whether or not the target word is related in meaning to the prime word. The stimuli were composed of 128 prime words (see examples in Box 2); 16 of them were homonym cognate words, which shared the dominant meaning of the homonym with Brazilian Portuguese; 16 were homonym cognate words, which shared the subordinate meaning across languages; 32 were homonym non-cognate words, which did not share any of the two meanings with Brazilian Portuguese; 32 were non-homonym cognate words; and 32 were non-homonym non-cognate words. Each homonym word, cognate and non-cognate, was paired with three different target words: one related to the dominant meaning, one to the subordinate meaning, and another unrelated in meaning. Non-homonym words, cognate and non-cognate, were paired with two target words: one related in meaning, one unrelated. Also, 64 filler prime words, 32 homonym (e.g., boil) and 32 non-homonym (e.g., avoid), were added to act as control words; each had one target word, unrelated in meaning to equate the number of yes/no answers.

Three lists of stimuli were created for balancing homonym cognate prime words and their three possible targets, which could be related to the dominant meaning, related to the subordinate meaning or unrelated. All homonym prime words (64) were included in all of the lists since they could be followed by three different targets. Non-homonym primes (64) were also balanced and some of the items ended up being repeated across lists because they could be followed by two targets only. Filler words (64) were entirely repeated across lists. List A and B were composed of 107 critical words, and list C was composed of 106.

Selection of stimuli was carried as follows. Homonym words were extracted from Arêas da Luz Fontes and Schwartz (2015), Armstrong, Tokowicz, and Plaut (2012), and Maciejewski and Klepousniotou (2016). Words less frequent than 10.0 according to CELEX2 (BAAYEN; PIEPENBROCK; GULIKERS, 1995), loan words in Portuguese (e.g. hertz, jeans) and polysemic words (e.g. coat) were excluded. Homonym words are spelled the same but have different meanings, and usually one of these meanings is more frequently used and thus is dominant over the other. Considering this frequency of use, half of the selected homonym cognate words had the dominant meaning shared with Brazilian Portuguese, and the other half had the subordinate meaning shared. For example, “band” is used in the sense of “a group of people” more frequently than in the sense of “a strip of material”. The Portuguese word “*banda*” shares the dominant meaning of “band”. Also, the word “arms” relates to “upper limbs” more frequently than to “weapons”. However, in this case, the word “*armas*” shares the subordinate meaning of “arms”.

To determine which meanings of the homonym words were dominant and which were subordinate, we carried out a task construction study. We selected 147 homonym words and arranged them in an online form, one word per each question gap. The instruction was to read this list of words and provide all the possible meanings to each of the words according to the participants' vocabulary. This online form was sent to a class of undergraduate Brazilian Portuguese-English bilingual students from another university. Ten participants, who did not become involved in the rest of the research, answered the form. They were not informed that these words were ambiguous and they were asked not to look them up in a dictionary. The meanings provided by the participants were organized from most to least mentioned and were also checked with the ones which matched the meanings indicated by eDom Norms[7] (ARMSTRONG; TOKOWICZ; PLAUT, 2012), British eDom Norms[8] (MACIEJEWSKI; KLEPOUSNIOTOU, 2016), and Wordsmyth website[9]. The most mentioned meanings for each word which were also present in these three corpora were selected as stimuli for the 64 homonym prime words.

Target words were selected according to the University of South Florida Free Association Norms[10] (NELSON; MCEVOY; SCHREIBER, 1998, appendix A). Whenever a prime word could not be found in the Norms, the target word was chosen using Wordsmyth website for related words and the help from research colleagues for unrelated words. Since each prime word could be followed by only one target word, three lists of stimuli were created. The presentation of these lists was counterbalanced between participants so that only one list was showed in each session. Filler words were the same in all three lists.

Moreover, prime words were also controlled for frequency, number of letters, and grammatical category – only nouns and verbs[11]. Box 2 presents this information for each condition and some examples of stimuli selected for the meaning decision task. Appendix E presents all stimuli lists for the meaning decision task.

[7] Corpus of homonym words of the English language and their meaning frequencies.
[8] Corpus of homonym words and their meaning frequencies in the British English variety.
[9] Free online English dictionary and thesaurus.
[10] Corpus of semantic association data for 72,000 English word pairs (NELSON; MCEVOY; SCHREIBER, 2004). Six measures of the strength of semantic relations between words are provided. Appendix A presents a database of participants' responses when seeing a cue word. For example, "abduct" was most frequently answered with "kidnap", followed by "take" and then "steal".
[11] The final stimuli list included nouns and verbs, although verbs are shown to be more complex than nouns (CONROY, SAGE, LAMBON RALHP, 2006). Otherwise, the experimental list would be too short.

Box 2 – Stimuli examples for the meaning decision task

Prime word			**Target word**
Homonym cognate (dominant meaning shared)	Mean frequency: 54.90 SD: 92.25 Range: 2.29-383.58 Mean number of letters: 4.69 SD: 1.08	band	SONG (dominant meaning)
			WRIST (subordinate meaning)
			HAM (unrelated)
Homonym cognate (subordinate meaning shared)	Mean frequency: 35.05 SD: 39.27 Range: 2.85-152.12 Mean number of letters: 5.13 SD: 1.20	arms	LEGS (dominant meaning)
			GUNS (subordinate meaning)
			BEACH (unrelated)
Homonym non-cognate	Mean frequency: 28.46 SD: 25.50 Range: 1.01-101.28 Mean number of letters: 4.47 SD: 1.08	fast	QUICK (dominant meaning)
			STARVE (subordinate meaning)
			TOE (unrelated)
Non-homonym cognate	Mean frequency: 41.86 SD: 54.65 Range: 0-251.17 Mean number of letters: 4.81 SD: 1	guitar	PIANO (related)
			DAIRY (unrelated)
Non-homonym non-cognate	Mean frequency: 37.01 SD: 41.78 Range: 0-183.30 Mean number of letters: 4.81 SD: 1.03	alike	SAME (related)
			SAILOR (unrelated)

Source: Prepared by the author (2018).

3.3.3 Meaning recognition task

During the pilot study, some participants did not know the less frequent meaning of some homonym words. This indicated that some participants may not be influenced by the subordinate meaning of a homonym word because they may not know this meaning. To control for this possibility in the testing session, each of the three lists of prime words – with the exception of filler words – was arranged in a meaning recognition task. In a list, each prime word, homonym or not, was followed by four possible meanings: its real one(s) and three invented ones. Participants were required to mark the meanings which they used or knew for the prime words. They were not informed that the list of words matched the list presented in the meaning decision task. This recognition task was completed in paper after they finished the meaning decision task in the computer. The three versions of the word recognition task, one for each list of stimuli in the meaning decision task, are in Appendix C.

3.3.4 Reading span task

This working memory capacity measure (WATERS; CAPLAN; HILDEBRANDT, 1987; WATERS; CAPLAN, 1996) is a reading span task designed to help determine the role of working memory and its systems (BADDELEY; HITCH, 1974 apud WATERS; CAPLAN; HILDEBRANDT, 1987) in written sentence comprehension. Participants are required to fulfill two objectives at the same time: decide whether sentences of four different syntactic structures are semantically acceptable or not while remembering the last word of each sentence. Semantic acceptability depends on the subject and object animacy. For example, the acceptable sentence

It was the man that grabbed the pillow.

could be transformed into the unacceptable sentence

It was the pillow that grabbed the man.

In sum, unacceptable sentences are the ones in which subject and object animacy is inverted. According to the authors (WATERS; CAPLAN; HILDEBRANDT, 1987), to judge the sentences' semantic acceptability, participants should analyze their animacy syntactically. However, difficulty to perform this analysis varies in relation to the syntactic structure. Sentences containing subject clef and subject relative clauses are analyzed more easily than the ones containing object cleft and object relative clauses, as well as sentences containing

relative clauses are analyzed more easily than the ones containing cleft clauses. In other words, processing difficulty increases with syntactic complexity.

Sentences were controlled for number of syllables and number of words. Box 3 presents examples of sentences used in the reading span task.

Box 3 – Sentence examples for the reading span task

Syntactic type	Sentence
Subject cleft	It was the employee that wanted the raise.
	It was the heartburn that gave the man chili.
Object cleft	It was the actor that the Academy Award won.
	It was the student by Chomsky that the book read.
Subject relative	The car in which the president rode was designed for an actress.
	The psychologist that the advice gave puzzled the client.
Object relative	The waiter served the coffee that the customer ordered.
	The pool dove in to the careless swimmer that was empty.

Source: Prepared by the author (2018).

The reading span task was presented through E-Prime software (PSYCHOLOGY SOFTWARE TOOLS, 2012). First, participants read the instructions on the computer screen. Then they completed a practice session with three sets of sentences, from two up to four sentences, in order to understand and get used to the test. In the experimental session, participants had 10 seconds to read a sentence out loud and decide whether it made sense or not, and press L or A on the keyboard respectively, before a new sentence appeared automatically. At the same time, they should memorize the last word of the sentence. At the end of the set, participants saw "Recall" on the screen and were required to write down on an answer sheet the last word of each sentence in the order they had appeared in the set. In total, there were 20 sets of sentences, starting with four sets of two sentences, and ending with four sets of six sentences. Participants' reaction times and error rates were recorded, and their reading span was defined as the last set of sentences whose words were fully and correctly recalled. The answer sheet is in Appendix D.

3.3.5 Language History Questionnaire

The objective of this questionnaire is to determine participants self-reported proficiency level in their L2 or any other language which they may use. The Language History Questionnaire (LHQ), created by Li, Zhang, Tsai, and Puls (2014), contains questions concerning some demographic data, number of languages spoken, age of beginning of acquisition, contexts of use, language learning skills, listening comprehension, writing, reading, and speaking skills, score in official proficiency tests, accent, daily use of languages for various activities, culture identification, and so on. This questionnaire was completed online on a computer.

3.3.6 DIALANG Proficiency Test

The DIALANG system was developed by a group of European universities with the support of the European Communities and now is maintained and funded by Lancaster University. It offers proficiency tests in listening, writing, reading, structures, and vocabulary for 14 different languages, including English. Participants completed a placement test, and reading, structures, and vocabulary tests online on a computer. The placement test presents a list of verb-like words and asks participants to decide which words are real ones and which are invented. The reading test is composed of questions about short pieces of text concerning inferencing, identification of main idea, and reading for detail, and requires that participants choose an answer from some options or fill in the gaps. The structures test displays questions regarding nouns, adjectives, adverbs, pronouns, verbs, numerals, grammar, parts of speech, and punctuation through fill in the gaps and multiple choice exercises. Finally, the vocabulary test asks participants to fill in the gaps or choose an answer in relation to word combination, word formation, semantic relations, and meaning. Participants' scores were presented on the screen and registered on a score sheet. These scores were added to the description of participants.

3.4 Procedures

All testing sessions were held in a university room shared by many professors. Participants were individually invited in the room and sat in front of a computer. They were reminded that the participation would last about one hour and a half and could be terminated

at any time. They read and signed the Informed Consent Form and had any doubts cleared. Next, they wrote their names in a numbered list to define their participant number and their task presentation order.

Materials were presented in a mixed-counterbalanced way. Participants completed either the reading span task or the meaning decision task as the first and second measures; the Reading Experience and Reading Habits Questionnaire as the third one; either the DIALANG proficiency test or the Language History Questionnaire as fourth and fifth measures; and the meaning recognition task as the last one. In other words, the reading span and the meaning decision tasks were counterbalanced in positions one and two; the Reading Experience and Reading Habits Questionnaire was fixed in position three; the DIALANG proficiency test and the Language History Questionnaire were counterbalanced in positions four and five; and the meaning recognition task was fixed in position six. This order was chosen so that the most cognitively demanding tasks were completed first, followed by the less demanding measures. Moreover, this mixed-counterbalanced task order was pre-set and printed in numbered sheet of paper which also defined participants' number, as mentioned earlier. At the end of the session, participants were thanked for their participation and handed a participation certificate. Also, the researcher offered the participants an opportunity for debriefing.

Most participants took two hours to finish all measures. They were not rushed to complete the tasks. The researcher quietly sat apart from the participant during the session to avoid creating any type of pressure on them. In addition, since the testing room was not an exclusive experimental research space but instead a room for many professors, some sessions were accompanied by external conversation in Brazilian Portuguese and in English. This fact may be a limitation for this study because listening to an irrelevant language during a verbal task can affect the co-activation of the participants' languages (KROLL; GULLIFER; ZIRNSTEIN, 2016).

3.5 Data analysis

Data was compiled in two different spreadsheets. The first one contained the answers to the Language History Questionnaire and to the proficiency test. The second spreadsheet contained the scores for all conditions of the meaning decision task, of the reading habits questionnaire, and of the reading span task. The last spreadsheet was entered in SPSS (SPSS INC, 2008).

Data from the meaning recognition test was used to determine which correct meanings for the homonym words were known by the participants. The number of times each meaning was recognized, that is, was marked as known, was manually counted. According to this calculation, 31 from the 64 homonym stimulus words had at least one of its meanings marked by less than 70% of the participants. This could indicate that more than 30% of the participants did not know one of the meanings of those homonym words, which would influence their performance at the meaning decision task. Thus, the data for those 31 words was discarded, and analyses were conducted on the data for the 33 remaining homonym words and also for the non-homonym ones. In addition, data from two participants was excluded from analyses because one of them quit participation half way through the testing session and the other one reported speaking German much more fluently than English. This exclusion left a sample size of 82 participants.

4 RESULTS

This section will be structured in the following fashion. First the analyses of the meaning decision task will be presented (section 4.1). They will be divided into a general analysis (section 4.1.1), which considers data for both the homonym and the non-homonym primes and does not look into any effect which might be caused by the meaning shared by the homonym cognate primes across languages; and into a homonym analysis (section 4.1.2), which involves data only for the homonym primes and is interested in verifying if the meaning shared by homonym cognate primes across languages may influence word recognition. Also, both the general and the homonym analyses will be divided into two sections, one for analyses of reaction times (sections 4.1.1.1 and 4.1.2.1 respectively) and one for error rates (sections 4.1.1.2 and 4.1.2.2 respectively). Then the regression analyses considering reading experience and working memory will be presented (section 4.2).

4.1 Meaning decision task analyses

Data from participants who presented error rates higher than 30%[12] on the non-homonym non-cognate prime, target related to prime condition was excluded from this analysis. This exclusion was based on answers for the most basic control condition in order to avoid that an excessive amount of data was discarded. A general analysis was conducted for the meaning decision scores considering homonym and cognate statuses of primes and target relatedness. In order to do that, new variables were created with means from conditions which differentiated between meaning shared across languages and between meaning primed by target words. For instance, the conditions of homonym non-cognate prime, target related to the dominant meaning and of homonym non-cognate prime, target related to the subordinate meaning were averaged to create a more general condition of target related to the prime. A more specific analysis was conducted for the meaning decision scores on the homonym words conditions, specifically the conditions which differentiated between meaning shared across languages and meaning primed by target words. Then, linear regression analyses were conducted in order to verify if the reading span task score and the L1, L2, and bilingual reading habits scores would predict performance in the homonym conditions of the meaning decision task. Later, calculation of the bilingual reading habits score will be detailed.

[12] Error rates closer to 50% suggest that participants are answering randomly.

Descriptive statistics were calculated together with normality tests and plots for every condition in the meaning decision task. Reaction times were normally distributed, which led to the use of parametric tests during analyses. However, the majority of error rates were not normally distributed, which led to the use of non-parametric tests. For the analysis of error rates, planned comparisons were conducted in order to avoid inflation of chance of a Type I error.

4.1.1 General analyses

After applying the exclusion criteria, general analysis of the meaning decision task data was run on a final sample of 73 participants.

4.1.1.1 Reaction times

First, a paired-samples t-test was carried out comparing reaction times for yes answers, that is, conditions with targets related to primes, and no answers, that is, conditions with unrelated targets. Significant differences were found in that related targets were responded to faster (M = 1030.71, SE = 23.60) than unrelated targets (M = 1335.46, SE = 34.92) [$t(72) = -10.97$, $p < 0.001$; 95% C.I.: -360.14 to -249.37]. This difference was expected since it is easier to create a connection between word meanings than to decide they are semantically unrelated.

A 2 (homonym, non-homonym) x 2 (cognate, non-cognate) repeated-measures ANOVA was conducted considering prime homonym and cognate statuses as independent variables only for conditions which presented target words related to the meaning of the prime word. In order to include only conditions with targets related to primes, the averages of conditions related to the dominant meaning and to the subordinate meaning were calculated. Main effects of homonym and cognate statuses were significant. Participants responded significantly faster after non-homonym primes (M = 946.364; SE = 19.104; 95% C.I.: 908.281 to 984.447) than after homonym primes (M = 1083.242; SE = 25.485; 95% C.I.: 1032.439 to 1134.044) [F (1,72) = 43.417, $p < 0.001$, partial $\eta^2 = 0.376$; 95% C.I.: 95.467 to 178.288], and after cognate primes (M = 969.907; SE = 22.507; 95% C.I.: 925.039 to 1014.774) than after non-cognate primes (M = 1059.699; SE = 21.252; 95% C.I.: 1017.333 to 1102.065) [F (1,72) = 25.261, $p < 0.001$, partial $\eta^2 = 0.260$; 95% C.I.: 54.178 to 125,406]. In addition, a two-way

interaction between homonym status and cognate status [F (1,72) = 8.873, p = 0.004; partial η^2 = 0.110] was significant. These results are in accordance with hypothesis 1.

In order to further investigate the two-way interaction, a paired-samples t-test was conducted on the average of the homonym and cognate statuses conditions considering only targets related to primes. Participants responded significantly faster after homonym cognate primes (M = 1009.99; SE = 33.82) than after homonym non-cognate primes (M = 1156.49; SE = 25.95) [t(72) = 4.55, p < 0.001; 95% C.I.: 82.33 to 210.67]. However, no significant difference in reaction times was found between the non-homonym cognate (M = 929.82; SE = 20.32) and non-homonym non-cognate conditions (M = 962.91; SE = 21.92) [t(72) = 1.81, p = 0.071; 95% C.I.: -2.97 to 69.13]. These results indicate that generally homonym cognate primes were more easily processed than homonym non-cognate ones, and that the cognate status had no effect on reaction times for non-homonym primes. This corroborates hypothesis 1.

Table 1 – Means, standard deviations and standard errors of reaction times for general analyses

Prime	**Homonym**		**Non-homonym**	
	Cognate	**Non-cognate**	**Cognate**	**Non-cognate**
Target	**Related**	**Related**	**Related**	**Related**
Mean	1009.99	1156.49	929.82	962.91
SD	288.92	221.74	173.60	187.30
SE	33.82	25.95	20.32	21.92

Source: Prepared by the author (2018).

4.1.1.2 Error rates

Analyses on error rates for the 73-participant sample were calculated using non-parametric tests, more specifically the Wilcoxon Signed Ranks test.

First, error rates for yes answers, that is, conditions with targets related to primes, and no answers, that is, conditions with unrelated targets, were compared. Significant differences were found in that related targets were responded to less accurately (M = 17%, SD = 0.08) than unrelated targets (M = 6%, SD = 0.07; Z = -6.29, p < 0.001). This difference was expected since participants took longer to respond when a target was unrelated to the prime word. This extra time may have contributed to smaller error rates.

Planned comparisons were conducted on homonym and cognate statuses. In other words, error rates were compared in pairs of conditions, which were previously selected, to

determine if there were differences between those pairs; more specifically, it was investigated whether a cognate prime word would influence error rates in comparison with a non-cognate one, and whether a homonym prime would impact error rates in contrast with non-homonym prime. Conditions were averaged so that meaning shared across languages was controlled for since it would be analyzed afterwards; for example, error rates for a condition with a homonym cognate dominant-shared prime and a related target were averaged with error rates for one with homonym cognate subordinate-shared prime and a related target.

Significant differences were observed between error rates during the recognition of prime-related targets following non-homonym non-cognate primes (M = 15%; SD = 0.09) and error rates during the recognition of prime-related targets following non-homonym cognate primes (M = 3%; SD = 0.05; Z = -6.56, $p < 0.001$), and differences between error rates during the recognition of prime-related targets following homonym non-cognate primes (M = 30%; SD = 0.17) and error rates during the recognition of prime-related targets following homonym cognate primes (M = 15%; SD = 0.12; Z = -5.36, $p < 0.001$). These results suggest that cognate status may have decreased error rates for non-homonym and homonym primes when targets were related to these primes. This also corroborates hypothesis 1.

Table 2 – Means and standard deviations of error rates for general analyses

Prime	**Homonym**		**Non-homonym**	
	Cognate	**Non-cognate**	**Cognate**	**Non-cognate**
Target	**Related**	**Related**	**Related**	**Related**
Mean	15%	30%	3%	15%
SD	0.11	0.17	0.05	0.09

Source: Prepared by the author (2018).

4.1.2 Analyses of homonyms

4.1.2.1 Reaction times

A 3 (dominant meaning shared, subordinate meaning shared, no meaning shared) x 2 (dominant meaning primed, subordinate meaning primed) repeated-measure ANOVA was conducted on reaction times with the meaning shared between languages by homonym primes and the meaning primed by the targets as the independent variables. Due to missing data from participants who did not answer fast enough the 15 conditions of the task (e.g. they failed to provide an answer within the 3000 ms limit on the target presentation), this analysis involved

data from 41 participants only. No main effect of meaning shared by primes across languages [$F(2,65.89) = 0.74$, $p = 0.456$] was identified. On the other hand, a main effect of meaning primed by targets [$F(1,40) = 39.31$, $p < 0.001$, partial $\eta^2 = 0.5$] was observed. Finally, an interaction between meaning shared and meaning primed [$F(2,73.92) = 10.83$, $p < 0.001$, partial $\eta^2 = 0.32$] was also found. These results suggest that generally only the meaning primed by targets influenced participants' reaction times. More specifically, the dominant meaning was responded to faster than the subordinate meaning in general. This corroborates hypothesis 2. However, meaning shared across languages interacted with meaning primed by target, which should be analyzed.

This interaction was further investigated via a sequence of planned comparisons with paired-sample t-tests. In order to verify the influence of meaning shared across languages on the access to the subordinate meaning of the homonym prime, reaction times to subordinate-related targets following homonym cognate primes which share the dominant meaning with the L1 ($M = 1447.9$, $SD = 600.98$) and reaction times to subordinate-related targets following homonym cognate primes which share the subordinate meaning with the L1 ($M = 1194.82$, $SD = 369.23$) were compared, and a significant difference was found [$t(40) = 2.58$, $p = 0.013$; 95% C.I.: 55.44 to 450.72]. This result suggests that access to the subordinate meaning of the homonym primes was facilitated when the same subordinate meaning was shared across languages than when the dominant one was shared. This corroborates hypothesis 3.

This comparison was also carried out for the dominant-related conditions. Significant differences were identified between reaction times to dominant-related targets following homonym cognate primes which share the dominant meaning with the L1 ($M = 956.03$, $SD = 245.65$) and reaction times to dominant-related targets following homonym cognate primes which share the subordinate meaning with the L1 ($M = 1068.41$, $SD = 335.37$) [$t(72) = -2.81$, $p = 0.006$; 95% C.I.: -192.03 to -32.73]. This result suggests that access to the dominant meaning of the homonym prime was facilitated when the same dominant meaning was shared across languages than when the subordinate one was shared. This corroborates hypothesis 3.

Next, the possibility of one meaning being shared across languages was compared to the possibility of no meaning being shared. Significant differences were seen for reaction times to subordinate-related targets following homonym non-cognate primes ($M = 1224.45$, $SD = 299.53$) against reaction times to subordinate-related targets following homonym cognate primes which share the dominant meaning with the L1 ($M = 1395.55$, $SD = 580.12$) [$t(50) = 2.36$, $p = 0.022$; 95% C.I.: 25.94 to 316.23]. However, no difference was found between reaction times to subordinate-related targets following homonym non-cognate primes

(*M* = 1221.59, *SD* = 306.68) and reaction times to subordinate-related targets following homonym cognate primes which share the subordinate meaning with the L1 (*M* = 1225.16, *SD* = 341) [*t*(61) = -0.069, *p* = 0.946]. These results suggest that access to the subordinate meaning of the homonym prime may have been slowed by the activation of the dominant meaning shared across languages, which did not happen when no meaning was shared. Also, it seems that whether the subordinate meaning of the homonym prime is shared across languages or not has no effect on the access of that meaning. This corroborates hypothesis 2 but not hypothesis 3.

These last comparisons were also carried out for the dominant-related conditions. Significant differences were identified between reaction times to dominant-related targets following homonym non-cognate primes (*M* = 1085.65, *SD* = 226.03) and reaction times to dominant-related targets following homonym cognate primes which share the dominant meaning with the L1 (*M* = 956.03, *SD* = 245.65) [*t*(72) = -4.25, *p* < 0.001; 95% C.I.: -190.30 to -68.93]. However, again there was no difference between reaction times to dominant-related targets following homonym non-cognate primes (*M* = 1085.65, *SD* = 226.03) and reaction times to dominant-related targets following homonym cognate primes which share the subordinate meaning with the L1 (*M* = 1068.41, *SD* = 335.37) [*t*(72) = -0.40, *p* = 0.686]. These results indicate that access to the dominant meaning of the homonym prime may have been facilitated by the increased activation of the same dominant meaning shared across languages, compared to the lack of extra activation when no meaning is shared. Also, it is suggested that whether the subordinate meaning of the homonym prime is shared across languages or not has no effect on the access of the dominant meaning. This corroborates hypothesis 2 and 3.

Table 3 – Means, standard deviations and standard errors of reaction times for homonym analyses

Prime	**Homonym**					
	Cognate				**Non-cognate**	
	Dominant shared		**Subordinate shared**			
Target	**Dominant**	**Subordinate**	**Dominant**	**Subordinate**	**Dominant**	**Subordinate**
Mean	936.29	1447.90	1068.60	1194.81	1108.46	1215.36
SD	240.05	600.99	393.58	369.24	238.06	302.33
SE	37.49	93.86	61.47	57.67	37.18	47.22

Source: Prepared by the author (2018).

4.1.2.2 Error rates

Analyses on error rates were calculated using non-parametric tests, more specifically the Wilcoxon Signed Ranks test. Planned comparisons were conducted on meaning shared by primes across languages and meaning primed by target words. Significant differences were found between error rates in the non-cognate dominant-related (M = 20%, SD = 0.16) and in the cognate dominant-shared dominant-related conditions (M = 3%, SD = 0.11; Z = -5.74, p < 0.001). In addition, significant differences were seen between the non-cognate subordinate-related (M = 40%, SD = 0.25) and the cognate subordinate-shared subordinate-related conditions (M = 30%, SD = 0.29; Z = -2.20, p = 0.028). These results indicate that, when a meaning of a homonym prime is shared across languages, it facilitates access to this same meaning, and that cognate words were more easily processed than non-cognate ones. This corroborates hypotheses 1 and 3.

Additionally, significant differences were identified between the cognate subordinate-shared subordinate-related (M = 30%, SD = 0.29) and the cognate subordinate-shared dominant-related conditions (M = 15%, SD = 0.18; Z = -3.02, p = 0.003), and between the cognate dominant-shared subordinate-related (M = 25%, SD = 0.29) and the cognate dominant-shared dominant-related conditions (M = 3%, SD = 0.11; Z = -4.2, p < 0.001). These results indicate that the meaning primed by the targets influenced error rates in that more frequent meanings were more easily processed than less frequent ones. This corroborates hypothesis 3 only partially. Further analysis was conducted concerning these last two pairs of comparisons. For each pair, a simple difference was calculated and both of these new values were compared. However, no significant difference was found (Z = -1.57, p = 0.117). This result suggests that the influence of the meaning primed by the targets was similar independently of whether the primes shared the dominant or the subordinate meaning across languages. This does not corroborate hypothesis 3.

Table 4 – Means and standard deviations of error rates for homonym analyses

Prime	**Homonym**					
	Cognate				**Non-cognate**	
	Dominant shared		**Subordinate shared**			
Target	**Dominant**	**Subordinate**	**Dominant**	**Subordinate**	**Dominant**	**Subordinate**
Mean	3%	25%	15%	29%	20%	39%
SD	0.11	0.30	0.19	0.29	0.15	0.25

Source: Prepared by the author (2018).

4.2 Reading experience and working memory capacity analyses

Participants answered 20 questions in the reading habits questionnaire according to a scale from zero (never reads) to 5 (always reads). Five questions (out of 20) from each questionnaire were selected to reflect the participants' most frequent reading habits. The selection criterion defined that questions which were answered with 3, 4 or 5 by the majority of the participants (more than 50%) would be extracted. The selected questions were related to reading short stories, didactic literature, advertisements, academic websites, and for pleasure online in Portuguese, and related to reading short stories, didactic literature, academic websites, for pleasure online, and internet journals in English. Scores for these questions were summed up for each language and were used as the reading experience scores for each language.

Also, a bilingual reading experience score was calculated from these scores via an equation used by Vaughn and Hernandez (2018) to calculate a bilingual proficiency score. This equation considers both languages as having equal weights and produces higher scores for bilinguals who are more balanced in their proficiencies. The formula is as follows: $(L1 + L2) * \sqrt{\frac{2*L1*L2}{L1^2+L2^2}}$. Finally, the reading span task total recall score was selected as a working memory capacity score since participants' reading span had little variation. The present study investigated whether these four individual differences factors would predict performance in the meaning decision task.

In order to further analyze the effects of cognate words and homonym words, two equations were used. Equation 1 was intended to measure cognate effects across both non-homonym and homonym words, while Equation 2 should test homonym effects and control for cognate effects at the same time. Reaction times and error rates data for specific conditions in the meaning decision task were entered in both equations, thus creating four variables of effects seen in the meaning decision task.

Equation 1 – Cognate effect

$$\frac{\left[\binom{nonhom}{cog} - \binom{nonhom}{noncog}\right] + \left\{\left[\frac{\binom{homcog}{dominant\ related}\binom{homcog}{subordinate\ related}}{2}\right] - \left[\frac{\binom{homnoncog}{dominant\ related}\binom{homnoncog}{subordinate\ related}}{2}\right]\right\}}{2}$$

Equation 2 – Homonym effect

$$\frac{\left\{\frac{\left[\left(\begin{matrix}cognate\\subordinate\\shared\\and\ related\end{matrix}\right)-\left(\begin{matrix}cognate\\dominant\\shared\\and\ related\end{matrix}\right)\right]+\left[\left(\begin{matrix}cognate\\dominant\\shared,\\subordinate\\related\end{matrix}\right)-\left(\begin{matrix}cognate\\subordinate\\shared\\and\ related\end{matrix}\right)\right]}{2}-0\right\}+\left\{\left[\left(\begin{matrix}noncog\\dominant\\related\end{matrix}\right)-\left(\begin{matrix}noncog\\subordinate\\related\end{matrix}\right)\right]-0\right\}}{2}$$

These four effects – cognate and homonym effects for reaction times and error rates – were entered one at a time as dependent variables in linear regression models together with the L1, L2, and bilingual reading experience scores and the working memory capacity score as predictors. There was no significant correlation between dependent variables and predictor variables. None of the four models presented a significant fit to the regression line (all $R^2 <$ 0.12, all *p*s > 0.079). However, the two effects were significantly predicted by two reading experience factors in both reaction times and error rates.

Cognate effects in reaction times were predicted by L1 reading habits and bilingual reading habits. More precisely, for every one unit increase in reading frequency in the L1, an increase of 37.95 was predicted for the cognate facilitation effect in reaction times (*B* = 37.95, *p* = 0.013; 95% C.I.: 8.35 to 67.54). Also, for every one unit increase in bilingual reading frequency, a decrease of 29.18 was predicted for the cognate facilitation effect in reaction times (*B* = -29.18, *p* = 0.022; 95% C.I.: -54.07 to -4.28). These results suggest that different reading habits are related to cognate effects differently. A positive unstandardized coefficient indicates that reaction times for cognate words were longer than to non-cognates, that is, an interference effect, while a negative unstandardized coefficient indicates that reaction times for non-cognate words were longer than to cognates, that is, a facilitation effect. Thus, it is suggested that higher frequencies of L1 reading are associated with cognate interference effects, and that higher frequencies of bilingual reading are related to cognate facilitation effects. These results corroborate only partially hypothesis 4. It was expected that more frequency of reading in general in both languages would be directly related to a facilitation effect. However, it was not expected that more frequency of reading in the L1 would be associated with an interference effect.

Homonym effects in error rates were predicted by L2 reading habits and bilingual reading habits. More specifically, for every one unit increase in L2 reading frequency, an increase of 0.05 was predicted for the homonym effect in error rates (*B* = 0.05, p = 0.016; 95% C.I.: 0.01 to 0.09). Moreover, for every one unit increase in bilingual reading frequency,

a decrease of 0.046 was predicted for the homonym effect in error rates (*B* = -0.046, p = 0.029; 95% C.I.: -0.09 to -0.01). These results suggest that different reading habits are related to homonym effects differently as well. A positive unstandardized coefficient indicates a facilitation effect while a negative one indicates an interference effect. Thus, it is suggested that higher frequencies of L2 reading are associated with homonym facilitation effects, while higher frequencies of bilingual reading are related to homonym interference effects. Despite the fact that hypothesis 4 did not involve the homonym effect, these results may be interpreted according to the frequency lag hypothesis. This will be carried out in section 5.

Finally, working memory was not able to predict any effect from the meaning decision task (all *ps* > 0.1). This result does not corroborate hypothesis 4. It was expected that working memory would be a weak predictor due to the fact that the task is composed of isolated words, which pose less demand on working memory than sentences. However, it was not expected that there would be no association at all.

5 DISCUSSION

This section will be structured similarly to section 4.

This study's general objective was to investigate the influence of L1 and L2 reading experience and of working memory capacity on the quality of L2 lexical representations of Brazilian Portuguese-English bilinguals during an L2 meaning decision task. This broader goal was divided into four specific objectives.

The first one was to examine the influence of L1 (Brazilian Portuguese) on the quality of L2 (English) lexical representations for homonym words, cognate or not with the L1. It was expected that cognate homonym words would be more efficiently processed than non-cognate homonym words and non-homonym words, and that non-homonym words would be recognized more easily than homonym ones. This is hypothesis 1.

The second objective was to verify the effect of the L1 in the access to dominant and subordinate meanings of L2 homonym words. It was expected that dominant meanings would be responded to faster than subordinate meanings. This is hypothesis 2.

The third objective was to investigate the influence of the L1 on the access to the meanings of L2 homonym words when these meanings were shared across languages (or not) and also primed (or not) by prime words. It was expected that congruence of meanings, that is, when a meaning was shared across languages and also primed by the target words, would facilitate access. This would happen for subordinate meanings as well: the fact that a meaning was shared across languages would have a stronger impact on reaction times to this meaning than the fact that its frequency of occurrence in the L2 is low. This is hypothesis 3.

In order to investigate these hypotheses, a meaning decision task was constructed with English homonym words which could be cognates or non-cognates with Brazilian Portuguese. Homonym cognate words could have their dominant (more frequent) meaning or their subordinate (less frequent) meaning shared with Brazilian Portuguese. Homonym non-cognate words did not share meanings with Brazilian Portuguese. There were also non-homonym words, which could also be cognate or non-cognate, and filler words. Participants should read silently these prime words and then decide whether a target word was related in meaning to the prime or not. Targets could be related to the dominant meaning, to the subordinate meaning, related to the only possible meaning, or unrelated. The results for these three objectives will be discussed in the next sections.

The fourth objective was to test the influence of reading experience in both the L1 and the L2 and of working memory capacity on the quality of L2 lexical representations for

homonym words, cognate or not with the L1 as predictors of the performance in the meaning decision task. It was expected that more reading experience in both and either languages would predict higher processing efficiency for cognate words than non-cognate words and would predict more efficient access to dominant meanings than to subordinate meanings. More reading experience would also predict more efficient access to subordinate meanings of homonym words shared across languages compared to subordinate meanings which were not shared. In addition, it was expected that higher working memory capacity would predict better performance in the meaning decision task. This is hypothesis 4. This was investigated through the calculation of cognate, meaning shared and meaning primed effects from the scores for the meaning decision task, which were entered to a linear regression model together with the L1, L2, and bilingual reading experience and the reading span total recall scores. Results for this objective were not significant and did not corroborate these hypotheses. The reasons for these outcomes will be explored in section 5.3.

5.1 Meaning decision task general analyses

The meaning decision task used by Perfetti and Hart (2001) tested the impact of the quality of lexical representations and involved word and meaning frequencies, lexical ambiguity, and semantic comprehension. In this study, conditions tapping language co-activation were added to the task. Word frequency was controlled for when stimuli were selected for this task. Meaning frequency was tested and controlled for in a task construction study. Despite that, some meanings of some homonym words selected as stimuli were highly infrequent, at least for the sample studied here, and participants did not know them. Thus, these words were discarded from the analyses as previously mentioned. This lack of knowledge of word meanings may not have been caused by low proficiency in English since even participants who scored high in the proficiency test did not know some of the discarded meanings.

5.1.1 Reaction times

In general, a significant difference between yes answers (related targets) and no answers (unrelated targets) was seen. Target words which were related to the meaning of the prime word were answered to faster than unrelated targets. This may be due to activation of that meaning which was already primed and spread through the semantic network, activating

nearby links and accumulating activation (COLLINS; LOFTUS, 1975). A similar result was reported also by Arêas da Luz Fontes and Schwartz (2015).

General analyses of reaction times for both homonym and non-homonym conditions showed significant main effects of homonym status and of cognate status. Targets related to homonym words took longer to process due to the fact that the primes map onto two different meanings compared to non-homonym words, which map onto one meaning only. This may indicate that two semantic representations were competing for activation, which causes interference. This effect was expected by hypothesis 1 and is similar to the ones reported by Perfetti and Hart (2001) for homophones, and by Durlik et al. (2016) for homographs. This homonym interference corroborates the LQH in that, ambiguous words such as homonyms, homophones, and homographs, may cause confusion because they are not one-to-one mappings and they may lead to the retrieval of an inadequate lexical representation (PERFETTI; HART, 2001). This confusion is reflected in longer reaction times.

A main effect of cognate status was also seen. Targets related to cognate words were easier to process due to the fact that they share meaning, orthography and phonology across languages. These shared representations add activation from both languages to cognate words compared to non-cognate ones, which receive activation from one language only. This effect of cognate facilitation was expected by hypothesis 1 too and was also reported by Dijkstra, Grainger, and van Heuven (1999), Arêas da Luz Fontes and Schwartz (2011), and Arêas da Luz Fontes and Schwartz (2015). In addition, these results are in accordance with the language non-selectivity hypothesis (DIJKSTRA; VAN HEUVEN, 2002) in that words which are cognate across languages share meaning, orthography and sometimes phonology, and these shared representations increase the activation of the lexical items.

General analyses also showed a two-way interaction between homonym status and cognate status, which were further investigated through follow-up tests. A paired-samples t-test showed that participants were significantly faster after homonym cognate conditions than after homonym non-cognate conditions, but that no significant difference was found between the non-homonym cognate and non-homonym non-cognate conditions. These results indicate a cognate facilitation effect during the processing of homonym words. More specifically, it is suggested that the overlap in meaning and orthography across languages helped participants to deal with words which mapped onto two different meanings by strengthening the activation of one of the shared meaning. This result corroborates hypothesis 1 and points to a non-selective language view. On the other hand, this co-activation across languages had no effect for non-homonym words, which map onto one meaning only. The BIA+ model predicts that

the greater the amount of overlap between two representations, the greater the activation of these representations (DIJKSTRA; VAN HEUVEN, 2002, p. 182). This prediction explains the cognate facilitation seen with homonym words. The meaning decision task stimuli may be ordered in relation to the amount of overlap across languages. Homonym non-cognate words share form across languages, but not meaning, which leads to ambiguity; they present some overlap. Homonym cognate words share both form and meaning across languages and thus present more overlap. So, the meaning which receives activation from both languages is more easily accessed, which may help resolving the ambiguity caused by the homonym aspect of the word.

In summary, general reaction times analyses indicated that processing of target words related to the meaning of prime words was confounded when these prime words were homonyms. This interference was diminished by the co-activation of meaning and form of cognate words across languages. These effects corroborate hypothesis 1 presented above, are in accordance with predictions about cross-linguistic overlap by the BIA+ model, and contribute to a language non-selective view of lexical access.

5.1.2 Error rates

In general, a significant difference between yes answers (related targets) and no answers (unrelated targets) was seen. Related targets were responded to less accurately than unrelated ones, which may be explained by the fact that unrelated targets took longer to be answered. Participants spent more time and effort determining whether two meanings were not related to each other, and this may have provided them with extra time to define their answer.

Analyses of error rates also showed cognate facilitation effects in non-homonym and homonym prime conditions when the target word was related to the meaning of the prime. These facilitation effects were also reported by Arêas da Luz Fontes and Schwartz (2011), and Arêas da Luz Fontes and Schwartz (2015). In this case, when at least one meaning of the prime word was shared across languages, access to this same meaning was facilitated by the extra activation the meaning received from the semantic network. Once again, these results are in accordance with a non-selective language view and with hypothesis 1.

In summary, error rates also showed an effect of cognate facilitation. These results confirmed hypothesis 1 in that the co-activation of two languages, manipulated through cognate words, facilitates lexical access.

5.2 Meaning decision task analyses of homonyms

Analyses were run on homonym conditions only in order to investigate the effects of the meaning which was shared by prime words across languages in detail. The meaning primed by target words, that is, whether the target was related to the dominant or the subordinate meaning of the prime word, was also taken into account.

5.2.1 Reaction times

Reaction time analyses showed no main effect of meaning shared by primes. However, there was a main effect of meaning primed by targets and an interaction between meaning shared and meaning primed. These results suggest that whether the homonym prime words shared their dominant or their subordinate meaning with the other language did not make a difference by itself. This was not expected by hypothesis 3. According to a non-selective view of language, the shared meanings would feed activation from both languages of the bilingual, which would facilitate access to this meaning. Despite that, the meaning primed effect indicated that whether the target words were related to the more frequent or to the less frequent meaning of the homonym prime word influenced answers, especially when considered together with the meaning shared across languages. These results were expected by hypothesis 3. More specifically, it was hypothesized that congruency in meaning shared and meaning primed would produce double activation for that meaning, facilitating its access.

This interaction was further investigated through paired-sample t-tests. Participants were faster in the homonym cognate subordinate-shared, subordinate-related condition, when meanings were congruent, that is, when the meaning primed by the target was the same meaning shared across languages. In this case, the subordinate meaning would receive double activation, from both the prime and the target words. Also, participants took longer to answer to the targets related to the subordinate meaning of the homonym prime word when the meaning shared was the dominant one. This may indicate that there was some activation of the dominant meaning on the prime word, which could compete with the activation of the subordinate meaning on the target word. It could also point to a frequency effect due to frequency differences between dominant and subordinate meanings. Considering the conditions in which targets primed the dominant meaning, once again participants answered faster when meanings were congruent. In other words, access to the dominant meaning of the homonym prime word was facilitated when that same meaning was shared across languages

compared to when the subordinate meaning was shared. In this case, the dominant meaning would receive double activation, from both the prime and the target words. This also may indicate that there was some activation of the subordinate meaning on the prime word, which could compete with the activation of the dominant meaning on the target word.

Additional t-tests showed significant differences between the homonym non-cognate dominant-related condition and the homonym cognate dominant-shared dominant-related condition. Participants were faster to answer when the meaning primed by the target word was also shared across languages compared to when it was not shared. In this case, the dominant meaning of the homonym prime word may have received double activation from both the prime and the target words in the second condition, which facilitated access, while in the first condition there may have been only a single activation from the target word. On the other hand, no difference was found between performance when dominant-related targets followed homonym non-cognate primes and when these same targets followed homonym cognate primes which shared the subordinate with the L1. The fact that the subordinate meaning was shared across languages seemed to produce the same effect as when no meaning was shared at all. This suggests that any activation that the subordinate meaning shared across languages may have received was not enough to compete with the dominant meaning primed by the target word.

Similar t-tests showed significant differences between homonym non-cognate subordinate-related condition and homonym cognate dominant-shared subordinate-related condition. Participants were faster to answer to the subordinate meaning of the homonym prime word when no meaning was shared across languages compared to when the dominant meaning was shared. This may indicate that there was some activation of the dominant meaning on the prime word which competed with the subordinate meaning activated on the target word. However, no difference was seen between the homonym non-cognate subordinate-related condition and the homonym cognate subordinate-shared subordinate-related condition. This could suggest that there was no double activation of the subordinate meaning in the second condition compared to when no meaning was shared across languages; or this could indicate that the double activation was not strong enough to facilitate access to the subordinate meaning as opposed to a single activation from the target word only.

These results were not expected by hypothesis 3 and were different from the ones reported by Arêas da Luz Fontes and Schwartz (2015). In their study, when the sentence context was constrained to the subordinate meaning of homonym words, processing times were the same for non-homonym and for cognate homonyms. “This supports the hypothesis

that the combination of context and cognate status allowed the subordinate meaning's activation to out-pace that of the dominant" (ARÊAS DA LUZ FONTES; SCHWARTZ, 2015, p. 652). A similar effect was expected for the isolated words in the meaning decision task: access to the subordinate meaning primed by the target would be facilitated if this meaning was shared across languages via cognate words. However, this was not the case. The activation of the subordinate meaning when the prime word also shared this very meaning across languages was not enough to facilitate access to this meaning in comparison with non-cognate primes.

In addition, the activation of the subordinate meaning shared across languages was not strong enough to cause competition with the dominant meaning primed by the target word. On the other hand, this competition may have happened to the access to the subordinate meaning when the prime word shared the dominant meaning across languages. In other words, the more frequent meaning of the homonym words produced stronger activation than the less frequent meaning in almost all conditions.

5.2.2 Error rates

Effects of cognate facilitation and of meaning frequency were also seen in error rates. There were significant differences between the non-cognate dominant-related and in the cognate dominant-shared dominant-related conditions, and between the non-cognate subordinate-related and the cognate subordinate-shared subordinate-related conditions. Accuracy was higher when the meaning primed by the target word was also shared across languages compared to when no meaning was shared. This effect of cognate facilitation happened when the target word primed the dominant meaning and also the subordinate meaning. However, accuracy was higher in the conditions which had the dominant meaning primed by the target word than the conditions which had the subordinate meaning primed. This indicates that access to the more frequent meaning of the homonym words was generally easier than to the less frequent one.

Influence of meaning frequency was also seen in the significant differences between the cognate subordinate-shared subordinate-related and the cognate subordinate-shared dominant-related conditions. Contrarily to the expected result, accuracy was higher when the dominant meaning was primed by the target word but the subordinate meaning was shared across languages in comparison to when the subordinate meaning was both primed and shared. This may indicate that either there was no activation of the subordinate meaning on

the prime word to compete with the activation of the dominant meaning on the target word, or it was not strong enough to create competition. Alternatively, the double activation of the subordinate meaning on the prime and the target words, which would have been expected, may have not been produced due to poor knowledge on that less frequent meaning.

Another indication of the meaning frequency effect was found in the significant differences between the cognate dominant-shared subordinate-related and the cognate dominant-shared dominant-related conditions. As it was expected by hypothesis 3, accuracy was higher when the meaning primed by the target was also shared across languages. In this case, the dominant meaning received double activation from both the prime and the target words, which facilitated access. Also, there may have been activation of the dominant meaning shared across languages in the first condition, which competed with the activation of the subordinate meaning primed by the target.

Although there were effects of meaning shared across languages, the simple difference between the conditions which had the dominant meaning shared was equivalent to the one between the conditions which had the subordinate meaning shared. In other words, the influence of meaning shared across languages, which interacted with meaning primed by target words, was similar both when the dominant meaning of the homonym word was shared and when the subordinate meaning was shared. Whether the one meaning or the other was shared seemed not to produce a difference in reaction times to target words. This suggests that the impact of meaning shared across languages was equivalent for both the dominant and the subordinate meanings primed by the target words for this sample of Brazilian Portuguese-English bilinguals.

In summary, the meaning primed by the targets affected performance in the meaning decision task and interacted with the meaning shared across languages by primes. When a subordinate meaning was shared across languages, the access to this meaning may have been facilitated. However, this facilitation could not compete with the effect of meaning frequency. In other words, access to the more frequent meaning was easier than to the less frequent one even when the less frequent meaning overlapped across languages. These results corroborate this study's hypotheses only partially. In general, homonym words caused interference during meaning decision while cognate words produced facilitation; both of these findings were expected (hypotheses 1 and 2). Nonetheless, the cognate facilitation was overridden by the frequency of the meanings of the homonym word, which was not expected (hypothesis 3). Hypothesis 3 stated that access to the subordinate meaning would be facilitated when this same meaning was shared across languages, but it was not confirmed. This indicates that, for

this sample of Brazilian Portuguese-English bilinguals, the dominance of a meaning has a stronger effect in lexical access than the overlap in meaning and form from cognate words.

Moreover, when this dominance is shared between languages, its influence is stronger than when it is not shared. In other words, the dominant meaning was easier to be accessed in any of the task conditions, especially when it was both shared across languages and primed by the target word. This could be explained by the participants' reading experience. They were all undergraduate students from the Languages and Literature course, which could influence the types of materials they are used to read. When books and papers about similar topics and from the same academic genre are considered, it is likely that the same meanings and lexical representations are encountered. This reinforces some constituents of these words, consequently decreasing the opportunities for finding and specifying other constituents, for example, a subordinate meaning of a homonym word (WHITFORD; TITONE, 2015). And, in extension of the assumptions of the LQH, with less diversity of reading materials, comes less diversity of vocabulary.

5.3 Reading experience and working memory capacity analyses

According to the LQH, reading experience influences lexical quality and reading behavior (TAYLOR; PERFETTI, 2016), which automatizes word recognition and frees higher cognitive processes, such as working memory, for dealing with more complex tasks (PERFETTI; HART, 2001). Parallel to that, working memory capacity was shown to compensate for low decoding skills during inference generation (HAMILTON; FREED; LONG, 2016). In order to investigate whether these factors would predict the effects of cognate facilitation observed in the analyses mentioned earlier, new variables were created with reaction times and error rates from the meaning decision task through two equations. Linear regression analyses were run on the cognate and homonym effects as dependent variables and on reading habits scores for L1, L2 and both languages and on reading span recall score as predictor variables. Cognate and homonym effects were predicted by L1 reading habits and bilingual reading habits, and L2 reading habits and bilingual reading habits, respectively. However, the working memory measure was not able to predict these effects.

These results corroborated only partially hypothesis 4. It was expected that cognate effects would be predicted by reading experience measures and by working memory capacity. It was observed that only reading experience measures were able to predict the effects from

the meaning decision task. It is important to highlight the nature of each reading experience measure. Scores for L1 reading habits should indicate reading experience considering materials in participants' L1 only. Similarly, scores for L2 reading habits should indicate reading experience based on only reading of material in the L2. And scores for bilingual reading habits should indicate participants' reading experience in general, involving both materials in their L1 and in their L2. Taking these characteristics into consideration, higher frequencies of L1 reading were associated with cognate interference effects (in reaction times), and higher frequencies of bilingual reading were related to cognate facilitation effects (in reaction times). These results suggest that, when only reading in the L1 is taken into account, independently of the frequency of reading in the L2, participants present interference from cognate words during reading of L2 words, that is, the higher the amount of reading in the L1, the higher the activation of L1 representations. In this case, this extra activation seems to be leading to confusion: participants were instructed to complete a task in English, but suddenly Brazilian Portuguese words appear during the task. L1 reading experience alone may be reflecting the level of activation of the L1. This may be also explained by a frequency approach, such as the frequency lag hypothesis (GOLLAN et al., 2011). This hypothesis states that a bilingual disadvantage in speed of retrieval, that is, that bilinguals present longer reaction times when compared to monolinguals in the same task, is due to frequency of use of each language. Bilinguals divide their time using each language since they cannot produce or listen to both languages at the same time. And this division implies that they have less experience with each language separately in comparison with monolinguals (GOLLAN et al., 2011). This is the frequency lag, and it may explain why more L1 reading only would lead to cognate interference during the recognition of L2 words. Since the L1 reading experience measure considered only reading in Brazilian Portuguese, it could be predicted that participants are reading less in their L2 than in their L1. As a result, familiarity with Brazilian Portuguese words will be higher than with English ones due to frequency of exposure, and the recognition of cognate words via Brazilian Portuguese will be faster than via English. This may define one possibility of source of the cognate interference seen here.

The observed results also suggest that, when reading in both languages is taken into account, participants show facilitation from cognate words during reading of L2 words, that is, the higher the amount of reading in general, more effectively the co-activation of languages is used. Participants use both languages more frequently and also may activate cognate words simultaneously more frequently and easily. This corroborates hypothesis 4 and is in accordance with a non-selective lexical access language view.

Another effect from the meaning decision task that was analyzed was a homonym effect. Initially, hypothesis 4 did not involve this effect in particular; however, the equation for calculating the homonym effect made it possible to add it to the regression analysis. The results suggested that higher frequencies of L2 reading are associated with homonym facilitation effects (in error rates), while higher frequencies of bilingual reading are related to homonym interference effects (in error rates). This denotes that when only reading in the L2 is taken into account, independently of the frequency of reading in the L1, participants present facilitation in the disambiguation of homonym words during reading of L2 words, that is, the higher the amount of reading in the L2, the higher the activation of L2 representations and, consequently, the easier the solving of L2 lexical ambiguity. On the other hand, results also suggest that, when reading in both languages is taken into account, participants show interference in the disambiguation of L2 homonym words, that is, the higher the amount of reading in general, the higher is language co-activation and, consequently, the higher is meaning competition. Both the homonym facilitation and the homonym interference effects may be explained by the frequency lag hypothesis (GOLLAN et al., 2011). Higher frequency of L2 reading alone should increase lexical quality of ambiguous words through exposure of both meanings of homonyms in diverse contexts. This would lead to facilitation during the disambiguation of the task stimuli. Comparatively, higher frequency of reading in both languages makes it easier to access word meanings from the two languages. Consequently, there would be higher co-activation of competing meanings and then interference during recognition. This interpretation is also in accordance with a non-selective lexical access language view.

The regression results observed in this study may be interpreted in a similar way as in Whitford and Titone's (2015). In their study, current language exposure modulated bilinguals reading fluency and perceptual span in a way that participants who reported higher current L2 exposure presented higher L2 reading fluency but lower L1 reading fluency. The authors interpret these findings according to the frequency lag hypothesis in that higher current exposure to one language excludes exposure to the other language, decreasing frequency effects in the less used one. Considering current language exposure as reading experience and reading fluency as reaction times and error rates, the present study shows that individual differences in reading experience, operationalized as reading habits, are associated with written word recognition. More specifically, reading habits in one or in two languages seem to influence L2 lexical access differently. When examining only L1 reading habits, a cognate interference effect was observed, while a cognate facilitation effect was seen when taking

both L1 and L2 reading habits into account. This shows that reading frequency in one language alone predicts word recognition effects in a distinct way than reading frequency in two languages would. This difference in predictive aspect is in accordance with the frequency lag hypothesis and a non-selective language lexical access view.

Furthermore, working memory results did not corroborate hypothesis 4. According to the literature, working memory should predict the effects focused in this study. Arêas da Luz Fontes and Schwartz (2011) reported that, in an ANOVA, the digit span score interacted with ambiguity status and with cognate status. Participants with low span were slower when reacting to ambiguous words compared to unambiguous ones and were faster when reacting to cognate words compared to non-cognate ones. The same did not happen for participants with high span. Setting aside the differences in statistical tests, there was some relationship between cognate status, ambiguity, and working memory. In this case, higher working memory capacity increased the efficiency of discriminating meanings of ambiguous words and decreased the reliance on word form, to a cost in accuracy. Similar outcomes were expected in that the reading span recall score would predict, even if only weakly, the cognate effect and the meaning frequency effect.

Additionally, Arêas da Luz Fontes and Schwartz's (2015) study showed that working memory and cognate effect were moderately and inversely correlated, $r = -0.32$, $p < 0.01$; and that cognate status and access to subordinate meanings in the L1 were also inversely correlated, $r = -0.25$, $p < 0.05$. Although working memory capacity was associated with cognate status, it was the latter that predicted error rates for non-cognate and cognate words. More specifically, accuracy decreased while the cognate effect increased. The authors clarify that working memory capacity was not expected to predict performance in a primed lexical decision task because processing of isolated words demands less from it than sentence processing for instance. They also explain that participants may have relied more on word form and that this strategy may have worked only for unambiguous cognates. Comparing Arêas da Luz Fontes and Schwartz' (2015) study with the present one, it is possible to interpret the finding that working memory capacity did not predict performance in the meaning decision task. The task was also composed of isolated words only, whose processing is not as demanding from working memory as a sentence comprehension task. However, there are the conflicting results that no cognate effect was associated with working memory in the present study. It may be the case that these effects were too small – since they were produced by millisecond differences – and specific – since they appeared in a meaning decision task

with very specific conditions – to be intensely influenced by an executive function which was expected to have a limited impact.

The present study's results were also different from the ones reported by Hamilton, Freed, and Long (2016). They showed that working memory capacity may compensate for low decoding skills. In order to verify that, the authors used a task consisting of short paragraphs which required participants to create inferences in order to decide whether a target word was related to the content of the paragraph or not. The task itself demanded more from working memory than the meaning decision task. However, in the present study, it was not possible to confirm the hypothesis that working memory capacity would predict performance in a task which mainly involved access to more or less frequent meaning of homonyms. It is true that here it was not used a decoding or spelling test, contrarily to Hamilton, Freed, and Long. On that account, the meaning decision task indicates the impact of higher lexical quality on meaning and word recognition. A decoding or spelling task reflects one step of the processes which feed the constituents of lexical representations. Together with reading experience measures, the decoding or the spelling task should be able to reflect the level of lexical quality. The present study was focused on the influence of reading experience and of working memory on the recognition of meanings of homonym cognate words by bilinguals. Since decoding or spelling skills were not being tested, these tests were not used. On the other hand, the meaning decision task was testing not only lexical quality, but also language co-activation and meaning frequency. It is possible that a decoding or spelling test, which test one construct only, would have shown a significant interaction with working memory or significant correlation with reading experience.

In addition, in the present study, no significant correlation was found between the reading span recall score and the three reading habit scores. Considering that both the reading span task (WATERS; CAPLAN, 1996) and the reading habits questionnaire (PRATHEEBA; KRASHEN, 2013) were correlated with reading comprehension tests, one would expect these tasks would present at least a small association. However, this was not the case. Here, the reading span recall score was used as a score for working memory capacity. Perhaps a composite score would reflect some correlation. Waters and Caplan (1996) mention that a composite *z*-score, for instance consisting of the average of the reaction time, the error rate, and the recall *z*-scores, presents higher test-retest reliability than the recall score.

Also, it could be that the reading habits questionnaire was an insufficient measure of reading experience. Taylor and Perfetti (2016) investigated individual differences in reading skills and in word knowledge through factor analyses. The authors identified that eye-tracking

reading speed measures, text exposure, reading attitudes, and book reading information reported on a reading history questionnaire loaded on a factor which was called reading experience. This factor showed that participants with more reading experience skipped more words, refixated less often, and presented low viewing times for low-frequency words. Similarly to lexical quality, reading experience is a composite construct. Eye-tracking measures would be able to complement and strengthen the operationalization of reading experience.

Perfetti and Hart (2001) highlight that readers who have lower reading skills suffer from frequency effects more generally than readers who have higher reading skills. In other words, when less-skilled readers encounter low-frequency or low-familiarity words, the processing of every word is slowed. In the present study, participants were not separated into two groups according to their reading comprehension abilities. Because of that, it was not possible to investigate the relationship between reading skill and meaning frequency. However, most participants presented higher error rates and longer reaction times for the less frequent meaning of the homonym prime words compared to the more frequent one. This suggests less knowledge of these meanings and, consequently, lower lexical quality for these representations. This is the rationale behind the hypothesis that the L1, L2 and/or the bilingual reading experience scores would predict this individual variability in performance.

Another characteristic of the reading habits questionnaire which may have influenced the results is that it does not specify whether these habits are current or long-term. Whitford and Titone (2015) considered current L2 exposure in their study on language experience and sentence reading. In general, the authors showed that an increase in current L2 exposure leads to higher L2 reading fluency but to lower L1 reading fluency. In the present study, it was not possible to detect such differences – maybe due to lack of specificity in the reading habits questionnaire. Most participants (54) reported similar reading frequencies between languages (less than 15% difference): if they read only sometimes in one language, they presented the equivalent reading habits in the other.

Other limitations of the present study which could have influenced the results are the following. Testing sessions were held in a room which was accessed by many professors daily. As a result, conversation in Brazilian Portuguese occurred during most testing sessions, which were conducted entirely in English. This may have slowed or interrupted participants' adaptation to an L2-only environment (KROLL; GULLIFER; ZIRNSTEIN, 2016). Unfortunately, a room exclusive for testing was not available. Moreover, most participants spoke one or more languages other than Brazilian Portuguese and English, and proficiency in

those languages was not controlled for. Since the sample for this study was drawn from an undergraduate course on languages, being bilingual or multilingual is a common characteristic of participants. Their proficiency on an L3 or L4 was only described and not controlled for. Permeability between those languages also may have influenced the results (KROLL; GULLIFER; ZIRNSTEIN, 2016).

In summary, the present study's results showed that reading experience scores were predicted cognate and homonym effects seen in the meaning decision task. However, and working memory capacity was not able to do the same. These findings may be explained by the fact that word recognition tasks demand less from working memory than sentence processing tasks (ARÊAS DA LUZ FONTES; SCHWARTZ, 2015). Considering the possibility of a working memory impact, the reading span recall score may be replaced for a composite score (WATERS; CAPLAN, 1996). Also, a decoding or spelling test may be lacking in order to observe an interaction with working memory (ARÊAS DA LUZ FONTES; SCHWARTZ, 2011) or a correlation with reading experience (TAYLOR; PERFETTI, 2016). Moreover, eye-tracking measures could complement the reading experience score (TAYLOR; PERFETTI, 2016), and the reading habits questionnaire should be more specific in terms of current exposure to languages (WHITFORD; TITONE, 2015). Finally, conversations in an irrelevant language during testing sessions and proficiency in a third or fourth language could have influenced performance in the meaning decision task (KROLL; GULLIFER; ZIRNSTEIN, 2016).

6 CONCLUSION

This study focused on the influence of L1 and L2 reading experience and of working memory capacity on the quality of L2 lexical representations of Brazilian Portuguese-English bilinguals during an L2 meaning decision task. Hypotheses were drawn for each of the four objectives, which concerned respectively co-activation and meaning frequency effects in the meaning decision task, the reading experience effects, the interaction between the latter ones and the co-activation of languages, and the working memory effects. The experiment was composed of a meaning decision task, a reading span task, a reading habits questionnaire, a language history questionnaire, a proficiency test, and a meaning recognition test. Significant results were observed but they corroborated only the hypotheses about the influence and interaction of language co-activation and meaning frequency in the meaning decision task. The hypotheses concerning reading experience and working memory could not be confirmed.

The findings in this study point in favor of a non-selective language view for word recognition (DIJKSTRA; VAN HEUVEN, 2002). Generally, homonym words caused interference due to the fact that they map onto two different meanings. Also, cognate words facilitated lexical access because of the overlap in meaning and form across languages. However, this cognate facilitation effect was restrained by the frequency of the meaning of the homonym words. Both homonym and the cognate effects were expected according to the literature (ARÊAS DA LUZ FONTES; SCHWARTZ, 2011, 2015). It was also expected that the cognate words would facilitate access to subordinate meanings when those meanings were shared across languages. It was observed that the higher frequency of the dominant meaning had a stronger influence on word recognition than cognate status. This suggests that, for this sample of Brazilian Portuguese-English bilinguals, meaning frequency had more impact on lexical access than cross-language overlap, which may have been generated by participants' reading experience in that they were exposed mostly to dominant meanings (WHITFORD; TITONE, 2015; PERFETTI; HART, 2001).

In addition, the hypotheses that reading experience, measured as reading frequency, and working memory capacity would predict performance in the meaning decision task were only partially confirmed. L1 and bilingual reading experiences predicted cognate effects, respectively interference and facilitation effects; and L2 and bilingual reading experiences predicted homonym effects, respectively facilitation and interference effects. These results may be explained by frequency (GOLLAN et al., 2011) and non-selective access (DIJSKTRA; VAN HEUVEN, 2002) accounts.

These results might have implications for the theoretical background presented earlier. This study presented evidence supporting the non-selective lexical access hypothesis (DIJKSTRA; VAN HEUVEN, 2002) in that the manipulation of the stimuli with cognate words had an effect on reaction times and error rates, more specifically a facilitation effect. Other than that, it suggested that the effect of meaning frequency can be stronger than the cognate effect. As a speculation, this might be modulated by the quality of lexical representations. Although participants reported knowing the subordinate meanings of the homonym prime words, access to those meanings was hampered during the meaning decision task. Independently of the subordinate meaning being shared across languages, access to the dominant meaning was generally easier. This might suggest that meaning frequency has a stronger impact on the resting level activation of lexical representation (DIJKSTRA; VAN HEUVEN, 2002) than the activation of one meaning produced from both languages. These hypotheses may be verified with the help of more precise instruments, such as ERPs. In the case of homophone words, which usually cause interference effects in the literature, Carrasco-Ortiz, Midgley, and Frenck-Mestre (2012) observed facilitation effects through a reduction in the N400. Considering that reading experience should have any effect in the meaning decision task, ERPs might reflect that impact more accurately.

Moreover, it was possible to verify the influence of reading experience (but not of working memory capacity) on the access to meanings of homonym words which were or were not shared across languages. The corroboration of these hypotheses may be used to emphasize the relation between reading in two different languages and lexical access and, as a consequence, to draw implications for language teaching. For instance, Taylor and Perfetti (2016) illustrated how training of specific word constituents can increase lexical quality and improve reading. Also, in general, the LQH can be relevantly applied to the area of language teaching. It specifies the properties which are able to characterize the quality of words as high or low, and it enables the use of a practical teaching perspective for developing vocabulary and the lexicon (KUCAN, 2012). As from LQH's premises, one may conclude that "Students need vocabulary instruction that allows them to build rich representations of words" and that phonology, orthography, morphology, and syntax can aid the study of semantics (KUCAN, 2012, p. 366). The study of word properties should respect their unitary and compositional characteristic because words are a whole composed of indispensable constituents (PERFETTI; HART, 2001). These characteristics might be used to build teaching techniques for improving L1 and L2 word knowledge and, consequently, reading abilities.

Finally, reading should be further studied with the aid of varied approaches. One example is eye-tracking measures which can register detailed characteristics of eye movements and describe fluent reading. In a study such as the present one, an accurate instrument such as the eye-tracker device might be a good pair for a reading habits questionnaire as a reading experience measure (TAYLOR; PERFETTI, 2016). This way, reading speed may be measured and a level of automaticity in reading may be defined as well.

Since reading is a complex activity, it seems that a set of methods and techniques might be a more complete way of investigating lexical access, especially when the interaction of two languages is considered. Use and exposure to each language varies between individuals, and this variation also influences word recognition. These individual differences are some of the characteristics of less or more experienced readers. A good reader is said to be able to read 400 to 500 words per minute. This is an amazing fact when we consider that reading is made of the basic perception of letters and then morphemes and then words (DEHAENE, 2012). This complex process is completed so automatically that it may be taken for granted in the everyday life and truly missed when there is some obstruction to word recognition.

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APPENDICES

APPENDIX A: INFORMED CONSENT FORM

Participante n° _____ Data: _____

TERMO DE CONSENTIMENTO LIVRE E ESCLARECIDO

Você está sendo convidado a participar do projeto de pesquisa com vistas ao mestrado em Letras de Pietra Cassol Rigatti intitulado A INFLUÊNCIA DA EXPERIÊNCIA LEITORA EM L2 E O PAPEL DA MEMÓRIA DE TRABALHO NA QUALIDADE DAS REPRESENTAÇÕES LEXICAIS EM L2. O objetivo da pesquisa é verificar a influência da experiência de leitura em inglês como segunda língua no reconhecimento de palavras em inglês. Caso aceite participar, por favor, leia os parágrafos a seguir e assine este documento, indicando que você entende a natureza deste estudo e que você consente em participar dele.

Nesta pesquisa, você irá preencher dois questionários em inglês sobre seu uso de línguas e hábitos de leitura e realizará três tarefas de leitura de palavras e de frases também em inglês no computador.

O estudo prevê riscos de gradação leve como cansaço, em função do tempo de duração total da sua participação (90 minutos), ou possível constrangimento, uma vez que você pode não reconhecer todas as palavras utilizadas no estudo. Garantimos que você terá intervalos para descanso. Além disso, seus dados serão mantidos em anonimato e em sigilo. Cada participante será representado por um número para que a pesquisadora não tenha acesso ao nome no momento de análise de dados. Os dados coletados serão salvos em um computador e em uma gaveta que só poderão ser acessados com senha ou chave, a qual é sabida apenas pelas pesquisadoras. Você poderá acessar seus dados sempre que requisitar. Sua participação é livre e voluntária, sendo liberada a sua saída do estudo a qualquer momento em caso de cansaço ou constrangimento. Ademais, você será convidado a participar em um único encontro presencial marcado com antecedência, de acordo com sua disponibilidade, e em nenhum outro momento, virtual ou não, além desse. Por fim, não haverá benefícios diretos decorrentes da participação nesta pesquisa.

Pelo presente Termo de Consentimento Livre e Esclarecido, declaro que autorizo a minha participação neste projeto de pesquisa, pois fui informado(a), de forma clara e detalhada, livre de qualquer forma de constrangimento e coerção, dos objetivos desta pesquisa e dos testes a que me submeterei, todos acima listados.
Fui, igualmente, informado(a):

• da garantia de receber resposta a qualquer pergunta ou esclarecimento a qualquer dúvida acerca dos procedimentos, riscos, benefícios e outros assuntos relacionados com a pesquisa;
• da liberdade de retirar meu consentimento, a qualquer momento, e deixar de participar do estudo sem que isto traga a mim prejuízo profissional, acadêmico ou pessoal;
• da garantia de que não serei identificado quando da divulgação dos resultados e que as informações obtidas serão utilizadas apenas para fins científicos vinculados ao presente projeto de pesquisa.

A pesquisadora responsável por este Projeto de Pesquisa é a Prof.ª Dr.ª Ana Beatriz Arêas da Luz Fontes, telefone (51) 3398-0179, professora do Instituto de Letras da UFRGS (Rua Bento Gonçalves, 9500, 90650-001, Porto Alegre/RS). Este projeto foi aprovado pelo Comitê de Ética em Pesquisa da UFRGS (Av. Paulo Gama, 110, sala 317, prédio Anexo 1 da Reitoria, Campus Centro, Porto Alegre/RS, 90040-060, telefone (51) 3308-3738). O presente documento foi assinado em duas vias de igual teor, ficando uma com o voluntário da pesquisa e outra com a pesquisadora responsável.

_____ _____
Nome do(a) participante Assinatura do(a) participante

_____
Pesquisadora responsável

APPENDIX B: L1 AND L2 READING EXPERIENCE AND READING HABITS QUESTIONNAIRE

Participant number _____ Date _____

READING HABITS AND READING EXPERIENCE QUESTIONNAIRE (L1)

Please answer the following questions on a 0 to 5 scale, where **0 = never, 1 = rarely, 2 = sometimes, 3 = often, 4 = almost always, 5 = always**. Check the box with the number that best fits your answer.

1. Are you in the habit of reading daily newspapers in Portuguese?

( ) 0 ( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5

2. Are you in the habit of reading newspaper editorials in Portuguese?

( ) 0 ( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5

3. Are you in the habit of reading scientific journals in Portuguese?

( ) 0 ( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5

4. Are you in the habit of reading comics in Portuguese?

( ) 0 ( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5

5. Are you in the habit of reading short stories in Portuguese?

( ) 0 ( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5

6. Are you in the habit of reading historical novels in Portuguese?

( ) 0 ( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5

7. Are you in the habit of reading didactic literature in Portuguese?

( ) 0 ( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5

8. Are you in the habit of reading sports magazines in Portuguese?

( ) 0 ( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5

9. Are you in the habit of reading film magazines in Portuguese?

( ) 0 ( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5

10. Are you in the habit of reading political novels in Portuguese?

( ) 0 ( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5

11. Are you in the habit of reading science fiction in Portuguese?

( ) 0 ( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5

12. Are you in the habit of reading biography in Portuguese?

( ) 0 ( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5

13. Are you in the habit of reading poetry in Portuguese?

( ) 0 ( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5

14. Are you in the habit of reading jokes in magazines, newspapers in Portuguese?

( ) 0 ( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5

15. Are you in the habit of reading advertisements in Portuguese?

( ) 0 ( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5

16. Are you in the habit of reading fiction in Portuguese?

( ) 0 ( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5

17. Are you in the habit of reading current affairs online in Portuguese?

( ) 0 ( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5

18. Are you in the habit of reading academic websites in Portuguese?

( ) 0 ( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5

19. Are you in the habit of reading for pleasure online in Portuguese?

( ) 0 ( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5

20. Are you in the habit of reading internet journals in Portuguese?

( ) 0 ( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5

Do you have any other reading habit that you feel it is important to share?

_____

_____

Thank you for your time!

Participant number _____ Date _____

READING HABITS AND READING EXPERIENCE QUESTIONNAIRE (L2)

Please answer the following questions on a 0 to 5 scale, where **0 = never, 1 = rarely, 2 = sometimes, 3 = often, 4 = almost always, 5 = always**. Check the box with the number that best fits your answer.

1. Are you in the habit of reading daily newspapers in English?

( ) 0 ( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5

2. Are you in the habit of reading newspaper editorials in English?

( ) 0 ( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5

3. Are you in the habit of reading scientific journals in English?

( ) 0 ( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5

4. Are you in the habit of reading comics in English?

( ) 0 ( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5

5. Are you in the habit of reading short stories in English?

( ) 0 ( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5

6. Are you in the habit of reading historical novels in English?

( ) 0 ( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5

7. Are you in the habit of reading didactic literature in English?

( ) 0 ( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5

8. Are you in the habit of reading sports magazines in English?

( ) 0 ( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5

9. Are you in the habit of reading film magazines in English?

( ) 0 ( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5

10. Are you in the habit of reading political novels in English?

( ) 0 ( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5

11. Are you in the habit of reading science fiction in English?

( ) 0 ( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5

12. Are you in the habit of reading biography in English?

( ) 0 ( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5

13. Are you in the habit of reading poetry in English?

( ) 0 ( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5

14. Are you in the habit of reading jokes in magazines, newspapers?

( ) 0 ( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5

15. Are you in the habit of reading advertisements?

( ) 0 ( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5

16. Are you in the habit of reading fiction for children?

( ) 0 ( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5

17. Are you in the habit of reading current affairs online?

( ) 0 ( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5

18. Are you in the habit of reading academic websites?

( ) 0 ( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5

19. Are you in the habit of reading for pleasure online?

( ) 0 ( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5

20. Are you in the habit of reading internet journals?

( ) 0 ( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5

Do you have any other reading habit that you feel it is important to share?

_____

_____

Thank you for your time!

APPENDIX C: MEANING RECOGNITION TASK

RECOGNITION TEST (A)				
Mark all the meanings that you use and/or know for each word on the leftmost column.				
actor	( ) someone who plays roles	( ) to account for	( ) article of furniture	( ) frightening scream
air	( ) predictability	( ) atmosphere	( ) without emotion	( ) to burn out
alike	( ) free of restrictions	( ) similar	( ) to pay back	( ) to fail to abduct
alter	( ) bath	( ) to change	( ) group of people	( ) portrait
arcade	( ) unable to sleep	( ) series of arches	( ) mobility	( ) to sit down
arch	( ) playful person	( ) curved structure	( ) animal	( ) board
arms	( ) edge	( ) weapons	( ) upper limbs	( ) stone
ash	( ) a tree	( ) fire residue	( ) outstanding	( ) to express
baby	( ) little child	( ) to show anxiety	( ) dust clouds	( ) to take out
ball	( ) furious	( ) dance	( ) sphere	( ) body part
ban	( ) public pronouncement	( ) large clock	( ) to clean	( ) to forbid
band	( ) group of people	( ) strip of material	( ) transparent square	( ) to fill
base	( ) to stack	( ) of little quality	( ) sore throat	( ) foundation
bat	( ) wooden club	( ) negation	( ) to require	( ) animal
bear	( ) animal	( ) to support	( ) area of space	( ) duty
bore	( ) prize	( ) to bring to consciousness	( ) to make holes	( ) monotony
box	( ) to fight	( ) container	( ) to fail to score	( ) expanding quickly
brick	( ) block of clay	( ) ridicule	( ) to stick up for	( ) standard
bust	( ) to create	( ) sculpture	( ) to break	( ) grass
capital	( ) city	( ) old picture	( ) to balance	( ) uppercase
carrot	( ) to warm up	( ) solid cube	( ) artistic value	( ) root
case	( ) little bag	( ) example	( ) green vegetable	( ) volume
chord	( ) animal	( ) musical tones	( ) lurking	( ) line
clasp	( ) always ready	( ) to tell	( ) fastening device	( ) pigment
color	( ) to calm down	( ) two moving parts	( ) engine	( ) tint
comic	( ) to furnish	( ) feeling of distaste	( ) funny	( ) feeling of gentleness
content	( ) to turn in	( ) unkind	( ) filling	( ) satisfied
converse	( ) talk	( ) body of water	( ) opposite	( ) sticker
date	( ) to shatter	( ) fruit	( ) radiation	( ) moment in time
deadly	( ) something that kills	( ) to fill up	( ) having fragrance	( ) to perceive

dove	( ) made of air	( ) past of dive	( ) fitting situation	( ) animal
elbow	( ) royalty	( ) body part	( ) acceptable	( ) to wear out
elevator	( ) safety	( ) to apply for	( ) lift	( ) not sincere
enter	( ) to go in	( ) substitution	( ) musical composition	( ) to freeze
eye	( ) to count on	( ) complement	( ) opinion	( ) body part
fame	( ) thin wedge	( ) celebrity	( ) relative	( ) to dress up
fan	( ) air device	( ) misunderstanding	( ) to misplace	( ) follower
fast	( ) quick	( ) to cease to eat	( ) fictional character	( ) a large amount
file	( ) folder	( ) stomach	( ) to cause sorrow	( ) grinding tool
final	( ) tool for cutting	( ) to soak	( ) last one	( ) to cancel
fleet	( ) horse racing	( ) ships	( ) swift	( ) to join
flight	( ) point in time	( ) surface of object	( ) flying	( ) fleeing
fly	( ) move through air	( ) bug	( ) athletic team	( ) to come up with something
fork	( ) self-service	( ) to wipe off	( ) spiritual entity	( ) cutlery
former	( ) previous	( ) person who forms	( ) path	( ) calculating machine
gem	( ) to agree with	( ) task	( ) precious stone	( ) shield
gloss	( ) solid structure	( ) social standard	( ) shine	( ) explanation note
grate	( ) to shred	( ) metal grid	( ) to be concerned	( ) alone
grave	( ) serious	( ) well-known song	( ) hole in the ground	( ) animal
guitar	( ) made of paper	( ) to come across	( ) to refer	( ) musical instrument
hell	( ) wool blanket	( ) place of suffering	( ) to leave behind	( ) performance
horror	( ) fear	( ) beverage	( ) earthquake	( ) to end up
hunger	( ) beginning	( ) need for food	( ) to aim at	( ) celestial body
intent	( ) focused	( ) intention	( ) door	( ) fragile
king	( ) monarch	( ) to cover	( ) comprehensive	( ) to let down
lap	( ) to announce	( ) body area	( ) identification	( ) segment in a circuit
launch	( ) musical instrument	( ) to propel	( ) crown	( ) motor boat
leaf	( ) part of plant	( ) staring eyes	( ) group leader	( ) to answer
liver	( ) someone who lives	( ) to escape	( ) organ	( ) to reveal
loan	( ) to shut off	( ) casting shadows	( ) something borrowed	( ) evidence
magic	( ) flat stone	( ) uninterrupted attention	( ) sorcery	( ) to cut in
mate	( ) to reach out	( ) solving problems	( ) friend	( ) a moment in chess

merit	( ) group of sounds	( ) to focus on	( ) piece of news	( ) worth
mortal	( ) to doubt	( ) to fall apart	( ) deadly	( ) consciously existing
mount	( ) cushion	( ) to climb	( ) usefulness	( ) to assemble
novel	( ) book	( ) to distinguish	( ) harvest	( ) new
pair	( ) to get rid of	( ) entertainment	( ) two items	( ) purpose
paste	( ) to stick	( ) texture	( ) to change position	( ) carrying
peas	( ) vegetable	( ) fully explained	( ) to add up	( ) finding pleasure
piano	( ) lightly spoken	( ) musical instrument	( ) to give away	( ) doughy
pipe	( ) unit of measurement	( ) sudden	( ) tube	( ) dart
plane	( ) plant product	( ) aircraft	( ) carpentry tool	( ) to be sorry
plot	( ) land	( ) to convert	( ) story line	( ) degree
pool	( ) game	( ) state of freedom from war	( ) to perform	( ) area of liquid
pose	( ) pointed stick	( ) to puzzle	( ) operating system	( ) to stand
prayer	( ) to drop abruptly	( ) words to God	( ) person who prays	( ) shovel
rabbit	( ) cavern	( ) animal	( ) to freak out	( ) ground surface
racket	( ) tennis instrument	( ) to make a hole	( ) irritating noise	( ) someone who leads
radio	( ) medium of communication	( ) ceremony	( ) to join in	( ) collecting money
rare	( ) uncommon	( ) to resist deterioration	( ) cooked briefly	( ) sunshine
rash	( ) compassion	( ) eruption	( ) to submit	( ) reckless
repair	( ) to go	( ) feeling fear	( ) to fix	( ) incomplete
resort	( ) design	( ) to arrange	( ) unspecified	( ) hotel
ring	( ) to call	( ) empty	( ) arena for fights	( ) to dismiss
seal	( ) animal	( ) emblem	( ) to treat rudely	( ) summit
shirt	( ) to cast aside	( ) peaceful	( ) specific state	( ) clothing
sky	( ) not bitter	( ) above earth	( ) currency	( ) to check in
spell	( ) having monetary value	( ) light beam	( ) to say letters of a word	( ) enchantment
stable	( ) firm	( ) building	( ) to collect patiently	( ) road for trains
stake	( ) to bet	( ) accidental opening	( ) post to hold a tent	( ) to accuse
strand	( ) systematic test	( ) to leave	( ) to develop	( ) braided fibers
strip	( ) to remove	( ) accomplishment	( ) long piece of material	( ) related to today
swallow	( ) glossy surface	( ) to eat	( ) bird	( ) serenity
symbol	( ) to swap	( ) terrifying	( ) to recover from	( ) sign

tacky	( ) cheap	( ) particular point	( ) to state strongly	( ) sticky
tap	( ) fictional character	( ) to knock	( ) water device	( ) to look at
tart	( ) fictional character	( ) sour	( ) having power	( ) pastry
temple	( ) building for worshiping	( ) sides of the head	( ) cautious	( ) acceptable
tend	( ) inclination	( ) clearer	( ) to care	( ) flavoring
tense	( ) to arrive	( ) tight	( ) to throw back	( ) verb inflection
tire	( ) rubber ring	( ) to lose energy	( ) threatening words	( ) remarkable
toast	( ) absence of sound	( ) revealing information	( ) bread	( ) to celebrate
total	( ) decoration	( ) to move in	( ) to overcome	( ) entire
tree	( ) baked food	( ) sweet wine	( ) plant	( ) to hold onto
video	( ) salutary option	( ) seasoning	( ) moving images	( ) to hold on
warmth	( ) heat	( ) to follow up	( ) square of cloth	( ) sweeping
zone	( ) making happy	( ) smooth	( ) area	( ) to rely on

RECOGNITION TEST (B)				
Mark all the meanings that you use and/or know for each word on the leftmost column.				
actor	( ) someone who plays roles	( ) to account for	( ) article of furniture	( ) frightening scream
air	( ) predictability	( ) atmosphere	( ) without emotion	( ) to burn out
aloud	( ) to put out	( ) mollusk	( ) to produce	( ) audible
arcade	( ) unable to sleep	( ) series of arches	( ) mobility	( ) to sit down
arch	( ) playful person	( ) curved structure	( ) animal	( ) board
arms	( ) edge	( ) weapons	( ) upper limbs	( ) stone
art	( ) creativity	( ) power to impose	( ) to find a job	( ) raising sun
ash	( ) a tree	( ) fire residue	( ) outstanding	( ) to express
ball	( ) furious	( ) dance	( ) sphere	( ) body part
ban	( ) public pronouncement	( ) large clock	( ) to clean	( ) to forbid
band	( ) group of people	( ) strip of material	( ) transparent square	( ) to fill
base	( ) to stack	( ) of little quality	( ) sore throat	( ) foundation
bat	( ) wooden club	( ) negation	( ) to require	( ) animal
bear	( ) animal	( ) to support	( ) area of space	( ) duty
beauty	( ) piece of rock	( ) being beautiful	( ) to turn around	( ) interruption
bore	( ) prize	( ) to bring to consciousness	( ) to make holes	( ) monotony
box	( ) to fight	( ) container	( ) to fail to score	( ) expanding quickly
brick	( ) block of clay	( ) ridicule	( ) to stick up for	( ) standard
bust	( ) to create	( ) sculpture	( ) to break	( ) grass

capital	( ) city	( ) old picture	( ) to balance	( ) uppercase
case	( ) little bag	( ) example	( ) green vegetable	( ) volume
chin	( ) to cross limits	( ) knowledge	( ) body part	( ) to work out
chord	( ) animal	( ) musical tones	( ) lurking	( ) line
clasp	( ) always ready	( ) to tell	( ) fastening device	( ) pigment
color	( ) to calm down	( ) two moving parts	( ) engine	( ) tint
content	( ) to turn in	( ) unkind	( ) filling	( ) satisfied
converse	( ) talk	( ) body of water	( ) opposite	( ) sticker
date	( ) to shatter	( ) fruit	( ) radiation	( ) moment in time
diet	( ) to form	( ) investigation	( ) dissolving material	( ) food and drink
dill	( ) to gather	( ) spice	( ) to take after	( ) competition
dove	( ) made of air	( ) past of dive	( ) fitting situation	( ) animal
elbow	( ) royalty	( ) body part	( ) acceptable	( ) to wear out
elevator	( ) safety	( ) to apply for	( ) lift	( ) not sincere
error	( ) to visit	( ) mistake	( ) to be alert	( ) revenge
fame	( ) thin wedge	( ) celebrity	( ) relative	( ) to dress up
fan	( ) air device	( ) misunderstanding	( ) to misplace	( ) follower
farmer	( ) flawless	( ) to knock over	( ) someone who operates a farm	( ) disloyalty
fast	( ) quick	( ) to cease to eat	( ) fictional character	( ) a large amount
file	( ) folder	( ) stomach	( ) to cause sorrow	( ) grinding tool
fleet	( ) horse racing	( ) ships	( ) swift	( ) to join
flight	( ) point in time	( ) surface of object	( ) flying	( ) fleeing
flower	( ) disastrous conclusion	( ) plant	( ) to encourage	( ) allusion
fly	( ) move through air	( ) bug	( ) athletic team	( ) to come up with something
fork	( ) self-service	( ) to wipe off	( ) spiritual entity	( ) cutlery
former	( ) previous	( ) person who forms	( ) path	( ) calculating machine
gem	( ) to agree with	( ) task	( ) precious stone	( ) shield
gloss	( ) solid structure	( ) social standard	( ) shine	( ) explanation note
grate	( ) to shred	( ) metal grid	( ) to be concerned	( ) alone
grave	( ) serious	( ) well-known song	( ) hole in the ground	( ) animal
hero	( ) rescuer	( ) piece of cloth	( ) to leave a vehicle	( ) noticeable
holy	( ) to pass over	( ) audience	( ) blessed	( ) to make full
horror	( ) fear	( ) beverage	( ) earthquake	( ) to end up
hunger	( ) beginning	( ) need for food	( ) to aim at	( ) celestial body
intent	( ) focused	( ) intention	( ) door	( ) fragile

lap	( ) to announce	( ) body area	( ) identification	( ) segment in a circuit
launch	( ) musical instrument	( ) to propel	( ) crown	( ) motor boat
lawyer	( ) carefully planned	( ) to set aside	( ) specific	( ) attorney
leaf	( ) part of plant	( ) staring eyes	( ) group leader	( ) to answer
liver	( ) someone who lives	( ) to escape	( ) organ	( ) to reveal
mate	( ) to reach out	( ) solving problems	( ) friend	( ) a moment in chess
media	( ) to drop by	( ) frightful	( ) abnormally large	( ) communications
merit	( ) group of sounds	( ) to focus on	( ) piece of news	( ) worth
mount	( ) cushion	( ) to climb	( ) usefulness	( ) to assemble
music	( ) songs	( ) sincerity	( ) illogical	( ) to get up
net	( ) web	( ) to point out	( ) chronicle	( ) being lucky
novel	( ) book	( ) to distinguish	( ) harvest	( ) new
pair	( ) to get rid of	( ) entertainment	( ) two items	( ) purpose
paste	( ) to stick	( ) texture	( ) to change position	( ) carrying
pipe	( ) unit of measurement	( ) sudden	( ) tube	( ) dart
plane	( ) plant product	( ) aircraft	( ) carpentry tool	( ) to be sorry
plot	( ) land	( ) to convert	( ) story line	( ) degree
poet	( ) author	( ) to go ahead	( ) to double	( ) having meaning
pool	( ) game	( ) state of freedom from war	( ) to perform	( ) area of liquid
pose	( ) pointed stick	( ) to puzzle	( ) operating system	( ) to stand
potato	( ) to break down	( ) illegal business	( ) food	( ) confidence
prayer	( ) to drop abruptly	( ) words to God	( ) person who prays	( ) shovel
rabbit	( ) cavern	( ) animal	( ) to freak out	( ) ground surface
racket	( ) tennis instrument	( ) to make a hole	( ) irritating noise	( ) someone who leads
radio	( ) medium of communication	( ) ceremony	( ) to join in	( ) collecting money
rare	( ) uncommon	( ) to resist deterioration	( ) cooked briefly	( ) sunshine
rash	( ) compassion	( ) eruption	( ) to submit	( ) reckless
repair	( ) to go	( ) feeling fear	( ) to fix	( ) incomplete
resort	( ) design	( ) to arrange	( ) unspecified	( ) hotel
ring	( ) to call	( ) empty	( ) arena for fights	( ) to dismiss
seal	( ) animal	( ) emblem	( ) to treat rudely	( ) summit
shirt	( ) to cast aside	( ) peaceful	( ) specific state	( ) clothing

spell	( ) having monetary value	( ) light beam	( ) to say letters of a word	( ) enchantment
stable	( ) firm	( ) building	( ) to collect patiently	( ) road for trains
stake	( ) to bet	( ) accidental opening	( ) post to hold a tent	( ) to accuse
strand	( ) systematic test	( ) to leave	( ) to develop	( ) braided fibers
strip	( ) to remove	( ) accomplishment	( ) long piece of material	( ) related to today
swallow	( ) glossy surface	( ) to eat	( ) bird	( ) serenity
tacky	( ) cheap	( ) particular point	( ) to state strongly	( ) sticky
tap	( ) fictional character	( ) to knock	( ) water device	( ) to look at
tart	( ) fictional character	( ) sour	( ) having power	( ) pastry
temple	( ) building for worshiping	( ) sides of the head	( ) cautious	( ) acceptable
tend	( ) inclination	( ) clearer	( ) to care	( ) flavoring
tense	( ) to arrive	( ) tight	( ) to throw back	( ) verb inflection
text	( ) to hang up	( ) written message	( ) list of items	( ) sword
theory	( ) sum	( ) label	( ) to find out	( ) explanations
tire	( ) rubber ring	( ) to lose energy	( ) threatening words	( ) remarkable
toast	( ) absence of sound	( ) revealing information	( ) bread	( ) to celebrate
total	( ) decoration	( ) to move in	( ) to overcome	( ) entire
tree	( ) baked food	( ) sweet wine	( ) plant	( ) to hold onto
virus	( ) microscopic being	( ) to look up	( ) to make holy	( ) done by habit
youth	( ) to hurry up	( ) sports court	( ) being young	( ) archives
zone	( ) making happy	( ) smooth	( ) area	( ) to rely on

RECOGNITION TEST (C)				
Mark all the meanings that you use and/or know for each word on the leftmost column.				
alike	( ) free of restrictions	( ) similar	( ) to pay back	( ) to fail to abduct
aloud	( ) to put out	( ) mollusk	( ) to produce	( ) audible
alter	( ) bath	( ) to change	( ) group of people	( ) portrait
arch	( ) playful person	( ) curved structure	( ) animal	( ) board
arms	( ) edge	( ) weapons	( ) upper limbs	( ) stone
art	( ) creativity	( ) power to impose	( ) to find a job	( ) raising sun
ash	( ) a tree	( ) fire residue	( ) outstanding	( ) to express
baby	( ) little child	( ) to show anxiety	( ) dust clouds	( ) to take out
ball	( ) furious	( ) dance	( ) sphere	( ) body part

ban	( ) public pronouncement	( ) large clock	( ) to clean	( ) to forbid
band	( ) group of people	( ) strip of material	( ) transparent square	( ) to fill
base	( ) to stack	( ) of little quality	( ) sore throat	( ) foundation
bat	( ) wooden club	( ) negation	( ) to require	( ) animal
bear	( ) animal	( ) to support	( ) area of space	( ) duty
beauty	( ) piece of rock	( ) being beautiful	( ) to turn around	( ) interruption
bore	( ) prize	( ) to bring to consciousness	( ) to make holes	( ) monotony
box	( ) to fight	( ) container	( ) to fail to score	( ) expanding quickly
bust	( ) to create	( ) sculpture	( ) to break	( ) grass
capital	( ) city	( ) old picture	( ) to balance	( ) uppercase
carrot	( ) to warm up	( ) solid cube	( ) artistic value	( ) root
case	( ) little bag	( ) example	( ) green vegetable	( ) volume
chin	( ) to cross limits	( ) knowledge	( ) body part	( ) to work out
chord	( ) animal	( ) musical tones	( ) lurking	( ) line
comic	( ) to furnish	( ) feeling of distaste	( ) funny	( ) feeling of gentleness
content	( ) to turn in	( ) unkind	( ) filling	( ) satisfied
converse	( ) talk	( ) body of water	( ) opposite	( ) sticker
date	( ) to shatter	( ) fruit	( ) radiation	( ) moment in time
deadly	( ) something that kills	( ) to fill up	( ) having fragrance	( ) to perceive
diet	( ) to form	( ) investigation	( ) dissolving material	( ) food and drink
dill	( ) to gather	( ) spice	( ) to take after	( ) competition
dove	( ) made of air	( ) past of dive	( ) fitting situation	( ) animal
enter	( ) to go in	( ) substitution	( ) musical composition	( ) to freeze
error	( ) to visit	( ) mistake	( ) to be alert	( ) revenge
eye	( ) to count on	( ) complement	( ) opinion	( ) body part
fan	( ) air device	( ) misunderstanding	( ) to misplace	( ) follower
farmer	( ) flawless	( ) to knock over	( ) someone who operates a farm	( ) disloyalty
fast	( ) quick	( ) to cease to eat	( ) fictional character	( ) a large amount
file	( ) folder	( ) stomach	( ) to cause sorrow	( ) grinding tool
final	( ) tool for cutting	( ) to soak	( ) last one	( ) to cancel
fleet	( ) horse racing	( ) ships	( ) swift	( ) to join
flight	( ) point in time	( ) surface of object	( ) flying	( ) fleeing
flower	( ) disastrous conclusion	( ) plant	( ) to encourage	( ) allusion

fly	( ) move through air	( ) bug	( ) athletic team	( ) to come up with something
former	( ) previous	( ) person who forms	( ) path	( ) calculating machine
gloss	( ) solid structure	( ) social standard	( ) shine	( ) explanation note
grate	( ) to shred	( ) metal grid	( ) to be concerned	( ) alone
grave	( ) serious	( ) well-known song	( ) hole in the ground	( ) animal
guitar	( ) made of paper	( ) to come across	( ) to refer	( ) musical instrument
hell	( ) wool blanket	( ) place of suffering	( ) to leave behind	( ) performance
hero	( ) rescuer	( ) piece of cloth	( ) to leave a vehicle	( ) noticeable
holy	( ) to pass over	( ) audience	( ) blessed	( ) to make full
intent	( ) focused	( ) intention	( ) door	( ) fragile
king	( ) monarch	( ) to cover	( ) comprehensive	( ) to let down
lap	( ) to announce	( ) body area	( ) identification	( ) segment in a circuit
launch	( ) musical instrument	( ) to propel	( ) crown	( ) motor boat
lawyer	( ) carefully planned	( ) to set aside	( ) specific	( ) attorney
liver	( ) someone who lives	( ) to escape	( ) organ	( ) to reveal
loan	( ) to shut off	( ) casting shadows	( ) something borrowed	( ) evidence
magic	( ) flat stone	( ) uninterrupted attention	( ) sorcery	( ) to cut in
mate	( ) to reach out	( ) solving problems	( ) friend	( ) a moment in chess
media	( ) to drop by	( ) frightful	( ) abnormally large	( ) communications
mortal	( ) to doubt	( ) to fall apart	( ) deadly	( ) consciously existing
mount	( ) cushion	( ) to climb	( ) usefulness	( ) to assemble
music	( ) songs	( ) sincerity	( ) illogical	( ) to get up
net	( ) web	( ) to point out	( ) chronicle	( ) being lucky
novel	( ) book	( ) to distinguish	( ) harvest	( ) new
paste	( ) to stick	( ) texture	( ) to change position	( ) carrying
peas	( ) vegetable	( ) fully explained	( ) to add up	( ) finding pleasure
piano	( ) lightly spoken	( ) musical instrument	( ) to give away	( ) doughy
pipe	( ) unit of measurement	( ) sudden	( ) tube	( ) dart
plane	( ) plant product	( ) aircraft	( ) carpentry tool	( ) to be sorry

plot	( ) land	( ) to convert	( ) story line	( ) degree
poet	( ) author	( ) to go ahead	( ) to double	( ) having meaning
pool	( ) game	( ) state of freedom from war	( ) to perform	( ) area of liquid
pose	( ) pointed stick	( ) to puzzle	( ) operating system	( ) to stand
potato	( ) to break down	( ) illegal business	( ) food	( ) confidence
prayer	( ) to drop abruptly	( ) words to God	( ) person who prays	( ) shovel
racket	( ) tennis instrument	( ) to make a hole	( ) irritating noise	( ) someone who leads
rare	( ) uncommon	( ) to resist deterioration	( ) cooked briefly	( ) sunshine
rash	( ) compassion	( ) eruption	( ) to submit	( ) reckless
repair	( ) to go	( ) feeling fear	( ) to fix	( ) incomplete
resort	( ) design	( ) to arrange	( ) unspecified	( ) hotel
ring	( ) to call	( ) empty	( ) arena for fights	( ) to dismiss
seal	( ) animal	( ) emblem	( ) to treat rudely	( ) summit
sky	( ) not bitter	( ) above earth	( ) currency	( ) to check in
spell	( ) having monetary value	( ) light beam	( ) to say letters of a word	( ) enchantment
stable	( ) firm	( ) building	( ) to collect patiently	( ) road for trains
stake	( ) to bet	( ) accidental opening	( ) post to hold a tent	( ) to accuse
strand	( ) systematic test	( ) to leave	( ) to develop	( ) braided fibers
strip	( ) to remove	( ) accomplishment	( ) long piece of material	( ) related to today
swallow	( ) glossy surface	( ) to eat	( ) bird	( ) serenity
symbol	( ) to swap	( ) terrifying	( ) to recover from	( ) sign
tacky	( ) cheap	( ) particular point	( ) to state strongly	( ) sticky
tap	( ) fictional character	( ) to knock	( ) water device	( ) to look at
tart	( ) fictional character	( ) sour	( ) having power	( ) pastry
temple	( ) building for worshiping	( ) sides of the head	( ) cautious	( ) acceptable
tend	( ) inclination	( ) clearer	( ) to care	( ) flavoring
tense	( ) to arrive	( ) tight	( ) to throw back	( ) verb inflection
text	( ) to hang up	( ) written message	( ) list of items	( ) sword
theory	( ) sum	( ) label	( ) to find out	( ) explanations
tire	( ) rubber ring	( ) to lose energy	( ) threatening words	( ) remarkable
toast	( ) absence of sound	( ) revealing information	( ) bread	( ) to celebrate
video	( ) salutary option	( ) seasoning	( ) moving images	( ) to hold on

virus	( ) microscopic being	( ) to look up	( ) to make holy	( ) done by habit
warmth	( ) heat	( ) to follow up	( ) square of cloth	( ) sweeping
youth	( ) to hurry up	( ) sports court	( ) being young	( ) archives

APPENDIX D: READING SPAN TEST ANSWER SHEET

After each set of sentences, write in the boxes bellow the last word of each sentence in the order of presentation.

Participant: _____

Practice 1	Practice 2	Practice 3

Set 1	Set 2	Set 3	Set 4

Set 5	Set 6	Set 7	Set 8

Set 9	Set 10	Set 11	Set 12

Set 13	Set 14	Set 15	Set 16

Set 17	Set 18	Set 19	Set 20

APPENDIX E: MEANING DECISION TASK STIMULI LIST

Prime	Type	Meaning shared	Frequency	# letters	TARGET	Meaning primed	List
arch	hom_cog	dom_shared	13,52	4	CURVE	dom	A
arms	hom_cog	sub_shared	152,12	4	BEACH	unrelated	A
ban	hom_cog	dom_shared	13,8	3	ANNOUNCE	sub	A
band	hom_cog	dom_shared	32,79	4	SONG	dom	A
base	hom_cog	dom_shared	70,56	4	CHEESE	unrelated	A
bust	hom_cog	sub_shared	6,42	4	BREAK	sub	A
capital	hom_cog	dom_shared	102,46	7	STATE	dom	A
case	hom_cog	dom_shared	383,58	4	ISLAND	unrelated	A
chord	hom_cog	dom_shared	2,35	5	LINE	sub	A
content	hom_cog	sub_shared	54,86	7	HAPPY	dom	A
converse	hom_cog	sub_shared	3,07	8	CHICKEN	unrelated	A
date	hom_cog	dom_shared	59,72	4	FRUIT	sub	A
former	hom_cog	sub_shared	80,17	6	PREVIOUS	dom	A
gloss	hom_cog	sub_shared	2,85	5	CAT	unrelated	A
grate	hom_cog	dom_shared	2,29	5	SEWER	sub	A
grave	hom_cog	sub_shared	30,11	5	DEATH	dom	A
intent	hom_cog	dom_shared	14,92	6	TOWEL	unrelated	A
launch	hom_cog	sub_shared	16,03	6	BOAT	sub	A
mate	hom_cog	sub_shared	15,59	4	FRIEND	dom	A
novel	hom_cog	sub_shared	36,37	5	FILTER	unrelated	A
paste	hom_cog	sub_shared	5,14	5	TOOTH	sub	A
pipe	hom_cog	sub_shared	22,91	4	WATER	dom	A
plane	hom_cog	sub_shared	45,53	5	NUMBER	unrelated	A
pose	hom_cog	dom_shared	11,51	4	FAKE	sub	A
rare	hom_cog	dom_shared	50	4	UNIQUE	dom	A
repair	hom_cog	dom_shared	14,3	6	JUICE	unrelated	A
resort	hom_cog	sub_shared	20,45	6	ARRANGE	sub	A
ring	hom_cog	sub_shared	66,09	4	CALL	dom	A
tart	hom_cog	sub_shared	3,02	4	CAVE	unrelated	A
temple	hom_cog	dom_shared	23,24	6	HEAD	sub	A
tend	hom_cog	dom_shared	65,81	4	LEAN	dom	A

tense	hom_cog	dom_shared	17,6	5	WINDOW	unrelated	A
ash	hom_noncog	none	36,31	4	PLANT	sub	A
ball	hom_noncog	none	92,96	4	ROUND	dom	A
bat	hom_noncog	none	10,56	3	ICE	unrelated	A
bear	hom_noncog	none	70,39	4	SUPPORT	sub	A
bore	hom_noncog	none	27,04	6	MONOTONY	dom	A
box	hom_noncog	none	78,66	3	HYPHEN	unrelated	A
dove	hom_noncog	none	2,96	4	OCEAN	sub	A
fan	hom_noncog	none	11,56	3	CHEER	dom	A
fast	hom_noncog	none	101,28	4	TOE	unrelated	A
file	hom_noncog	none	28,32	5	NAIL	sub	A
fleet	hom_noncog	none	24,02	5	SHIPS	dom	A
flight	hom_noncog	none	56,82	6	STRING	unrelated	A
fly	hom_noncog	none	50,95	4	BUG	sub	A
lap	hom_noncog	none	18,66	3	SIT	dom	A
liver	hom_noncog	none	13,52	3	ODD	unrelated	A
mount	hom_noncog	none	27,32	4	ASSEMBLE	sub	A
plot	hom_noncog	none	20,45	5	STORY	dom	A
pool	hom_noncog	none	34,69	4	VILLAIN	unrelated	A
prayer	hom_noncog	none	20,5	4	PREACHER	sub	A
racket	hom_noncog	none	10,34	6	TENNIS	dom	A
rash	hom_noncog	none	10,28	4	HAT	unrelated	A
seal	hom_noncog	none	12,85	4	STAMP	sub	A
spell	hom_noncog	none	21,34	5	MAGIC	dom	A
stable	hom_noncog	none	25,81	5	CREAM	unrelated	A
stake	hom_noncog	none	14,02	5	BET	sub	A
strand	hom_noncog	none	8,55	6	ALONE	dom	A
strip	hom_noncog	none	21,17	3	BELL	unrelated	A
swallow	hom_noncog	none	18,32	7	BIRD	sub	A
tacky	hom_noncog	none	1,01	5	CHEAP	dom	A
tap	hom_noncog	none	20,5	6	VARY	unrelated	A
tire	hom_noncog	none	4,97	4	SLEEP	sub	A
toast	hom_noncog	none	14,53	5	BUTTER	dom	A
actor	nonhom_cog	none	43,85	5	STAGE	related	A
air	nonhom_cog	none	251,17	3	BREATHE	related	A

alter	nonhom_cog	none	17,6	5	MACE	unrelated	A
color	nonhom_cog	none	0	5	PURPLE	related	A
comic	nonhom_cog	none	14,3	5	HABITAT	unrelated	A
elevator	nonhom_cog	none	8,44	8	UPWARD	related	A
enter	nonhom_cog	none	47,09	5	MOHAWK	unrelated	A
fame	nonhom_cog	none	9,78	4	GLORY	related	A
final	nonhom_cog	none	112,07	5	CARRY	unrelated	A
gem	nonhom_cog	none	0,95	3	DIAMOND	related	A
guitar	nonhom_cog	none	5,7	5	DAIRY	unrelated	A
horror	nonhom_cog	none	29,89	6	SCARY	related	A
magic	nonhom_cog	none	37,49	5	TRACK	unrelated	A
merit	nonhom_cog	none	10,84	5	AWARD	related	A
mortal	nonhom_cog	none	6,82	6	OFFICE	unrelated	A
pair	nonhom_cog	none	58,77	4	TWO	related	A
piano	nonhom_cog	none	26,03	5	SMELL	unrelated	A
radio	nonhom_cog	none	83,97	5	STEREO	related	A
symbol	nonhom_cog	none	23,46	6	BLANKET	unrelated	A
total	nonhom_cog	none	0	5	ALL	related	A
video	nonhom_cog	none	6,65	5	DICE	unrelated	A
zone	nonhom_cog	none	11,28	4	AREA	related	A
alike	nonhom_noncog	none	19,22	5	SAILOR	unrelated	A
arcade	nonhom_noncog	none	2,51	6	COLUMN	related	A
baby	nonhom_noncog	none	183,3	4	REPLAY	unrelated	A
brick	nonhom_noncog	none	27,82	5	WALL	related	A
carrot	nonhom_noncog	none	2,51	6	LAGOON	unrelated	A
clasp	nonhom_noncog	none	3,8	5	HOLD	related	A
deadly	nonhom_noncog	none	13,13	6	TYPE	unrelated	A
elbow	nonhom_noncog	none	15,64	5	KNEE	related	A
eye	nonhom_noncog	none	127,6	3	CALENDAR	unrelated	A
fork	nonhom_noncog	none	13,63	4	KNIFE	related	A
hell	nonhom_noncog	none	0	4	TURTLE	unrelated	A
hunger	nonhom_noncog	none	24,25	6	FOOD	related	A
king	nonhom_noncog	none	89,27	4	TANGERINE	unrelated	A
leaf	nonhom_noncog	none	15,53	4	GREEN	related	A
loan	nonhom_noncog	none	18,99	4	EGG	unrelated	A

socks	nonhom_noncog	none	15,75	5	SHOES	related	A
peas	nonhom_noncog	none	8,16	4	FABRIC	unrelated	A
rabbit	nonhom_noncog	none	10,78	6	BUNNY	related	A
sky	nonhom_noncog	none	77,09	3	SWORD	unrelated	A
tree	nonhom_noncog	none	72,23	4	TRUNK	related	A
warmth	nonhom_noncog	none	23,91	6	DUST	unrelated	A
bit	filler_hom	none	240,67	3	LAMP	unrelated	ABC
boil	filler_hom	none	19,5	4	STANDARD	unrelated	ABC
bridge	filler_hom	none	60,17	6	OBSERVABLE	unrelated	ABC
brush	filler_hom	none	17,93	5	LEGEND	unrelated	ABC
cotton	filler_hom	none	27,71	6	OPPOSITION	unrelated	ABC
fit	filler_hom	none	69,94	3	SEA	unrelated	ABC
flavor	filler_hom	none	0	6	HEARING	unrelated	ABC
grill	filler_hom	none	4,75	5	ADULT	unrelated	ABC
hot	filler_hom	none	139,55	3	CENTER	unrelated	ABC
husky	filler_hom	none	2,4	5	STAPLE	unrelated	ABC
incline	filler_hom	none	1,79	7	SOUL	unrelated	ABC
issue	filler_hom	none	92,96	5	MATRIX	unrelated	ABC
jet	filler_hom	none	12,63	3	NEST	unrelated	ABC
jobs	filler_hom	none	89,05	4	HAND	unrelated	ABC
jog	filler_hom	none	3,35	3	CUSHION	unrelated	ABC
joint	filler_hom	none	39,22	5	PLACE	unrelated	ABC
key	filler_hom	none	71,56	3	SPOON	unrelated	ABC
litter	filler_hom	none	7,93	6	BOTTLE	unrelated	ABC
mad	filler_hom	none	48,21	3	DUCK	unrelated	ABC
match	filler_hom	none	56,98	5	LEARN	unrelated	ABC
perk	filler_hom	none	0,78	4	UMBRELLA	unrelated	ABC
pinch	filler_hom	none	5,64	5	WARM	unrelated	ABC
quack	filler_hom	none	0,56	5	PHRASE	unrelated	ABC
relish	filler_hom	none	8,66	6	INFANT	unrelated	ABC
roll	filler_hom	none	28,04	4	FIGHTING	unrelated	ABC
shoulder	filler_hom	none	68,16	8	ROOT	unrelated	ABC
sink	filler_hom	none	26,2	4	RIBBON	unrelated	ABC
slide	filler_hom	none	16,42	5	LEAVE	unrelated	ABC
switch	filler_hom	none	29,27	6	DRAGON	unrelated	ABC

trip	filler_hom	none	56,87	4	INFORMATION	unrelated	ABC
wave	filler_hom	none	45,36	4	FEAR	unrelated	ABC
wound	filler_hom	none	24,13	5	GOAL	unrelated	ABC
avoid	filler_nonhom	none	75,2	5	MUCH	unrelated	ABC
bathroom	filler_nonhom	none	34,64	8	HEAVY	unrelated	ABC
beach	filler_nonhom	none	59,22	5	WOOD	unrelated	ABC
bone	filler_nonhom	none	27,26	4	LAST	unrelated	ABC
boss	filler_nonhom	none	27,43	4	BLENDER	unrelated	ABC
building	filler_nonhom	none	159,44	8	INSANE	unrelated	ABC
cake	filler_nonhom	none	21,4	4	PHONE	unrelated	ABC
candle	filler_nonhom	none	7,82	6	CARDS	unrelated	ABC
cap	filler_nonhom	none	30,34	3	FLOOR	unrelated	ABC
closet	filler_nonhom	none	9,83	6	SALT	unrelated	ABC
desk	filler_nonhom	none	82,29	4	GOODBYE	unrelated	ABC
eagle	filler_nonhom	none	7,21	5	STILL	unrelated	ABC
grapes	filler_nonhom	none	7,93	6	BARBECUE	unrelated	ABC
laptop	filler_nonhom	none	0	6	BIG	unrelated	ABC
liar	filler_nonhom	none	7,04	4	LASAGNA	unrelated	ABC
library	filler_nonhom	none	52,63	7	INFECTION	unrelated	ABC
month	filler_nonhom	none	90	5	ENJOY	unrelated	ABC
movie	filler_nonhom	none	29,83	5	FAUCET	unrelated	ABC
oak	filler_nonhom	none	14,19	3	TIGHT	unrelated	ABC
painting	filler_nonhom	none	54,86	8	PLAYGROUND	unrelated	ABC
rug	filler_nonhom	none	11,68	3	DOCTOR	unrelated	ABC
shirt	filler_nonhom	none	45,36	5	IMPORTANT	unrelated	ABC
shoe	filler_nonhom	none	14,47	4	MANNER	unrelated	ABC
shore	filler_nonhom	none	24,08	5	RAZOR	unrelated	ABC
soap	filler_nonhom	none	20,45	4	SORE	unrelated	ABC
button	filler_nonhom	none	3,02	4	PROFESSION	unrelated	ABC
spend	filler_nonhom	none	87,26	5	STRIKE	unrelated	ABC
tall	filler_nonhom	none	64,64	4	BREAD	unrelated	ABC
thief	filler_nonhom	none	6,7	5	HARSH	unrelated	ABC
thigh	filler_nonhom	none	12,68	5	HILL	unrelated	ABC
uncle	filler_nonhom	none	59,27	5	CRAB	unrelated	ABC
wall	filler_nonhom	none	138,16	4	COUPLE	unrelated	ABC

arch	hom_cog	dom_shared	13,52	4	PLAYFUL	sub	B
arms	hom_cog	sub_shared	152,12	4	LEGS	dom	B
ban	hom_cog	dom_shared	13,8	3	CLIP	unrelated	B
band	hom_cog	dom_shared	32,79	4	WRIST	sub	B
base	hom_cog	dom_shared	70,56	4	FOUNDATION	dom	B
bust	hom_cog	sub_shared	6,42	4	WHALE	unrelated	B
capital	hom_cog	dom_shared	102,46	7	UPPERCASE	sub	B
case	hom_cog	dom_shared	383,58	4	TRIAL	dom	B
chord	hom_cog	dom_shared	2,35	5	DRACULA	unrelated	B
content	hom_cog	sub_shared	54,86	7	MATERIAL	sub	B
converse	hom_cog	sub_shared	3,07	8	TALK	dom	B
date	hom_cog	dom_shared	59,72	4	CARRIAGE	unrelated	B
former	hom_cog	sub_shared	80,17	6	MAKER	sub	B
gloss	hom_cog	sub_shared	2,85	5	SHINE	dom	B
grate	hom_cog	dom_shared	2,29	5	PHOTO	unrelated	B
grave	hom_cog	sub_shared	30,11	5	SERIOUS	sub	B
intent	hom_cog	dom_shared	14,92	6	PURPOSE	dom	B
launch	hom_cog	sub_shared	16,03	6	THICK	unrelated	B
mate	hom_cog	sub_shared	15,59	4	CHESS	sub	B
novel	hom_cog	sub_shared	36,37	5	BOOK	dom	B
paste	hom_cog	sub_shared	5,14	5	PARROT	unrelated	B
pipe	hom_cog	sub_shared	22,91	4	BARRIL	sub	B
plane	hom_cog	sub_shared	45,53	5	CRASH	dom	B
pose	hom_cog	dom_shared	11,51	4	FUNGUS	unrelated	B
rare	hom_cog	dom_shared	50	4	MEAT	sub	B
repair	hom_cog	dom_shared	14,3	6	FIX	dom	B
resort	hom_cog	sub_shared	20,45	6	PASTA	unrelated	B
ring	hom_cog	sub_shared	66,09	4	ARENA	sub	B
tart	hom_cog	sub_shared	3,02	4	SOUR	dom	B
temple	hom_cog	dom_shared	23,24	6	BEANS	unrelated	B
tend	hom_cog	dom_shared	65,81	4	CARE	sub	B
tense	hom_cog	dom_shared	17,6	5	NERVOUS	dom	B
ash	hom_noncog	none	36,31	4	BRAIN	unrelated	B
ball	hom_noncog	none	92,96	4	DANCE	sub	B
bat	hom_noncog	none	10,56	3	VAMPIRE	dom	B

bear	hom_noncog	none	70,39	4	GAUNTLET	unrelated	B
bore	hom_noncog	none	27,04	6	HOLE	sub	B
box	hom_noncog	none	78,66	3	CARDBOARD	dom	B
dove	hom_noncog	none	2,96	4	MOUSSE	unrelated	B
fan	hom_noncog	none	11,56	3	AIR	sub	B
fast	hom_noncog	none	101,28	4	QUICK	dom	B
file	hom_noncog	none	28,32	5	BEER	unrelated	B
fleet	hom_noncog	none	24,02	5	FEET	sub	B
flight	hom_noncog	none	56,82	6	TRAVEL	dom	B
fly	hom_noncog	none	50,95	4	ALGAE	unrelated	B
lap	hom_noncog	none	18,66	3	RUN	sub	B
liver	hom_noncog	none	13,52	3	ALCOHOL	dom	B
mount	hom_noncog	none	27,32	4	PALE	unrelated	B
plot	hom_noncog	none	20,45	5	LAND	sub	B
pool	hom_noncog	none	34,69	4	WATER	dom	B
prayer	hom_noncog	none	20,5	4	BURRITO	unrelated	B
racket	hom_noncog	none	10,34	6	NOISE	sub	B
rash	hom_noncog	none	10,28	4	ITCH	dom	B
seal	hom_noncog	none	12,85	4	SHIRT	unrelated	B
spell	hom_noncog	none	21,34	5	WRITE	sub	B
stable	hom_noncog	none	25,81	5	HORSE	dom	B
stake	hom_noncog	none	14,02	5	REMIND	unrelated	B
strand	hom_noncog	none	8,55	6	HAIR	sub	B
strip	hom_noncog	none	21,17	3	REMOVE	dom	B
swallow	hom_noncog	none	18,32	7	KEYBOARD	unrelated	B
tacky	hom_noncog	none	1,01	5	STICKY	sub	B
tap	hom_noncog	none	20,5	6	KNOCK	dom	B
tire	hom_noncog	none	4,97	4	YOGURT	unrelated	B
toast	hom_noncog	none	14,53	5	CELEBRATE	sub	B
actor	nonhom_cog	none	43,85	5	CYCLONE	unrelated	B
air	nonhom_cog	none	251,17	3	DATA	unrelated	B
art	nonhom_cog	none	166,03	3	PAINT	related	B
color	nonhom_cog	none	0	5	NUTRIENT	unrelated	B
diet	nonhom_cog	none	55,03	4	FAT	related	B
elevator	nonhom_cog	none	8,44	8	MERMAID	unrelated	B

error	nonhom_cog	none	20,45	5	MISTAKE	related	B
fame	nonhom_cog	none	9,78	4	TERMITE	unrelated	B
flower	nonhom_cog	none	27,71	6	PETALS	related	B
gem	nonhom_cog	none	0,95	3	VIRTUAL	unrelated	B
hero	nonhom_cog	none	30,45	4	SUPERMAN	related	B
horror	nonhom_cog	none	29,89	6	LUGGAGE	unrelated	B
media	nonhom_cog	none	45,36	5	NEWS	related	B
merit	nonhom_cog	none	10,84	5	DAGGER	unrelated	B
music	nonhom_cog	none	133,58	5	ROCK	related	B
pair	nonhom_cog	none	58,77	4	TOUCH	unrelated	B
poet	nonhom_cog	none	17,04	4	WRITER	related	B
radio	nonhom_cog	none	83,97	5	JET	unrelated	B
text	nonhom_cog	none	28,32	4	STUDY	related	B
total	nonhom_cog	none	0	5	VACCINE	unrelated	B
virus	nonhom_cog	none	9,33	5	SICK	related	B
zone	nonhom_cog	none	11,28	4	CANDY	unrelated	B
aloud	nonhom_noncog	none	18,32	5	SCREAM	related	B
arcade	nonhom_noncog	none	2,51	6	PAJAMAS	unrelated	B
beauty	nonhom_noncog	none	54,75	6	PRETTY	related	B
brick	nonhom_noncog	none	27,82	5	BABY	unrelated	B
chin	nonhom_noncog	none	25,53	4	BEARD	related	B
clasp	nonhom_noncog	none	3,8	5	FEVER	unrelated	B
dill	nonhom_noncog	none	0,39	4	SPICE	related	B
elbow	nonhom_noncog	none	15,64	5	ROOF	unrelated	B
farmer	nonhom_noncog	none	31,4	6	CROPS	related	B
fork	nonhom_noncog	none	13,63	4	TELESCOPE	unrelated	B
holy	nonhom_noncog	none	44,92	4	BIBLE	related	B
hunger	nonhom_noncog	none	24,25	6	ATOMIC	unrelated	B
lawyer	nonhom_noncog	none	25,92	6	COURT	related	B
leaf	nonhom_noncog	none	15,53	4	QUEST	unrelated	B
net	nonhom_noncog	none	32,35	3	FISH	related	B
socks	nonhom_noncog	none	15,75	5	COUSIN	unrelated	B
potato	nonhom_noncog	none	11,51	6	CHIP	related	B
rabbit	nonhom_noncog	none	10,78	6	INK	unrelated	B
theory	nonhom_noncog	none	109,22	6	IDEA	related	B

tree	nonhom_noncog	none	72,23	4	RACE	unrelated	B
youth	nonhom_noncog	none	64,75	5	CHILD	related	B
arch	hom_cog	dom_shared	13,52	4	DOG	unrelated	C
arms	hom_cog	sub_shared	152,12	4	GUNS	sub	C
ban	hom_cog	dom_shared	13,8	3	STOP	dom	C
band	hom_cog	dom_shared	32,79	4	HAM	unrelated	C
base	hom_cog	dom_shared	70,56	4	INFERIOR	sub	C
bust	hom_cog	sub_shared	6,42	4	SCULPTURE	dom	C
capital	hom_cog	dom_shared	102,46	7	CLOAK	unrelated	C
case	hom_cog	dom_shared	383,58	4	BAG	sub	C
chord	hom_cog	dom_shared	2,35	5	MELODY	dom	C
content	hom_cog	sub_shared	54,86	7	SANDAL	unrelated	C
converse	hom_cog	sub_shared	3,07	8	OPPOSITE	sub	C
date	hom_cog	dom_shared	59,72	4	TIME	dom	C
former	hom_cog	sub_shared	80,17	6	TOILET	unrelated	C
gloss	hom_cog	sub_shared	2,85	5	NOTE	sub	C
grate	hom_cog	dom_shared	2,29	5	CHEESE	dom	C
grave	hom_cog	sub_shared	30,11	5	GLASS	unrelated	C
intent	hom_cog	dom_shared	14,92	6	ATTENTIVE	sub	C
launch	hom_cog	sub_shared	16,03	6	ROCKET	dom	C
mate	hom_cog	sub_shared	15,59	4	SUN	unrelated	C
novel	hom_cog	sub_shared	36,37	5	NEW	sub	C
paste	hom_cog	sub_shared	5,14	5	GLUE	dom	C
pipe	hom_cog	sub_shared	22,91	4	WALLET	unrelated	C
plane	hom_cog	sub_shared	45,53	5	SURFACE	sub	C
pose	hom_cog	dom_shared	11,51	4	MODEL	dom	C
rare	hom_cog	dom_shared	50	4	BUCKET	unrelated	C
repair	hom_cog	dom_shared	14,3	6	GOING	sub	C
resort	hom_cog	sub_shared	20,45	6	HOTEL	dom	C
ring	hom_cog	sub_shared	66,09	4	DRAW	unrelated	C
tart	hom_cog	sub_shared	3,02	4	PASTRY	sub	C
temple	hom_cog	dom_shared	23,24	6	CHURCH	dom	C
tend	hom_cog	dom_shared	65,81	4	FAR	unrelated	C
tense	hom_cog	dom_shared	17,6	5	PAST	sub	C
ash	hom_noncog	none	36,31	4	FIRE	dom	C

ball	hom_noncog	none	92,96	4	JAW	unrelated	C
bat	hom_noncog	none	10,56	3	BASEBALL	sub	C
bear	hom_noncog	none	70,39	4	TEDDY	dom	C
bore	hom_noncog	none	27,04	6	FOREST	unrelated	C
box	hom_noncog	none	78,66	3	GLOVE	sub	C
dove	hom_noncog	none	2,96	4	PEACE	dom	C
fan	hom_noncog	none	11,56	3	VINE	unrelated	C
fast	hom_noncog	none	101,28	4	STARVE	sub	C
file	hom_noncog	none	28,32	5	CABINET	dom	C
fleet	hom_noncog	none	24,02	5	GHOST	unrelated	C
flight	hom_noncog	none	56,82	6	RUNAWAY	sub	C
fly	hom_noncog	none	50,95	4	AIRPLANE	dom	C
lap	hom_noncog	none	18,66	3	NEGOTIATE	unrelated	C
liver	hom_noncog	none	13,52	3	LIFE	sub	C
mount	hom_noncog	none	27,32	4	CLIMB	dom	C
plot	hom_noncog	none	20,45	5	DRAWER	unrelated	C
pool	hom_noncog	none	34,69	4	TABLE	sub	C
prayer	hom_noncog	none	20,5	4	GOD	dom	C
racket	hom_noncog	none	10,34	6	JELLY	unrelated	C
rash	hom_noncog	none	10,28	4	DECISION	sub	C
seal	hom_noncog	none	12,85	4	ANIMAL	dom	C
spell	hom_noncog	none	21,34	5	MAPLE	unrelated	C
stable	hom_noncog	none	25,81	5	SECURE	sub	C
stake	hom_noncog	none	14,02	5	TENT	dom	C
strand	hom_noncog	none	8,55	6	RACCOON	unrelated	C
strip	hom_noncog	none	21,17	3	PIECE	sub	C
swallow	hom_noncog	none	18,32	7	EAT	dom	C
tacky	hom_noncog	none	1,01	5	CACTUS	unrelated	C
tap	hom_noncog	none	20,5	6	WATER	sub	C
tire	hom_noncog	none	4,97	4	CAR	dom	C
toast	hom_noncog	none	14,53	5	MARKER	unrelated	C
alter	nonhom_cog	none	17,6	5	CHANGE	related	C
art	nonhom_cog	none	166,03	3	NURSE	unrelated	C
comic	nonhom_cog	none	14,3	5	LAUGH	related	C
diet	nonhom_cog	none	55,03	4	BAIT	unrelated	C

enter	nonhom_cog	none	47,09	5	INSIDE	related	C
error	nonhom_cog	none	20,45	5	JINGLE	unrelated	C
final	nonhom_cog	none	112,07	5	END	related	C
flower	nonhom_cog	none	27,71	6	MUMBLE	unrelated	C
guitar	nonhom_cog	none	5,7	5	PIANO	related	C
hero	nonhom_cog	none	30,45	4	FUR	unrelated	C
magic	nonhom_cog	none	37,49	5	TRICK	related	C
media	nonhom_cog	none	45,36	5	RINKLE	unrelated	C
mortal	nonhom_cog	none	6,82	6	DANGER	related	C
music	nonhom_cog	none	133,58	5	GUILLOTINE	unrelated	C
piano	nonhom_cog	none	26,03	5	INSTRUMENT	related	C
poet	nonhom_cog	none	17,04	4	QUAKE	unrelated	C
symbol	nonhom_cog	none	23,46	6	SIGN	related	C
text	nonhom_cog	none	28,32	4	PANCAKE	unrelated	C
video	nonhom_cog	none	6,65	5	CAMERA	related	C
virus	nonhom_cog	none	9,33	5	EYEBROW	unrelated	C
alike	nonhom_noncog	none	19,22	5	SAME	related	C
aloud	nonhom_noncog	none	18,32	5	CABBAGE	unrelated	C
baby	nonhom_noncog	none	183,3	4	KID	related	C
beauty	nonhom_noncog	none	54,75	6	WHEEL	unrelated	C
carrot	nonhom_noncog	none	2,51	6	VEGETABLE	related	C
chin	nonhom_noncog	none	25,53	4	FROG	unrelated	C
deadly	nonhom_noncog	none	13,13	6	POISON	related	C
dill	nonhom_noncog	none	0,39	4	KARATE	unrelated	C
eye	nonhom_noncog	none	127,6	3	SEE	related	C
farmer	nonhom_noncog	none	31,4	6	AWKWARD	unrelated	C
hell	nonhom_noncog	none	0	4	DEVIL	related	C
holy	nonhom_noncog	none	44,92	4	CABLE	unrelated	C
king	nonhom_noncog	none	89,27	4	QUEEN	related	C
lawyer	nonhom_noncog	none	25,92	6	PALETTE	unrelated	C
loan	nonhom_noncog	none	18,99	4	BORROW	related	C
net	nonhom_noncog	none	32,35	3	PORTRAIT	unrelated	C
peas	nonhom_noncog	none	8,16	4	POD	related	C
potato	nonhom_noncog	none	11,51	6	BALOON	unrelated	C
sky	nonhom_noncog	none	77,09	3	CLOUD	related	C

theory	nonhom_noncog	none	109,22	6	WALK	unrelated	C
warmth	nonhom_noncog	none	23,91	6	HEAT	related	C
youth	nonhom_noncog	none	64,75	5	PILLOW	unrelated	C