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LITERÁRIOS**

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**INVESTIGATING LEXICAL ACCESS IN MULTILINGUALS: A  
STUDY ON THE PROCESSING OF ENGLISH AS L3**

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STUDY ON THE PROCESSING OF ENGLISH AS L3**

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## ABSTRACT

The interaction of two or more languages in the bilingual/multilingual brain may influence lexical access during language comprehension and production. The present study investigated lexical access of trilingual speakers of Brazilian Portuguese, German and English in three experiments dealing with language comprehension and production. The thesis of the present study is that lexical access of multilinguals is qualitatively different from that of bilinguals and monolinguals. More specifically, the present study has the following objectives: (1) to investigate which cognates are more facilitative in the comprehension of English as a target language, double cognates (between English and German, and English and Brazilian Portuguese) or triple cognates (among English, German, and Brazilian Portuguese), (2) to investigate how lexical access is influenced by cognates among German, English and Brazilian Portuguese in the oral production of English, and (3) to investigate if there is a difference in the semantic priming effect when presented in the native (Brazilian Portuguese), non-native (German) or target language (English) for bilingual and trilingual speakers. There were 56 participants who took part in the present study, which were divided into the following groups: (1) native speakers of English – the L1G, (2) native speakers of Brazilian Portuguese with English as the L2 – the L2G, and (3), native speakers of Brazilian Portuguese, with German as the L2 and English as the L3 – the L3G. Participants took part in an experimental session which consisted of three experiments: (1) an eye-tracking experiment with a sentence comprehension task containing cognates among the participants' three languages, (2) a narrative oral production experiment, in which there were pictures that represented cognate words in the participants' three languages, and (3) a cross-language priming experiment, in which participants had to name pictures (which were preceded by a masked prime, which was the name of the word in English, German or Brazilian Portuguese) in English, as fast and accurately as possible. The results of the three experiments of the present study showed that for the participants from the L3G, triple cognates facilitated the comprehension of English sentences, whereas the prime word in German caused an increase in reaction time. The results of the present study were interpreted as evidence of non-selective lexical access as well as of a common lexical storage for the trilinguals' languages. Nevertheless, an asymmetry in trilingual lexical organization is proposed, where links L1-L2, L1-L3 are stronger than links L2-L3. The thesis that lexical

access of trilinguals is qualitatively different from that of bilinguals was supported by the findings of the present study. The present study contributed with new data to the discussion regarding the multilingual lexicon, with a new language combination Brazilian Portuguese-German-English, in the Brazilian context.

**Keywords:** Lexical access. Multilingualism. Crosslinguistic Influences.

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## RESUMO

A interação de duas ou mais línguas no cérebro bilíngue/multilíngue pode influenciar o acesso lexical durante a compreensão e a produção da linguagem. O presente estudo investigou o acesso lexical de trilíngues falantes de português brasileiro, alemão e inglês em três experimentos envolvendo a compreensão e a produção da linguagem. A tese apresentada no presente estudo é de que o acesso lexical de multilíngues é qualitativamente diferente daquele de bilíngues e monolíngues. Mais especificamente, o presente estudo tem os seguintes objetivos: (1) investigar quais cognatos facilitam mais a compreensão do inglês como língua alvo, se cognatos duplos (entre o inglês e o alemão, e, entre o inglês e o português) ou triplos (entre o inglês, o alemão, e o português), (2) investigar como o acesso lexical é influenciado por cognatos entre o alemão, o inglês e o português na produção oral de inglês, e (3) investigar se há diferença no efeito de *priming* semântico quando apresentado na língua materna (português), na língua não-materna (alemão) ou na língua alvo (inglês) para falantes bilíngues e trilíngues. O presente estudo contou com 56 participantes, os quais foram divididos nos seguintes grupos: (1) falantes nativos de inglês – o L1G, (2) falantes nativos de português brasileiro com inglês como L2 – o L2G, e (3) falantes nativos de português brasileiro, com alemão como L2 e inglês como L3 – o L3G. A seção experimental consistiu de três experimentos: (1) um experimento de rastreamento ocular com uma tarefa de compreensão de sentenças contendo cognatos entre as três línguas dos participantes, (2) um experimento de produção oral de narrativa, na qual haviam figuras que representavam palavras cognatas nas três línguas dos participantes, e (3) um experimento de *priming* interlinguístico, no qual participantes tinham que nomear figuras (as quais eram precedidas por um prime mascarado, que podia ser o nome da palavra em inglês, em alemão ou em português) em inglês, o mais correto e rapidamente possível. Os resultados dos três experimentos do presente estudo mostraram que para os participantes do grupo L3, cognatos triplos facilitaram a compreensão das sentenças em inglês, enquanto que o prime em alemão causou um aumento no tempo de reação. Os resultados do presente estudo são interpretados como evidência de acesso lexical não-seletivo bem como de um armazenamento integrado para as três línguas do trilíngue. Com base nesses resultados, propõe-se uma assimetria na organização lexical do trilíngue, onde os links L1-L2, L1-L3 são mais fortes que os links L2-L3. A tese de que o acesso lexical de trilíngues é qualitativamente

diferente daquele de bilíngues foi confirmada pelos resultados do presente estudo, o qual contribuiu com novos dados para a discussão sobre o léxico multilíngue, com uma nova combinação linguística, português brasileiro-alemão-inglês, no contexto brasileiro.

**Palavras-chave:** Acesso lexical. Multilinguismo. Influência translinguística

**Número de páginas:** 211 (224 com referências)

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## LIST OF FIGURES

<b>Figure 1</b>	Representation of a coordinate system.....	32
<b>Figure 2</b>	Representation of a compound system.....	33
<b>Figure 3</b>	Representation of a subordinative system.....	33
<b>Figure 4</b>	Revised Hierarchical model.....	39
<b>Figure 5</b>	The BIA model.....	43
<b>Figure 6</b>	The BIA+ model.....	44
<b>Figure 7</b>	Representation of the Multilingual Interactive Activation model.....	60
<b>Figure 8</b>	The five steps of the experimental session.....	84
<b>Figure 9</b>	Frequency range of the 194 cognates.....	100
<b>Figure 10</b>	Frequency range of the triple cognates (English- German- Brazilian Portuguese).....	101
<b>Figure 11</b>	Frequency range of the double cognates.....	101
<b>Figure 12</b>	Frequency range of double cognates.....	102
<b>Figure 13</b>	The operator screen from the Experiment Center.....	115
<b>Figure 14</b>	Example from the validation procedure.....	117
<b>Figure 15</b>	Picture of the concept dentist.....	125
<b>Figure 16</b>	Picture of the concept boat.....	125
<b>Figure 17</b>	Age at which the participants from the L2G started having contact with English.....	137
<b>Figure 18</b>	Age at which the participants from the L3G started having contact with English.....	138
<b>Figure 19</b>	Age that the participants from the L2G started the English language course.....	138
<b>Figure 20</b>	Age that the participants from the L3G started the English language course.....	139
<b>Figure 21</b>	Self- estimation proficiency in English of the participants from the L2G.....	140
<b>Figure 22</b>	Self- estimation proficiency in English of the participants from the L3G.....	141
<b>Figure 23</b>	Self-estimation proficiency in German of the participants from the L3G.....	145
<b>Figure 24</b>	First pass for the condition CGEP and CTEP for the three groups.....	152
<b>Figure 25</b>	First pass for the condition CGEG and CTEG for the three groups.....	154
<b>Figure 26</b>	First pass for the critical word condition CGT and CTT for the three groups.....	156

<b>Figure 27</b> Second pass for the condition CGEP and CTEP for the three groups.....	158
<b>Figure 28</b> Second pass for the condition CGEG and CTEG for the three groups.....	160
<b>Figure 29</b> Second pass for the condition CGT and CTT for the three groups.....	162
<b>Figure 30</b> First fixation for the conditions CGEP and CTEP.....	164
<b>Figure 31</b> First fixation for the condition CGEG .....	166
<b>Figure 32</b> First fixation for the condition CGT .....	168
<b>Figure 33</b> Reaction time for the three groups in the three conditions .....	187

## LIST OF TABLES

<b>Table 1</b> Empirical studies supporting the RHM .....	40
<b>Table 2</b> Empirical support to the BIA model.....	46
<b>Table 3</b> Empirical studies on bilingual lexical access in speech production .....	56
<b>Table 4</b> Empirical studies on crosslinguistic influences (CLI) and multilingualism .....	69
<b>Table 5</b> General information about the L3 group .....	89
<b>Table 6</b> General information about the L2 group .....	90
<b>Table 7</b> General information about the L1 group .....	91
<b>Table 8</b> List of cognates with a medium frequency and their respective controls.....	103
<b>Table 9</b> List of cognates with a high frequency and their respective controls.....	105
<b>Table 10</b> Cognates and number of characters.....	109
<b>Table 11</b> Results of the naturalness judgement test of the critical sentences .....	112
<b>Table 12</b> Results of the predictability test for the critical words of the experimental sentences.....	114
<b>Table 13</b> List of elements of the pictures of the narrative task.....	122
<b>Table 14</b> Results of the vocabulary tests in German and English for the L2G and the L3G .....	135
<b>Table 15</b> Way of contact with English before the language course....	140
<b>Table 16</b> Purpose for learning English .....	141
<b>Table 17</b> Time dedicated to the study of English outside the language course .....	142
<b>Table 18</b> Situations that the participants have contact with English ..	143
<b>Table 19</b> Participants' mean accuracy in answering the comprehension questions.....	149
<b>Table 20</b> Participants' mean accuracy in answering the comprehension questions by group .....	150
<b>Table 21</b> First pass for the conditions CGEP and CTEP for the three groups.....	153
<b>Table 22</b> First pass for the conditions CGEG and CTEG for the three groups.....	155
<b>Table 23</b> First pass for the conditions CGT and CTT for the three groups.....	157
<b>Table 24</b> Second pass for the conditions CGEP and CTEP for the three groups.....	159

<b>Table 25</b> Second pass for the critical word for the conditions CGEG and CTEG .....	161
<b>Table 26</b> Second pass for the conditions CGT and CTT for the three groups.....	163
<b>Table 27</b> First fixation for the conditions CGEP and CTEP for the three groups.....	165
<b>Table 28</b> First fixation for the conditions CGEG and CTEG for the three groups.....	167
<b>Table 29</b> First fixation for the conditions CGT and CTT for the three groups.....	169
<b>Table 30</b> Results of the normality tests Kolmogorov- Smirnov and Shapiro-Wilk.....	171
<b>Table 31</b> Results of Wilcoxon test for the measure of first pass .....	174
<b>Table 32</b> Results of Wilcoxon test for the measure of second pass.....	175
<b>Table 33</b> Results of Wilcoxon test for the measure of first fixation....	175
<b>Table 34</b> Results of Mann-Whitney for the measure of first pass .....	176
<b>Table 35</b> Results of Mann-Whitney for the measure of second pass ..	177
<b>Table 36</b> Results of Mann-Whitney for the measure of first fixation..	178
<b>Table 37</b> Results of the narrative production experiment.....	183
<b>Table 38</b> Reaction time for the picture-naming task for the three groups and three conditions .....	189
<b>Table 39</b> Comparison of the mean reaction time of participants from the L1G with/without knowledge of Brazilian Portuguese.....	190
<b>Table 40</b> Results of the normality tests Kolmogorov- Smirnov and Shapiro-Wilk.....	192
<b>Table 41</b> Wilcoxon test for the pairs of conditions .....	193
<b>Table 42</b> Results of the Mann-Whitney test to compare groups across conditions.....	194

## LIST OF APPENDICES

<b>Appendix A:</b> Consent form .....	225
<b>Appendix B:</b> Biographical questionnaire .....	229
<b>Appendix C:</b> Pictures presented in the Picture-naming task .....	237
<b>Appendix D:</b> Transcription of the narrative experiment.....	243





## **TABLE OF CONTENTS**

<b>CHAPTER I</b> .....	21
<b>INTRODUCTION</b> .....	21
1.1 PRELIMINARIES .....	21
1.2 THE PRESENT STUDY .....	24
1.3 SIGNIFICANCE OF THE RESEARCH .....	26
1.4 ORGANIZATION OF THE DISSERTATION .....	27
<b>CHAPTER II</b> .....	29
<b>REVIEW OF LITERATURE</b> .....	29
2.1 THE MENTAL LEXICON .....	30
2.2 THE DISTINCTION OF THE TERMS BILINGUAL AND MULTILINGUAL .....	30
2.3 THE MULTILINGUAL LEXICON: ISSUES ON LANGUAGE STORAGE AND ACCESS.....	31
2.4 ISSUES ON LEXICAL ACCESS.....	35
2.5 MODELS OF LEXICAL ACCESS .....	37
<b>2.5.1 The Revised Hierarchical Model of lexical access for bilinguals</b> .....	37
<b>2.5.2 The Bilingual Interactive Activation model for bilingual word         recognition</b> .....	42
2.5.2.1 The representation of cognates in the bilingual lexicon according to the BIA+ model .....	51
<b>2.5.3 Serial and interactive models of bilingual speech production</b> .....	54
<b>2.5.4 Models of lexical access for multilinguals</b> .....	59
2.5.4.1 The Multilingual Interactive Activation model .....	60
2.5.4.2 The Multilingual Processing model .....	61
2.5.4.3 The Dynamic Model of Multilingualism.....	61
2.6 EYE MOVEMENTS AND LEXICAL ACCESS .....	63
2.7 CROSSLINGUISTIC INFLUENCES AND MULTILINGUALISM .....	67

2.8 SEMANTIC PRIMING.....	77
<b>CHAPTER III.....</b>	<b>81</b>
<b>METHOD.....</b>	<b>81</b>
3.1 DESIGN OF THE STUDY .....	82
3.2 OBJECTIVE, RESEARCH QUESTIONS AND HYPOTHESES ...	85
3.3 PARTICIPANTS.....	86
<b>3.3.1 The L3 English speakers.....</b>	<b>88</b>
<b>3.3.2 The L2 English speakers.....</b>	<b>89</b>
<b>3.3.3 The control group: native speakers of English .....</b>	<b>91</b>
3.4 BIOGRAPHICAL QUESTIONNAIRE .....	92
3.5 VOCABULARY TESTS .....	94
<b>3.5.1 Analysis of the vocabulary tests .....</b>	<b>96</b>
3.6 EYE-TRACKING EXPERIMENT .....	97
<b>3.6.1 Stimuli preparation for the eye-tracking experiment .....</b>	<b>97</b>
<b>3.6.2 Procedures for the eye-tracking experiment.....</b>	<b>114</b>
<b>3.6.3 Analysis of the data of the eye-tracking experiment .....</b>	<b>119</b>
3.7 THE NARRATIVE ORAL PRODUCTION EXPERIMENT.....	121
<b>3.7.1 Stimuli preparation for the narrative task.....</b>	<b>121</b>
<b>3.7.2 Procedures for the narrative oral production experiment..</b>	<b>122</b>
<b>3.7.3 Analysis of the data of the narrative oral production     experiment .....</b>	<b>123</b>
3.8 THE CROSS-LANGUAGE PRIMING EXPERIMENT .....	123
<b>3.8.1 Stimuli preparation for the cross-language priming     experiment .....</b>	<b>124</b>
<b>3.8.2 Procedures for the cross-language priming task .....</b>	<b>126</b>
<b>3.8.3 Analysis of the data of the cross-language priming     experiment .....</b>	<b>127</b>
3.9 PILOT STUDY .....	128
<b>CHAPTER IV.....</b>	<b>133</b>
<b>RESULTS.....</b>	<b>133</b>
4.1 THE VOCABULARY TESTS.....	134

4.2 THE BIOGRAPHICAL QUESTIONNAIRE .....	136
<b>4.2.1 Information regarding the learning of English of the L2 and L3 groups</b> .....	136
<b>4.2.2 Information regarding the learning of German</b> .....	143
4.3 EXPERIMENT 1: SENTENCE COMPREHENSION TASK .....	146
<b>4.3.1 Dependent and independent variables of the eye-tracking experiment</b> .....	147
<b>4.3.2 Descriptive analysis</b> .....	148
4.3.2.1 Results of first pass .....	151
4.3.2.2 Results of second pass .....	158
4.3.2.3 Results of first fixation .....	164
<b>4.3.3 Statistical analysis of the eye tracking data</b> .....	170
<b>4.3.4 Discussion of the results of the eye-tracking data</b> .....	179
4.4 EXPERIMENT 2: NARRATIVE TASK .....	182
4.5 EXPERIMENT 3: PICTURE NAMING TASK WITH THE MASKED PRIMING PARADIGM .....	186
<b>4.5.1 Descriptive analysis</b> .....	187
<b>4.5.2 Statistical analysis of the cross-language priming experiment</b> .....	191
<b>4.5.3 Discussion of the results of the cross-language priming experiment</b> .....	195
4.6 GENERAL DISCUSSION .....	197
4.7 ANSWER TO THE RESEARCH QUESTIONS .....	201
<b>CHAPTER V</b> .....	205
<b>FINAL REMARKS</b> .....	205
5.1 CONCLUSIONS .....	205
5.2 LIMITATIONS AND SUGGESTIONS FOR FURTHER RESEARCH .....	207
5.3 PEDAGOGICAL IMPLICATIONS .....	210
5.4 A FINAL WORD .....	211
<b>REFERENCES</b> .....	213
<b>APPENDIX A</b> .....	225

<b>APPENDIX B</b> .....	229
<b>APPENDIX C</b> .....	237
<b>APPENDIX D</b> .....	243

## CHAPTER I INTRODUCTION

### 1.1 PRELIMINARIES

We use words all the time in our daily life, and “we would be quite lost without them” (Aitchinson, 1987, p. 3). Accessing a word from the mental lexicon for production and/or recognition is a requirement for communication. However, the effortless and automatized cognitive activity of uttering and recognizing words all the time requires a series of mechanisms for its accomplishment. The process of lexical access, that is, the search for a word, or for the match of a word and its correspondent meaning, can be fast, automatic and effective most of the time. However, many variables may interfere with this process, mainly when the multilingual lexicon is concerned. The social context, the number of languages spoken, the similarity among the two, three or more languages, the proficiency level in each language, and the frequency of use of each language involved may interfere in lexical access processes.

Regarding language production, everyone has already experienced difficulties trying to retrieve a specific word in a conversation. For instance, Ecke (2015) explains two phenomena related to the failure of lexical retrieval: (1) intrusion, that is, when the target word is replaced by another, which may lead to a lexical substitution or to the blending of two or more lexical forms, and (2) lexical errors that occur when there is difficulty in retrieving the target word. According to Ecke (2015), these difficulties in lexical retrieval might shed light on the processes involved in lexical production.

Failure of lexical retrieval may occur in the native as well as in the non-native languages. However, in the L2, L3 or L<sub>n</sub><sup>1</sup>, which might be a non-dominant language, the failures in lexical retrieval might be even more common. In cases of failure of lexical retrieval in the L2, it is possible that a word in the L1 will be more easily accessed than its translation in the L2. This phenomenon is called crosslinguistic influence, that is, the influence that one language causes in the processing of another (Jessner, 2003).

In bilingual processing, many factors will constrain the retrieval of words, including the level of activation of the languages (dormant

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<sup>1</sup> In the present study, the term L1 will be used to refer to the native language, whereas the term L2 will be used interchangeably to refer to both foreign or second language, and the term L3 will be used to refer to third language.

languages may be hard to access) and the cognate status of the words (cognate words may be easier to access). For multilinguals, the process of lexical access can become more complex than for bilinguals and monolinguals, due to the greater possibilities of language influence and/or interference, that is, for multilinguals that are more sources of crosslinguistic influences. For a trilingual, during lexical access of the L3, there can be influence of both L1 and L2 (Hammarberg, 2001; Vinnitskaya, Flynn & Foley, 2002; Leung, 2005; Hartsuiker, Beerts, Loncke, Desmet & Bernolet, 2016). There is also evidence in the literature of the influence of a foreign language (L2) in the processing of the native language (L1) (Souza & Oliveira, 2011; Souza, 2012).

This influence of the non-target languages in lexical access may depend on the strength of the connections between the representations of the lexical and conceptual levels among the languages (Szubko-Sitarek, 2015), the lexical level being related to language forms, and the conceptual level, to the word meaning. There are some factors that constrain the availability of the lexical/conceptual connections between the bilinguals' two languages or the multilinguals' several languages. These factors might be related to the similarity among the languages, or more specifically, among the words of the different languages at the meaning level, orthographic level, phonological level, among others. In addition, context may play a role in lexical access, level of proficiency, and relationship between the languages. For instance, the relation native-nonnative language might be seen as dominant versus non-dominant language. In this case, the role of the L1 must be analyzed. According to Kroll (1993):

For adults who already have a fluent and dominant first language, and for whom the second language is acquired within the cultural context of the first language, the problem is not to learn new concepts, but rather to acquire new mappings between concepts and second language words. Changes in the development of those mappings as second language learners become increasingly fluent in the second language may reveal important constraints for theories of lexical and semantic memory. (Kroll, 1993, p. 55)

In the present study, the issue under investigation lies in the scenario described by Kroll (1993), in which participants have a dominant L1 (Brazilian Portuguese) and have learned the foreign languages (German and English) in the environment of this L1.

Therefore, the general intellectual question guiding the present study tackles the issue of how the new language adapts into the already established system: in the multilingual case, how the two new languages adapt into an already consolidated linguistic system.

Lexical access is, in itself a complex process that can be even more complex when two languages are involved. If we add a third language to already existing linguistic systems, the complexity of lexical access increases, since there are more sources of influence among the languages. According to Ecke (2015, p.1):

What makes word production in multilinguals different from that in monolingual or bilingual speakers is the more complex configuration of their lexical network(s), and the number of possible sources and directions for cross-linguistic influence (CLI), reflected in 'errors' and other kinds of retrieval phenomena. Ecke (2015, p. 1).

Lexical access has since long intrigued researchers, mainly regarding the organization and processing of bilinguals – there seems to be no consensus regarding the organization and processing of the mental lexicon for L1 and L2. Li (2009) claims that the issue of representation of the mental lexicon for bilinguals has been highly controversial, since there is no answer to the existence of a single lexicon or a shared lexical storage. According to Li (2009), neuroimaging data has offered relevant but conflicting results, which has strengthened this debate.

Gass and Selinker (2008) posit that the lexicon may be considered the most important aspect for second language acquisition (SLA). The authors claim that analysis of the production of L2 learners shows that lexical errors are more frequent than grammatical errors. Moreover, lexical errors may interfere with the intent of communication (Gass & Selinker, 2008).

Another central issue in SLA research is the organization of the bilingual memory, more specifically, the degree of integration in the representation of the bilingual's two languages (Francis, 2005). Empirical studies show that several factors can influence the representation of words, in relation to their form and concepts. One of these factors may be related to the level of proficiency of the L2. Other factors might be related to the similarity between L1 and L2, the presence of cognates, interlingual homographs and words with a similar pronunciation.

Kroll and Sunderman (2003) state that studies on the mental lexicon initially confused lexical representation with lexical access. According to the authors, most studies used to assume that separate lexical representations for the two languages would imply selective activation for the words in only one language. On the other hand, studies that assumed an integrated lexicon for the two languages would argue in favor of non-selective parallel activation in the two languages. Nevertheless, Kroll and Sunderman (2003) argue that representation and lexical access are independent and other alternatives could be considered, such as an integrated lexicon with selective lexical access, or a separated lexicon with non-selective lexical access.

The literature on the lexical access offers different models and hypotheses under different perspectives in order to explain the bilingual and multilingual mental lexicon (Kroll & Stewart, 1994; Dijkstra & Van Heuven, 2002; Dijkstra, 2003; De Bot, 2004). There are distinct results for studies on lexical access, which aim at comprehension (Sunderman & Kroll, 2006; Libben & Titone, 2009; Titone, Libben, Mercier, Whitford & Pivneva, 2011; Jared & Kroll, 2001; Schwartz & Kroll, 2006; Chambers & Cooke, 2009; Van Assche, Duyck & Brysbaert, 2013; Duñabeitia, Dimitropoulou, Uribe-Etxebarria, Laka & Carreiras, 2010; Kerkhofs, Dijkstra, Chwilla & De Bruijn, 2006; Perea, Duñabeitia & Carreiras, 2008) and production (Costa, Miozzo & Caramazza, 1999; Colomé & Miozzo, 2010; Colomé, 2001; Costa, Caramazza & Sebastian-Galles, 2000; Hermans et al., 1998). The present study is interested in looking at the lexical access of trilinguals, both in language comprehension and production.

## 1.2 THE PRESENT STUDY

The greatest motivation for the present study was to further investigate the issues dealt with in my M.A. thesis (Toassi, 2012), which investigated crosslinguistic influences in the acquisition of English as a third language. In that study, the results of the analysis of crosslinguistic influences at the lexical level showed that learners of English who had Brazilian Portuguese (Brazilian Portuguese) as the L1 and German as the L2, were influenced by these two languages in production tasks. The results also showed that, compared to German, the native language exerted a slightly greater influence in the production of English, contradicting my expectations that German, being typologically closer



to English would cause more crosslinguistic influence than Brazilian Portuguese.

To further explore crosslinguistic influences, the present study was set forth in order to investigate the influence of non-target languages in the comprehension and production of English by multilinguals. More specifically, the present study was designed in order to investigate lexical access processes in the comprehension and production of non-native English speakers who also have knowledge of Brazilian Portuguese as the L1 and German as the L2.

The thesis advanced in the present study is that trilingual lexical access is qualitatively different from bilingual and monolingual lexical access. That is, the number of languages one is able to use has implication to how the lexicon is organized and accessed.

The issues investigated in the present study address two main questions in the field of lexical access in bilingualism and multilingualism, which are related to the separation/integration of the lexicons of a bi/multilingual and to the issue of selective or non-selective lexical access when more than two languages are at play.

There is no consensus in the literature regarding whether lexical storage in bilinguals and multilinguals is shared or separated and whether lexical access is selective or non-selective. In addition, studies normally focus on either the receptive or productive aspect of the lexical access, which has led to an apparent contradiction of data for these two processes. To contribute to a better description of lexical access in production and comprehension, the present study investigates lexical access of multilinguals during both language comprehension and production. Given that bilingual and multilingual lexical access can be approached from a myriad of perspectives, in the present study the issues of shared or separated lexical organization as well as selective and non-selective lexical access will focus on the role of cognates in the representation and processing of words. Cognates are very informative in the investigation of bilingual and multilingual lexical access, because they allow the analysis of the cognitive processing in the two/three languages of the bi/multilingual in a monolingual task. Due to their shared orthographic and semantic representation in the two/three languages, cognates allow the analysis of the non-target languages, implicitly, in a monolingual task. The present study addressed the following research questions:

1. Which cognates are more facilitative in the comprehension of English as a target language: double cognates (between English and

German and English and Brazilian Portuguese) or triple cognates (among English, German and Brazilian Portuguese)?

2. How is lexical access influenced by cognates among German, English and Brazilian Portuguese in the oral production of English?

3. Is there a difference in the semantic priming effect when presented in the native (Brazilian Portuguese), non-native (German) or target language (English) for bilingual and trilingual speakers?

### 1.3 SIGNIFICANCE OF THE RESEARCH

There is evidence that both comprehension and production are influenced by the bilinguals' non-target language. However, there is no consensus in the literature regarding an explanation about bilingual lexical access that embraces these two phenomena – language production and comprehension. Therefore, the present study may contribute to the research on lexical access in non-native English by comparing groups of trilingual and bilingual speakers in tasks that involve both language comprehension and production. In addition, the present study innovates in terms of the language combination, Brazilian Portuguese, German and English. The relevance of the present study also lies in the fact that it adopted state of the art methods, such as the eye movement recording technique, and traditional, well consolidated experimental paradigms, such as semantic priming and narrative oral production.

Eye movements are an indication of attention. Besides, the eye movement recording technique allows the observation of on line language processing, in a natural way. Likewise, narrative oral production adopted in the present study because it is a more natural task that allows the observation of the unplanned speech of the trilingual speaker. The technique of semantic priming allows the observation of the facilitate role of a word when preceded by a related one.

The results of the three experiments of the present study will contribute to the discussion regarding the organization of the multilingual mental lexicon, thus helping to elucidate the main questions regarding lexical access of multilinguals. Several hypotheses have been put forth in order to explain lexical access of bilinguals/multilinguals. The results of the present study may help to confirm these different hypotheses. The present study has as the main goal to contribute to the literature with new data concerning lexical access of English, in processes of comprehension and production, in the Brazilian context.

## 1.4 ORGANIZATION OF THE DISSERTATION

The present study is organized into five major chapters. Chapter I is the present chapter, which contains the introduction of this study. Chapter II reviews important concepts for the present study. Chapter II covers the following issues: the mental lexicon (section 2.1); the distinction of the terms bilingual/multilingual (section 2.2); issues on lexical storage/access regarding the multilingual lexicon (section 2.3); lexical access (section 2.4); models of lexical access (section 2.5); studies on eye movements and lexical access (section 2.6); studies on crosslinguistic influences and the multilingual lexicon (section 2.7); studies on semantic priming and lexical access (section 2.8).

Chapter III presents and discusses the method chosen for this investigation. The first section presents the research design of the present study (3.1). Section 3.2 presents the objective, hypotheses and research questions that motivated the present study. Next, section 3.3 presents the participants that took part in the present study, followed by the presentation of the biographical questionnaire (section 3.4), and the vocabulary tests in English and German (section 3.5). After that, the three experiments designed for the present study are presented in detail: the eye-tracking experiment (section 3.6); the narrative production experiment (section 3.7); the cross-language priming experiment (section 3.8). Finally, the last section of chapter III presents the pilot study carried out to test the instruments of the present study (section 3.9).

Chapter IV presents the results of the present study. First, the results of the vocabulary tests (section 4.1) and the information gathered through the biographical questionnaire (section 4.2) are presented. Next, the results of the three experiments carried out are presented and discussed: the eye-tracking experiment (section 4.3); the narrative production experiment (section 4.4); the cross-language priming experiment (section 4.5). After that, a general discussion regarding the three experiments of the present study is presented (section 4.6). Finally, the answers to the research questions that motivated the present study are presented (section 4.7).

Chapter V presents the conclusion of the present study. In this chapter, the main findings of this study are summarized (5.1). The limitations of the present study are also presented together with suggestions for further research in this area (section 5.2). Finally, some

pedagogical implications of the presents study are presented (section 5.3).

## **CHAPTER II**

### **REVIEW OF LITERATURE**

This chapter presents definitions for the main concepts involved in the present study and a review of literature regarding the multilingual mental lexicon. Assumptions related to the monolingual and bilingual lexicon are presented first, since the first studies investigated the monolingual lexicon, than the bilingual one. Even though many assumptions for the L1 mental lexicon can be applied to L2, L3, Ln, in the multilingual case, the complexity of the organization and processing of the lexicon is increased by the number of languages and factors that interfere in its organization. Consequently, processes of comprehension and/or production are more complex when analyzed through the multilingual perspective.

Therefore, in this chapter the main concepts that permeate the research area of lexical access and the multilingual lexicon are gathered and presented. For that, the chapter contemplates a brief introduction to the concepts of mental lexicon, lexical access and the main dichotomies related to these concepts, which refer to the one/two storage view for the bilingual lexicon and the selective/non-selective view on bilingual lexical access. In addition, the most influencing models of lexical access in bi/multilingual research are presented and discussed. The chapter also presents a review of literature regarding eye movements and lexical access, followed by a review of literature on crosslinguistic influences and the multilingual lexicon, and finally a review of literature on semantic priming is presented and discussed.

This chapter is organized as follows: section 2.1 presents the assumptions concerning the mental lexicon. Section 2.2 presents the arguments that justify a distinction of the terms bilingual and multilingual. Section 2.3 consists of a discussion on issues of lexical storage/access regarding the multilingual lexicon. After that, issues on lexical access are further discussed in section 2.4. In section 2.5, the models of lexical access are also presented, compared and discussed. Next, a review of literature regarding eye movements and lexical access is presented and discussed in section 2.6. After that, studies on crosslinguistic influences and the multilingual lexicon are presented and discussed in section 2.7. Finally, section 2.8 presents a review of literature on semantic priming and lexical access.

## 2.1 THE MENTAL LEXICON

In order to discuss issues related to lexical access, it is necessary first to define one of the most important constructs for the present study – the mental lexicon. Aitchinson (1987) defined the mental lexicon as the human word-store or mental dictionary. However, when Aitchinson wrote *Words in the mind – An introduction to the mental lexicon* (1987), dictionaries were not as evolved as today, mainly because the present technological resources were not available then. Therefore, Aitchinson's 1987 comparison of the mental lexicon to a dictionary was indeed a rather simplistic one, where only a few similarities between our word-store and a dictionary could be seen (Aitchinson, 1987).

The mental lexicon is a flexible and extendable word-store, being able of incorporating new words (Aitchinson, 1987). In other words, the mental lexicon is capable of constant updates as current dictionaries also are. The mental lexicon also stores a great amount of information for each word in all language aspects: syntax, semantics, phonology. Along the same lines, Szubko-Sitarek (2015, p. 34) provides the following definition for the mental lexicon: "The mental lexicon includes a large number of lexical entries containing all the information on individual words." This definition still leaves us with the following questions: How is the mental lexicon organized? How are the lexical entries connected with one another and how are the lexical links established?

Lexical items can be linked and organized in the mental lexicon according to their relation of meaning (synonym, antonym) and according to their morphological similarity (Szubko-Sitarek, 2015). However, it has to be clear that these assumptions are based on the L1 mental lexicon. When we add more languages to the system, it is still unclear how it is structured/affected. In the next section, the differentiation of bilinguals and multilinguals is justified.

## 2.2 THE DISTINCTION OF THE TERMS BILINGUAL AND MULTILINGUAL

Before entering into the discussion about the multilingual lexicon, a distinction has to be made in the present study between bilinguals and multilinguals. In the present study, the term bilingual will be restricted to the individual with knowledge of two languages, whereas the term multilingual will be used to refer to a person with

knowledge of three or more languages (Hammarberg, 2001) or to an user of three or more languages (Ecke, 2015).

This distinction is supported by scholars in the area of multilingualism (Cenoz, 2008, De Angelis, 2007, Jessner, 2006). De Angelis (2007) argues in favor of this differentiation, mainly due to the effects that prior linguistic knowledge has on subsequent language acquisition. She claims that if the term L2 is applied to all languages learned after the L1, this implies no difference in the process of acquisition of a third and a second language. Along the same lines, Butler (2012, p. 111) states that it is important that researchers “do not blindly assume that bilinguals are the same as multilinguals”. The present study takes these assumptions in account and aims at comparing the results of experiments on lexical access of bilinguals and multilinguals, in order to confirm the hypothesis that lexical processing of an individual with three or more languages differs from that of an individual with two languages.

According to Szubko-Sitarek (2015), since psycholinguistic research has started focusing on the bilingual mental lexicon (and later on the multilingual lexicon as well), there are two intriguing questions which permeate the field: (1) regarding lexical storage - is there a separate or integrated lexicon for the bilinguals' two languages?; (2) regarding lexical access – is lexical access non-selective or is it restricted to the target language?. In the next section, these two issues will be discussed.

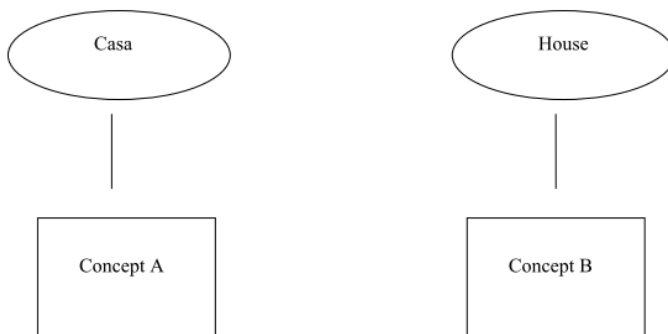
### 2.3 THE MULTILINGUAL LEXICON: ISSUES ON LANGUAGE STORAGE AND ACCESS

There are some dichotomies regarding lexical access and storage, which need to be clarified. Regarding storage, the overall debate concerns the functional integration or separation of the two languages in a bilingual brain (Illes et al., 1999). According to Fabbro (2001), back in the 19<sup>th</sup> century, several neurologists supported a general assumption, which favored common brain areas for all the languages of a bilingual or a multilingual. However, recently, this issue has not been such a consensus among scholars.

Therefore, in order to solve this issue, two opposite hypothesis were proposed: (1) the two- store hypothesis – according to which “words from each language are represented separately” (Szubko-Sitarek, 2015, p. 67); (2) the one-store hypothesis – according to which, there is

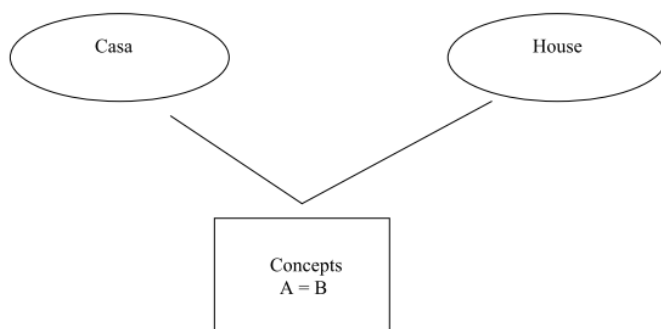
“a single integrated memory system for both languages.” (Szubko-Sitarek, 2015, p. 67). This is the dichotomy related to lexical storage.

However, the focus of this debate has changed from the perspective of language as a whole to the levels of representation of the word, and the new question posited by researchers concerns the integration/ separation of the lexical and conceptual levels of words. The lexical level would consist of the word form, whereas the conceptual level would be the word meaning. In order to discuss these two levels of representation, it is important to go back to the first definition regarding the bilingual lexicon, proposed by Weinreich (1953, as cited in Marini and Fabbro, 2007). According to this definition, there were three types of bilinguals: coordinate, compound and subordinative, as can be seen in Figures 1 to 3.

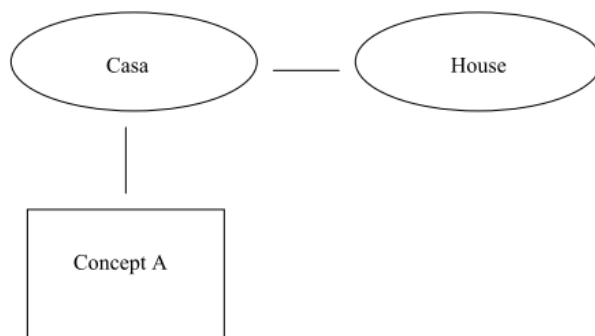


**Figure 1. Representation of a coordinate system.** Circles represent the lexical level, whereas squares represent the conceptual level. Source: Weinreich (1953, as cited in Marini and Fabbro, 2007).





**Figure 2. Representation of a compound system.** Circles represent the lexical level, whereas the square represents the conceptual level. Source: Weinreich (1953, as cited in Marini and Fabbro, 2007).



**Figure 3. Representation of a subordinative system.** Circles represent the lexical level, whereas the square represents the conceptual level. Source: Weinreich (1953, as cited in Marini and Fabbro, 2007).

According to Figures 1 to 3, it can be seen that, for the coordinate bilinguals, there are two conceptual representations, one for each word in the L1 and L2. Compound bilinguals, on the other hand, possess only one conceptual representation for the two words (L1 and its translation equivalent in the L2). In the case of the subordinative bilinguals, there is a clear dependency from the L2 into the L1, since; access to the conceptual representation of the L2 word is only possible through the L1 word. For this type of bilingual, level of proficiency determines the way the L2 lexicon will be accessed (De Groot, 1993).

In order to solve this debate regarding the bilinguals' lexicon integration or separation, another hypothesis was proposed, which stated that lexical forms were separated across words of the bilingual's two languages but meaning was shared. However, this simple view cannot be accepted, since studies on word recognition have shown that, even though the representation of lexical forms might be integrated, there might be some restrictions regarding the shared representation of semantics (Kroll & Sunderman, 2003).

Still on this matter, De Angelis (2007) claims that the manifestation of crosslinguistic influences does not seem to be compatible with the hypothesis of a total integration of the lexicons, since in total integration it would not be reasonable for one lexicon to interfere with the other. In agreement with De Angelis (2007), Singleton (2006) explains that the term cross-lexical transfer can only be applied if we consider that the two lexicons are at some point integrated, but also separated at another, as in a continuum.

Regarding language production, Kroll and Sunderman (2003, p. 94) state that "the translation equivalent and related words are active prior to speaking even when the bilingual intends to speak only in one of his or her two languages." Along the same lines, the authors claim that in language comprehension "orthographic and phonological information about words in both languages is activated even when a bilingual is reading in one language alone." (Kroll & Sunderman, 2003, p. 94).

Recently, this question regarding the integration/separation of the bilinguals' two lexicons has been rephrased as the following: "to what extent words from the multilingual's different languages are interconnected at both the lexical and the conceptual levels?" (Szubko-Sitarek, 2015, p. 68). Alongside this new view on the issue of lexical storage, it has been proposed that the variables that may influence the answer to this question are both related to the learner/language user and to the specific characteristics of the languages involved.

However, these assumptions of a separate/shared lexicon do not need to be directly correlated to the dichotomy of a selective/non-selective lexical access, since one dichotomy is related to language storage, whereas the other is related to language activation. Szubko-Sitarek (2015) explains that the non-selective view on lexical access does not mean that the multilingual cannot distinguish the words from the three or more languages. It means that language information is available later than word activation. For this reason, words from the non-target language may be initially activated. In the next section, issues on lexical access are further discussed.

## 2.4 ISSUES ON LEXICAL ACCESS

According to the E-Z reader model, “lexical access corresponds to the process of activating a word’s meaning so that it can be used in further linguistic processing.” (Reichle, 2011, p.774). *Further linguistic processing* can be interpreted as both recovering the word’s meaning in order to integrate a sentence (lexical access in comprehension) or recovering the word’s meaning in order to communicate (lexical access in speech production). However, this definition makes the processes involved in lexical access seem too simplistic, which is not the case. Researchers want to know how the meaning of the word is activated and how is it possible to find an intended word for production or to identify a word for comprehension. More importantly, for the present study, I want to look for the influence of having two or three languages in the process of lexical access.

In order to reach some conclusions for the questions raised above, I will start the discussion with the assumptions regarding the L1 mental lexicon. It is well known that, for access of a monolingual lexicon, there are already many possibilities of interference from within the language. For instance, when one word is activated other words of similar form, meaning, syntax, orthography or emotional content may also be activated and compete for selection (Szubko-Sitarek, 2015). If these assumptions of the L1 mental lexicon are extended to the bilingual/multilingual lexicon, the question that remains is whether the similar words will be activated only in the intended language or in all of the languages of the multilingual. This question is intrinsically related to the selective/non-selective view of lexical access. Since, according to the former one, only words or lexical entries of the intended language will be activated for competition. The non-selective view, on the other hand, postulates that words/lexical entries from the bilinguals’ two languages will be activated for competition. It is the purpose of the present study to provide some evidence regarding this issue of language selectivity.

Other factors that might constrain access to the mental lexicon are frequency, context and imageability (Szubko-Sitarek, 2015). According to the non-selective view of lexical access, it could be predicted that these characteristics of the word will be more influential in lexical access than the tag of the language from which the word belongs to. In other words, I mean that, if these factors constrain lexical access, it is

possible that the greatest influence, or the greatest number of activated lexical items will belong to the target language and little influence is expected from the other languages of the multilingual. That is why it is important to investigate the multilingual lexicon, mostly to compare lexical access of bilinguals and multilinguals. According to Szubko-Sitarek (2015, p. 67): “In the case of multilingual speakers ... the complexity involved in L1 lexical storage and processing ... is further multiplied by the complications added by other lexical systems, those of L2, L3, Ln.”

Moreover, in the present study processes of lexical access are analyzed both in language production and comprehension. For Szubko-Sitarek (2015), lexical access in language comprehension and production are opposite processes. Regarding language comprehension, the author claims that: “Word recognition involves receiving a perceptual signal, rendering it into the phonological or orthographic representation and then accessing its meaning.” (Szubko-Sitarek, 2015, p. 52). As for language production, Szubko-Sitarek (2015, p. 52) states that: “... producing a word requires first choosing the meaning for the intended concept, then recovering its phonological or orthographic representation, and finally converting it into a series of motor actions.” In other words, the author claims that the two processes are opposite due to the direction of the stages involved in the process, however, the stages are indeed very similar.

A final issue to be raised in this section regarding lexical access concerns a debate regarding the existence of a single lexicon storage for both comprehension and production or the existence of one lexical for production and another for comprehension. Studies show that our receptive lexicon is larger than the productive one, for this reason, it is believed that a single lexicon would cause a delay in the retrieval of words. (Szubko-Sitarek, 2015). However, from all of the stated above and in the previous section (2.2), it has to be said that this view is not appropriate since the questions being raised now are more related to the interconnectivity of the levels of representations of words in each language than to the language as a unitary system. In addition, it is hard to believe that there would be different lexical organizations for the purpose of the process involved: production or comprehension. Even though it is well known that our receptive vocabulary knowledge tends to be larger than our productive one, this hypothesis still seems unreliable. It would mean that the process (production or comprehension) is more important in constraining lexical organization than the features of the languages involved, the properties and

similarities of each word regarding semantics, orthography and phonetics.

This discussion regarding lexical access is further developed in the next section, where models of lexical access for bilinguals and multilinguals, both for language production and comprehension, are presented and discussed. The first model presented is the Revised Hierarchical model. Hierarchical models propose two levels of representation for words: the lexical and the conceptual level. Moreover, in the hierarchical view of lexical access, the words of the bilingual's two languages are stored separately.

## 2.5 MODELS OF LEXICAL ACCESS

This section presents the different views on lexical access of bilinguals and multilinguals, together with the models and hypothesis proposed. First, the hierarchical view on lexical access is presented, with a short historical background. This view is the first presented because it originated the first models and hypothesis to explain lexical access of bilinguals. Next, a computational model of word recognition is presented, the Bilingual Interactive Activation model (BIA). After that, the serial and interactive models of speech production are presented. Finally, three models designed for multilinguals, the Multilingual Interactive Activation model, the Multilingual Processing model and the Dynamic Model of Multilingualism, are presented and discussed.

In short, this section contains one model developed with focus on language acquisition, the RHM, one model of bilingual word recognition, the BIA, two views on lexical access in speech production, the serial and interactive ones and three models specifically designed for multilinguals.

### 2.5.1 The Revised Hierarchical Model of lexical access for bilinguals

Weinreich's (1953, as cited in Marini & Fabbro, 2007) distinction of compound and coordinate bilinguals raised issues regarding the distinction between lexical and conceptual representation of words and of language storage for bilinguals. This distinction proposed by Weinreich strongly influenced what is called hierarchical models. These models maintain the distinction proposed by Weinreich (1953, as cited in Marini & Fabbro, 2007) of the two levels of representation for words:

the lexical and the conceptual and they are called hierarchical due to the dominance of the L1 over the L2.

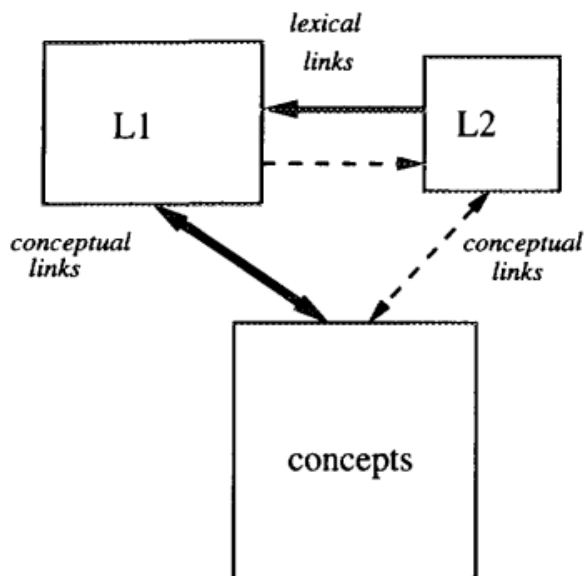
According to the hierarchical models, words of the two languages are stored in separate lexicons (Marini & Fabbro, 2007). Potter, So, Eckardt and Feldman (1984) proposed the first hypotheses on this hierarchical view: the word association and the concept mediation. These two hypotheses aimed at explaining the connections that are established during L2 vocabulary acquisition. According to the word association hypothesis, when L2 words are acquired they are directly associated to the L1 words. On the other hand, the concept mediation hypothesis suggests that L2 words are associated with the non-linguistic concepts, which are common for L1 and L2.

In order to investigate these two hypotheses (word association and concept mediation), Potter, So, Eckardt and Feldman (1984) conducted an experiment with two bilingual groups, one group of Chinese native speakers, who were proficient speakers of English as the L2 and another group of English native speakers, learners of French as the L2. The experiment consisted in reading words, translating these words into the other language and naming pictures. For the two groups of participants, the results of the experiment favored the concept mediation hypothesis, since participants named pictures in the L2 faster than they translated an L1 word into the L2.

Following Potter et al. (1984), Kroll and Stewart (1994) investigated these two hypotheses on the hierarchical view (the word association and the concept mediation). The study conducted by Kroll and Stewart (1994) consisted of three experiments: picture and word naming and a translation task. The results of the study showed that words were named faster than the corresponding pictures. The results also provided evidence that only picture naming requires concept mediation. Additionally, translation from L1 to L2 took more time than from L2 to L1, since this translation was conceptually mediated and was not influenced by the semantic context. On the other hand, translation from L2 to L1 was not influenced by the semantic context as naming also was not. Consequently, translation from L2 to L1 seemed to be lexically mediated.

The results of Kroll and Stewart (1994) provided empirical support for an asymmetric model of bilingual lexical organization, the Revised Hierarchical Model (RHM), which proposes that, for late L2 acquisition, where the L1 lexicon and the conceptual memory have already been established, L2 words are added to the system through lexical links with the L1. Nevertheless, as proficiency increases,

conceptual links for the L2 words are also acquired. However, the lexical connections between L1 and L2 words do not disappear. The RHM is represented in Figure 4.



**Figure 4.** Revised Hierarchical model. Source: Kroll and Stewart (1994).

As can be seen in Figure 4, the lexical links between L2 and the conceptual level are weak, as well as the link from the L1 to the L2. However, the links in the direction L2 to L1 are strong, as the links between the L1 and the conceptual level. The RHM has received empirical support from several studies, as can be seen in the Table 1.

Table 1

*Empirical studies supporting the RHM*

<b>Study</b>	<b>Goal of the study</b>	<b>Participants</b>	<b>Task</b>	<b>Results</b>
Kroll, Michael, Tokowicz & Dufour (2002)	To examine lexical access for L1 and L2 during second language acquisition.	Native speakers of English with French or Spanish as the L2.	-Naming task; -Translation task.	-Translation was faster from L2 to L1 than from L1 to L2 in all levels of proficiency.
Palmer, Van Hooff & Havelka (2010)	To test the assumptions of the RHM.	Bilingual speakers of English and Spanish.	-A translation recognition paradigm; - ERP measures.	-A greater N400 effect was observed in backward translation than in forward translation.
Alvarez, Holcomb & Grainger, 2003	To examine the organization and processing of words in L1 and L2 for early bilinguals.	Bilingual speakers of English and Spanish.	-A semantic word detection task; - ERP measures..	-The priming effect was faster in the backward order of presentation (L2-L1) than when the L2 word followed the equivalent translation in the L1.
Phillips, Segalowitz, O'Brien & Yamasaki (2004)	To investigate L2 proficiency variability in semantic priming efficiency.	Native speakers of English with French as the L2, at a variable proficiency level.	-A semantic classification task; -Measures of ERPs and reaction time.	-There was a delay of 50 ms in the effect of the N400 component in the L2 for the highly proficient bilinguals, in comparison to the L1 of



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Sholl, Sankaranarayana & Kroll (1995)	To investigate the relationship between picture naming and translation for bilinguals.	English- bilinguals.	Spanish	A transfer paradigm involving naming pictures and translation.	these bilinguals. -Naming pictures produced transfer to the translation from L1 to L2, but not for the translation from L2 to L1.
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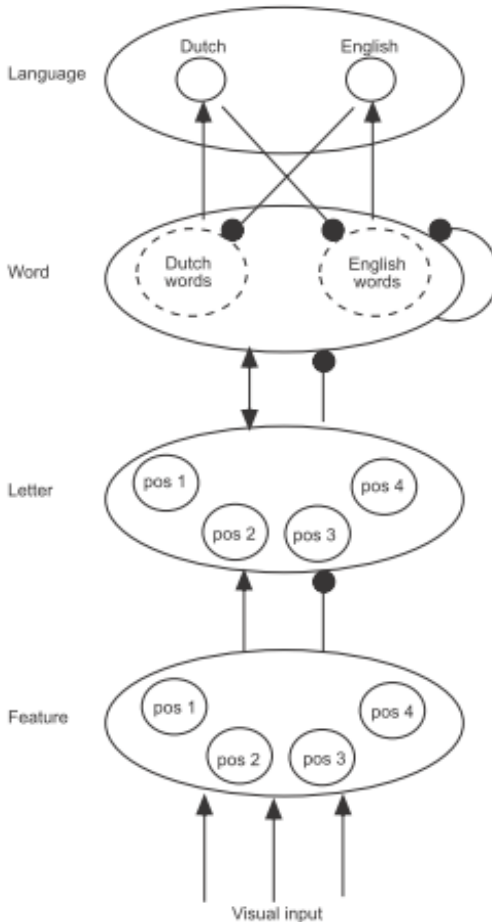
As can be seen in Table 1, empirical support for the RHM was found either with the translation asymmetry effect (Kroll, Michael, Tokowicz & Dufour, 2002) or in a greater N400 effect in backward than in forward translation (Palmer, Van Hooff & Havelka, 2010). In addition, it was found a faster priming effect in backward order than in the order L1- L2 (Alvarez, Holcomb & Grainger, 2003). Moreover, there was evidence that L2 processing is slower than the L1, due to the necessity to access L2 words through the L1 lexicon (Phillips, Segalowitz, O'Brien & Yamasaki, 2004). Finally, repetition of concepts were shown to be more effective from L1 to L2, than from L2 to L1 (Sholl, Sankaranarayanan & Kroll, 1995).

Although the RHM has received empirical support from studies with bilinguals, the question that remains regarding the RHM is how it can be extended to multilinguals. The RHM leaves room for investigation regarding the multilingual lexicon, since the connections established when a third or additional language is acquired are not specified in the model (De Angelis, 2007). Moreover, the assumptions of the RHM are not accepted by all scholars, Brysbaert and Duyck (2010), for instance, claim that the RHM should be replaced by computational models like the BIA model, which is presented in the next section, which covers lexical access in the recognition of words or comprehension.

### **2.5.2 The Bilingual Interactive Activation model for bilingual word recognition**

The Bilingual Interactive Activation (BIA) model is very important in research on bilingual word recognition. Grainger and Dijkstra (1992) explain that the BIA model consists of three levels of representation, which are letter, word and language. Dijkstra and Van Heuven (2002) state that in 1998, the BIA model was a word recognition model, concerned with the recognition of orthographic representations. The BIA+ (Dijkstra & Van Heuven, 2002) incorporates some changes in relation to the BIA (1998, as cited in Dijkstra & Van Heuven, 2002), as refers to the language nodes, as well as the addition of representations and a task decision component. Dijkstra and Van Heuven (2002) state that the BIA+ model distinguishes between a word identification system and a task decision system. Moreover, the model assumes interactivity within the word identification system and higher order systems such as the parser. The BIA model defends non-selective

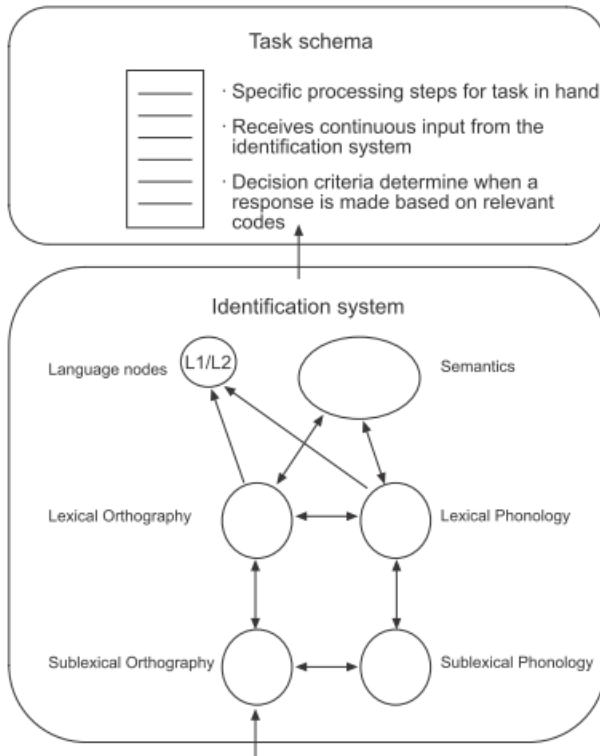
lexical access and an integrated mental lexicon across languages. According to the model, target word recognition is influenced by orthographic neighbors from both languages. The BIA model is represented in Figure 5.



**Figure 5.** The BIA model. Source:Dijkstra and Van Heuven (2002).

As can be seen in Figure 5, the BIA model has three levels of representation: word, letter and language, where both languages can compete for selection. In the 2002 version of the model, the BIA+, bilingual word recognition is affected not only for crosslinguistic

orthographic similarity effects, but also by crosslinguistic phonological and semantic overlap. When orthographic representations are activated they also activate associated phonological and semantic representations. The activation of orthographic codes in the BIA+ model is the same as in the BIA model; a number of lexical candidates are activated in parallel. In orthographically related languages, the number of items activated will be larger than for more distinct languages. The authors claim that the BIA+ model is a system that identifies which information is activated from the different languages in a given task or in task schema. The authors explain that task schemas are like mental algorithms with the steps necessary to the processing of a specific task. The BIA+ model can be seen in Figure 6.



**Figure 6.** The BIA+ model. Source: Dijkstra and Van Heuven (2002).

As can be seen in Figure 6, the BIA+ model does not account only for orthography as in the previous version. Semantic and

phonological representations were incorporated to the model, as well as a task schema. Many studies have found empirical support for the BIA+ model at some aspect, as can be seen in Table 2.

Table 2

*Empirical support to the BIA model*

Study	Goal of the study	Participants	Task	Results
Sunderman & Kroll (2006)	To investigate the predictions of the RHM and the BIA model.	Native speakers of English with Spanish as the L2 at different levels of proficiency.	- Translation recognition task.	<ul style="list-style-type: none"> <li>- Lexical form neighbors were activated for both less and more proficient L2 learners.</li> <li>- Only the less proficient L2 learners activated the L1 translation equivalent.</li> </ul>
Jared & Kroll (2001)	To investigate the activation of spelling-to-sound correspondences in the non-target language.	Bilingual speakers of French and English.	- A naming task, where neighbor words with different pronunciations were named in the dominant language.	- French phonology was not activated when the participants were naming in their dominant language, English.

Schwartz & Kroll (2006)	To investigate the effects of sentence context on cross- language activation.	Highly proficient Spanish- English bilinguals and L1- Spanish speakers, intermediate learners of English.	- Reading low and high constraint sentences with cognates and interlingual homographs.	- There was a cognate facilitation effect only for low constraining sentences for the two groups of bilinguals. - There was a great effect of the interlingual homographs for the less proficient bilinguals.
Chambers & Cooke (2009)	To investigate the effects of sentence context and proficiency on parallel language activation.	Native speakers of English with French as the L2 with varying degrees of proficiency.	- Visual world paradigm with the eye- tracker..	- There were no effects of proficiency on interlingual competition.

Libben & Titone (2009)	To investigate the effects of semantic constraint on nonselective access.	French- English bilinguals.	- Reading sentences with interlingual homographs and cognates while monitored by the eye- tracker.	- Semantic constraint had little influence on late comprehension measures. - Cognates facilitated reading.
Titone, Libben, Mercier, Whitford & Pivneva (2011)	To investigate non- selective lexical access during L1 reading.	English- French bilinguals.	- Reading paragraphs with interlingual homographs and cognates while monitored by the eye- tracker.	- The cognate facilitation effect was greater when the L2 was acquired earlier. - There was cross- language activation both for cognates and interlingual homographs.
Kerkhofs, Dijkstra, Chwilla & De Bruijn (2006)	To investigate word recognition of interlingual homographs.	Dutch- English bilinguals.	- A lexical decision task with homographs in the participant's L2 preceded by an item semantically related or unrelated.	- Related primes elicited a smaller amplitude in the N400 component than unrelated primes, favoring a non- selective and parallel view of lexical access.



- ERP measures.

Van Assche, Duyck & Brysbaert (2013)	To investigate the effects of cognate verbs on bilingual lexical access.	Dutch- English bilinguals.	- A lexical decision task. - Reading sentences with cognate verbs in present and past tense while being monitored by the eye-tracker.	- The cognate facilitation effect was not modulated by verb tense.
Duñabeitia, Dimitropoulou, Uribe-Etxebarria, Laka, & Carreiras (2010)	To investigate the masked translation priming effect.	Spanish- Basque bilinguals.	- Masked priming translation with ERP measures.	- There were symmetric effects of the N400 component in the two translation directions.
Perea, Duñabeitia & Carreiras (2008)	To investigate early and automatic access to shared semantic representation	Basque- Spanish simultaneous and Basque- Spanish late bilinguals.	- Lexical decision.	- Both groups of bilinguals demonstrated priming effects of automatic and early semantic association

for highly  
proficient  
bilinguals.

for pairs of non-  
cognate words  
within and across  
the bilingual's two  
languages.

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As can be seen in Table 2, the empirical studies found support for the BIA model related to the aspect of non-selectivity (Sunderman & Kroll, 2006; Liben & Titone, 2009; Titone, Libben, Mercier, Whitford & Pivneva, 2011), or to the inhibition of the non-intended language (Jared & Kroll, 2001). Other studies favored the model since the context affected activation of the bilingual lexicon (Schwartz & Kroll, 2006; Chambers & Cooke, 2009). The model was also supported in results of studies such as the cognate facilitation effect (Van Assche, Duyck & Brysbaert, 2013) and the effect of the N400 component, showing that the increase of proficiency decreases the difference of activation between L1 and L2 (Duñabeitia, Dimitropoulou, Uribe-Etxebarria, Laka & Carreiras, 2010). Parallel activation of the bilingual's two languages in interlingual homographs recognition (Kerkhofs, Dijkstra, Chwilla & De Bruijn, 2006) and the results of early and automatic semantic priming between the bilingual's two languages (Perea, Duñabeitia & Carreiras, 2008) were also interpreted as evidence in favor of the BIA+ model.

Since the BIA+ is a word recognition model that favors the view of non-selective lexical access, many issues have been raised to investigate the model. One of this issue concerns the representation of cognates in the bilingual lexicon and this is the topic of the next subsection.

### 2.5.2.1 The representation of cognates in the bilingual lexicon according to the BIA+ model

Cognates are lexical items of similar form and meaning, which can be identical, as in German *Hand* and English hand, or not, as in the German verb *trinken* and English drink, where these non-identical cognates with a similar form have gone through a regular phonological change in each language (Szubko-Sitarek, 2015). Both identical and almost identical cognates have an effect on bilingual language processing (Szubko-Sitarek, 2015).

The origin of cognate pairs can be etymological or through language contact, that is, borrowings from one language to the other (Szubko-Sitarek, 2015). However, in psycholinguistics, processing is more relevant than etymology when defining a cognate pair (Szubko-Sitarek, 2015). One possible definition of cognates for psycholinguistics

may be related to whether the pair of words have shared aspects of spelling, sound and meaning (Szubko-Sitarek, 2015).

The BIA+ model proposes that cognates have an integrated representation across the bilingual's two languages. According to Dijkstra (2005), it is possible that cognates have a special representation with stronger orthographic and semantic links across the two languages. Dijkstra (2005) also claims that the strongest evidence for non-selectivity comes from studies with neighbors.

The stimulus normally used to investigate lexical access in bilinguals are interlingual homographs (words that have the same orthography but different meaning – also called false friends), cognates (words that have similar orthography and the same meaning) and words that exist in only one language but vary in the number of neighbors in the other language (Dijkstra, 2005).

According to Sánchez-Casas and García-Albea (2005), cognate status might be a different morphological relation among words, which are represented together in the bilingual lexicon. The authors argue that the representation of words in bilingual memory is related to the word's characteristics. Poarch and Van Hell (2012) state that the use of cognates in research on the bilingual lexicon allows to observe the influence from the other language in a language exclusive setting. Szubko-Sitarek (2015) state that if responses to cognates differ from their respective controls, it can be seen as evidence that the readings of the cognate word in the two, three or more languages have become active and affect each other.

It is assumed that cognates are processed faster than non-cognate words. This is commonly referred to as the cognate facilitation effect. This effect has often been taken as evidence for an integrated multilingual lexicon and/or for parallel lexical access – the nonselective access hypothesis – where word candidates are activated in several languages (Szubko-Sitarek, 2015).

Costa, Santesteban and Caño (2005) state that the best explanation for the cognate effects is the interactive one, where lexical and sublexical levels of representation interact within and across languages, since cognates share phonological and semantic properties.

Dijkstra, Grainger and Van Heuven (1999) investigated word recognition of Dutch- English cognates and false friends, aiming at orthography, phonology and semantics. Three experiments were carried out. The first one was a progressive demasking task. The other two experiments were standard lexical decision tasks. The results of the

study showed that orthographic and semantic overlap had a facilitatory effect, whereas phonological overlap caused inhibitory effects.

Lemhöfer and Dijkstra (2004) conducted four experiments involving a lexical decision task with the stimulus material consisting of Dutch-English interlingual homographs and cognates. The results of the study with cognates replicate the ones of the study by Dijkstra, Grainger and Van Heuven (1999), where semantic and orthographic overlap led to faster reaction time. Nevertheless, phonology seemed to have an interference effect, since, cognates with phonological overlap had a reduced facilitation effect. The results for interlingual homographs were null, meaning that, orthography and phonology did not lead to a facilitation effect, whereas semantic overlap did.

Poarch and Van Hell (2012) conducted a study with cognates at the phonological level, where children were required to name pictures in only one language. More specifically, bilinguals and trilinguals were required to name pictures that represented cognates and non-cognates in their dominant and non-dominant language. Participants of the study were speakers of German (L1), English (L2) and another language (X) as the L3. The results of the study favored coactivation of the bilinguals and trilingual's languages.

Lemhöfer, Dijkstra and Michel (2004) conducted a study with trilingual speakers of Dutch, English and German. The tasks of the study were applied in the participants' weakest language, the L3. Cognates in the participants' two and three languages were the stimulus of the study. The results of the study reinforce the cognate effects in the combination Dutch- German, since participants answered faster to these cognates than to non- cognates. Additionally, the results of the study showed that triple cognates facilitated the lexical decision task more than the double cognates. The authors state that both the native language and the foreign language influenced the comprehension of the target language. The results of the study suggest that participant's three languages are activated in a monolingual task.

Cognates offer a very interesting source of investigation, due to their similarity in the bilingual or trilingual's languages, which lead to the hypothesis that they have a common representation in multiple languages. In the area of multilingualism, the effect of triple cognates (Lemhöfer, Dijkstra & Michel, 2004) offers an interesting source of investigation that can provide information regarding the multilingual lexical organization. Cognates will only have an effect in lexical access if access is nonselective with respect to language. Thus, candidates from two or more languages will compete, leading to longer reaction times.

However, if access were selective, cognates would have no effect on reaction time (Szubko-Sitarek, 2015).

As presented in this section, research on word recognition has demonstrated that activation flow is not language specific (Costa, 2005). Nevertheless, the processes involved in word recognition, are bottom-up processes, as opposed to the ones involved in speech production, which are top-down processes. In comprehension, the external stimulus activates the representations of the person, whereas in speech production, lexical representations are activated in accordance with the conceptual representations activated as a consequence of the intent of communication of the speaker. In speech production, the speaker also has more control on some aspects, as for instance, the language that will be used for production, the content of the message and the words that will be used. Since comprehension was covered in the present section, the next section is devoted to lexical access in speech production, with special emphasis on the serial and interactive models proposed for the bilingual lexicon.

### **2.5.3 Serial and interactive models of bilingual speech production**

There is an agreement in lexical access research on the existence of a process where lexical representation is specified and another where orthographic and phonological representations are specified (Caramazza & Miozzo, 1998). This would constitute two levels of representation, the lemma and lexeme level. The lemma level consists of the syntactic properties of the word, and the lexeme level consists of the phonological and orthographic information of the word (Caramazza & Miozzo, 1998).

Roelofs (1992) argues that there are three processes involved in speech production. The first process is the conceptualization, where the concepts that are going to be expressed are specified. The second process is the formulation, where the words corresponding to the intended concepts are selected. At this process the representation of syntactic and phonological structures are formed. The third process is the articulation, where the speech is uttered.

Two principles are known to govern these processes: activation and selection (Costa, 2005). Availability of the representations (concepts, words and phonemes) at the different levels of processing is determined by their corresponding activation levels (Costa, 2005). According to Costa (2005), the first representation activated is the one of the concepts, which then, spreads activation to the corresponding

lexical representations. Costa (2005) claims that at this moment of speech production, a decision has to be made regarding the lexical node that will be chosen among the several possible candidates, which consists of the lexical selection process. Thus, lexical selection is one part of the process of lexical access.

According to Costa (2005), activation of the lexical node also spreads to the sublexical level or phonological level, since the last step is the production of speech. Moreover, there is competition among the representation of the possible candidates in all levels of representation. However, the main question regarding bilingual speech production is whether the activation of the representations at the different levels are restricted to one language or the two languages (Costa, 2005).

Current models of lexical access postulate that the activation of the conceptual system flows to the lexical representations of the bilingual's two languages (Costa, 2005). This means that activation from the semantic to the lexical level is language non-specific. The question that remains is whether the activated lexical representations also activate phonological representations in the bilingual's two languages.

Regarding the two processes that form lexical retrieval – the lemma and lexeme – Morsella and Miozzo (2002) claim that there is a controversy on whether they occur in a fixed or dynamic order. In the serial view of lexical access, the order of these two stages is hypothesized to be fixed. Morsella and Miozzo (2002) claim that serial models originated from reaction time experiments. According to this serial view, phonological activation consists only of the selected lexical node. On the other hand, an opposing view of lexical access is the cascade one. Morsella and Miozzo (2002) explain that cascade models originated from speech errors research, where errors would be both semantic and phonological, named mixed errors. This is a dynamic view where phonological activation can occur before lexical selection. For this reason, in this view, there might be phonological activation of unselected lexical nodes. In other words, Hermans, Bongaerts, De Bot and Schreuder (1998) explain that, in the fixed order of lexical access, lemma selection precedes lexeme retrieval. On the other hand, in interactive models, lexeme retrieval can affect lemma selection and these are not separated processes. The literature on bilingual lexical access in speech production presents different results, as can be seen in Table 3.

Table 3

*Empirical studies on bilingual lexical access in speech production*

<b>Study</b>	<b>Goal of the study</b>	<b>Participants</b>	<b>Task</b>	<b>Results</b>	<b>Model favored</b>
Hermans, Bongaerts, De Bot & Schreuder (1998)	To investigate activation of a dominant language during lexical access of a less dominant language.	Dutch- English bilinguals.	Picture- word interference paradigm.	- There was evidence of activation of the Dutch name during lexical access of English.	Both serial and interactive models.
Costa, Miozzo & Caramazza, (1999)	To investigate parallel activation of the bilingual's two languages.	Catalan- Spanish bilinguals.	Picture- word interference paradigm.	- There was facilitation of identical words from different languages.	Language-specific models of lexical selection.



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Colomé (2001)	To investigate lexical activation of units with a common semantic representation in the two languages.	Catalan- Spanish bilinguals.	Phoneme monitoring task.	- Participants took more time to reject the phonemes that belonged to the translation than the phonemes that were absent from the Spanish or Catalan words.	Language-independent hypothesis and contradicts strict serial models.
Costa, Caramazza & Sebastian-Galles (2000)	To investigate if the non-selected lexical nodes activate their phonological representation.	Highly proficient Catalan- Spanish bilinguals and Spanish monolinguals.	Name pictures that consisted of cognate and non-cognate words.	Bilingual speakers named the pictures with cognate names faster than the pictures with non- cognate names.	Cascaded models, where both selected and non-selected items activate phonological segments.

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Colomé and Miozzo (2010)	To investigate if the non- target words are also activated in the non- used lexicon.	Experiment 1: Spanish- Catalan bilinguals. Experiment 2: Catalan- Spanish bilinguals.	Picture- picture interference paradigm.	Experiment 1: no difference in naming latencies between related and unrelated words. Experiment 2: there was a phonological effect with cognates.	The results show that phonology can be activated even in the non- selected language.
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As can be seen in Table 3, the study by Costa, Miozzo and Caramazza, (1999) favored the language specific hypothesis; whereas Colomé and Miozzo (2010) argued that, the two languages of the bilingual have their phonological representations activated in speech production. Nevertheless, Colomé and Miozzo (2010) did not assume a specific position regarding the serial or interactive models of lexical access. Concerning these models, other studies have found distinct results. One study found results that contradict serial models (Colomé, 2001). Another study favored interactive models (Costa, Caramazza & Sebastian-Galles, 2000). On the other hand, Hermans et al. (1998) state that the results of their study can be explained on the basis of both interactive and serial models.

These results show that regarding the serial and interactive view there is no consensus in the literature. Therefore, there is room for research in this area, mainly regarding the multilingual lexicon, which has not been extensively explored in research on speech production. The results of Colomé and Miozzo (2010), for instance, could be investigated with trilinguals to see if all languages are also activated during speech production and what mechanisms regulate this activation. Moreover, other factors can be analyzed, as task type, the level of proficiency of the participants and the frequency of use of the languages involved.

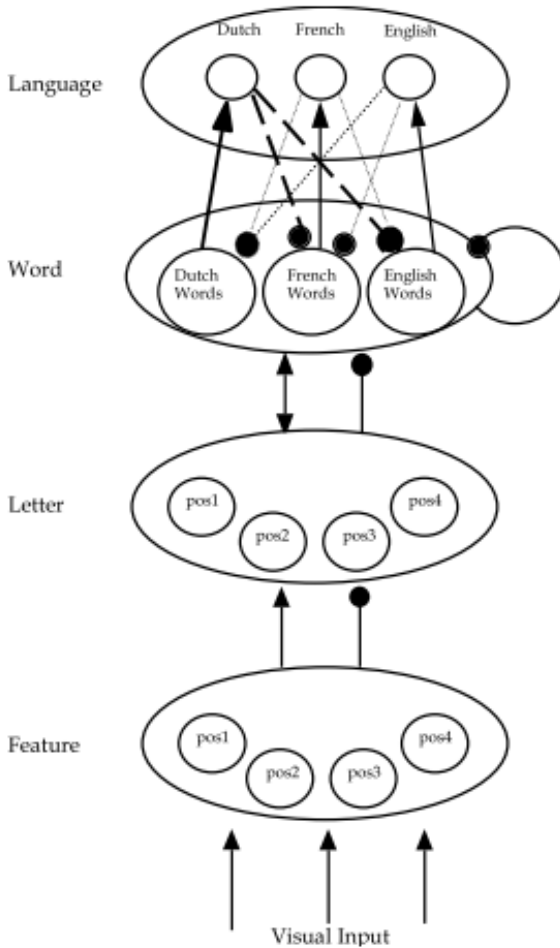
Having seen the different models and studies of lexical access regarding word recognition and speech production, the next subsection covers two models aimed specifically at multilingualism.

#### **2.5.4 Models of lexical access for multilinguals**

In the previous sections of this paper, models of lexical access aimed at bilinguals were presented and discussed. In this section, three models specifically designed to account for multiple languages are presented. First, the Multilingual Interactive Activation model is presented. After that, the Multilingual Processing model is presented and discussed. Next, a dynamic view of lexical access is presented in the Dynamic Model of Multilingualism.

### 2.5.4.1 The Multilingual Interactive Activation model

The BIA+ model was further adapted in order to incorporate an additional language, forming the Multilingual Interactive Activation model (Dijkstra, 2003), as can be seen in Figure 7.



**Figure 7. Representation of the Multilingual Interactive Activation model.** Arrows indicate activation, whereas dotted lines indicate inhibition. Source: Dijkstra (2003).

According to Figure 7, it can be seen that for the MIA model, the lexicon of the three languages are integrated, since there are words from Dutch, French and English stored together. In relation to the BIA model, there is a greater amount of words, or a great density of words. This may turn lexical access into a slower process, since the competition of words is stronger (Dijkstra, 2003). The next subsection presents the Multilingual Processing model, which is also very similar to the BIA+ model.

#### 2.5.4.2 The Multilingual Processing model

De Bot (2004) developed a model for multilinguals: the Multilingual Processing model. This model focuses on language production and supports the view of non-selective lexical access. The model can be applied to both bilinguals and multilinguals irrespectively of the number of languages. This model is divided into three basic stores, one of them contains the conceptual features, another the syntactic procedures and the third one, the form elements. These three stores are further divided into language specific subsets, where the similarities across the different languages overlap. In the model, there is a language node responsible to control for the language to be used. Language selection, in this language nodes is regulated by the level of activation. In other words, when a specific language is required for communication, the language node will send information in order to activate the right language. However, since there is overlap of similar elements across languages, these can be activated too.

This model offers possibilities to investigate the multilingual lexicon. Moreover, the Multilingual Processing model is similar to the BIA+ model in some respects. Both models have the level of activation of the languages as the starting point. In addition, in both models, similarity across languages has an influence on lexical access. The next subsection presents a dynamic view of multilingualism.

#### 2.5.4.3 The Dynamic Model of Multilingualism

The Dynamic Model of Multilingualism (DMM) (Herdina & Jessner, 2002) postulates that the multilingual system is dynamic and adaptive. This model accounts for the development of new qualities of the multilingual, which is a result of the acquisition of a further

language (Jessner, 2006). In addition, the DMM is in agreement with the assumption supported by both Cook (2009) and Grosjean (1998) that bilinguals cannot be compared with monolinguals because of their multi-competence (Jessner, 2006).

Jessner (2008) states that in the multilingual context, due to the increase of the languages involved, the dynamics, or the changes and complexity of language learning are more evident (p. 270). The DMM applies dynamic system theory (DST) to multiple language acquisition. Lowie and Verspoor (2011) state that DST is a theory of change. The authors state that earlier models (like Levelt's) were proposed in a linear way, however, a more recent view of language is the one of a complex dynamic system.

The DMM also posits that language learning is dependent on time and energy being dedicated to it. However, since the model assumes that learners' resources are limited, access to the language knowledge will depend on the investment of the learner. The DMM also proposes that the different language systems of the multilingual are interdependent. Moreover, the model adopts a holistic view of multilingualism, which is necessary to understand the complexity involved in the system.

Jessner (2006, p. 33) states that the DMM: "stresses the non-linearity of language growth, the interdependence between language systems and the change of quality in the language learning process as well as learner variation". Jessner (2006) claims that the non-linear view of language growth has to be considered because of the dynamics of the language system.

In short, from the stated above, it can be concluded that the literature on lexical access offers different models and hypotheses. Moreover, studies aimed at language comprehension and production do not reach a common conclusion as regards bilingual lexical access. Additionally, most studies are restricted to bilingual or monolingual population, which leaves room for investigation with multilinguals. There are few models specifically designed for multilinguals and these models need to be further investigated. The next sections of this chapter aim at exploring studies that investigated lexical access using eye movements (section 2.6), studies focused on crosslinguistic influences (section 2.7) and finally, studies focused on semantic priming (section 2.8).

## 2.6 EYE MOVEMENTS AND LEXICAL ACCESS

Alongside different methods, Rayner and Pollatsek (2006, p. 613) state that “eye movements represent one of the best ways to study language comprehension processes”, i.e. eye movements can best account for language processing in real time. The statement by Rayner and Pollatsek (2006) is supported by the fact that the eye-tracking technique allows researchers to investigate on-line language processing in a natural way.

Roberts and Siyanova-Chanturia (2013) claim that the eye-tracking method provides valuable insight and understanding about the nature of participants’ real-time language processing and comprehension without being invasive , i.e. participants do not need to be interrupted while performing the task to give information about their processing stages.

Also favoring the eye-tracking technique, Dussias (2010) states that the major advantage of the eye-tracker is that the characteristics of tasks or stimuli do not need to be altered in order for the language processing to be analyzed. In other words, Wu, Cristino, Leek and Thierry (2013) also favor this online technique because it offers the full flexibility of measuring ocular responses in natural reading conditions in order to investigate language processing and comprehension.

Although the eye-tracking technique has been applied for three decades, it has recently attracted more attention from researchers interested in investigating comprehension of L2 sentences (Dussias, 2010). According to Dussias (2010), research has shown that there is a relation between eye fixation and the characteristics of the words being fixated. For instance, longer words, phonologically more difficult words or words that are more important are normally fixated for longer time. On the other hand, shorter words, or phonologically simpler words or cognates (words that share form and meaning in the two languages) are recognized faster and more likely to be skipped (Duyck, Van Assche, Drieghe & Hartsuiker, 2007). Moreover, Dussias (2010, p. 151) claims that “recordings of eye movements can be very informative when studying the structural decisions that people make during reading.”

In agreement with the researcher just mentioned, Winke, Godfroid and Gass (2013) argue that the eye-tracking technique is a very versatile one, which has different applications. According to the authors, the technique has been applied in studies dealing with lexical

access and representation in bilinguals, syntactic ambiguity resolution, attention and other cognitive processes in tasks that involve second language testing and video based L2 listening.

There are two main applications for the eye-tracking technique commonly reported in the literature. The eye-tracker can be used to investigate reading processes and track the eye movements while processing some visual and auditory information, the latter is commonly called the visual- word paradigm (Roberts & Siyanova-Chanturia, 2013; Wu et al., 2013). Although the visual- word paradigm is a successful technique, the majority of the L2 eye-tracking studies deal with reading (Roberts & Siyanova-Chanturia, 2013).

Roberts and Siyanova-Chanturia (2013) argue that by using the eye-tracker, it is possible to see that reading is composed of saccades and fixations. Saccades are a series of rapid movements made by the eyes (Rayner & Pollatsek, 2006). Dussias (2010) defines saccades as small “jumps” that the eyes make while we are reading. It is believed that, since saccades are very fast, no information input occurs (Roberts & Siyanova-Chanturia, 2013). Dussias (2010) states that, in general, saccades last from 20 to 40 milliseconds (ms).

Still regarding saccades, four types of movements have been identified: rightward movements, regressions, return sweeps, and corrective movements (McConkie, 1983, as cited in Dussias, 2010). Concerning regressive saccadic movements, Dussias (2010) states that they tend to occur approximately 10–15% of the time. Regressive saccadic movements are normally performed because the reader wants to go back to material that has already been read. Concerning the length of a saccadic movement, Dussias (2010) claims that it can range in average up to eight letter spaces. Readers normally make about three to four saccadic movements per second, each lasting between 20 and 40 ms.

On the other hand, fixations refer to the moment that the eyes fix at a given point, which is hypothesized to be the moment where processing of input occurs (Roberts & Siyanova-Chanturia, 2013). According to Dussias (2010), it is during the fixations that the reader extracts important information from the text. Rayner and Pollatsek (2006) also argue that visual information is only encoded during the fixations. Fixations last approximately for 200 to 250 ms (Dussias, 2010). Winke, Godfroid and Gass (2013) explain that fixation durations are commonly divided into early and late measures. Early measures may include word recognition and lexical access, for instance.



First pass and first fixation are classified as early measures. According to Rayner (1998, p. 376) first pass is “the initial reading consisting of all forward fixations”, whereas first fixation is “...the duration of the first fixation on a word regardless of whether it is the only fixation on a word or the first of multiple fixations on a word” (Rayner, 1998, p. 377). Second pass, a late comprehension measure is defined by Rayner (1998, p. 376) as “rereading”.

Dussias (2010) explains the use of the eye-tracker with the visual-word paradigm. This paradigm consists of an auditory stimuli and a related visual scene. The instructions are informed by the auditory material regarding some actions to be taken by the participant when submitted to the visual material. In this paradigm, a phonologically related object might be included in the visual scene. The eye-tracker will show the participants' fixations in the target picture in relation to its competitors (Winke, Godfroid & Gass, 2013).

Tanenhaus and Trueswell (2006) explain the usefulness of the visual world paradigm. The authors claim that eye movements provide a sensitive and implicit measure of spoken language processing. Moreover, it can be used with natural tasks; being possible to be used with children and special needs populations. In addition, the combination of language and visual world makes it possible to evaluate questions about reference and real-time interpretation that would be difficult to evaluate only with measures of processing difficulty. According to the authors, with this paradigm, it is also possible to investigate real time production and comprehension in natural tasks.

The eye-tracker is a valuable tool in investigating lexical access (Roberts & Siyanova-Chanturia, 2013). Marian, Spivey and Hirsch (2003) conducted three eye-tracking experiments with fluent Russian-English bilinguals in order to investigate the activation of multiple lexical items. The experiments tested spoken language processing. In Experiment 1, participants were instructed in one language, where control distractor objects and a between-language cohort object were also presented. The second experiment contained competitors within and across bilinguals' two languages. In the third experiment, participants were tested only in one language. The results of the three experiments showed competition of activation of lexical items between and within the two languages, suggesting that even when the environment is monolingual, phonetic input of words are simultaneously activated in the bilinguals' two lexicons. The authors also state that switching off one of the languages does not seem to be possible but rather suppressing the irrelevant one may best account for this.

Another study, carried out by Titone et al. (2011) showed that the L2 words of a bilingual were activated while participants performed a reading task, exclusively in their L1. The study applied the eye-tracking technique in order to investigate if the L2 lexicon interferes with processing of the L1. The results of the study showed an effect of cognate facilitation and the activation of interlingual homographs. The conclusion of the study was that for early L2 acquisition, lexical access is non-selective. Still according to the authors, the results of the study favor an integrated lexical storage for both L1 and L2.

Alloppenna, Magnuson and Tanenhaus (1998) applied the visual world paradigm, as in the study by Marian Spivey and Hirsch (2003). In their experiment, participants had to move line drawings of four objects on a computer screen. In the oral instruction, participants were informed about the object that should be moved and where it should be placed. The results of the study showed that even the words that do not share onsets can be activated to compete for lexical access. Additionally, the results provided evidence for activation of cohort competitors. However, no evidence was found for activation of rhyme competitors.

The eye-tracking technique was also applied by Libben and Titone (2009) to investigate the effects of semantic constraints on non-selective access for interlingual homographs and cognates. Participants of the study were French- English bilinguals. The task was performed in their second language, English. The results of the study for early comprehension measures showed that high and low constraint sentences with interlingual homographs were read more slowly than their matched controls. On the other hand, for cognates, the opposite result was found as they facilitated reading. The results of the study favor language non-selectivity at the early stages of comprehension regardless of sentence constraint.

Van Assche, Duyck and Brysbaert (2013), used verbs both in present and past tense forms to investigate the cognate facilitation effects, with the aid of the eye-tracking technique. The participants of the study were Dutch- English bilinguals. The results of the study showed only a small cognate facilitation effect for late measures and no clear effects for early measures. Present tense verbs were read more quickly than past tense ones. However, the cognate facilitation effect was not modulated by verb tense.

Chambers and Cooke (2009) investigated the effects of sentence context and L2 proficiency on the effects of competition of interlingual homographs. The participants of the study were native speakers of English with varying degrees of proficiency in French as L2. The study

applied a variant of the visual word eye-tracking technique to evaluate interlingual competition during sentence comprehension. The pairs of competitor words were interlingual near-homophones that differed in meaning. Participants listened to French, which was their non-native language. The results of the study indicated no effects of proficiency on interlingual competition, which supported the idea that proficiency does not provide sufficient control to inhibit the inactive language.

Having discussed the importance of eye movements in the study of lexical access with multilinguals. The next section discusses how the study of crosslinguistic influences can contribute to the understanding of the multilingual mental lexicon.

## 2.7 CROSSLINGUISTIC INFLUENCES AND MULTILINGUALISM

Crosslinguistic influences or the study of how one language influences the acquisition and processing of a subsequent one is a very important aspect to be considered when studying multilingualism. That is because the more languages involved in the system, the greater the chances of influence/interference from one language to the other. The results of studies on crosslinguistic influences can help elucidate questions on the mental lexicon and multilingualism, since the results of interference/influence from one language to the other might give evidence from the organization and processing of the three or more languages of the multilingual.

Crosslinguistic influence can be manifested in many directions: (1) from the native language to the foreign languages; (2) between the foreign languages; (3) from the foreign language into the native language. The third topic is the least investigated by researchers, however, it offers a very interesting perspective on the multilingual lexicon, since studies in this area might demonstrate how dynamic the mental lexicon is, moreover, they may significantly contribute to the greatest questions regarding the mental lexicon, which are related to the degree of integration/separation or to the interconnectivity among the multilinguals' three or more languages.

Several studies (Cenoz, 2001; Hammarberg, 2001; Ringbom, 2001; Ecke, 2001; Fouser, 2001; Gibson, Hufeisein & Libben, 2001; Vinnitskaya, Flynn & Foley, 2002; Leung, 2005; Carvalho & Silva, 2006; Llana, Cardoso & Collins, 2007; Bardel & Falk, 2007; Flynn, 2009; Shoostari, 2009; Bayona, 2009; Perales, Mayo & Liceras, 2009;

Chin, 2009; Foote, 2009; Jin, 2009; Ranong & Leung, 2009; Rothman & Amaro, 2010; Montrul, Dias & Santos, 2011; Rothman, 2011; Falk & Bardel, 2011; Toassi, 2012) have investigated the role of L1 and L2 in the acquisition of an L3. De Angelis and Selinker (2001) investigated the role of L1, L2 and L3 in the production of an L4 (Italian). Herwig (2001) investigated the influence of the mother tongue in the translation from L1 to L2, L3 and L4. Table 4 presents some of the most relevant studies in the area of CLI, which looked for the role of the previous language into the acquisition and/or processing of a subsequent one.

Table 4

*Empirical studies on crosslinguistic influences (CLI) and multilingualism*

<b>Study</b>	<b>Goal of the study</b>	<b>Participants</b>	<b>Task</b>	<b>Results</b>
Cenoz (2001)	To investigate factors that interact with CLI	L1- Basque or Spanish L2- Basque or Spanish L3-English	Oral narrative based on the wordless picture story <i>Frog, where are you?</i>	The factors of linguistic similarity and L2 status are influential in third language acquisition (TLA).
Hammarberg (2001)	To investigate the role of L1 and L2 in the acquisition and production of the L3.	L1 -English L2- German L3- Swedish	Audiotaped conversations, and retrospective comments.	L1 had a more functional role, whereas the L2 had a supplier role.
Ringbom (2001)	To investigate transfer from the L1 and L2 into the L3.	L1-Swedish L2- Finnish L3- English	Translation	L2 status and typology are more influential in third language processing.
Ecke (2001)	To investigate the acquisition, organization and processing of L3 words.	L1- Spanish L2- English L3- German	Translation	More influence from within the L3 and L2 in CLI.
Fouser (2001)	To investigate the effect of typology	L2- Japanese L3 or L5- Korean	Discourse completion task;	A positive influence of the L2 in the process of

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	in CLI.		language Choice Questionnaire; short writing task.	TLA.
Gibson, Hufeisein & Libben (2001)	The influence of the L2 in the production of prepositional verbs.	L1s- varied L2- English L3- German	Translation and filling in task.	English as an L2 did not facilitate the production of the prepositional verbs in German.
Vinnitskaya, Flynn & Foley (2002)	To investigate the role of L1 and L2 in L3 acquisition.	L1- Kazakh L2- Russian L3- English	Listening and repeating sentences with relative clauses.	Point to the influence of both L1 and L2 in the acquisition of the L3.
Leung (2005)	To investigate the Failed Feature Hypothesis (FFH) and the Full Transfer Full Access Hypothesis.	L1- Cantonese or Vietnamese L2- English L2 or L3- French	Composition; sentence completion task; grammaticality preference task.	The results favored the FTFA hypothesis.
Carvalho & Silva (2006)	To investigate the factors of order of acquisition or typological distance in CLI.	L1- English or Spanish L2-Spanish or English L3- Portuguese	Writing sentences in the present subjunctive and in the future subjunctive and think aloud protocols.	Typological distance among languages overrides order of acquisition.

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Llama, Cardoso & Collins (2007)	To investigate the factors of typology and L2 status in CLI.	L1- English or French L2- French or English L3- Spanish	Reading word lists.	L2 status as a stronger source of influence in the acquisition of L3 phonology
Bardel & Falk (2007)	To investigate the placement of negation in the initial state of L3 acquisition.	L1- Albanian, Hungarian and Italian L1 or L2- Dutch, English and German. L3- Dutch and Swedish as L3	Recorded oral communication during classes.	Typological proximity seems to favor transfer from L2 to L3, but not from L1 to L3.
Flynn (2009)	To investigate the acquisition of relative clauses in the L3.	L1- Kazakh L2- Russian L3- English	An elicited imitation task.	The most influential language in TLA is the L2.
Shooshtari (2009)	To investigate the Failed Feature Hypothesis (FFH) and the Full Transfer Full Access Hypothesis (FTFA).	L1- Persian L2- English and L1- Arabic L2- Persian L3- English	Translation	The biggest source of influence in TLA is from L2 and not L1.
Bayona (2009)	To investigate the acquisition of	L1- English L2- French	A grammaticality judgment task and a	Higher proficiency in the L2 facilitated the

	middles and impersonal passive constructions in the L3.	L3- Spanish	true value judgment task.	recognition of morphosyntactic and semantic features of the L3.
Perales, Mayo & Licerias (2009)	To investigate the acquisition of negation in the L3.	L1- Basque L2- Spanish L3- English	Telling stories from picture wordless books and a movie.	Learners tend to reproduce their L1s when using negation in English.
Chin (2009)	To investigate the acquisition of the preterit and imperfect marking in L3.	L1- Chinese L2- English L3- Spanish	A morphology test and an acceptability test.	The strongest source of influence comes from the L2.
Foote (2009)	To investigate whether there was transfer of the contrast in aspectual meaning between Romance past tenses from L1 and L2 to L3.	L1- English L2 and L3- Romance languages or L1 and L3- Romance languages L2- English	A morphology test and a sentence conjunction judgment task.	Typological proximity favors transfer to L3.
Jin (2009)	To investigate the acquisition of null objects in the L3.	L1- Chinese L2- English L3- Norwegian	A grammaticality judgment and sentence correction task.	There is a stronger influence of the L1 compared to the L2.
Ranong & Leung (2009)	To investigate the acquisition of null	L1- Thai L2- English	An offline written interpretation task	A privileged role of the L1 in L3 acquisition of



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	objects in the L3.	L3- Chinese	with sentences containing null or embedded null or overt objects	the property of null objects in Chinese.
Rothman & Amaro (2010)	To investigate syntactic transfer.	L1- English L2- Spanish L3- French and Italian	A grammaticality judgment/correction task and a context/sentences matching task.	The L2 status factor is a better predictor of source of influence in TLA.
Montrul, Dias & Santos (2011)	To investigate the acquisition of clitics and object expression in the L3.	L1- English L2- Spanish L3- English	Semi- spontaneous oral productions and a written acceptability judgment task.	Structural similarity and/or psychotypology played a role in TLA.
Rothman (2011)	To investigate the acquisition of adjectival interpretation in the L3.	L1- Italian L2- English L3- Spanish and L1- English L2- Spanish L3- Brazilian Portuguese	A semantic interpretation task and a context- based collocation task.	The strongest factor that determines multilingual syntactic transfer is typological proximity.
Falk & Bardel (2011)	To investigate syntactic transfer from L1/L2 in the acquisition of	L1- French L2- English L3- German	A grammaticality judgment test and a correction test.	The L2 has a stronger role than the L1 in TLA.

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	object pronouns in the L3.			
Souza & Oliveira (2011)	To investigate if there is activation of L2 semantics-syntax in L1 processing.	L1- Brazilian Portuguese L2- English	Self- paced moving window reading paradigm.	There is activation of a non-dominant L2 on-line sentence processing of the L1.
Souza (2012)	To investigate effects of the L2 on online parsing of sentences in the L1.	L1- Brazilian Portuguese L2- English and Brazilian Portuguese monolinguals; native speakers of English.	Self- paced moving window reading paradigm.	Knowledge of L2 may affect processing of sentences in the L1.
Toassi (2012)	To investigate the influence of the L1 and L2 in TLA.	L1- Brazilian Portuguese L2s- German, Spanish or Italian L3- English	Two narrative tasks, one oral and one written.	The greatest source of influence in the production of English as an L3 came from the L1.
Falk, Lindqvist & Bardel (2015)	To investigate the role of explicit metalinguistic knowledge in the acquisition of	L1- Swedish L2- English L3- Dutch	An oral production task with prompt cards.	High explicit metalinguistic knowledge in the L1 leads to a better accuracy in the L3.

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	adjective placement in the L3.			
Hartsuiker, Beerts, Loncke, Desmet & Bernolet (2016)	To investigate structural priming.	L1- Dutch L2- English L3- French	Cross-linguistic structural priming.	Priming within-languages did not differ from priming between languages, favoring the view of a shared syntax across languages.

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According to Table 4, it can be seen that the results of the studies, concerning the role of L1 and L2 in the acquisition or processing of the L3 differed. The results of the studies by Perales et al (2009), Jin (2009), Ranong and Leung (2009), Toassi (2012) and Falk, Lindqvist and Bardel (2015) favored a greater influence from the L1 to the L3, whereas the results of the studies by Ringbom (2001), Ecke (2001), Fouser (2001), Llana, Cardoso and Collins (2007), Flynn (2009), Shooshtari (2009), Bardel and Falk (2007), Chin (2009), Rothman and Amaro (2010), Falk and Bardel (2011), favored the role of the L2 as more influential in L3 production/acquisition. The results of the studies by Cenoz (2001), Carvalho and Silva (2006), Foote (2009), Montrul, Dias and Santos (2011), Rothman (2011) pointed to typology as the determinant factor in CLI. That means, it is not a matter of a privileged role of the native language or the L2, but to the language that shares more similarities with the target one. On the other hand, some studies (Hammarberg, 2001; Vinnitskaya, Flynn & Foley, 2002; Leung, 2005; Hartsuiker, Beerts, Loncke, Desmet & Bernolet, 2016) pointed to the cumulative influence of L1 and L2 in TLA while others found evidence of the influence from the L2 into the L1 (Souza & Oliveira, 2011; Souza, 2012).

These results show that much still has to be investigated regarding crosslinguistic influences and the mental lexicon. Moreover, there are many factors that may interfere with crosslinguistic influences, language acquisition/processing and production, such as the similarity among the languages, the proficiency level in each of the languages, recency – that is the frequency on which the speaker uses each of his/her languages - and order of acquisition - that is the sequence on which the languages were acquired. The similarity among the languages may be an important factor determining how one language will influence the acquisition and processing of the subsequent one. In addition, shared properties among languages is an important factor present in models of lexical access, such as the BIA+. Proficiency is also a key factor, since it is possible that a higher level of proficiency in one language may be correlated with a higher level of activation of this language. Consequently, there are more chances of this language interfering/influencing the acquisition and processing of another language, even when the former is not the target one. On the other hand, a lower level of proficiency in one of the multilinguals' languages may lead to greater chances of interference/ influence from another language into this one. That might occur due to the weaker links that the words of this language have between the lexical and conceptual levels and to a

greater dependency on another language to access concepts, according to the RHM. Recency is an important factor because the frequency of use of the language may increase its activation level and the greatest the activation of this language, the chances of crosslinguistic influences are greater too. At last, the factor of order of acquisition may also be considered, since learners might resort to their native language, the L1, when learning or producing a foreign language, what would give a privileged status to the L1 in matters of crosslinguistic influences. However, it is also possible that the learner/speaker will prefer (unconsciously) to resort to the last acquired language. Taking as example a learner of an L4, he might resort more frequently to his L3, since it was the last language acquired and the one whose metalinguistic knowledge is better developed.

The next section presents and discusses how the effect of semantic priming can help elucidating the questions raised in research on lexical access and on the multilingual mental lexicon.

## 2.8 SEMANTIC PRIMING

Priming effect is related to the facilitation caused in a given task, when previous access to a related word is realized. For instance, if words are stored in the mental lexicon according to their meaning, thus, a related prime presented before a given task (e.g.: lexical decision, picture naming), will pre activate that concept. Consequently, access to the target word will depend on a shorter path on the mental lexicon, resulting in a shorter reaction time.

Cross- language priming occurs when the two languages of the bilingual are present in the same task, one for the target word, and the other for the prime. This technique will be applied in the present study as a semantic priming task. Semantic priming refers to the facilitation of processing a word preceded by a related word comparatively to an unrelated word (Phillips, Segalowitz, O'Brien & Yamasaki, 2004). This facilitation is commonly measured by means of the reaction time in a lexical decision task, which consists of judging a string of letters as a word or a non- word (Phillips, Segalowitz, O'Brien & Yamasaki, 2004). Besides behavioral studies, that apply reaction time as a measure to evaluate priming effects, there are many studies that have applied neuroimaging techniques such as Event Related Potentials (ERPs), PET and fMRI. In ERP studies, the N400 component is analyzed as the dependent variable, since this component is sensitive to semantic

violations and difficulties in semantic integration (Federmeier & Kutas, 1999). The amplitude of the N400 component varies inversely to the amount of semantic activation that a word has in memory. In other words, the amplitude of the N400 component is diminished when a word is preceded by a semantically related context (Phillips, Segalowitz, O'Brien & Yamasaki, 2004).

Duñabeitia, Dimitropoulou, Uribe-Etxebarria, Laka and Carreiras (2010) explain the translation priming effect, that is when two L1/ L2 words that represent the same concept are presented to the participant and facilitate the reading of the second word that becomes faster. This translation priming paradigm is extensively used in studies of lexical and semantic memory. The researchers explain that the conscious presentation of a prime and a target may lead the participant to develop a series of strategies. For this reason, researchers have adopted a masked version of this paradigm, which is the masked priming translation. This masked paradigm is based in automatic and unconscious stages of word processing that are not affected by strategies. Researchers argue that a series of factors may influence the degree of facilitation in the recognition of a translation of non- cognate word in the other language, specially, the type of the task, the level of proficiency in the L2 and the direction of priming, i.e. forward: L1-L2 and backward: L2-L1.

Perea, Duñabeitia and Carreiras (2008) explain that in the masked priming paradigm, the prime is presented in lowercase for approximately 30 to 66 ms and, in the sequence, the prime is substituted by the target word, which is written in uppercase. According to the authors, the presentation of a prime under these conditions is not perceptible to the participant, who may not realize the existence of the prime. Based on these assumptions, the authors believe that it is unlikely that any trace of episodic memory is created. The authors claim that any priming effect of semantic association may reflect automatic processes and not strategic ones. Visible primes, on the other hand, are normally presented for approximately 200 ms.

Alvarez, Holcomb and Grainger (2003) conducted an ERP study while a semantic word detection task was performed. Their study was designed to compare repetition effects within the same language and between two different languages of a bilingual. The results of the study showed that the priming effect was faster in the backward order of presentation (L2-L1) than when the L2 word followed the equivalent translation in the L1.

Another study (Palmer, Van Hooff & Havelka, 2010) used ERPs to investigate lexico- semantic activation in a translation task with late

Spanish- English and English- Spanish bilinguals. The results of the study favored an asymmetric view of L1-L2 and L2-L1 translation, since the N400 effect was bigger for L2-L1 translation than to L1-L2 translation.

Sholl, Sankaranarayanan and Kroll (1995) investigated the relation between naming pictures and translation, using a transfer paradigm. For that, English- Spanish bilinguals were asked to name pictures and consequently translate words in their first and second languages. Some words from this translation task were repetitions from concepts previously presented as pictures. The results of the study showed that naming pictures produced transfer to the translation from L1 to L2, but not for the translation from L2 to L1. The results of the study favor the argument that the connections in the bilingual memory are asymmetric, and that the translation from L1 to L2 is conceptually mediated, whereas the translation from L2 to L1 is lexically mediated. The results also showed that conceptual access may produce transfer between languages. According to the authors, there is still an asymmetry in the effects of priming from L1 and L2. The evidence of the study is that only L1 facilitates naming in the L2.

The study by Kerkhofs, Dijkstra, Chwilla and De Bruijn (2006) investigated the processing of ambiguity between homographs from the bilingual's two languages in the recognition of words. In this study, highly proficient Dutch- English bilinguals performed a lexical decision task, where homographs in the participant's L2 were preceded by an item semantically related or unrelated. The results of the study showed that related primes elicited a smaller amplitude in the N400 component than unrelated primes, favoring a non- selective and parallel view of lexical access.

Duñabeitia, Dimitropoulou, Uribe-Etxebarria, Laka, and Carreiras (2010) applied ERPs to evaluate the effects of masked priming translation in simultaneous Spanish- Basque bilinguals with the same level of proficiency in the two languages. The results of the study showed symmetric effects of the N400 component in the two translation directions. The results suggest that, at this proficiency access to concepts occurs in a direct way to the bilingual's two languages.

The study by Phillips, Segalowitz, O'Brien and Yamasaki (2004) consisted of two experiments with ERPs and reaction time measures in a semantic categorization task, performed by participants who were native speakers of English and had French as an L2, at a variable proficiency level. The results showed a delay of 50 ms in the effect of the N400 component in the L2 for the highly proficient bilinguals, in comparison

to the L1 of these bilinguals. According to the authors, this result is consistent with the idea that L2 processing is slower than the L1, due to the necessity to access L2 words through the L1 lexicon.

Perea, Duñabeitia and Carreiras (2008) conducted a study with bilingual Basque- Spanish participants, who performed a lexical decision task. The results of the study showed that simultaneous bilinguals of Basque and Spanish demonstrated priming effects of automatic and early semantic association for pairs of non- cognate words in a lexical decision task. These results are true within and across the bilingual's two languages. The same effect was obtained for late bilinguals who were highly proficient.

From the stated above, it can be seen that cross- language priming is a technique which offers great possibilities for research related to bilingual lexical access or representation. However, some methodological considerations need to be made when applying this technique. Dijkstra, Hilberink- Schulpen and van Heuven (2010) state that there are two important variables that need to be taken into account when investigating orthographic priming. The first one refers to whether the prime is a word or a non- word. If the prime is a word, its frequency has to be considered. Moreover, the relatedness of the prime also need to be taken into account, that is the presence or absence of orthographic overlap between prime and target. An additional factor that has to be considered is the resting level activation, which refers to the recency of use of this item, this is proportional to the frequency of use of the word.

This chapter laid the ground for the presentation of the experiments developed in the present study. First, concepts related to the mental lexicon and the dichotomies of lexical storage and access were presented and discussed. Next, models of lexical access focusing on bilinguals and multilinguals were presented. After that, this chapter covered studies that dealt with eye movements, crosslinguistic influences and semantic priming in order to investigate lexical access and/or the mental lexicon. Thus, the next chapter of this dissertation will present and justify the method developed and applied in the present study in order to investigate lexical access of trilingual speakers of Brazilian Portuguese, German and English.



### CHAPTER III METHOD

Aiming at investigating lexical access of multilinguals, three experiments were prepared for the present study. These experiments were designed with the main goal of investigating the influence of the non- target languages (Brazilian Portuguese and German) in the lexical access of English as a second and third language, aiming both at comprehension and production. In order to fulfill this objective, three groups of participants took part in the present study. The experimental groups consisted of speakers of English as a second language, with Brazilian Portuguese (Brazilian Portuguese) as the L1, and speakers of English as a third language, with Brazilian Portuguese as the L1 and German as the L2. The control group was formed by native speakers of English. Participants took part in an experimental session, which consisted of filling in a biographical questionnaire and performing three tasks. The first task consisted of the presentation of English sentences, aiming at comprehension, while eye movements were registered. The second task consisted of the production of an oral narrative based on four pictures containing cognates in the participants' three languages. The third task consisted of the presentation of 72 pictures preceded by a masked prime in English, German or Brazilian Portuguese. These pictures had to be named as fast and accurately as possible. By the end of the session, participants also responded to a vocabulary test in English and German.

The present chapter presents and justifies the method of the present study. The criteria for selection of participants, preparation of the stimuli and procedures for data collection are presented in detail. More specifically, this chapter is organized as follows: section 3.1 presents the research design of the present study. After that, section 3.2 presents the objective, research questions and hypotheses proposed. Next, section 3.3 describes the criteria for selection of the participants and provides general information regarding participants' profile in each of the three groups. Section 3.4 consists of the description of the biographical questionnaire administered to participants prior to data collection. Section 3.5 describes the two vocabulary tests chosen as a measure of language knowledge of English and German. Sections 3.6, 3.7, and 3.8 present the most robust part of this chapter, which contains the description of the experiments of the present study. Each experiment is described in detail, containing the procedures for stimuli selection, data collection, and data analysis. Section 3.6 consists of the eye-

tracking experiment. Section 3.7 presents the narrative production experiment. Section 3.8 presents the cross-language priming experiment. Finally, section 3.9 presents the conclusions of the pilot study carried out in order to test the tasks developed for the present study. The following section provides an overview of the general research design of the present study.

### 3.1 DESIGN OF THE STUDY

The present section has the main goal of providing an overview of the research design of the present study as well as to illustrate how the experimental session worked. This information is summarized in this section in order to help the reader to understand the dynamics of the present study.

The design of the present study was the following. First, two experimental groups were necessary to perform the tasks of the present study: one group of trilingual speakers of Brazilian Portuguese (BP), German, and English and one group of bilingual speakers of Brazilian Portuguese and English. In addition, a control group formed by native speakers of English also took part in the present study. The tasks of this study were applied in English as the target language for the three groups of participants. In order to avoid the induced activation of participants' two/ three languages during the performance of the tasks, participants performed first those tasks that involved only one language – English. The cross-language priming task was the last one performed by participants.

The first task performed by participants was a sentence-processing task with cognates in the participants' three languages. In this task, eye movements were registered while participants performed the reading task, focusing on comprehension. In this task, I examined whether the processing of sentences in English was faster when cognates in Brazilian Portuguese and English, and English and German were presented in the sentence. Additionally, I could evaluate whether triple cognates (cognates among German, Brazilian Portuguese and English) would lead to faster processing of English sentences than double cognates (cognates between German and English and Brazilian Portuguese and English) would. The bilingual group as well as the control group performed the same task as the trilingual group, as a means of comparing the results. This task is described in detail in subsection 3.6.1.

After that, participants were required to tell a story based on a series of pictures adapted from the wordless book *Frog, where are you?* (MAYER, 1969). The pictures adapted from this book contained images that represented cognates in the participants' three languages. The story narrated by participants had its audio recorded, transcribed and analyzed. Participants' oral production was examined with focus on the lexical influence of the non- target languages – Brazilian Portuguese and German – in the production of the task, aiming mainly at the production of the cognates represented in the pictures. Based on the analysis of this task, I could make inferences about the activation of the other languages (German and Brazilian Portuguese). This task is better described in subsection 3.6.2. Finally, participants were asked to perform a picture-naming task in English. This task contained masked primes in the participants' three languages. In this task, I analyzed facilitation by means of the response time provided by participants. It is assumed that the faster the response, the greatest the connection between prime and target word. This task is described in subsection 3.6.3 of the present chapter.

Before the experiment, participants signed a consent form (Appendix A) to agree on participating in the study. Participants also answered to a biographical questionnaire (Appendix B). At the end of the experimental session, participants had their vocabulary knowledge evaluated both in English and German, by performing the following tests: the Vocabulary Levels Test (PVLТ), for English and the test of the Institute for Test Research and Test Development (ITT) for German (further details in section 3.5). During the experiments, participants had enough time to perform training sessions. Participants also had doubts clarified before the experiment. Participants were all volunteers and were not be paid for their participation. The research project of this dissertation was approved by the CEPESH at UFSC. The present study was conducted in the following steps:

1<sup>st</sup>. Participants signed the consent form and filled in the biographical questionnaire.

2<sup>nd</sup>. Participants had a training session on how to perform Experiment 1- Eye-tracking task.

3<sup>rd</sup>. Participants performed Experiment 1- Eye-tracking task.

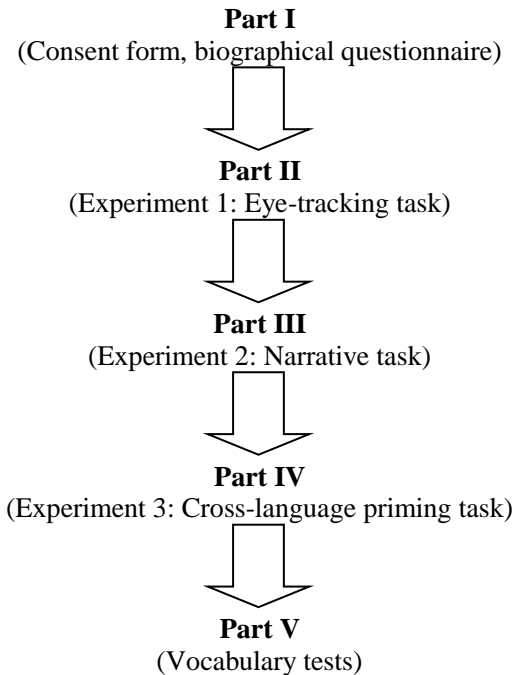
4<sup>th</sup>. Participants produced the oral narrative.

5<sup>th</sup>. Participants had a training session on how to perform – Experiment 2 – Cross-language priming task.

6<sup>th</sup>. Participants performed Experiment 2- Cross-language priming task.

7<sup>th</sup>. Participants performed the vocabulary tests PVLТ, for English, and the test of the ITT, for German.

Figure 8 illustrates the order of the experimental session:



**Figure 8.** The five steps of the experimental session.

As illustrated in Figure 8, after the selection of the participants, they were required to read and sign a consent form, which had information about the present study. After that, participants performed the eye-tracking task. Participants had the opportunity to perform a training session in order to understand the dynamics of the task. Having performed the eye-tracking task, participants were required to produce an oral narrative, based on a series of pictures. In the sequence, participants were presented to a cross-language priming task, where they had time to perform a training session in order to understand the dynamics of the task. Having finished all the experiments, participants performed a vocabulary test for the two foreign languages, English and German. The results of the tests were provided to the participants

immediately. This way, participants received an evaluation of their vocabulary knowledge in the foreign language(s).

Having presented a general idea about the design of the present study, I proceed now to the presentation of the objective and research questions that motivated the present study.

### 3.2 OBJECTIVE, RESEARCH QUESTIONS AND HYPOTHESES

The main goal of the present study was to investigate lexical access in the comprehension and production of English as a second and third language, comparing lexical access processes of trilingual speakers of Brazilian Portuguese (BP), German, and English, to that of bilingual speakers of Brazilian Portuguese and English. The specific objectives of the present study were (1) to investigate which cognates are more facilitative in the comprehension of English as a target language, double cognates (between English and German and English and Brazilian Portuguese) or triple cognates (among English, German and Brazilian Portuguese), (2) to investigate how lexical access is influenced by cognates among German, English and Brazilian Portuguese in the oral production of English, (3) to investigate if there is a difference in the semantic priming effect when presented in the native (Brazilian Portuguese), non- native (German) or target language (English) for bilingual and trilingual speakers,

As already stated in the review of literature of the present study, studies on lexical access normally aim either at comprehension or production and their results do not always converge to the same conclusions. The present study seeks to fill this gap in the literature, by comparing lexical access of bilinguals and multilinguals, also by analyzing processes of comprehension and production. In order to achieve these objectives, the following research questions were proposed:

1. Which cognates are more facilitative in the comprehension of English as a target language: double cognates (between English and German and English and Brazilian Portuguese) or triple cognates (among English, German and Brazilian Portuguese)?
2. How is lexical access influenced by cognates among German, English and Brazilian Portuguese in the oral production of English?
3. Is there a difference in the semantic priming effect when presented in the native (Brazilian Portuguese), non-native (German) or target language (English) for bilingual and trilingual speakers?

Based on the studies presented in the literature (Alloppenna, Magnuson & Tanenhaus, 1998; Alvarez, Holcomb & Grainger, 2003; Chambers & Cooke, 2009; Dijkstra, Van Heuven, 2002; Duñabeitia, Dimitropoulou, Uribe-Etxebarria, Laka & Carreiras., 2010; Kerkhofs, Dijkstra, Chwilla & De Bruijn, 2006; Lemhöfer, Dijkstra & Michel, 2004; Liben & Titone, 2009; Marian, Spivey & Hirsch, 2003; Palmer, Van Hooff & Havelka, 2010; Perea, Duñabeitia & Carreiras, 2008; Phillips, Segalowitz, O'Brien & Yamasaki, 2004; Sholl, Sankaranarayanan & Kroll, 1995; Titone, Libben, Mercier, Whitford & Pivneva, 2011; Van Assche, Duyck & Brysbaert, 2013), the following hypotheses were proposed:

1A. Double cognates between English and Brazilian Portuguese and English and German will have the same facilitative effect in the comprehension of English.

1B. Triple cognates shall be more facilitative than double cognates.

The hypotheses 1A and 1B are based on evidence from the literature that cognates have a facilitative effect in all languages of a bilingual/ trilingual.

2. Cognates will be more frequently produced than non-cognate words.

Hypothesis 2 is based on the evidence from the literature in favor of the cognate facilitation effect.

3. Primes in the target language (English) will be more facilitative in picture naming than primes in the non-native language (German), which will be more facilitative than primes in the native language (Brazilian Portuguese).

This hypothesis is based on results of studies of semantic priming with bilinguals, which point to a greater effect of priming from L2 to L1.

The next section presents the participants that were required to perform the three experiments of the present study.

### 3.3 PARTICIPANTS

As already stated, the main goal of the present study was to compare lexical access processes of speakers of English as an L2 and L3. Consequently, two experimental groups were required to perform the tasks of the present study: one group of bilinguals, with Brazilian Portuguese as the L1 and English as the L2, and one group of trilinguals,

with Brazilian Portuguese as the L1, German as the L2 and English as the L3. In order to establish a baseline to the analysis of the data collected through the three tasks, a control group was also required. Since the focus of the tasks of the present study is placed on English, the control group was formed by native speakers of English. Having explained the reasons for choosing the specific three groups of participants, I proceed now to the description of the selection of the participants.

In order to invite volunteers to take part in the present study, posters were spread in the buildings of the university. The invitation was also propagated through the institutional email of the Departamento de Letras e Literatura Estrangeira (DLLE) of the University. Participants of this study were all volunteers, adults, with normal or corrected to normal vision and fitted in one of the following three groups:

(A) Trilingual speakers of Brazilian Portuguese, English and German: L3 Group (L3G);

(B) Bilingual speakers of Brazilian Portuguese and English: L2 Group (L2G);

(C) Native speakers of English: L1 Group (L1G).

The experimental groups of the present study were the L2 and L3 groups, whereas the control group was the L1G. Given the importance of differentiating bilinguals and multilinguals, and bearing in mind the hypothesis of the shared representation of the multiple languages in the mental lexicon, an utmost care was taken with the criterion to admit volunteers for the present study regarding their language knowledge.

An important factor for the participants of the L2 and L3 groups described above is that they could not have knowledge of other languages, besides the one requested for this study, otherwise, participants' more diverse linguistic knowledge could interfere in the results of the present study. This criterion – number of languages spoken - was necessary to be controlled for. However it caused a serious difficulty, restricting the availability of participants for the present study.

In order to take part in the present study, participants from the L3G needed to be native speakers of Brazilian Portuguese as the native language, and speakers of both German and English as foreign languages, independent on the order of acquisition of these two foreign languages. The criteria adopted in the present study to classify L2 and L3 was proficiency and not order of acquisition. In addition, participants of the L3G could not speak another foreign language, besides the two languages required for the present study. For the L2G, the criteria for

selecting participants was that they should have Brazilian Portuguese as the native language, should speak English as a foreign language, and could not speak another foreign language, besides English. For the L1G, the selection criteria was that participants should speak English as a native language.

The profile of the participants who agreed to take part in the present study and fulfilled the established criteria was the following: students from language courses, exchange students, graduation or post-graduation courses, professors and people from the staff of the university.

In total, 56 participants took part in the present study. However, due to technical problems during data collection, some data had to be disregarded<sup>2</sup>. Thus, for the eye-tracking experiment, the final sample of participants was 35: 13 participants for the L3 group, 11 for the L1G, and 11 for the L2G. For the narrative production experiment, the final sample of participants was 28: 11 participants for the L2G, and 17 for the L3G. The native speakers of English were not required to perform this task since it was not a task that demanded a baseline to compare reading/ reaction time. For the cross-language priming experiment, the final sample of participants was 41: 16 participants for the L3G, 12 for the L2G, and 13 for the L1G. The next subsections (3.2.1 – 3.2.3) describe the general profile of the participants of each of the three groups.

### **3.3.1 The L3 English speakers**

This subsection presents the general information regarding the participants of the L3 group, which was formed by 17 participants. The specific information about these participants regarding sex, age, city of birth, parents' nationality and profession is displayed in Table 5 in order to facilitate the analysis of this data.

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<sup>2</sup> Some problems that may cause difficulty in collecting precise eye-tracking data are related to the participants' vision. For instance, participants with high levels of astigmatism or that use reading glasses have problems to perform the calibration procedure. Apart from that, if there is any interruption of the eye-tracking experiment due to computer or electrical problems, the data may also need to be disregarded.



Table 5  
*General information about the L3 group*

<b>Number of participants</b>	17	
<b>Sex</b>	12 male	5 female
<b>Age</b>	Average: 26 (18-59)	
<b>City of birth</b>	Blumenau – SC (29,4%), São José – SC (11,8%) Chapecó – SC (5,9%) Florianópolis – SC (5,9%) Indaial – SC (5,9%) Itajaí – SC (5,9%) Jaraguá do Sul – SC (5,9%) Joinville – SC (5,9%) Passo Fundo – RS (5,9%) Ribeirão Preto – SP (5,9%) São Paulo – SP (5,9%) Volta Redonda – RJ (5,9%)	
<b>Parents' nationality:</b>	Brazilians (91,2%)	Uruguayan (2,9%); German (5,9%).
<b>Profession</b>	Graduate student (58,8%) German teacher (11,8%) Computer technician (5,9%) History teacher (5,9%) Fireman (5,9%) Military (5,9%)	

As can be seen in Table 5, there were more male participants than female ones in the L3G (12 and 5, respectively). According to mean age of the group (26), it can be concluded that participants of this group were young adults. All of them were Brazilians; most of them were born in the state of Santa Catarina. The great majority of their parents were also Brazilians. Regarding their profession, it can be observed that most of them were graduate students. The next subsection presents the information regarding the profile of the L2 group.

### 3.3.2 The L2 English speakers

This subsection presents information regarding the participants of the L2 group, which consisted of 16 participants. These participants'

profile is presented in Table 6, where can be found information regarding sex, age, city of birth, parents' nationality and profession.

Table 6  
*General information about the L2 group*

<b>Number of participants</b>	16	
<b>Sex</b>	10 male	6 female
<b>Age</b>	Average: 22 (17-35)	
<b>City of birth</b>	Florianópolis –SC (12,5%) São Paulo –SP (12,5%) Concórdia – SC (6,25%) Guabiruba –SC (6,25%) Nova Erechim – SC (6,25%) Rio Fortuna –SC (6,25%) São João Batista – SC (6,25%) São José –SC (6,25%) São Lourenço do Oeste – SC (6,25%) Tijucas – SC (6,25%) Videira – SC (6,25%) Campo Bom – RS (6,25%) Santo Ângelo –RS (6,25%) Santarém – PA (6,25%)	
<b>Parents' nationality:</b>	Brazilians (100%)	
<b>Profession</b>	Graduate student (68,8%) English teacher (18,8%) Psychology teacher (6,3%) Pharmacy attendant (6,3%)	

As can be seen in Table 6, as in the L3 group, there were more male than female participants (10 and 6) in the L2 group. The mean age of these participants was 22, a little bit lower than the L3 group (26). The two experimental groups might be considered homogeneous as concerns age. All participants from the L2G were Brazilians, and had Brazilian parents. Most of them were born in the state of Santa Catarina and the majority of them were university students. Therefore, it can be concluded that the profile of the participants of the L2G and L3G is very similar. In the next subsection, the information regarding the control group is presented.

### 3.3.3 The control group: native speakers of English

This subsection presents information regarding the participants of the L1 group, which consisted of 20 participants. The specific information about these participants regarding sex, age, city of birth, parents' nationality and profession is displayed in Table 7.

Table 7

*General information about the L1 group*

<b>Number of participants</b>	20	
<b>Sex</b>	12 male	8 female
<b>Age</b>	Average: 21 (19-27)	
<b>Nationality</b>	American (90%) British (5%) New Zealander (5%)	
<b>Parents' nationality:</b>	American (85%) British (2,5%) Canadian (2,5%) New Zealander (2,5%) Brazilian (2,5%) Dominican (2,5%) Puerto Rican (2,5%)	
<b>Profession</b>	Graduate student (100%)	

As can be seen in Table 7, as in the L3 and L2 groups, there were more male than female participants in the L1 group (12 and 8, respectively). Their mean age was 21. This shows that the three groups of participants were homogeneous as concerning their mean age (21, 22, and 26). The great majority of the participants from the L1G were Americans and had American . In addition, all of them were graduate students. It can be concluded that the three groups of participants were quite homogeneous considering age and occupation.

The information presented in the previous sections was available through a biographical questionnaire, which also included questions regarding participants' background language knowledge. More specific information about this questionnaire is provided in the next section.

### 3.4 BIOGRAPHICAL QUESTIONNAIRE

Before applying the three tasks of the present study, a biographical questionnaire (Toassi, 2012) was administered, in which participants provided general information about their profile together with their background language knowledge (see Appendix B for the questionnaire). General information regarding participants' profile was described in the previous section. This information helped to identify whether the three groups were somehow homogeneous regarding age, sex, nationality and occupation.

The questionnaire also aimed at gathering information regarding individual variables related to foreign language acquisition, which might be helpful to explain the results of the present study. Some variables that may affect foreign language acquisition, which were investigated by means of this questionnaire were related to age of acquisition, to the acquisitional aspect – formal, by means of instruction, or informal, to the number of years of study of the language, to the purpose of learning, to the identification with the language/ culture of the country where the language is spoken, to contact with native speakers of the language and/or with the country where the language is officially spoken and to the frequency of use of the language. In addition, self- estimation questions related to participants' proficiency were added to this questionnaire.

The questionnaire was divided in three sections. In the first section, participants were asked to provide general information. It contained questions about the day and time of data collection, participants' name, date of birth, age, sex, nationality, place of birth, parents' nationality, level of schooling, area of study (when graduated), occupation and information for contact. Participants were also required to report their language experience/ competence, by answering questions about how many languages they could speak and which they were. To this section, some questions were included due to the eye tracking study. These questions were kindly sent by Arlene Koglin, from the LETRA<sup>3</sup> laboratory. These questions concerned the participants' handedness, the participants' approximate eye color. There were also questions concerning eye surgery, use of glasses/ corrective lenses. These questions had to be included in the questionnaire because they are

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<sup>3</sup> Letra (Laboratório Experimental da Tradução) from the Federal University of Minas Gerais (UFMG) (<http://letra.letas.ufmg.br/letra/index.xml>).

related to variables, which may interfere with data collection with the eye tracker. For instance, the infrared camera of the eye tracker may have problems to distinguish the iris from the pupil of dark eyes. High levels of astigmatism may also impede data collection with the eye tracker.

However, the main goal of the questionnaire was to obtain information regarding participants' language experience. For that, the second and third sections of the questionnaire were related to the learning of German and English, respectively. In these sections participants answered questions concerning the way of acquisition of both English and German, the frequency and intent of use of these languages. Other questions were related to the time of acquisition of the languages, the ways of instruction and to any experience in English or German speaking countries.

More specifically, in the second section of the questionnaire, participants were asked about the age they started learning German, the context of learning, whether they had been to a German speaking country, whether they had studied German in a language school, if they were still learning German. There were questions regarding the frequency and the purpose of use of the language and whether they had contact with native speakers of German. The last question was a self-evaluation question regarding their proficiency level in German.

The third part of the questionnaire contained questions regarding the learning of English. These questions were very similar to the ones of section 2, however, they were about learning and use of English and not German.

Trilinguals answered the three sections of the questionnaire. On the other hand, participants of the control group (native speakers of English) answered only section 1, whereas participants of the L2 group (speakers of Brazilian Portuguese as the L1 and English as the L2) answered sections 1 and 3.

Even though number of years of study of the foreign language and a self-estimation question have been used as an indication of language proficiency (Bayona, 2009), it was decided to include another instrument to evaluate participants' foreign language knowledge, which were two vocabulary tests, one in German and another in English. The next section describes these tests and justifies this choice.

### 3.5 VOCABULARY TESTS

Proficiency is a key factor when analyzing crosslinguistic influences (Cenoz, 2001; Ringbom, 2001) and the mental lexicon. One of the first models developed to explain lexical access (Weinreich, 1953, as cited in Marini and Fabbro, 2007) had proficiency determining the organization of the bilingual mental lexicon. In that model, bilinguals were classified into coordinate, compound and subordinate, depending on their dependence on the L1 in order to access the L2 lexicon. Following this line of thought, a very prominent model of lexical access in the literature, the RHM (Kroll & Stewart, 1994) also takes proficiency as a key factor in determining the organization of the mental lexicon (further details about these models on section 2.5.1). Therefore, proficiency could not be ignored in the present study. However, taking in consideration the length of the experimental session (approximately 2h), it was not viable to require participants to perform a proficiency test in each of the languages (German and English), since proficiency tests take on average 2h. As already mentioned, proficiency self-estimation alone is also not a precise indication of the participants' proficiency.

Baring these arguments in mind, it was necessary to have an instrument to evaluate the participants' level of proficiency in the languages involved in the present study in order to guarantee that the sample of participants who took part in the present study was somewhat homogeneous. Since it was not possible to apply a proficiency test in each of the participants' foreign language, a vocabulary test was adopted. Thus, all of the participants performed the vocabulary tests after the experimental session and it was possible to obtain a precise measure of the participants' vocabulary knowledge. Vocabulary was chosen because the focus of the present study is lexical access. Since it was not possible to evaluate participant's level in each of the four abilities in the foreign languages, it was decided to focus on the language aspect most relevant to the present study, which is the lexicon. Since Brazilian Portuguese, was the native language of the participants of the two experimental groups, it was not necessary to test participants' level.

Knowledge of English vocabulary was tested by means of the Vocabulary Levels Test (PVLТ) (Laufer & Nation, 1999) in its productive version. The test is available on line (<http://www.lexтutor.ca/tests/levels/productive/>). The PVLТ sees

vocabulary of English based on frequency of occurrence. The levels of the test consist of the 1000 most frequent words in English, the next most frequent 1000 words and so on. This test was validated by Laufer and Nation (1999) and has already been used in several studies in the area of second language acquisition (Souza, 2012; Souza & Oliveira, 2014; Oliveira, 2014; Vieira, 2015). There are three versions of the test available at the site. Versions A and B are equivalent and version C is one which combines items from A and B that are not cognate words with French.

The rationale for this test is to present participants with a task containing the most frequent words of English at the first level and then, at each level, to decrease the frequency of the words being presented. Thus, the last level contains the least frequent words in the language.

In the present study, participants performed the A version of the test. Even though it is an on line test, all of the participants reported never having performed this test before. Version A of the test is divided into 5 levels. The first level refers to the 2000 level, the second is the 3000, next the 5000, then there is the University Word List level and finally the 10000 level.

The design of the test is a cloze format. Each level of the test contains 18 cloze items. In other words, there are 18 sentences in each of the levels of the test, where one word is incomplete. Sometimes only the first letter of the word was written, others the first two or three letters or even more.

Example:

I'm glad we had this opp\_\_\_\_\_ to talk. (*opportunity*)

For the present study, participants were given 10 minutes to complete each of the levels. However, all of the participants were not able to go beyond the second level (3000), since they did not reach the minimum score to go on. According to the instructions of the test, it is necessary to have a score over 83% in order to proceed to the next level of the test.

Knowledge of German was evaluated according to the test of the *Institut für Testforschung und Testentwicklung* (Institute for Test Research and Test Development). This test was developed by the Language Centre of the University of Leipzig. The test was based on Nation's PVLTL for English. The test was a kind suggestion of Professor Peter Ecke. It was a great accomplishment to be able to apply two vocabulary tests developed on the same rational. This gives more validity to the comparison of the test results.

The German test was developed on the basis of the frequency list of the Herder/BYU-corpus (<http://corpus.byu.edu/corpora.asp>). In order to keep the same line of evaluation, the productive version of this test was chosen. As can be seen in the following example, the German vocabulary test also consisted of cloze items:

*In der Klasse gibt es zehn Jungen und zwölf Mä\_\_\_\_\_.*  
(Mädchen)

(In the classroom, there are ten boys and twelve girls)

Even though the two tests have the same structure, there are some differences between them. The first difference is that in the German test there is a timer of 25 minutes going on since the start of the test. Another difference is that in the German test it is possible to complete the 5 levels of the test before knowing the score of each level. In addition, the levels start with the 1000 most frequent words for the Level 1, whereas the PVLТ starts with the 2000 for the Level 1, for the German test level 2 consists of the 2000 most frequent words, Level 3 the 3000 most frequent words, Level 4 the 4000 most frequent words and, finally, Level 5 the 5000 most frequent words. Another difference is that, in the German test, it is necessary to score 90% or more in order to go on to the next level.

According to the German test, if the participant successfully completes levels 1000 and 2000, he/she can be considered at an A2 level of reading proficiency in the CEFR. Successful completion of level 3000 would be equivalent to level B1, whereas completion of the five levels would indicate B2 level. (<http://www.itt-leipzig.de/static/informationeneng.html>)

### **3.5.1 Analysis of the vocabulary tests**

In order to compare the results of the vocabulary tests in English and German, the results of the study were computed as the following. In each of the five levels of the tests, there were 18 items. The number of correct items in each of these levels was summed in order to have a similar result. For instance: if the participant made 16 correct items correct in Level 1 of the test and 8 correct items in Level 2, his/her final grade was 24. The maximum grade that a participant could reach was 90 (18 items in the five levels).

Having presented the the biographical questionnaire and the vocabulary tests, the next sections of this chapter focus on the heart of



this research: the three experiments applied to investigate lexical access in the production and comprehension of English. The experiments are presented in the same order that they were conducted in the experimental session. Section 3.6 presents the eye-tracking experiment. Section 3.7 presents the narrative production experiment, and section 3.8 presents the cross-language priming experiment.

### 3.6 EYE-TRACKING EXPERIMENT

In this experiment, eye movements were registered (SMI 250 Hz) while participants performed a sentence comprehension task. The task was designed with the main goal of investigating how cognates among the participants' three languages (Brazilian Portuguese, German and English) influenced the reading of sentences in English. Szubko-Sitarek (2015) states that previous studies on cognates focused on word recognition of isolated words. The results of these studies favored the view that lexical representations for the cognates are activated in the bilinguals' two languages. Nevertheless, more recent studies have focused on reading of cognates in sentential context, instead of isolated words. This increases the complexity of the methodological design of the studies, since other variables have to be considered, such as language cue and semantic constraint. In whole sentences, the reader already knows the language that the cognate word belongs to in that context – this is the language cue. The semantic constraint refers to how much information is given prior to the target word that may induce the reader to predict the upcoming word.

Bearing this information in mind, investigating lexical access in sentence context requires a strict preparation of the stimuli material. In addition, the present experiment was carried out with the eye tracker, which is a very informative instrument to investigate lexical access; however, it also demands a series of procedures to assure the validity of the data. These procedures are described in detail in the next subsection.

#### 3.6.1 Stimuli preparation for the eye-tracking experiment

The stimuli preparation for the eye-tracking task proceeded as follows. First, a list of cognates was prepared. Since no studies with cognates between Brazilian Portuguese and English were found in the literature, the selection of cognates was first based on a study by Schwartz and Kroll (2006), which focused on cognates between Spanish

and English. Anna Schwartz kindly sent her stimuli material to help in the present study. Nevertheless, Schwartz and Kroll's stimuli were completely reformulated to be used in the present study. Since the present study dealt with cognates between English and Brazilian Portuguese (CGEP), English and German (CGEG), and cognates among the three languages (CGT), there was a particular difficulty in preparing this list of cognates, since CGEP could not be cognates with German, as well as CGEG could not be cognates with Brazilian Portuguese.

After this initial process of selection of the cognate words, it was necessary to establish criteria to verify whether the words selected could be classified as cognates. Since the stimuli was prepared for a sentence comprehension task, two features were chosen to be controlled for: semantics and orthography. Even though, the phonological aspect of the cognate word is very relevant for studies of lexical access, it was not possible to control for all of these features. In addition, phonology would be more essential to be controlled for if the task had focus on production rather than on comprehension.

In relation to the semantical aspect of the cognate words, it was verified whether the cognate pairs English- Portuguese (EN-PT) and English- German (EN-GR) had semantic overlap. First, this was verified in on line dictionaries (<http://pt.bab.la/dicionario/>; <http://michaelis.uol.com.br>; <http://www.pauker.at>; <https://translate.google.com.br>). After that, the cognate pairs were submitted to an evaluation of two highly proficient L2 speakers of German.

Regarding the other feature, orthography, the orthographic similarity (OS) between cognate pairs was calculated on the basis of Van Orden (1987, p. 196) scale, who defines OS as the ratio between graphemic similarity (GS) of word 1 and word 2 and GS between word one with itself. Graphemic similarity is calculated as follows:

$$GS = 10 \left( \frac{50F + 30V + 10C}{A} \right) + 5T + 27B + 18E$$

Where:

F= number of pairs of adjacent letters in the same order, shared by word pairs;

V= number of pairs of adjacent letters in reverse order, shared by word pairs;

C= number of single letters shared by word pairs;

A= average number of letters in the two words;

T= ratio of number of letters in the shorter word to the number in the longer word;

B= 1 if the first letter in the two words is the same; otherwise, B = 0;

E= 1, if the last letter in the two words is the same, otherwise, E = 0.

First of all, graphemic similarity (GS) had to be calculated for the word and itself. For instance, for the target word *inspector*, it was calculated the GS between *inspector/ inspector*. The following result was given:

A = 9

B = 1

C = 9

E = 1

F = 8

T = 1

V = 0

Similarity = 1044.44

For the pair *inspector* (EN)/*inspetor* (PT), it was necessary to calculate the GS between these two. The following result was given:

A = 8.5

B = 1

C = 8

E = 1

F = 6

T = 0.888888888889

V = 0

Similarity = 941.50

In order to obtain OS for this pair of cognates, it was necessary to calculate the ratio between graphemic similarity (GS) of word 1 and word 2 (*inspector/inspetor*) and GS between word one with itself (*inspector/inspector*), as follows:

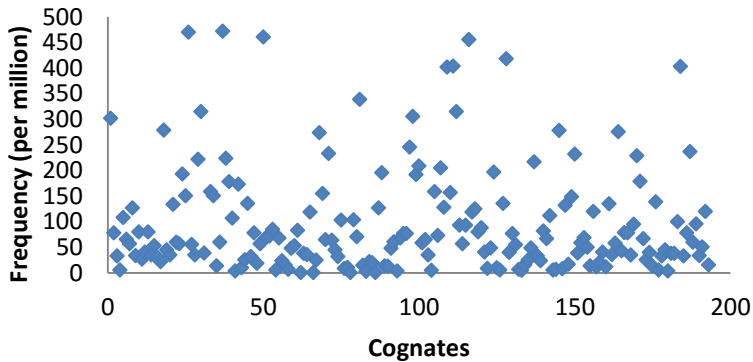
OS (*inspector/inspetor*) = (GS *inspector/inspetor*) / (GS *inspector/inspector*)

OS (*inspector/inspetor*) = 941.50 / 1044,44

OS (*inspector/inspetor*) = 0,90

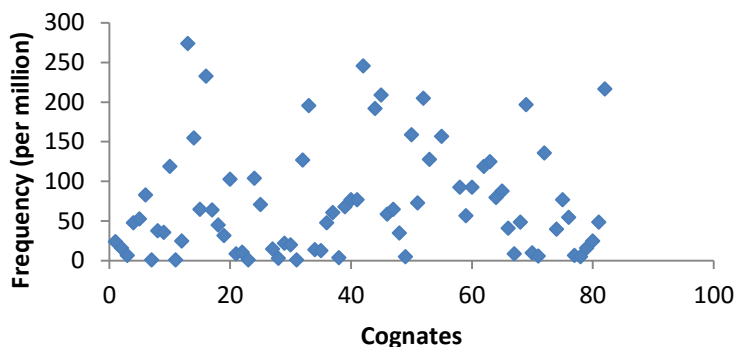
As demonstrated, the orthographic similarity between the word *inspector*, from English and the word *inspetor*, from Brazilian Portuguese is very high, which was confirmed by the value of 0,90 obtained. This formula was applied for all cognate pairs of the present study. Only the cognate pairs which had and OS superior to 0,5 were considered in the present study.

After this initial process, a list of 194 cognate words was formed. However, this list still needed to be refined: the cognate words had to fulfill another criterion. Since frequency is a very important factor that can influence word fixation, it was necessary to refine the list of cognate words in order to establish a range of frequency for the cognates that would be part of the experimental sentences. Considering the difficulty in searching for the cognate words, the strategy chosen for this selection process was to analyze the range of frequency where it was possible to find the greatest number of words, as shown in Figure 9.



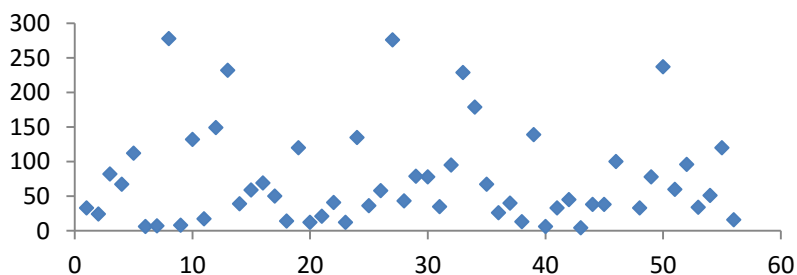
**Figure 9. Frequency range of the 194 cognates (CGEG; CGEP and CGT).**

As can be seen in Figure 9, most of the cognates were in the frequency range between 0 and 150 per million. Figure 10 shows the frequency range of the cognates separated by the condition they belonged to.



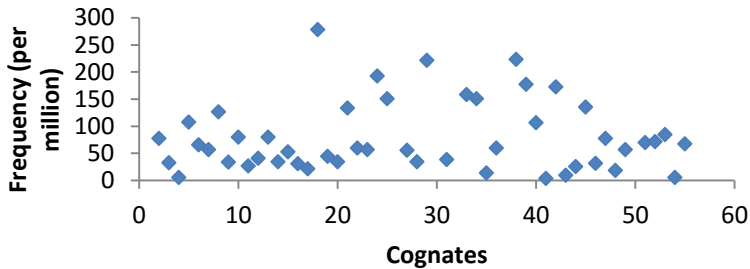
**Figure 10. Frequency range of the triple cognates** (English- German- Brazilian Portuguese).

According to Figure 10, it can be seen that the frequency range of the triple cognates is very well distributed between 0 and 250, however, there is a small concentration of cognates in the range of frequency between 0 – 100 per million. Figure 11 shows the frequency range of the double cognates between English and Brazilian Portuguese.



**Figure 11. Frequency range of the double cognates** (English- Brazilian Portuguese).

Figure 11 shows that the greatest amount of cognates between English and Brazilian Portuguese have their frequency ranging between 0 and 50 and, at second place, between 50 and 100 per million. Figure 12 shows the frequency range of the double cognates between German and English.



**Figure 12. Frequency range of double cognates (English- German).**

As can be seen in Figure 12, the greatest number of cognates English- German have their frequency ranging between 0 – 100 per million. The analysis of Figures 9 to 12 showed that there was a greater number of cognates with frequency ranging from 11 to 150 per million. For this reason, the cognates selected for the experimental sentences of this study were the ones within this range. For the purpose of the present study, it was considered that the range of frequency from 11- 50 would be classified as medium frequency, whereas the range from 51- 150 would be high frequency. Therefore, the 20 cognates selected for the experimental sentences of the present study were counterbalanced between medium and high frequency. In other words, for each type of cognate (CGEG, CGEP, and CGT), there were 10 cognates whose frequency ranged between 11- 50, and 10 whose frequency ranged from 51 to 150.

After having selected cognate words that matched their translation in both orthographic similarity and semantic overlap, it was necessary to find non-cognate words, with the same number of characters, grammatical class and approximate frequency in English to serve as a control word for the cognates selected. By having a pair of cognate – non-cognate (control) that matched on number of letters and frequency, it was possible to compare fixation time on these two words. Frequency was obtained from Kucera and Francis (1967) word frequency list, available at MRC Psycholinguistic Database, which also provides information about word length and grammatical class. Tables 8 and 9 present the 60 cognates selected for the present study, together with their respective controls.

Table 8

*List of cognates with a medium frequency and their respective controls*

<b>Medium frequency</b>				
<b>Condition</b>	<b>Cognate</b>	<b>Frequency</b>	<b>Control</b>	<b>Frequency</b>
EN-PT	actor	24	clerk	34
EN-PT	cereal	17	pepper	13
EN-PT	error	36	laugh	28
EN-PT	piano	38	bench	35
EN-PT	dentist	12	surgeon	11
EN-PT	accident	33	basement	31
EN-PT	fruit	35	candy	16
EN-PT	desert	21	jungle	20
EN-PT	discount	12	salesman	12
EN-PT	suggestion	34	assumption	41
Mean frequency		M= 26,2		M= 24,1
EN-GR-PT	inspector	13	physician	14
EN-GR-PT	tractor	25	nursery	13
EN-GR-PT	insect	14	potato	15

EN-GR-PT	academy	24	lecture	16
EN-GR-PT	fantasy	15	holiday	17
EN-GR-PT	camera	36	ladder	19
EN-GR-PT	author	48	reader	43
EN-GR-PT	tourist	16	emperor	19
EN-GR-PT	restaurant	41	enterprise	31
EN-GR-PT	guitar	20	mirror	27
Mean frequency		M= 25,2		M= 21,4
EN-GR	corn	35	meat	45
EN-GR	fish	35	bird	31
EN-GR	butter	27	candle	18
EN-GR	beer	34	meal	30
EN-GR	knee	35	bone	33
EN-GR	magazine	39	workshop	24
EN-GR	neighbor	14	employee	24
EN-GR	affair	33	injury	27
EN-GR	ending	31	screen	48
EN-GR	engagement	22	commitment	13



Mean frequency	M= 30,5	M= 29,3
Mean frequency all cognates	M= 27,3	M= 24,93

Table 9

*List of cognates with a high frequency and their respective controls*

<b>High frequency</b>				
<b>Condition</b>	<b>Cognate</b>	<b>Frequency</b>	<b>Control</b>	<b>Frequency</b>
EN-PT	poet	100	file	81
EN-PT	favor	78	break	88
EN-PT	fun	95	trust	78
EN-PT	exercise	58	fighting	72
EN-PT	color	149	price	108
EN-PT	success	96	failure	89
EN-PT	decision	120	marriage	95
EN-PT	test	120	bill	143
EN-PT	conclusion	59	assignment	62
EN-PT	member	139	letter	145
Mean frequency		M= 101,4		M= 96,1
EN-GR-PT	professor	57	painting	59

EN-GR-PT	plant	128	horse	117
EN-GR-PT	object	65	speech	61
EN-GR-PT	project	93	chapter	74
EN-GR-PT	quality	119	freedom	128
EN-GR-PT	theme	55	depth	53
EN-GR-PT	phase	73	score	66
EN-GR-PT	model	77	frame	74
EN-GR-PT	student	136	husband	131
EN-GR-PT	director	103	security	91
Mean frequency		M= 90,6		M= 85,4
EN-GR	cousin	53	player	51
EN-GR	summer	136	spring	127
EN-GR	friend	134	couple	122
EN-GR	bear	57	hole	58
EN-GR	nose	60	foot	70
EN-GR	wine	72	tree	59
EN-GR	wind	70	snow	59
EN-GR	brother	80	teacher	80

EN-GR	wagon	57	chair	66
EN-GR	scene	107	judge	77
Mean frequency		M= 82,6		M= 76,9
Mean frequency all cognates		M= 91,53		M= 86,13

As can be seen in Tables 8 and 9, cognates and controls were matched for frequency. In each condition (CGEG, CGEP and CGT), there were 10 pairs of cognates and controls within a medium frequency range (11-50 occurrences per million) and 10 pairs of cognate- controls of a high frequency range (51 to 150 occurrences per million).

Frequency is a well stated factor in the literature (Rayner, 1998) that influences lexical access. However, studies that make use of the eye tracker also need to take in consideration number of characters, since this property of the word is directly related to fixation time. Longer words are fixated more than shorter ones (Rayner, 1998). Table 10 shows the cognates of the present study and their number of characters.

Table 10  
*Cognates and number of characters*

<b>Cognates EN- BP</b>	<b>Number of characters</b>	<b>Cognates EN- GR</b>	<b>Number of characters</b>	<b>Cognates EN- GR-BP</b>	<b>Number of characters</b>
accident	8	affair	6	academy	7
actor	5	bear	4	author	6
cereal	6	beer	4	camera	6
color	5	brother	7	director	8
conclusion	10	butter	6	fantasy	7
decision	8	corn	4	guitar	6
dentist	7	cousin	6	insect	6
desert	6	ending	6	inspector	9
discount	8	engagement	10	model	5
error	5	fish	4	object	6
exercise	8	friend	6	phase	5
favor	5	knee	4	plant	5
fruit	5	magazine	8	professor	9
funds	5	neighbor	8	project	7
member	6	nose	4	quality	7
piano	5	scene	5	restaurant	10
poet	4	summer	6	student	7
success	7	wagon	5	theme	5
suggestion	10	wind	4	tourist	7

test	4	wine	4	tractor	7
Mean number of characters	6,35		5,55		6,75

As can be seen in Table 10, the average number of characters of the cognate words in each condition was very similar ranging from 5 to 6. The next step in stimuli preparation was to construct the experimental sentences of the present study. Sentences were formed with the critical words (cognates selected and their matched controls) with the following criteria: there should be a minimum of 3 words before and after the critical word. Moreover, the same sentence needed to accommodate both the cognate and the matched control, as in the following example, where *actor* is a cognate with *ator* (PT) and *clerk* is its control:

S1: Mary said that the **actor** was happy with his career.

S2: Mary said that the **clerk** was happy with his career.

The sentences below are examples of sentences formed with the triple cognate author (*autor*, *Autor*) and its respective control, reader:

S3: Kate said that the **author** was inspired by the new book.

S4: Kate said that the **reader** was inspired by the new book.

The following sentences were formed with the double cognate EN-GR neighbor (*Nachbar*) and its respective control, employee:

S5: John thought that the **neighbor** was weird but intelligent.

S6: John thought that the **employee** was weird but intelligent.

All of the sentences were formed within the same syntactic structure. Thus, two intervenient variables were avoided: semantic constraint and syntactic complexity. The sentences were divided in two presentations lists and each participant saw only one of these sentences. Apart from that, 96 filler sentences were added to the experiment. Twenty-five percent (25%) of the sentences (both experimental and fillers) were followed by a comprehension question, in order to confirm that participants were devoting attention to the task being performed. For the comprehension questions, participants needed to answer *yes* or *no*, as in the following example:

Filler sentence: *The unexpected storm was not predicted in the forecast that we heard on the radio*

Comprehension question: *Was the storm predicted in the radio forecast?*

All of the sentences of the present study (experimental sentences and filler sentences) were submitted to a naturalness judgement test. This means that the sentences were judged as natural or not by native speakers of English. The entire list of sentences were submitted to two naturalness judgement tests. One was carried out before the pilot study. In this test, 5 native speakers of American English judged experimental

sentences, fillers and comprehension questions as natural or not. In case they were rated as unnatural, they gave suggestions on how to modify the sentence. However, the qualifying committee that evaluated the research project of the present study suggested some changes to the experimental sentences in order to adjust the syntactic structure of the sentences. The reformulated experimental sentences were submitted to another naturalness judgement test. This new test was constructed on a Likert scale basis, ranging from 1 to 7, whereas 1 meant unacceptable and, 7, completely natural.

There was a total of 14 raters that responded to this test, who were all native speakers of American English, with a mean age of 24 (16-43). Their level of schooling was the following: 4 of them were high school students, 2 of them had finished high school, 3 were graduate students, 1 was graduated, 2 had a master degree and 2 were PhD candidates. The results of the naturalness judgement test are summarized in Table 11:

Table 11

*Results of the naturalness judgement test of the critical sentences*

	Mean	SD	Minimum	Maximum
CGEP	4,89	0,77	3,36	6,14
CTEP	4,83	0,63	3,43	5,79
CGT	4,89	0,84	3,57	6,36
CTT	4,73	0,91	2,79	6,14
CGEG	4,88	0,82	3,29	6,00
CTEG	5,06	0,78	2,93	6,07

As can be seen in Table 11, the average grade for the sentences in each condition was around 4 and 5. Since the highest grade for this test was 7, it can be concluded that the sentences received a high score. In other words, they were considered natural sentences, that is, according to the raters these sentences could be normally uttered by a native speaker of English. The results of Table 6 also show that no sentence received the minimum grade, which was 1. According to the results of the test, no sentence had to be disregarded. According to the results of the naturalness judgement test, all of these sentences could remain in the study. Thus, another procedure needed to be carried on: the experimental sentences needed to be submitted to a predictability test.



This test was applied in order to verify whether the semantic constraint of the sentence was low enough for the reader not to predict the target word.

Five native speakers of English responded to this test in order to guarantee that the critical words were embedded in a low constraint sentence. Four of the raters were Americans and one was British, their mean age was 25 (minimum 17, maximum 37 – SD -8). Concerning level of schooling, for the raters who responded the predictability test 40% were graduate students, 40% had finished graduation, and 20% had a masters' degree.

In this test, the critical word of the sentence was removed and the evaluators had to complete the sentence with the most obvious word. For instance, the evaluator was presented with the following sentence and had to provide a word to complete the blank space:

The boy said that the \_\_\_\_\_ was good with other ingredients.

To this sentence, participants gave the following answers: recipe, bacon, cake, fish and soup. The critical words for this sentence were cereal (cognate English-Portuguese) and pepper (control). As can be seen, both words were unpredictable, since they were not mentioned by any of the native speakers of English who responded the test. This means that the critical words were embedded in a low constraint sentence. On the other hand, an example of a word embedded in a high constraint sentence would be the following. For the sentence:

They said that the \_\_\_\_\_ was nervous during the tests.

The five respondents of the predictability test completed this sentence with the word *student*. This means that this word was 100% predictable according to the results of this test and could not serve for the purposes of the present study. Luckily, the critical words of this sentence were inspector (cognate English- German- Portuguese) and physician (control).

Table 12 summarizes the results of the predictability test. The percentages were calculated as follows: if the critical word appeared once in the raters' response, it was considered as 20% predictable, twice, 40%, three times, 60%, four times, 80% and five times, 100%.

Table 12  
*Results of the predictability test for the critical words of the experimental sentences*

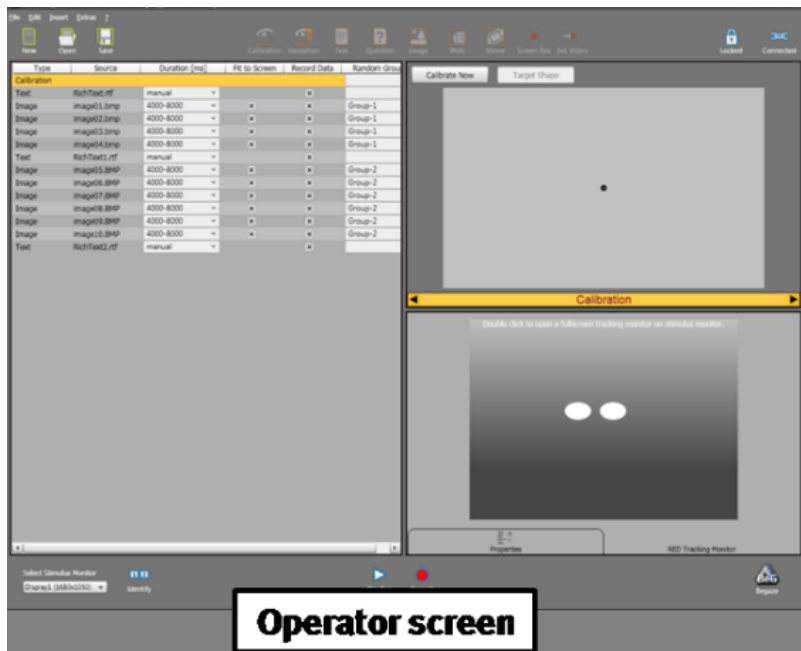
	Mean (%)	SD	Minimum	Maximum
CGEP	4,17	10,18	0	40
CTEP	0,83	4,08	0	20
CGEG	1,90	6,02	0	20
CTEG	3,81	8,05	0	20
CGT	0,95	4,36	0	20
CTT	4,76	10,78	0	40

The results of the predictability test, presented in Table 12, indicate that the critical words of the experimental sentences were embedded in a low constraint context, since the average percentage of predictability did not go over 5%.

After carrying out all of the reported steps in order to guarantee the quality of the stimulus of the present experiment, the experiment was ready to be conducted. The next subsection covers the procedures adopted for this task.

### **3.6.2 Procedures for the eye-tracking experiment**

Before the start of the experiment, participants were instructed to find a comfortable position in order to read sentences in the computer screen. Participants were also told that they would need to use the mouse and the space bar of the keyboard to provide answers to the comprehension questions and to change from one screen to the other. After that, the researcher examined whether participants' position was appropriate according to the information provided by the I-view-X, which pointed arrows indicating the ideal position of the participant for data collection. The I-view-X is the software that converts the eye movements into fixation time and sends this information to the BeGaze, the software where the data is analyzed. Both software are part of the SMI Eye Tracker. Figure 13 shows an example of the screen of the experimenter.



**Figure 13. The operator screen from the Experiment Center.** Example from the experimenter screen. Source: Experiment Center Manual.

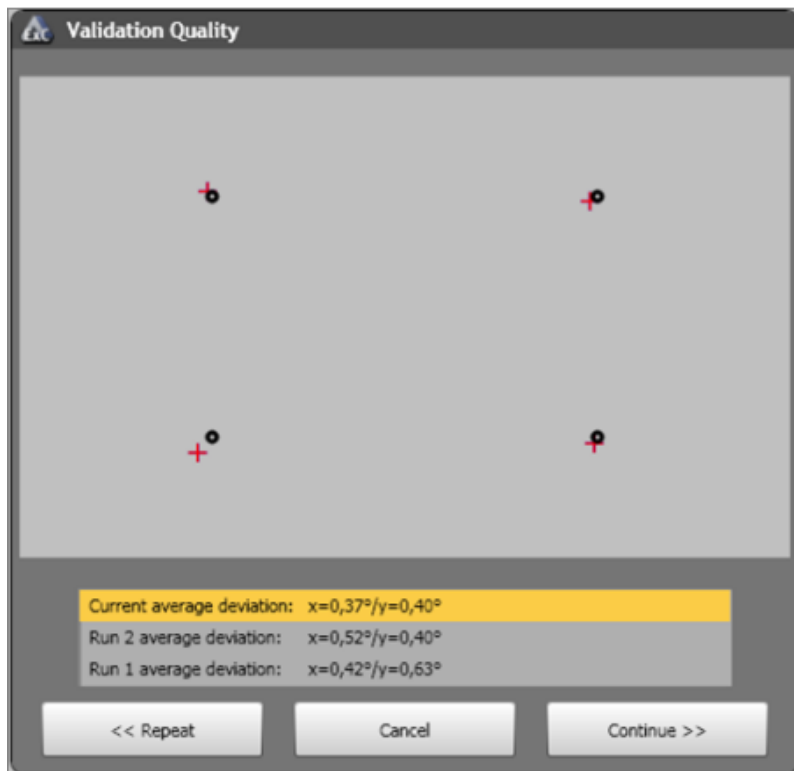
As can be seen in Figure 13, the experimenter can see an image of the participants' eyes on the screen. In case the participants' position is not appropriate, arrows will appear in this image indicating whether the participant needs to move closer, further, to the right, or to the left. It is essential to adjust participants' position in the beginning of the experiment to assure the quality of the data being collected.

Participants sat at a viewing distance of 50 to 60 cm of the monitor. Eye movements were recorded using an SMI Eye tracking system, running at 250Hz. Viewing was binocular. However, eye movements were recorded only from the right eye. The entire experimental session lasted approximately 1h and it was divided into three blocks. The first block consisted of a training session. The other two blocks contained the experimental stimuli. The presentation of the experimental stimuli was divided into two blocks to avoid participants' exhaustion as an intervenient variable in the study.

Before the start of the experiment, there was a welcome screen and two screens containing the instructions of the experiment. After that, participants were instructed about the calibration procedure that

they would have to perform. The calibration consisted of 9 white little balls with a red dot inside, which moved all over the screen. Participants were supposed to fix their eyes on the red dot and follow it as it moved, without moving their head. This can be sometimes difficult since the ball moves to extreme sides of the screen. However, good performance in this calibration procedure is essential to guarantee the quality of the experiment. In order to ensure a good calibration to start the experiment, the deviation should not exceed  $0,5^\circ$  in the  $x$  and  $y$ -axes. Therefore, the calibration procedure was performed more than once, if necessary, in order to reach this deviation limit.

In order to confirm the calibration procedure, a validation was carried out. The validation procedure is very similar to the calibration. The ball moves to the same directions, however, participants' eye movements during the calibration are displayed in this procedure in order to confirm that they actually performed those eye movements. This procedure is necessary to confirm if the calibration was correct. If there is a deviation above the limit of  $0,5^\circ$  in the validation, the entire calibration procedure must be repeated. Figure 14 exemplifies this procedure.



**Figure 14. Example from the validation procedure.** Figure taken from the Experiment Center Manual.

After calibration was considered adequate, the training session of the experiment would begin. . This training session was necessary for participants to get familiar with the dynamics of the task. This session contained 10 sentences to be read for comprehension, 4 of these sentences were followed by a comprehension question. Before each sentence appeared on the screen, there was a fixation cross for 2s. This fixation cross indicated where the sentence would appear. Participants were supposed to fix their eyes in this cross in order to be ready for the presentation of the next sentence. Each sentence was presented once in the computer screen and remained on screen for 15s. Sentences were displayed for 15s, in order to obtain a measure of three readings, since, in the pilot study, non- native speakers of English took approximately 5s to read each sentence once.

At the end of this session, participants were able to ask any questions they had about the dynamics of the task and, if necessary, their position could be better adjusted and some instructions about head movement could be reinforced.

Sentences were presented in a single line, font Monaco 26. This font was chosen because it is a monospaced font, where each letter occupies the same “space”. Example of monospaced font and a normal one:

University

University

The letter size 26 was chosen, because it was the limit size for each of the sentences presented to occupy a single line on the screen and avoid participants’ movement to another line (downward movement). Due to calibration deviations, it could be difficult to examine eye fixations on the target region if sentences occupied two lines on the screen.

Having completed the training session, another calibration procedure was performed before the start of the task. The official list of sentences for this task contained 120 experimental sentences (which were divided in two lists, 60 for each) and 96 filler sentences. Twenty-five percent (25%) of both experimental and filler sentences were followed by a comprehension question. The experimental session was divided in two rounds in order to avoid participant’s exhaustion. Each round lasted approximately 20-25 minutes. In each of these rounds, participants were presented to 77 sentences. The order of experimental and filler sentences was randomized by the software Experiment Center in order to avoid order effects.

As in the training session, there was a fixation cross indicating the start of the sentence for 2s. After that, the cross was replaced by the sentence to be read. After each sentence, either a comprehension question or another sentence appeared on the screen. The comprehension questions required participants to answer *yes* or *no*, on the computer screen, with the aid of the mouse. The list of sentences was presented in a random order. After completing the first round of this task, participants were free to move, drink some water, stand up and relax a little bit. When participants felt like they were ready to restart the experiment, the second round began. However, it was necessary to execute a new calibration and validation procedure in order to restart the task. The instructions of the task were also reinforced and presented in a screen, before the experimental session restarted.

At the end of the experimental session, there was a screen indicating the END of the task. The entire data collection took place in 6 months (from October/2014 until April/ 2015) in the Laboratório da Linguagem e Processos Cognitivos (LABLING)<sup>4</sup>, at UFSC.

The data was analyzed with the software BeGaze from SMI. This software offers detailed information for the analysis of the data collected from participants' eye movements during the reading task, such as the total time of fixation in the region of interest, the percentage of skips and saccades. This information was used to infer from the facilitation of cognates in the processing of English. The next subsection explains how the data was analyzed.

### **3.6.3 Analysis of the data of the eye-tracking experiment**

The analysis of the data proceeded as the following. First, each experimental sentence read by each one of the participants who performed the experiment (there were 60 experimental sentences read by each participant; total of 2100 sentences to be analyzed), was analyzed with the software BeGaze in order to verify the validity of the data. This analysis had the main goal of looking for deviations above the established limit of 0,5°. This procedure was necessary because during data collection, the participant might move his/her head, causing an imprecise measure of his/her eye movements. In this case, this specific trial must be rejected. Other possibilities that might cause a trial to be rejected may be related to a failure of the equipment, where sometimes the infrared lamp may stop capturing participants' eye movements in the middle of the experiment. For this reason, this procedure is essential for data analysis. After that, areas of interest were drawn around the critical words of the experimental sentences. In the specific case of the present study, areas of interest were drawn for the critical words (cognates and controls) and for the spillover region, which was considered as the two words that followed the critical word. This is important because processing may sometimes spill over to the next word (further details in section 2.6.1). This is a common practice in eye tracking studies to analyze fixations in the region immediately following the target one (Roberts, Siyanova-Chanturia, 2013). The areas of interest were drawn

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<sup>4</sup> The main objective of LabLing is to investigate the relationship between language processing and cognitive systems such as memory, attention, and executive functions. The research techniques adopted include eye-tracking and EEG/ERPs.

20 pixels above and below the target region in order to compensate for the 0.5 degrees of deviation admitted in the calibration procedure.

After that, the Reading Statistics module of the BeGaze provided all the information regarding fixation time for the areas of interest selected. The measures chosen to be analyzed for the present study were first pass, first fixation and second pass.

The measure of first pass consists of all of the forward fixations in the region of interest in the first time the reader lays his/her eyes in this region until the gaze moves either to the right or to the left of the region of interest. (Roberts, Siyanova-Chanturia, 2013). On the other hand, the measure of first fixation provides information about the duration of the first fixation in the region of interest. This measure can consist of a single fixation or multiple fixations (Roberts, Siyanova-Chanturia, 2013). The measure of second pass refers to all the fixations made in the region of interest when the gaze has already exited the region and reenters it for the first time (Roberts, Siyanova-Chanturia, 2013).

The results of these measures were further analyzed in Excel and SPSS, where *t*-tests and ANOVAs were carried out in order to compare the results of fixation time between cognates and controls for each of the groups. Moreover, statistical tests were carried out in order to compare the behavior of the three groups. More specifically, for each of the three groups of participants in each of the experimental conditions (CGEG, CGEP, CGT), the average time of first pass, first fixation and second pass was compared for cognates and controls, both for the critical word and for the spillover region. After that, statistical tests indicated whether there were significant differences between the average fixation time in each of the experimental conditions. Another part of the statistical analysis consisted in comparing the results of the three groups. For this analysis, the average time of first pass, first fixation and second pass was compared in each of the conditions among the groups.

Having presented the eye-tracking task, which was an experiment designed in order to investigate lexical access in processes of comprehension, I proceed now to the description of the other two tasks that were part of the present study. These tasks aimed at language production. The next section covers the narrative task.



### 3.7 THE NARRATIVE ORAL PRODUCTION EXPERIMENT

In this experiment, participants were required to tell a story based on a series of pictures adapted from the wordless picture book *'Frog, where are you?'* (MAYER, 1969). This book has been used by several studies in the area of third language acquisition (Cenoz, 2001; Perales et al, 2009; Mayo & Olaizola, 2011) and in my M.A. thesis (Toassi, 2012). However, for the present study, I intended to work with pictures that represented cognate words in the participants' three languages. Since it was not possible to find this material on the internet and the book in question does not have many pictures of cognate words, it was decided to reproduce similar pictures, which represented the intended words. The inclusion of this experiment in this study is justified for the following reasons. First, because narratives are natural tasks, they are a good mean to access the lexicon of multilingual participants in an unplanned language production moment. Second, this experiment was important for the present study because it triangulates the results of the other two experiments since it contains some of the cognates which were part of the eye-tracking experiment. However, in this experiment the aim is on the production of these cognates and not on their comprehension. The narrative production experiment is also related to the cross-language priming experiment, since it deals with lexical access in language production.

#### **3.7.1 Stimuli preparation for the narrative task**

As already mentioned, the pictures of the wordless book *Frog, where are you?* did not contain many pictures that represented cognate words. For this reason, the story was reproduced and pictures that represented cognate words were added. The main plot of the story remained, that is, a boy looking for his frog. There were four pictures that represented the whole story and participants were free to choose the most appropriate order for the pictures in order to narrate the story. The cognate words were taken from the database developed for the eye-tracking task. Table 13 presents the list of elements of the four pictures of the narrative task.

Table 13  
*List of elements of the pictures of the narrative task*

CGEG	CGEP	CGT	Non-cognates
Lamp ( <i>Lampe</i> )	Rat ( <i>Rato</i> )	Banana (Banana/ Banana)	Table
Cheese ( <i>Käse</i> )	Jar ( <i>Jarra</i> )	Poster ( <i>Poster/ poster</i> )	Window
Fish ( <i>Fisch</i> )		Balloon ( <i>Ballon/</i> <i>balão</i> )	Boy
Mouse ( <i>Maus</i> )		Lion ( <i>Löwe/ leão</i> )	Dog
Wine ( <i>Wein</i> )			Cloud
Glass ( <i>Glas</i> )			Tree
Sun ( <i>Sonne</i> )			River
Cat ( <i>Katze</i> )			
Bed ( <i>Bett</i> )			
Moon ( <i>Mond</i> )			
Apple ( <i>Apfel</i> )			
Corn ( <i>Korn</i> )			

As can be seen in Table 13, there was a total of 25 items in the four pictures that represented the story. From these 25 items, 12 were images that represented cognates between German and English (CGEG); 2 represented cognates between English and Brazilian Portuguese (CGEP); 4 represented cognates among German, English and Brazilian Portuguese (CGT), and 7 represented non-cognate words. In short, there were more images that represented cognate than non-cognate words in the pictures, mainly cognates with German. Therefore, it is expected a greater effect of the foreign language, German, in the production of the trilingual participants.

### 3.7.2 Procedures for the narrative oral production experiment

Instructions for this task were provided orally to participants. However, each participant received the same instruction, which was that they were going to see four pictures and they had to narrate a story on the basis of these pictures, in the order that they found more appropriate. They did not have time to prepare for telling the story. The only time provided for them was to organize the pictures in the order they found

more appropriate. As soon as they organized the pictures, they started telling the story, while being audio recorded.

### **3.7.3 Analysis of the data of the narrative oral production experiment**

In this task, participants' narrative was audio recorded, further transcribed and analyzed. The analysis consisted in verifying the production of the cognate words. The analysis was quantitative; the number of cognate words produced by the trilingual participants was compared to that of the bilingual participants. With this information, it was possible to make inferences regarding the activation of the non-target languages (German and Brazilian Portuguese) while participants produced the narrative in English. The next subsection presents and describes the cross-language priming task, which also had its focus placed on lexical access in language production.

## **3.8 THE CROSS-LANGUAGE PRIMING EXPERIMENT**

The experiment of cross-language priming was designed in order to evaluate lexical access in English on the basis of reaction time and accuracy. Priming refers to previous access to a word/ concept in the mental lexicon. The priming effect can be measured by means of the facilitation caused in a given task. If we assume that words are stored in the mental lexicon according to their meaning, thus, a related prime presented before a given task (e.g.: lexical decision or picture naming), will pre activate that concept. Consequently, access to the target word will depend on a shorter path on the mental lexicon, resulting in a shorter reaction time. Moreover, it is argued that a word that can prime another is closely connected to this word in the mental lexicon.

Therefore, an experiment consisting of a picture-naming task within a cross-language priming paradigm was designed for the present study in order to investigate the relationship among the participants' three languages German, English and Brazilian Portuguese. In other words, this experiment allowed to make inferences on which language is more closely connected to the target one, English, if is the foreign language, German, or the native language, Brazilian Portuguese.

In this task, the pictures to be named represented concrete objects. These pictures were black and white line drawings (Appendix

C) that represented common objects, taken from Szekely et al (2005). From the 520 pictures of the study by Szekely et al (2005), 212 are available to be downloaded free. However, many of them represented cognate words between Brazilian Portuguese and English and/or between German and English and could not be used as stimuli for the present study.

The task consisted of the presentation of these pictures in the computer screen. Participants were asked to name these pictures fast and accurately. Before the presentation of the picture, a masked prime appeared on the screen. This masked priming paradigm was applied in German, English and Brazilian Portuguese.

Primes were the word that represented the picture, in one of the participants' three languages, Brazilian Portuguese, German and English. In other words, primes were either the name of the picture in English or the translation equivalent in German or Brazilian Portuguese. The following subsection presents the steps taken in order to prepare the stimuli for this task.

### **3.8.1 Stimuli preparation for the cross-language priming experiment**

The procedure adopted in order to build the list of stimuli for the picture-naming task with the cross-language priming paradigm was the following. The 212 words of the Szekely et al (2005) study were evaluated in order to avoid intervenient variables. First, pictures that represented cognate words in the pairs EN-BP or En-GR were eliminated. For instance, the following figure represented the word dentist.



**Figure 15.** Picture of the concept dentist.

The picture portrayed in Figure 15 had to be eliminated since dentist is a cognate word with *dentista* in Brazilian Portuguese. The same happened with the following picture that represented a boat.



**Figure 16.** Picture of the concept boat.

This picture from Figure 16 was also eliminated because it is a cognate with German *Boot*. Cognates needed to be avoided because they

are well known in the literature to be named faster than non-cognate words. In addition, pictures that represented words that resembled the target word phonologically or orthographically were also excluded. For instance, the picture of the concept of cheese was excluded because of its phonological resemblance with the German translation *Käse*. Another example of a picture that needed to be excluded was the picture that represented a whale, since its orthography resembles the equivalent word in German *Wal*, even though the pronunciation of these two words is very distinct.

After eliminating the pictures that were cognates and/or that resembled the equivalent translation in German or Brazilian Portuguese in terms of orthography or phonology, the remaining pictures that followed these criteria were 72. The rationale for this task was that each picture needed to be preceded by its name in English and its equivalent translation in German and Brazilian Portuguese. However, each picture could be presented only once for each participant. Therefore, three lists had to be prepared. For each list, 24 pictures were preceded by its name in English, 24 for its equivalent translation in German and 24 for its equivalent translation in Brazilian Portuguese. This way each picture was preceded by the prime word in each of the languages across the presentation lists and each participant was exposed to the three experimental conditions, being that prime in EN, in GR, and in Brazilian Portuguese. This procedure was adopted to make sure that the priming effect would not be due to an effect of the prime and the picture.

The primes that were translation equivalents in German and Brazilian Portuguese were verified in online dictionaries from English-Portuguese and English-German (<http://pt.bab.la/dicionario/>; <http://michaelis.uol.com.br>; <http://www.pauker.at>; <https://translate.google.com.br>). In addition, the name of the pictures and the primes in German were verified in Google Images, in the German version ([www.google.de](http://www.google.de)). A native speaker of German also verified the correctness of the prime words. In the following subsection the procedures for data collection are specified.

### **3.8.2 Procedures for the cross-language priming task**

The picture-naming task with the cross-language priming paradigm was organized as the following. In the first screen, instructions were given to the participant on how to perform the task. After that, a training session was provided for participants to understand the

dynamics of the task. This training session contained three pictures to be named. Next, the answer for these three pictures of the practice was provided to participants. Another screen reinforced the instructions of the task and asked the participant if he/she was ready to start the task. Next, the picture-naming task started. The order of presentation of the stimuli was the following. First, a fixation point appeared in the center of the computer screen for approximately 200 ms, followed by a blank interval of 500 ms. Next, the masked prime was presented for approximately 30 ms, in lowercase, in the center of the computer screen. Immediately after the prime, the picture to be named appeared in the center of the computer screen. The picture remained in the computer screen for 3s. The next picture to be named appeared in the screen after an interval of 1s.

The experiment was programmed in the *E-prime 2.0* software, which registered participants' reaction time, voice and accuracy for each stimuli. After data collection, each participants' vocal response was heard in order to check their accuracy. After that, participants' performance was analyzed through a report provided by the software.

### **3.8.3 Analysis of the data of the cross-language priming experiment**

The information taken from the report provided by the E prime software was the name of the picture, the name of the prime and the reaction time, which is the time in milliseconds that the participant takes to name the picture. This data was confirmed by means of checking the audio of each participants' response. In case the participant said the incorrect word or made some noise before actually naming the picture, the response had to be disregarded. This is a common procedure for studies with picture naming tasks, where only the correct responses are considered for analysis.

Having cleared all the data, participants' response was averaged according to each condition: prime in EN, GR or BP. Reaction time was compared for each condition in the groups and further the results were compared among groups. *T*-tests and ANOVAS were carried out in order to verify if there were significant differences in the means. It is assumed that the faster the response, the greater the facilitation of the prime word.

The next section reports the preliminary results of the two pilot studies that were carried out in order to test the eye-tracking task and the

cross-language priming task. On the basis of these pilot studies the procedures for the doctoral research project were traced.

### 3.9 PILOT STUDY

Two pilot studies were conducted prior to data collection in order to access the efficacy of the methodological procedures to provide answers to the research questions of the present study. In other words, the two pre- pilot studies presented in this section were conducted with the main goal of evaluating if the tasks proposed for this study were efficient to provide answers for the research questions proposed.

The first pilot study had the main goal of evaluating the task with the eye-tracker. The second pilot study was carried out in order to test the cross-language priming task. Due to technical problems, it was not possible to conduct the two studies at the same time, not even to require the same participants to perform the two tasks.

In the eye-tracking experiment, eye movements were registered while participants performed a sentence-processing task. There were 14 highly proficient L2 English speakers who participated in the study. In this experiment, participants' attention to the task was confirmed through comprehension questions that were presented randomly. The critical words of the sentences presented in this task were cognates in Brazilian Portuguese, English and German, even though the participants of this pilot study did not have knowledge of German, the intention of the study was to test the entire list of stimuli that would be used in the doctoral study.

Since the participants of this pilot study were bilingual speakers of Brazilian Portuguese and English, the task allowed evaluating whether PT-EN cognates facilitated the processing of sentences in the target language (English) in relation to their respective non- cognate controls.

Another pilot study was conducted with 6 members of the laboratory Labling to test the cross-language priming task. This experiment had to be carried out after the eye-tracking one because of technical problems that occurred in its execution.

The experiment consisted of a picture-naming task, in English. There were 72 pictures, taken from the Windows' Art Gallery, which were presented to participants, one at a time. Participants received oral and written instructions on how to perform the task. They were instructed that they should name the pictures presented, in English, in a



single word, as fast and as accurately as possible. In addition, they were instructed to be silent before the presentation of the picture because any sound produced would be detected by the microphone as a response. The first part of the experiment consisted of a training session, where 3 pictures were presented to participants. After that, a screen with the correct answers for these pictures was presented. At this moment, participants had time to ask any questions about the dynamics of the task. After that, the instructions were reinforced and participants indicated if they were ready to start the task.

The task contained masked primes in German, English and Portuguese, which were presented for 30 ms before the picture appeared on the screen, in related and unrelated conditions. This made a total of 12 primes for each condition:

- related prime in English;
- related prime in German;
- related prime in Portuguese;
- unrelated prime in English;
- unrelated prime in German;
- related prime in Portuguese.

The related prime word in English was the name of the picture; the related prime word in German and Brazilian Portuguese were the equivalent translations of the picture name. On the other hand, in the unrelated condition, the prime word belonged to a different semantic category than the picture. For instance, for the picture of an animal, the prime word could not be another animal, but could be a housework instrument.

The pre-pilot study of this task allowed the observation that some pictures caused processing difficulties for the participants, since most of them could not be named within the time interval provided (3s). The 23 pictures which caused processing difficulties were the following:

- beaver;
- bow;
- chameleon;
- cheetah;
- chipmunk;
- chopsticks;
- corkscrew;
- dustpan
- faucet;
- flamingo;

- ostrich;
- pliers;
- raccoon;
- screwdriver;
- seahorse;
- skunk;
- stapler;
- stethoscope;
- toucan;
- trumpet;
- turkey;
- wrench.

Apart from that, two other pictures caused naming difficulties because of the quality of the picture, which were the pictures that represent a *hanger* and a *stopwatch*. The software provided audio response for every picture, which was named by the participant. However, reaction time was not recorded for each stimulus for the first participants that performed the pre- pilot study, for technical problems. It was observed that reaction time was only recorded when the participant spoke extremely close to the microphone. Having observed that, the recordings of reaction time of the last two participants were successfully accomplished.

The results of the two pilot studies provided indications for the next steps that needed to be taken to fulfill the objectives of this doctoral study. Overall, the pilot studies allowed the researcher to test the instruments and to test the equipment of data collection. Some changes were necessary for the stimuli of the two tasks in order to carry out the official data collection of this study.

It was observed that the stimuli of the eye- tracking study needed to be submitted to the evaluation of native speakers of English so they could judge the sentences as natural or not. After that, sentences also needed to be submitted to a predictability test, in order to verify if the critical word of the sentence is embedded into a low constraint context.

Regarding the cross-language priming task, the conclusions of the pilot study were that some pictures need to be replaced, either because they caused processing difficulty or because the picture did not represent its concept clearly. Additionally, it was decided to remove the unrelated condition from this experiment for two reasons. The first one was to increase the number of items per condition in order to improve the statistical analysis of the data. The second reason was that by adding an unrelated condition to this task, another process would be on focus:

interference. It was decided not to broaden too much the scope of the present study by restricting this task only to the related prime condition.

Nevertheless, the pilot studies indicated that the method chosen for this study was appropriate to answer the research questions proposed. The eye-tracking experiment allowed the observation of the processing differences of cognates and controls. These results can be very informative in analyzing lexical access of bilingual/ trilingual speakers. Moreover, these results can provide insights into the organization of the mental lexicon of multilinguals.

The same conclusions are true for the cross-language priming task. The analysis of response time allows the analysis of the influence of the three languages in language production. These results are very informative into the lexical access of the multilingual participants. Moreover, they can provide insights into the factors that constrain the processing of the multilingual mental lexicon.

Other than that, it was decided to incorporate another task to this study, which would consist of a narrative oral task. This task, being a more natural task, could provide results to confirm the ones obtained through the eye-tracking and cross-language priming tasks.

The next chapter presents and discusses the results of the three experiments carried out in the present study – the eye-tracking experiment, the narrative production experiment, and the cross-language priming experiment. In addition, the information gathered through the biographical questionnaire and the results of the vocabulary tests in English and German are presented and discussed.



## CHAPTER IV RESULTS

The main goal of this chapter is to present and discuss the results of three experiments conducted in order to investigate lexical access in English both during language production and language comprehension. In the three experiments, the target experimental group was a group of trilinguals speakers of Brazilian Portuguese as the L1, German as the L2 and English as the L3, (the L3G). Another group formed by native speakers of Brazilian Portuguese with English as the L2 also participated in the present study, the L2G. This group was necessary in order to determine whether the effects observed in the L3G were due to the participants' L2, German. A control group formed by native speakers of English was also required for the present study, the L1G, and served as a baseline to the behavior of the other groups and to the adequacy of the design of the experiments.

More specifically, the three experiments were conducted in order to provide answers to the following research questions: (1) Which cognates are more facilitative in the comprehension of English as a target language: double cognates (between English and German, and English and Brazilian Portuguese), or triple cognates (among English, German and Brazilian Portuguese)?; (2) How is lexical access influenced by cognates among German, English and Brazilian Portuguese in the oral production of English?. (3) Is there a difference in the semantic priming effect when it is presented in the native (Brazilian Portuguese), non-native (German) or target language (English) for bilingual and trilingual speakers?;

The experimental session of the present study consisted of three experiments. Experiment 1 was a sentence comprehension task performed in the eye-tracker. Experiment 2 was an oral narrative based on a series of pictures. Experiment 3 was a picture-naming task within the cross-language priming paradigm. In addition, other instruments aided data collection: a biographical questionnaire, where participants provided information regarding their background language knowledge, and a vocabulary test in German and in English, in order to measure foreign language knowledge in this specific aspect.

The present chapter presents the results of the three experiments in addition to the results of the vocabulary tests and the biographical questionnaire. The organization of this chapter is as follows: section 4.1 presents the results of the vocabulary tests. Next, section 4.2 presents the most relevant information gathered through the biographical questionnaire. After that, in section 4.3 the results of the eye-tracking experiment are presented and discussed. Section 4.4 consists of the results of the narrative experiment. After that, in section 4.5 the results of the picture-naming experiment are presented and discussed. Section 4.6 contains a general discussion regarding the three experiments applied in the present study and the models of lexical access proposed in the literature. Finally, in section 4.7, answers for the research questions proposed in the beginning of this study are provided.

#### 4.1 THE VOCABULARY TESTS

In this section, the results of the vocabulary tests performed by participants from the L2G and the L3G are presented. As already mentioned, due to time constraints, it was not possible to submit participants to a proficiency test in each foreign language – English and German – , since proficiency tests take, on average, 2h, and the experimental session alone lasted approximately 2h. For this reason, a vocabulary test was the instrument selected to analyze participant's knowledge of this aspect of the foreign language. As already explained in the method chapter of this dissertation, the German vocabulary test was developed on the basis of the English PVLТ (Laufer and Nation, 1999). This allows the comparison of the results of the two tests.

In the previous chapter (section 3.5), it was explained that both the English PVLТ and the German vocabulary test consisted of 5 levels each. In each of these levels, there were 18 items. Thus, the maximum number of correct items that a participant could reach in each test was 90. In order to have a general score for each test, the correct items in each level of the test was summed up. The results are presented in Table 14 together with the mean, standard deviation, minimum and maximum number of correct items.

Table 14

*Results of the vocabulary tests in German and English for the L2G and the L3G*

<b>L3G</b>			<b>L2G</b>	
Subject	German test	English PVLТ	Subject	English PVLТ
P2	53	14	P1	12
P8	5	13	P3	12
P10	46	22	P4	13
P11	61	5	P5	11
P13	4	28	P6	14
P16	6	10	P7	9
P21	48	29	P9	32
P42	7	23	P12	12
P44	3	6	P19	14
P49	23	11	P20	13
P50	14	9	P24	23
P51	13	9	P27	26
P52	21	22	P28	9
P53	27	11	P41	14
P54	6	11	P43	10
P55	22	14	P47	29
P56	25	14		
Minimum	3	5		9
Maximum	61	29		32
<b>Mean (SD)</b>	22,58 (18,74)	14,76 (7,34)		15,81 (7,35)
<b>N=</b>	17	17	16	16

*Note: N= number of participants*

As can be seen in Table 14, the results of the vocabulary tests in English for the L2G and the L3G are very similar. On the other hand, for the trilingual participants it has to be noticed the higher number of correct items in the German test than in the English test. This result suggests that these participants had more vocabulary knowledge in German than in English. This information might help in the explanation

of the results of the three experiments conducted in the present study. The next section provides information regarding participants' background language knowledge gathered through the biographical questionnaire.

## 4.2 THE BIOGRAPHICAL QUESTIONNAIRE

This section presents the information gathered through the biographical questionnaire regarding participants' background language knowledge, which is important to identify the different variables that may interact with the acquisition of a foreign language, mainly in the case of the present study, in which there are two foreign languages involved, making the process even more complex (Cenoz, Hufeisen & Jessner, 2003; Jessner, 2006; Gass & Selinker, 2008). For trilinguals, there are more possibilities of cross-linguistic influences and/or language interference (Jessner, 2006; Bardel & Falk, 2007; Carvalho & Silva, 2006; Leung, 2005; Maghsoudi, 2008; Melhorn, 2007; Tremblay, 2006; Hammarberg, 2001; Dewaele, 2001; Ecke, 2001; De Angelis & Selinker, 2001; Herwig, 2001). Concerning language acquisition, it might not be a linear process, since one of the foreign languages might have its learning process interrupted in order for the learning process of the other language to begin. As can be seen, when it comes to trilinguals, many variables may interfere in language acquisition. A consequence of trilingualism as compared to bilingualism is that the presence of an additional foreign language may alter lexical organization and processing. The present study seeks to find out the effects of trilingualism in lexical access during language production and comprehension.

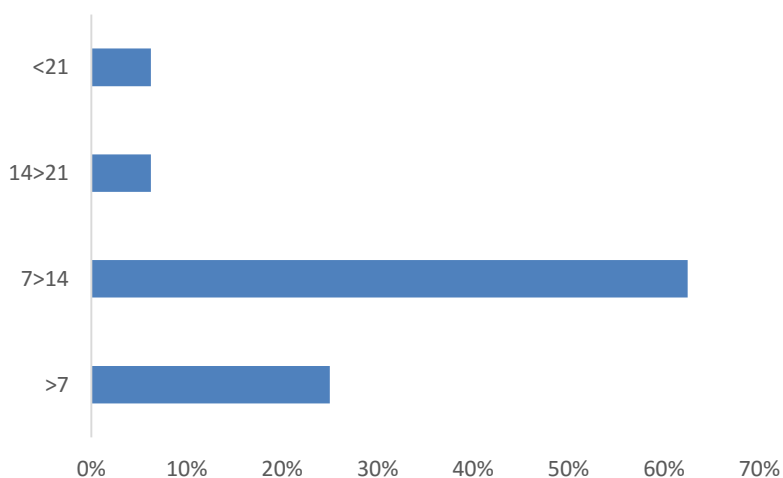
Therefore, the information reported in this section may help explain the results of the present study. This section is organized as follows: subsection 4.2.1 presents information regarding the learning of English of the L2 and L3 groups. Next, subsection 4.2.2 presents information regarding the learning of German of the L3G.

### **4.2.1 Information regarding the learning of English of the L2 and L3 groups**

This subsection presents the information gathered through the biographical questionnaire regarding the learning of English of the participants from the L2 and L3 groups (see Appendix B for the

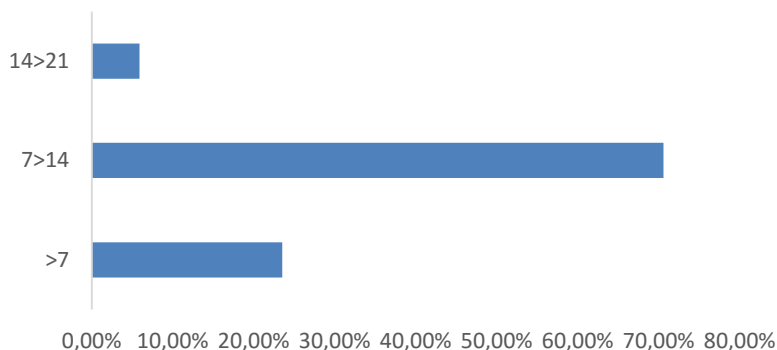


questionnaire). One variable that is of particular interest for research on foreign language learning is age of onset, which is the age when the participant started having significant contact with the foreign language (Birdsong, 2006 as cited in Muñoz, 2010). For this reason, two questions, related to this variable, were included in the questionnaire. The first question was: “How old were you when you started having contact with English?” Figure 17 shows the answers provided by participants from the L2G for this question.



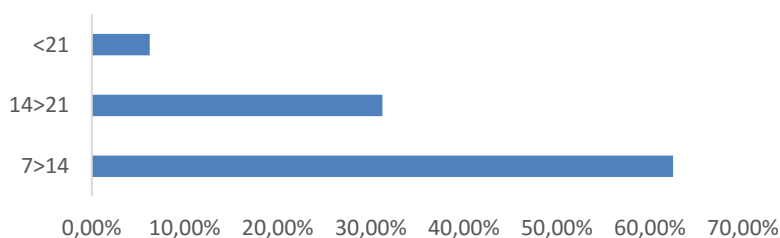
**Figure 17.** Age at which the participants from the L2G started having contact with English.

As can be seen in Figure 17, the majority (62,50%) of the participants from the L2G had their first contact with English in the age range of 7 to 14, whereas 25% of the participants had their first contact with English after 7 years old, and the minority of the participants (12,50%) had their first contact with English after 14 years old. Next, Figure 18 illustrates the results of the participants from the L3G for the same question.



**Figure 18.** Age at which the participants from the L3G started having contact with English.

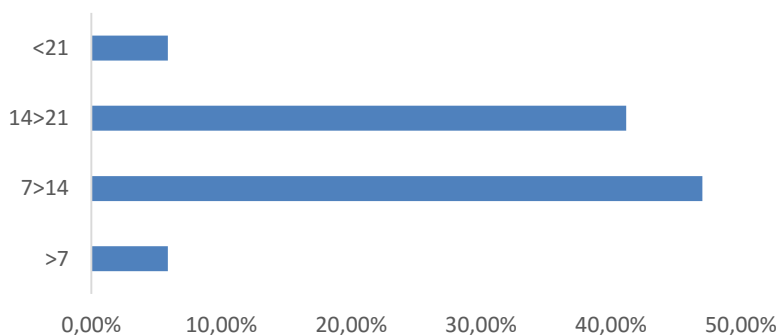
As can be seen in Figure 18, the answers of the participants from the L3G are very similar to the ones reported by the L2G. The majority (70,59%) of the participants had their first contact with English in the age range of 7 to 14; 23,53% of the participants from the L3G had their first contact with English after 7 years old. The minority (5,89%) of the participants had their first contact with English in the age range of 14 to 21. The next question related to age of onset was: “How old were you when you started the English course?” Figure 19 illustrates the answers provided by participants from the L2G for this question.



**Figure 19.** Age that the participants from the L2G started the English language course.

As can be seen in Figure 19, the answer for this question was very similar to the previous one, where participants reported having started learning English in the age range of 7 to 14. In short, the results of the previous question with the present one indicate that some

participants started having contact with English around the age range of 7 to 14, but started the English course only after 14 years old. It can also be observed that the minority (6,25%) of the participants reported having started the English course after the age of 21. Next, Figure 20 shows the answers of the participants from the L3G for this question.



**Figure 20.** Age that the participants from the L3G started the English language course.

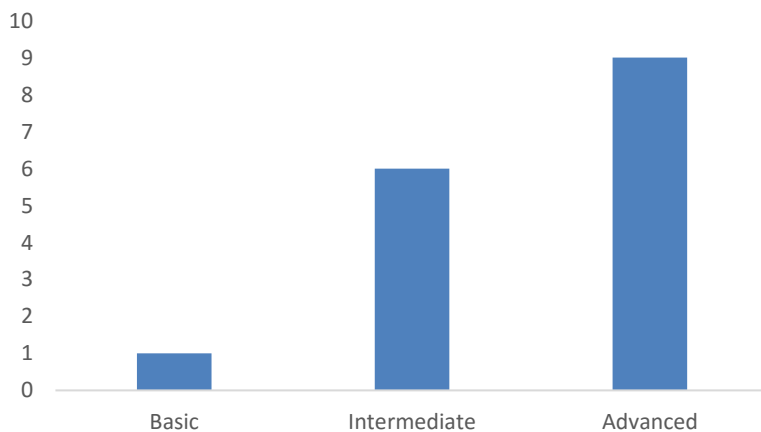
As can be seen in Figure 20, the percentage of participants who responded having started the English course in the age range of 7 to 14 was just 6% greater than the ones who started the English course in the age range of 14 to 21. The answers provided by the participants from the L2G for this question are very similar to the ones provided by the participants from the L2G, which indicates that the two experimental groups of the present study are homogenous regarding the variable of age of onset. The next question concerned the participants' contact with English before the language course. In other words, this question aimed at determining how participants interacted with English. Table 15 presents the answers provided by participants from the L2 and L3 groups.

Table 15

*Way of contact with English before the language course*

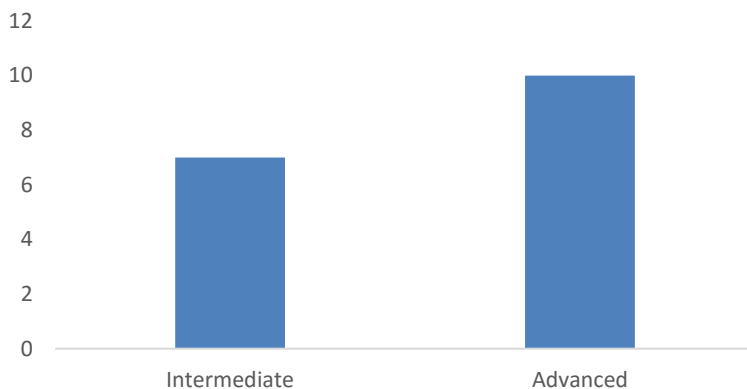
	L2G	L3G
Through movies, music, video game, internet, TV, radio.	50,00%	70,59%
Through school.	18,75%	17,65%
By talking to a fluent or a native speaker of English.	6,25%	11,76%
There was no contact with the language.	25,00%	-

As can be seen in Table 15, most of the participants of the two groups (50% from the L2G, and 70,59% for the L3G) reported having contact with English through the media, that is, TV, music, movies, video game, internet and radio. Next, participants were asked whether they were still having English classes. For this question, 81,25% of the participants from the L2G reported still having English classes, whereas only 17,65% of the participants from the L3G reported still having English classes. The questionnaire also aimed at assessing participants' proficiency in the foreign languages, by means of a self-estimation question. Thus, participants were asked: "How do you evaluate your level of language knowledge in English?" Figure 21 shows the answers of the participants from the L2G.



**Figure 21.** Self- estimation proficiency in English of the participants from the L2G.

As can be seen in Figure 21, the majority (56,25%) of the participants from the L2G considered their proficiency level in English as advanced, many (37,5%) participants self-estimated their proficiency as intermediate and only a few (6,25%) as basic. Figure 22 illustrates the answers of the participants from the L3G for this question.



**Figure 22.** Self- estimation proficiency in English of the participants from the L3G.

As can be seen in Figure 22, the majority (58,82%) of the participants from the L3G also considered themselves as advanced speakers of English and some (41,17%) participants self-estimated their proficiency as intermediate. In this group, no participant evaluated him/herself as having basic knowledge of the language. Next, participants were asked about the purpose for which the knowledge of English was important for them. Table 16 displays the answers provided by participants from the L2 and L3 groups.

Table 16

*Purpose for learning English*

	L2G	L3G
For improvement in the studies.	-	29,41%
For professional reasons.	68,75%	35,29%
For travelling.	12,5%	11,76%
For leisure.	-	5,88%
In order to teach the language.	6,25%	-
All of the above.	12,5%	17,65%

As can be seen in Table 16, the purpose for learning English for the majority (68,75%) of the participants from the L2G is professional. On the other hand, the purposes of the participants from the L3G are divided into learning English for professional reasons (35,29%) and for improvement in the studies (29,41%). The next question was about how much time participants dedicated to studying English besides the time they spent in the language course. Table 17 presents the results of the two groups for this question.

Table 17

*Time dedicated to the study of English outside the language course*

	<b>L2G</b>	<b>L3G</b>
More than 2h a week.	37,5%	23,53%
Up to 2h a week.	12,5%	11,76%
Up to an hour a week.	25,00%	23,53%
None.	25,00%	41,18%

As can be seen in Table 17, the majority (37,5%) of the participants from the L2G reported dedicating more than 2h a week to the study of the language. On the other hand, the majority (41,18%) of the participants from the L3G do not dedicate any extra time to the study of the language. This answer is in line with the fact reported in the previous question that the majority (81,25%) of the participants from the L2G are learning English formally now, whereas the majority (82,35%) of the participants from the L3G are not.

Participants were also asked whether they had contact with native speakers of English. For this question, 75% of the participants from the L2G and 71% of the participants from the L3G answered yes. For this question, the answers of the participants of the two groups were quite even. When they were asked if they had already been in an English speaking country, only 37,5% of the participants from the L2G answered yes. From these, 66% spent less than 2 months abroad, whereas 33% spent from 6 months to 2 years. Regarding the participants from the L3G, only 41% had already been to an English speaking country. From these, 57% spent less than 2 months abroad, 29% spent up to 6 months, and 14% spent more than 2 years. Participants were also asked in which situations they have contact with English. Table 18 presents the answers provided by participants from the L2 and L3 groups.

Table 18

*Situations that the participants have contact with English*

	<b>L2G</b>	<b>L3G</b>
Having English classes.	14,47%	7,59%
Watching movies.	21,05%	21,51%
Listening to music in English.	18,42%	21,51%
Playing video game.	7,89%	11,39%
Talking to other students or English speakers.	19,73%	17,72%
Reading.	18,42%	18,98%
Translating and teaching.	-	1,27%

As can be seen in Table 18, participants from the L2G reported having had contact with English in very diverse situations, such as watching movies, talking to other people, listening to music and reading. The same was reported by the participants from the L3G. In short, the information provided by participants regarding the learning of English showed that the two experimental groups of this study are homogeneous as regards age of onset, self-estimated proficiency, way of language contact and experience in an English speaking country. The next subsection presents the information regarding the learning of German of the participants from the L3G.

#### **4.2.2 Information regarding the learning of German**

This subsection presents the information gathered through the biographical questionnaire regarding the learning of German of the participants from the L3G. The first relevant information asked to this group was about the age on which they started learning German. On average, participants reported having started learning German at 17,8 years old (minimum: 3; maximum: 28; SD: 6,18). When asked about the context in which they learned the language, 64,71% reported having learned German at a language school, whereas 29,41% reported having learned it in the country where the language is spoken (Germany and Switzerland). Participants who had learned German in a language school were asked about how much time they had studied the language. Their answers varied as follows:

- 7,69% up to 6 months;
- 23,08% up to an year;

- 30,77% up to 2 years;
- 38,46% more than 2 years.

Participants were also asked if they were still studying German at a language school. For this question, 58,8% of the participants responded yes. After that, participants were asked how frequently they use the language. Their answers varied as follows:

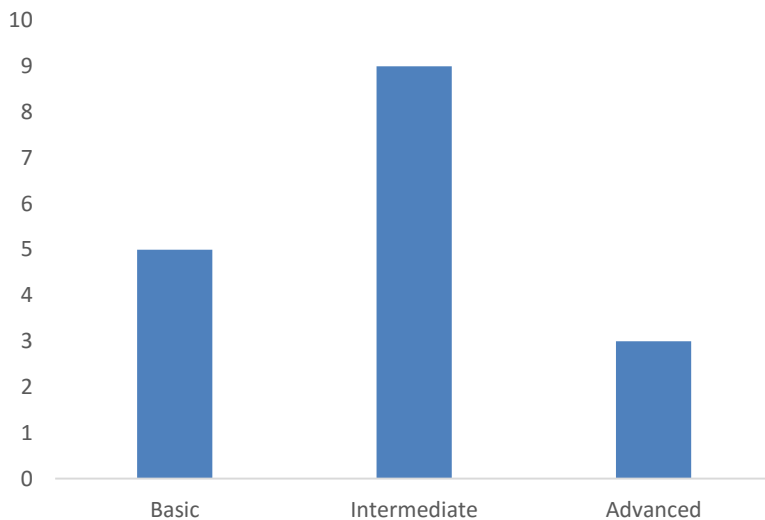
- 76,47% in certain occasions;
- 11,76% almost all the time;
- 11,76% rarely.

The L3 speakers of English were asked about how they used their foreign language, German. They provided the following answers:

- 22,22% to watch movies, listen to music, play video games, to read for fun;
- 16,67% to talk to family and friends;
- 16,67% for classes;
- 16,67% for readings at work;
- 5,56% for the study of the German language and literature;
- 5,56% for research
- 5,56% all of the above
- 5,56% to talk to family and friends, for translations, TV, movies;
- 5,56% rarely.

The majority of the participants (82%) reported having contact with native speakers of German. In addition, 58,82% reported having been to Germany. From these, 30% spent up to 6 months there, 30% spent from 6 months to 2 years, 30% spent less than 2 months and 10% spent more than 2 years. At last, participants were asked to self-estimate their level of knowledge of German. Figure 23 illustrates their answer.





**Figure 23.** Self-estimation proficiency in German of the participants from the L3G.

As can be seen in Figure 23, most of the participants (52,94%) from the L3G considered themselves as having an intermediate proficiency level in German, 29,41% considered themselves at a basic level and only a few participants (17,64%) self-estimated their proficiency as advanced. In comparison with the results of self-estimation of their proficiency in English, there is a great difference. In English, most of the participants (58,82%) from the L3G, considered themselves as advanced, and some (41,17%) as intermediate. In addition, the comparison of the results of the self-estimation question and the vocabulary tests, show contradictory results, since in the vocabulary tests, participants from the L3G scored higher in German than in English. However, the vocabulary test is a more precise instrument to evaluate language knowledge.

Having presented the most relevant information regarding the two instruments used in data collection, the vocabulary test and the biographical questionnaire, this chapter goes on to present the data from the three experiments run. The first one to be presented in the next section is the eye-tracking experiment.

### 4.3 EXPERIMENT 1: SENTENCE COMPREHENSION TASK

The first experiment performed by participants in the present study consisted of the presentation of sentences in English, while the eye-tracker registered participants' eye movements. This experiment was designed in order to investigate the influence of cognates in the processing of English, by comparing fixation time between cognates and their respective controls in a sentence context. The design of this experiment has already been presented in the previous chapter (section 3.6.1). Nevertheless, due to the complexity of its design, I will briefly mention the most important aspect of the eye-tracking experiment.

Three groups took part in the eye-tracking experiment:

Native speakers of English – the L1G;

Native speakers of Brazilian Portuguese, with English as the L2 – the L2G;

Native speakers of Brazilian Portuguese, with German as the L2 and English as the L3 – the L3G.

The experiment included 6 conditions, three related to the cognate words, and three related to their respective controls (non-cognates that were equivalent to the cognate words in grammatical category, frequency and word length):

Condition 1: Double cognates between English and Brazilian Portuguese – CGEP;

Condition 2: Double cognates between English and German-  
CGEG;

Condition 3: Triple cognates among German, English, and Brazilian Portuguese – CGT;

Condition 4: Control for the cognate between English and Brazilian Portuguese – CTEP;

Condition 5: Control for the cognate between English and German – CTEG;

Condition 6: Control for the cognate among English, German, and Brazilian Portuguese – CTT.

The conditions CGT and CGEG are expected to have a stronger effect only for the L3G, whose participants have knowledge of German, whereas the performance of the L2G is a parameter to compare the results of the L3G and determine whether there are effects of the foreign language, German. Along the same lines, the performance of the L1G is

a baseline to evaluate whether the experiment was correctly designed and to compare the results of the other two groups.

As already explained in subsection 3.6.1.3, in order to analyze the data from the eye tracker, areas of interest must be drawn around the experimental sentences. Two regions of the experimental sentences were chosen to be analyzed in the present study: (1) the region containing the target word (cognate or control), and (2) the spillover region. Spillover is the processing of a word on the subsequent one, which occurs due to a delay in processing time (Rayner, 1998). The spillover region was further divided into two other regions: (1) the verb *was* that immediately followed the target word, and (2) the auxiliary verb *was* together with the verb in the 3<sup>rd</sup> form or the adjective that followed the target word. The spillover region can be seen in the following example:

Ex.: Mary said that the **actor** [(was) happy] with his career.

Critical word: CGEP actor

Spillover region 1: was

Spillover region 2: was happy

The example above shows the critical word (actor) and the spillover regions that immediately followed the critical word – spillover region 1 (was), and spillover region 2 (was happy). The next subsection presents the dependent and independent variables involved in this experiment.

#### **4.3.1 Dependent and independent variables of the eye-tracking experiment**

The independent variables of this experiment were of two types: group and cognate status. The independent variable *group* consisted of the L1G, L2G, and L3G. The independent variable *cognate status* was formed by the cognate types CGEP, CGEG, and CGT and their respective controls – CTEP, CTEG, and CTT.

On the other hand, the dependent variables of this experiment were related to fixation time. The eye tracker offers a series of measures to provide information regarding fixation time and these measures are interpreted as an indication of processing cost. It is assumed that the longer the processing time, the greatest the cognitive effort. Easier or simpler words might be processed faster. In line with these assumptions, it is assumed that cognates might be processed faster than non-cognate words. Mainly triple cognates, in the specific case of this study, since they have representations in the learners' three languages. For this

reason, one of the hypotheses of the present study is that triple cognates might be processed faster than double cognates.

Fixation time measures provided by the eye tracker are basically divided into early and late comprehension measures. Early comprehension measures are first fixation duration, first pass (or gaze duration). Late comprehension measures include second pass, regressions and go past; these measures are more informative for studies dealing with anaphoric resolution or integration processes. For the matter investigated in the present study, which is lexical access, early comprehension measures are more informative. The most important measure for the present study is first pass, which is the measure related to all of the fixations in the target region during the first time the participant reads the sentence. In other words, the measure of first pass consists of all of the fixations in the target region before the eyes move to the right or to the left of the target region.

One late comprehension measure analyzed in the present study was second pass. This measure is more informative for studies dealing with phrases or longer regions of interest and it is related to all the fixations made in the region of interest after the eyes have already left this region and reentered it for the first time.

First fixation is a more physiological measure and, for this reason, it is not very informative if analyzed alone. However, in the present study, the results of first fixation were analyzed in order to confirm the results of first pass. The next subsection presents the descriptive analysis of this experiment, where it can be seen that the results of the two measures – first pass and first fixation – were in the same direction.

### **4.3.2 Descriptive analysis**

This section presents the results of the descriptive analysis of the eye-tracking experiment. The main goal of this analysis was to compare fixation time (first pass, second pass and first fixation) between cognates and controls for each group, in each condition (CGEP-CTEP, CGEG-CTEG, CGT-CTT), both for the critical word and for the spillover region. Moreover, this analysis also aimed at identifying if there were great differences in the processing time of the different types of cognates among the three groups.

From the 44 participants that took part in the eye tracking experiment, 6 had to be excluded because they did not reach 90% of eye

data registered; 3 were excluded due to lack of proficiency in either of the foreign languages, German or English. Thus, the final sample of participants for this experiment consisted of 35 participants: 11 from the L1G, 11 from the L2G, and 13 from the L3G.

Before presenting the results of the dependent variables of the present study, it is important to determine the accuracy of the participants in answering the comprehension questions of the sentence-comprehension task. Even though this was not the main goal of this experiment, accuracy in responses indicates whether participants were paying attention to the sentences being presented or not. More specifically, the results of the comprehension questions show if participants were engaged in the task being performed. Table 19 presents the results of the mean accuracy of each participant in the comprehension questions, and Table 20 presents the results of mean, standard deviation, minimum and maximum scores for each group.

Table 19

*Participants' mean accuracy in answering the comprehension questions*

<b>Subject</b>	<b>Group</b>	<b>Mean accuracy</b>
P15	L1G	97,83%
P17	L1G	95,65%
P18	L1G	95,65%
P22	L1G	93,48%
P23	L1G	97,83%
P25	L1G	95,65%
P26	L1G	97,83%
P29	L1G	97,83%
P31	L1G	95,65%
P32	L1G	97,83%
P33	L1G	97,83%
P1	L2G	97,83%
P12	L2G	95,65%
P20	L2G	95,65%
P27	L2G	97,83%
P28	L2G	95,65%

P3	L2G	89,13%
P41	L2G	97,83%
P5	L2G	97,83%
P6	L2G	97,87%
P7	L2G	89,36%
P9	L2G	97,87%
P10	L3G	91,3%
P11	L3G	91,49%
P16	L3G	95,65%
P2	L3G	93,62%
P42	L3G	95,65%
P44	L3G	93,48%
P49	L3G	91,3%
P51	L3G	93,48%
P52	L3G	95,65%
P53	L3G	100%
P55	L3G	93,48%
P56	L3G	95,65%
P8	L3G	95,65%

N= 35; L1G=11; L2G=11; L3G=13

*Note: N= number of participants*

Table 20

*Participants' mean accuracy in answering the comprehension questions by group*

<b>Group</b>	<b>Mean</b>	<b>SD</b>	<b>Min</b>	<b>Max</b>
L1G	96,64%	1,5%	93,5%8	97,8%
L2G	95,68%	3,3%	89,1%	97,9%
L3G	94,34%	2,4%	91,3%	100%

N=35; L1G=11; L2G=11; L3G=13

*Note: N= number of participants*

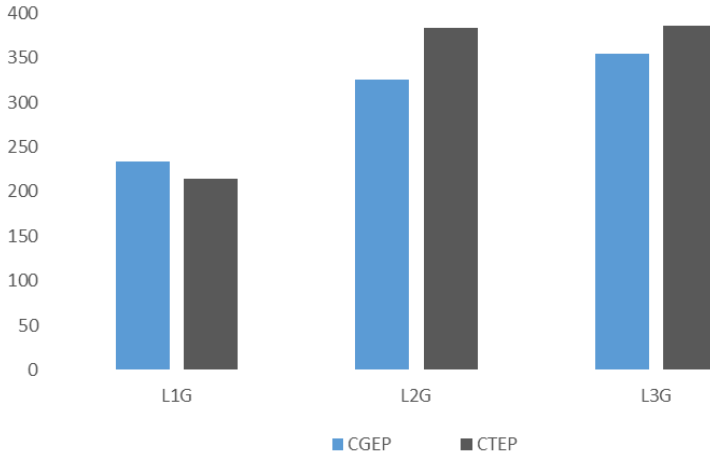
As demonstrated in Tables 19 and 20, the accuracy of the participants in answering the comprehension question indicates that they

were devoting attention to the task being performed. The lowest accuracy percentage was close to 90 (89,1%), whereas the maximum was 100. The mean accuracy of the three groups was in the range of 95%, which indicates an excellent performance of the participants of the three groups. It can also be highlighted that the performance of the nonnative speakers was very close to the one of the native speakers, whereas the L2G had a mean score of 95% and the L3G, 94%, the L1G scored 96%. This demonstrates that, concerning attention to the task, the three groups behaved similarly. These results are important to validate the eye-tracking experiment because they show that participants were devoting attention to the sentences being presented.

This chapter goes on to present the results of the dependent variables, which were analyzed in this experiment. As already mentioned, the most relevant measure to analyze lexical access is first pass. Therefore, the next subsection presents the results obtained for this measure.

#### 4.3.2.1 Results of first pass

This subsection presents the results obtained for the measure of first pass, which is the most informative measure regarding the goal of the present study, that is to investigate lexical access. Figure 24 illustrates the mean fixation time for the measure of first pass for the conditions CGEP and CTEP for the three groups of participants.



**Figure 24.** First pass for the condition CGEP and CTEP for the three groups.

As can be seen in Figure 24, the comparison of the conditions CGEP and CTEP for the three groups of participants does not seem to indicate any difference in processing time between conditions. The L1G took on average 200ms to read the target words, whereas the participants from the L2 and L3 groups took, on average, more than 300ms. These results might indicate some difference in processing time between native and non-native speakers. The literature presents evidence that native speakers of English take, on average, 225ms for reading a word of 8 letters silently (Rayner, 1998), which would be in agreement with the results of the native speakers (L1G) of the present study. More details for the comparison of the conditions CGEP and CTEP can be observed in Table 21, which presents the descriptive statistics with the results of the minimum and maximum scores, the median and mean, as well as the standard deviation for each group.



Table 21

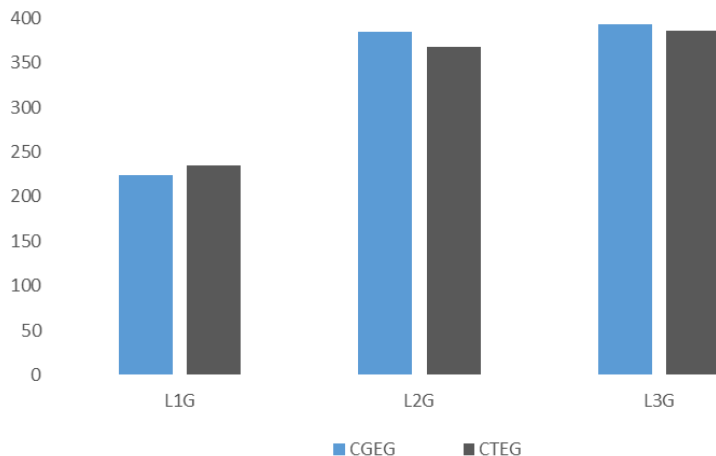
*First pass for the conditions CGEP and CTEP for the three groups*

		CGEP	CTEP
<b>L1G</b>	<b>Mean (SD)</b>	234,08 (63,48)	214,57 (34,14)
	Median	223,20	205,30
	Minimum	147,9	171,6
	Maximum	348,3	277,4
<b>L2G</b>	<b>Mean (SD)</b>	325,27 (66,58)	383,68 (96,31)
	Median	344,40	346,40
	Minimum	197	277,1
	Maximum	427,6	599,3
<b>L3G</b>	<b>Mean (SD)</b>	354,14 (66,58)	385,97 (88,82)
	Median	359,20	354,60
	Minimum	206,6	259,2
	Maximum	462,5	547,7

N=35; L1G=11; L2G=11; L3G=13

Note: *N*= number of participants; *SD*=Standard deviation

Table 21 shows that, for each group, the mean values of processing time for the measure of first pass were very similar in the two conditions (CGEP and CTEP), indicating no difference between them. For the L1G there was a small difference of 20ms between conditions (234ms for CGEP, and 214ms for CTEP). For the L2G, the mean fixation time for the condition CGEP was 58ms shorter than for the control condition – CTEG. However, for the L3G there was a shorter difference, the means were 354 and 385ms for the cognate and control conditions, respectively. In brief, these descriptive results indicate no difference between conditions CGEP and CTEP for the three groups. Next, Figure 25 presents the results of first pass for the condition of CGEG and CTEG for the three groups.



**Figure 25.** First pass for the condition CGEG and CTEG for the three groups.

It can be seen that Figure 25 presents similar results to the ones of Figure 24, where the behavior of the three groups was very similar, indicating that there was no effect of the cognate word. Moreover, the same behavior observed for the previous condition was confirmed, that is, the native speakers of English took on average 200ms to read the target words, whereas the non-native speakers took more than 300ms. These results can be better visualized in Table 22, which presents the descriptive statistics with the results of the mean, median, standard deviation, minimum and maximum scores for the measure of first pass for the conditions CGEG and CTEG for each group.

Table 22

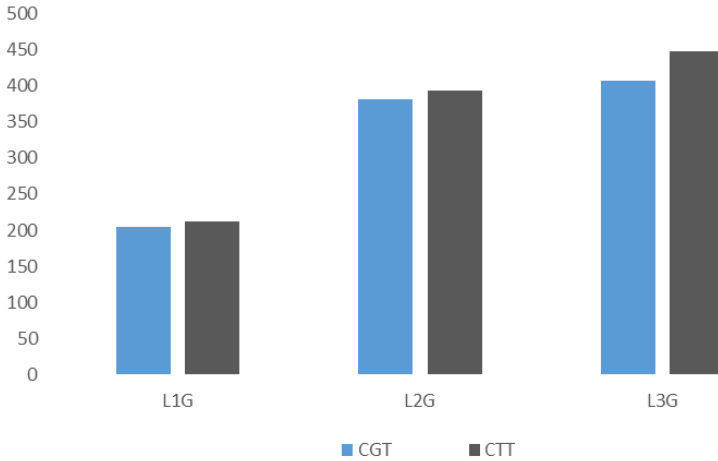
*First pass for the conditions CGEG and CTEG for the three groups*

		CGEG	CTEG
<b>L1G</b>	<b>Mean (SD)</b>	223,73 (33,85)	235,30 (66,34)
	Median	234,44	252,80
	Minimum	173,8	121,13
	Maximum	288,78	353,90
<b>L2G</b>	<b>Mean (SD)</b>	385,20 (83,20)	367,52 (75,99)
	Median	414,30	353,55
	Minimum	265,22	220,40
	Maximum	507,11	467,5
<b>L3G</b>	<b>Mean (SD)</b>	393,79 (83,85)	385,76 (90,78)
	Median	384,44	372,60
	Minimum	267,00	274,88
	Maximum	544,56	582,60

N=35; L1G=11; L2G=11; L3G=13

Note: *N*= number of participants; *SD*=Standard deviation

The analysis of the results presented in Table 22 confirms what was observed in Figure 25. The results of first pass of the cognates EG and EP seem to be very similar. For the L1G, the mean fixation time of the CTEG condition was only 12ms longer than for the CGEG condition. For the L2G, the mean fixation time for the CGEG condition was 18ms longer than the CTEG. For the L3G, the mean fixation time for the CGEG condition was only 8ms longer, on average, than the CTEG condition. These mean numbers show no difference between conditions, which means that there was no effect of the cognate condition CGEG for the three groups. Next, Figure 26 presents the results of first pass for the conditions CGT and CTT for the three groups of participants.



**Figure 26.** First pass for the critical word condition CGT and CTT for the three groups.

According to Figure 26, it seems that the comparison of the conditions CGT and CTT did not yield differences for each of the three groups. Regarding the mean fixation time, the behavior of the previous conditions was repeated: native speakers took on average 200ms to read the target words whereas non-native speakers took almost 400ms. These results can be better visualized in Table 23, which presents the descriptive statistics with the results of the minimum and maximum scores, the mean and median, as well as the standard deviation for the conditions CGT and CTT for each group.

Table 23

*First pass for the conditions CGT and CTT for the three groups*

		CGT	CTT
<b>L1G</b>	<b>Mean (SD)</b>	204,40 (39,89)	211,80 (38,83)
	Median	205,54	218,20
	Minimum	140,27	136,70
	Maximum	251,64	276,20
<b>L2G</b>	<b>Mean (SD)</b>	382,01 (58,39)	394,03 (78,19)
	Median	347,45	397,00
	Minimum	310,27	238,60
	Maximum	487,45	536,70
<b>L3G</b>	<b>Mean (SD)</b>	407,51 (124,65)	448,22 (160,79)
	Median	374,90	445,90
	Minimum	228,73	260,40
	Maximum	647,64	864,80

N=35; L1G=11; L2G=11; L3G=13

Note: *N*= number of participants; *SD*=Standard deviation

According to Table 23, it seems that for the L3G, the fixation time of the control condition was somewhat longer than that for the cognate condition (448ms for the CTT and 407ms for the CGT). These results might indicate some effect for this type of cognate. For the other groups, the results of the mean fixation time do not seem to indicate any difference between conditions. For the L1G, the mean fixation time for the condition of the CTT was only 7ms longer than for the CGT. For the L2G, the mean fixation time for the CTT condition was 12ms longer than the CGT.

In short, what it can be initially argued from the results presented in Figures 24, 25 and 26, together with Tables 21, 22 and 23, that the L2G and the L3G had a similar behavior, since the differences between cognates and their respective controls do not seem to be large for all of the groups. Moreover, the reading time of the L1G is consistent with the

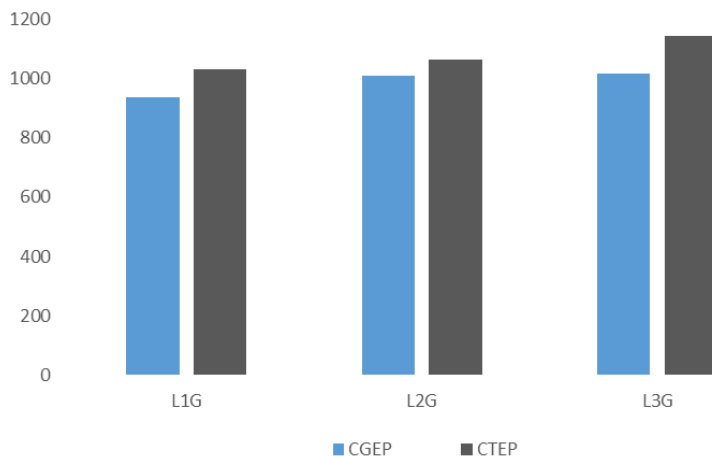
literature (Rayner, 1998). Nonnative speakers, on the other hand, took almost twice as much time to read the same words.

The analysis of the data also proceeded with the spillover region, which is the region that immediately follows the target one, since processing might spill on to the next word. A delay in processing time in the region immediately following the target one might indicate some effect of the experimental manipulation. Nevertheless, for the measure of first pass, for the present study, the analysis of the results for the region of spillover that immediately followed the target word did not yield any difference between the means. The processing time of the spillover regions of sentences containing cognates and controls was equivalent. Therefore, no effect of cognate conditions was observed in the region that followed the target one.

In brief, the results of the measure of first pass do not seem to indicate great differences between conditions (cognate-control). Having presented the results obtained for the measure of first pass, the next subsection presents the results obtained for the measure of second pass.

#### 4.3.2.2 Results of second pass

This subsection presents the results obtained for the measure of second pass, which is a late comprehension measure. Figure 27 presents the results of second pass for the conditions CGEP and CTEP for the three groups of participants.



**Figure 27.** Second pass for the condition CGEP and CTEP for the three groups.

As can be seen in Figure 27, the mean fixation time for the measure of second pass was above 800 ms and below 1200ms. The analysis of figure 27 shows that the second reading of the three groups was very similar between conditions and among groups. Differently from what was observed in the measure of first pass, for the measure of second pass the L1G did not present difference in processing time as compared to the groups of nonnative speakers. This result might be due to the fact that the sentences remained on screen for 15s, which might lead to an equivalent mean fixation time for all of the participants when late comprehension measures are analyzed. Next, Table 24 presents the descriptive statistics with the results of mean, median, standard deviation, minimum and maximum scores for the measure of second pass for the conditions CGEP and CTEP for the three groups of participants.

Table 24

*Second pass for the conditions CGEP and CTEP for the three groups*

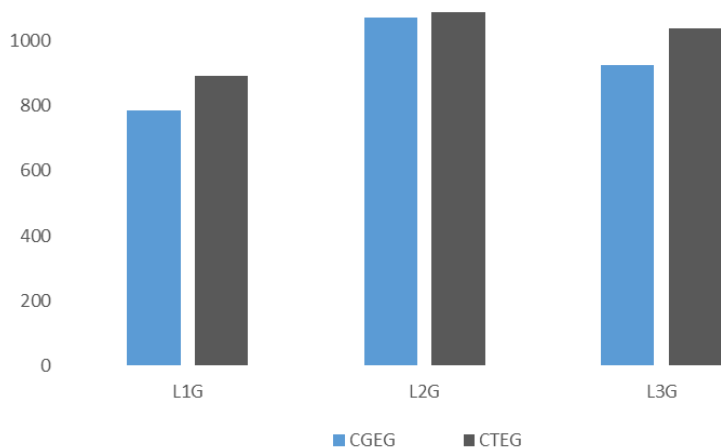
		CGEP	CTEP
<b>L1G</b>	<b>Mean (SD)</b>	938,22 (526,50)	1030,22 (450,36)
	Median	762,70	858,33
	Minimum	282,14	420,83
	Maximum	2106,00	2100,70
<b>L2G</b>	<b>Mean (SD)</b>	1010,87 (250,49)	1062,22 (337,59)
	Median	1034,50	979,10
	Minimum	583,40	671,70
	Maximum	1426,80	1731,60
<b>L3G</b>	<b>Mean (SD)</b>	1015,02 (286,14)	1145,07 (365,78)
	Median	1078,30	1096,66
	Minimum	464,20	657,66
	Maximum	1314,55	1914,60

N=35; L1G=11; L2G=11; L3G=13

Note: N= number of participants; SD=Standard deviation

As can be seen in Table 24, the results of second pass for the conditions CGEP and CTEP indicate a similar behavior among groups,

where all of them fixated less on the cognates than on the controls. Nevertheless, this does not seem to be a large difference. For the L1G, the mean fixation time for the CGEP was 938ms, whereas for the CTEP it was 1030ms. For the L2G, the means were 1010ms for the CGEP and 1062ms for the CTEP. For the L3G the means were 1015ms and 1045ms for the CGEP and CTEP, respectively. Next, Figure 28 illustrates the results obtained for the measure of second pass for the conditions CGEG and CTEG for the conditions CGEG and CTEG.



**Figure 28.** Second pass for the condition CGEG and CTEG for the three groups.

As can be seen in Figure 28, for the L1 and L3 groups, there seems to be a longer fixation time on the non-cognate word, whereas for the L2G, there appears to be no difference between the two conditions. It also has to be observed that the mean fixation time for the L1G did not differ from the one of the nonnative speakers. These results are presented in detail in Table 25, which presents the descriptive statistics with the results of mean, median, standard deviation, minimum and maximum scores, for the measure of second pass for the conditions CGEG and CTEG for the three groups of participants.



Table 25

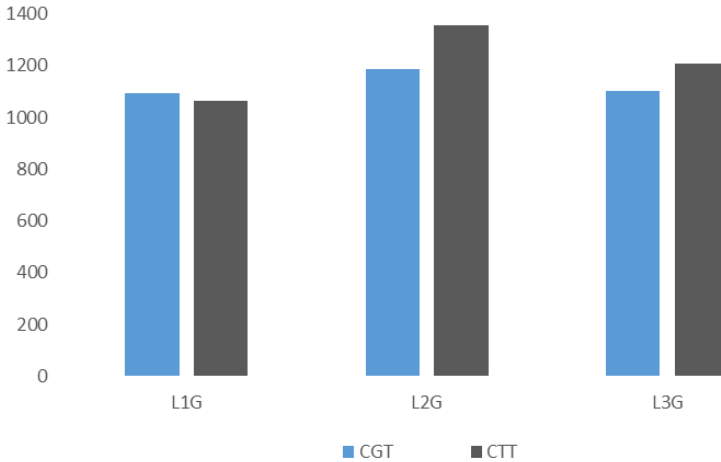
*Second pass for the critical word for the conditions CGEG and CTEG*

		<b>CGEG</b>	<b>CTEG</b>
<b>L1G</b>	<b>Mean (SD)</b>	785,01 (389,51)	891,08 (336,77)
	Median	749,55	864,33
	Minimum	314,16	389,00
	Maximum	1764,80	1355,70
<b>L2G</b>	<b>Mean (SD)</b>	1070,16 (196,90)	1086,52 (197,77)
	Median	1092,40	1048,66
	Minimum	760,30	794,90
	Maximum	1422,60	1466,40
<b>L3G</b>	<b>Mean (SD)</b>	923,57 (266,90)	1037,55 (367,93)
	Median	885,80	1070,00
	Minimum	613,44	542,00
	Maximum	1483,50	1697,90

N=35; L1G=11; L2G=11; L3G=13

Note: *N*= number of participants; *SD*=Standard deviation

According to Table 25, it can be seen that there was a longer fixation time in the non-cognate words for the L1 and L3 groups. For the L1G, there was a difference of 106ms between conditions (785ms for the CGEG and 891 for the CTT). For the L3G there was a difference of 114ms between conditions (923ms for the CGEG and 1037 for the CTEG). On the other hand, the results of the L2G are very similar, 1070ms for the CGEG and 1086ms for the CTEG. Next, Figure 29 illustrates the results obtained for the measure of second pass for the conditions CGT and CTT.



**Figure 29.** Second pass for the condition CGT and CTT for the three groups.

Figure 29 shows that there seems to be no difference between the conditions CGT and CTT for the L1G. For the L2 and L3 groups there seems to be a slightly longer fixation time for the condition CTT than for the condition CGT. This data can be better visualized in Table 26, which presents descriptive statistics with the results of mean, median, standard deviation, minimum and maximum scores for the measure of second pass for the conditions CGT and CTT for the three groups of participants.

Table 26  
*Second pass for the conditions CGT and CTT for the three groups*

		CGT	CTT
<b>L1G</b>	<b>Mean (SD)</b>	1092,25 (476,26)	1062,27 (413,97)
	Median	1163,54	1028,00
	Minimum	272,50	329,33
	Maximum	1963,90	1796,60
<b>L2G</b>	<b>Mean (SD)</b>	1184,77 (256,80)	1354,29 (367,22)
	Median	1270,10	1418,50
	Minimum	612,81	570,50
	Maximum	1433,18	1863,60
<b>L3G</b>	<b>Mean (SD)</b>	1103,37 (363,75)	1208,90 (351,37)
	Median	1013,72	1180,10
	Minimum	663,45	657,00
	Maximum	1946,54	1944,14

N=35; L1G=11; L2G=11; L3G=13

Note: N= number of participants; SD=Standard deviation

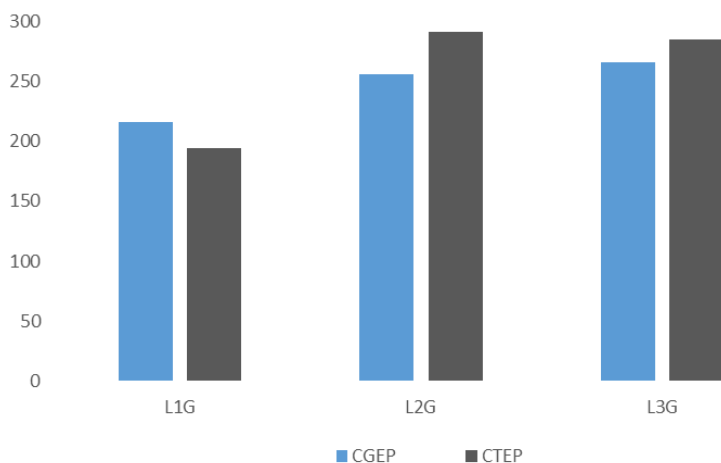
According to Table 26, it can be seen that for the L1G, the mean fixation time for the two conditions was very similar: 1092ms and 1062ms for CGT and CTT, respectively. On the other hand, the L2 and L3 groups demonstrated a greater difference between conditions. For the L2G, the CTT condition was 170ms longer than the CGT (1354ms and 1184ms, for CGT and CTT, respectively). For the L3G, the CTT condition was 105ms longer than the CGT condition (mean values: 1103ms for CGT and 1208ms for CTT). Nevertheless, the results do not indicate a large difference between conditions for the two groups.

In short, it can be seen that the analysis of the results of the measure of second pass did not yield great differences between conditions for the three groups of participants. Nevertheless, it has to be mentioned that these are results from a late comprehension measure, which might not be as informative as the measure of first pass to investigate lexical access. Another measure considered in the present study was first fixation. Even though this measure reflects more the

physiological process of vision than cognitive processing, these results seemed informative for the present study, confirming the results found for the measure of first pass. The results of the measure of first fixation are presented in the next section.

#### 4.3.2.3 Results of first fixation

This subsection presents the results obtained for the measure of first fixation. Figure 30 illustrates the results for the conditions CGEP and CTEP for the three groups of participants.



**Figure 30.** First fixation for the conditions CGEP and CTEP.

As can be seen in Figure 30, the comparison of mean fixation time between the two conditions CGEP and CTEP does not seem to yield large differences for any of the three groups. In addition, the difference of mean fixation time between native and nonnative speakers does not seem to be very large for this measure. This data can be better visualized in Table 27, which presents the descriptive statistics, with the results of mean, median, standard deviation, minimum and maximum scores for the measure of first fixation for the conditions CGEP and CTEP for the three groups of participants.

Table 27

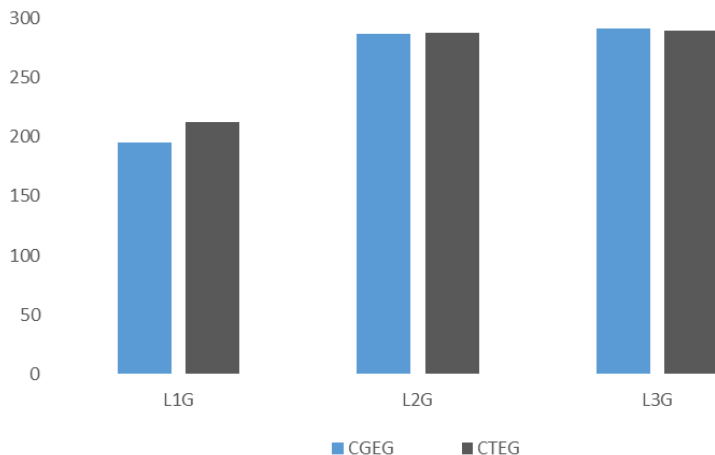
*First fixation for the conditions CGEP and CTEP for the three groups*

		<b>CGEP</b>	<b>CTEP</b>
<b>L1G</b>	<b>Mean (SD)</b>	215,73 (68,55)	194,62 (37,86)
	Median	217,00	194,80
	Minimum	117,10	139,00
	Maximum	348,30	258,70
<b>L2G</b>	<b>Mean (SD)</b>	256,32 (48,57)	291,20 (94,93)
	Median	256,50	256,30
	Minimum	196,90	211,80
	Maximum	319,80	520,60
<b>L3G</b>	Mean	265,52 (63,23)	284,59 (45,35)
	Median	244,50	278,10
	Minimum	182,20	208,20
	Maximum	375,80	357,50

N=35; L1G=11; L2G=11; L3G=13

Note: N= number of participants; SD=Standard deviation

Table 27 shows that the difference of mean fixation time observed in Figure 30 is indeed very small. The mean values of fixation time for the L1G were 215ms for the CGEP and 194ms for the CTEP, indicating a difference of 21ms. For the L2G, the mean difference between conditions was 35ms, 256ms for the CGEP and 291ms for the CTEP. For the L3G, the mean values were 265ms for the CGEP and 284ms for the CTEP, which represents a difference of 19ms. Next, Figure 31 illustrates the results obtained for the measure of first fixation for the conditions CGEP and CTEG.



**Figure 31.** First fixation for the condition CGEG.

As can be seen in Figure 31, for the three groups of participants, the comparison of the conditions CGEG and CTEG does not yield great differences of mean fixation time. Moreover, the difference of mean fixation time between native and nonnative speakers seems to be in the range of 100ms. These results can be seen in Table 28, which presents the descriptive statistics, with the results of mean, median, standard deviation, minimum and maximum scores for the measure of first fixation for the conditions CGEG and CTEG for the three groups of participants.

Table 28

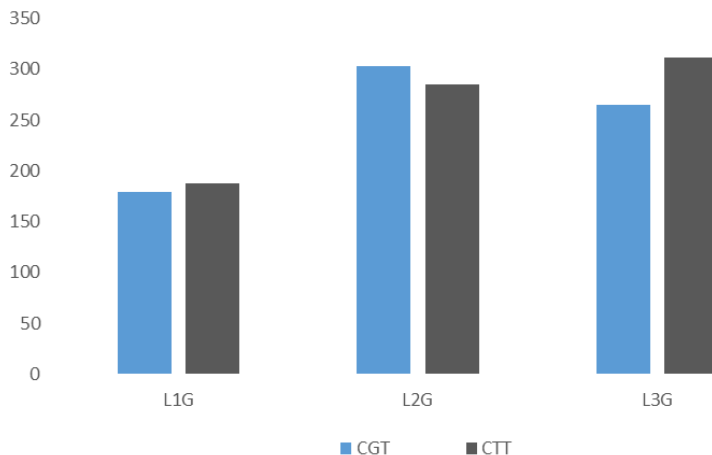
*First fixation for the conditions CGEG and CTEG for the three groups*

		CGEG	CTEG
<b>L1G *</b>	<b>Mean (SD)</b>	195,31 (29,96)	212,50 (54,52)
	Median	190,20	228,80
	Minimum	135,90	96,90
	Maximum	237,90	280,90
<b>L2G *</b>	<b>Mean (SD)</b>	286,66 (59,72)	287,30 (62,56)
	Median	313,80	279,50
	Minimum	199,10	212,40
	Maximum	370,20	411,60
<b>L3G **</b>	<b>Mean (SD)</b>	291,37 (57,58)	289,84 (78,68)
	Median	293,66	261,00
	Minimum	183,66	191,50
	Maximum	400,00	467,70

N=35; L1G=11; L2G=11; L3G=13

Note: *N*= number of participants; *SD*=Standard deviation

Table 28 shows that indeed the fixation time between conditions was equivalent for the three groups. For the L1G, the mean fixation time was 195ms for the CGEG and 212ms for the CTEG, which represents a difference of 17ms. For the L2 and L3 groups there is practically no difference between conditions. The mean fixation time for the L2G was 286ms for the CGEG and 287ms for the CTEG. For the L3G the mean fixation time was 291ms for the CGEG and 289ms for the CTEG. Next, Figure 32 shows the results obtained for the conditions CGT and CTT for the three groups of participants.



**Figure 32.** First fixation for the condition CGT.

According to Figure 32, it can be seen that the L1 and L2 groups had an equivalent processing time between conditions. As for the L3G, there seems to be a small difference between conditions CGT and CTT. As regards the difference in processing time between native and nonnative speakers, it seems to remain in the range of 100ms shorter for the native ones. This data can be observed in detail in Table 29, which presents the descriptive statistics with the results of mean, median, standard deviation, minimum and maximum scores for the measure of first fixation for the conditions CGT and CTT for the three groups of participants.



Table 29

*First fixation for the conditions CGT and CTT for the three groups*

		CGT	CTT
<b>L1G</b>	<b>Mean (SD)</b>	178,88 (37,35)	187,50 (40,92)
	Median	176,18	185,00
	Minimum	119,27	136,70
	Maximum	238,27	276,20
<b>L2G</b>	<b>Mean (SD)</b>	303,01 (34,03)	284,52 (60,37)
	Median	296,63	286,40
	Minimum	252,45	202,60
	Maximum	360,90	418,30
<b>L3G</b>	<b>Mean (SD)</b>	264,88 (73,76)	311,30 (97,03)
	Median	234,36	270,20
	Minimum	173,90	205,00
	Maximum	416,36	503,90

N=35; L1G=11; L2G=11; L3G=13

Note: *N*= number of participants; *SD*=Standard deviation

According to Table 29, it can be seen that for the L1G there was a very small difference of 9ms between the means (178ms for the CGT and 187ms for the CTT). For the L2G, there was a small difference of 19ms (303ms for the CGT and 284ms for the CTT). Indeed, the L3G was the one that demonstrated the greatest difference between conditions; controls were fixated 47ms longer than cognates (264ms for CGT and 311ms for CTT).

To summarize, the information presented in Figures 30 to 32 and Tables 27 to 29 showed that the results of the measure of first fixation do not demonstrate a large difference between cognates and controls for any of the groups. The next section contains information about the statistical analysis carried out with this data. The statistical tests will

determine whether the differences observed in the different conditions are significant or not.

### **4.3.3 Statistical analysis of the eye tracking data**

This subsection presents the results of the statistical analysis of the data from the eye-tracking experiment. This analysis is important to elucidate whether the differences observed in the mean values of fixation time for the measures of first pass, second pass and first fixation are significant or not. The first step into the inferential statistics is to analyze whether the distribution of the data approaches normality or not. Studies with human beings normally have a hard time approaching normality distribution, mainly when the number of participants is small such as in the case of the present study.

The analysis of the distribution of the data goes through the observation of the histogram, box plots –where outliers can be visualized – analysis of the mean and median, skewness, kurtosis and, finally, the last part of the analysis is to submit the data to the tests of normality. There are two tests of normality commonly used in research, Kolmogorov- Smirnov and Shapiro-Wilk. In order for the data to be considered normally distributed, these tests cannot reach significance. In other words, their result cannot be below 0,05. For the data of the present study, almost all of the results of first and second pass could be considered normally distributed. Nevertheless, the data from the measure of first fixation was not normally distributed. The results of the tests of normality Kolmogorov- Smirnov and Shapiro-Wilk for the measures of first pass, first fixation, and second pass are presented in Table 30.

Table 30  
*Results of the normality tests Kolmogorov- Smirnov and Shapiro-Wilk*

Condition	Group	First pass		First fixation		Second pass	
		Kolmogorov- Smirnov	Shapiro- Wilk	Kolmogorov- Smirnov	Shapiro- Wilk	Kolmogorov- Smirnov	Shapiro- Wilk
CGEP	L1G	,200	,496	,200	,895	,200	,163
	L2G	,200	,733	,200	,118	,200	,662
	L3G	,200	,950	,200	,478	,200	,088
CGEG	L1G	,200	,644	,200	,404	,086	,057*
	L2G	,200	,412	,141	,259	,200	,678
	L3G	,200	,413	,200	,875	,200	,349

CGT	L1G	,200	,281	,200	,928	,200	,998
	L2G	,026*	,185	,200	,762	,200	,038*
	L3G	,200	,389	,001*	,019*	,200	,080
CTEP	L1G	,200	,645	,200	,815	,200	,130
	L2G	,200	,218	,057*	,014*	,106	,119
	L3G	,200	,489	,200	,625	,200	,398
CTEG	L1G	,200	,804	,200	,447	,200	,402
	L2G	,200	,647	,073	,082	,200	,821
	L3G	,200	,268	,182	,228	,200	,446
CTT	L1G	,200	,959	,200	,293	,200	,821

L2G	,200	,961	,200	,495	,200	,614
L3G	,200	,059*	,148	,091	,080	,424

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N=35; L1G = 11; L2G = 11; L3G = 13

\* $p < 0,05$

*Note: N= number of participants*

According to Table 30, it can be seen that the results of the tests Kolmogorov-Smirnov and Shapiro-Wilk showed that the following data was not normally distributed: for the measure of first pass, the results of the L2G in the condition CGT (Kolmogorov-Smirnov), and for the L3G in the condition of CTT (Shapiro-Wilk); for the measure of first fixation, the results of the L3G in the condition of CGT (both tests), and the L2G in the condition CTEP (both tests); for the measure of second pass, the results of the L1G in the condition CGEG (Shapiro-Wilk), and the L2G in the condition CGT (Shapiro-Wilk). For this reason, I decided to use non-parametric tests to the statistical analysis of the data.

For each of the groups, a Wilcoxon test was carried out comparing the pairs of conditions CGEP-CTEP, CGEG-CTEG and CGT-CTT. In addition, a Mann-Whitney test was carried out in order to compare the groups in each cognate condition. Tables 31 to 33 present the results of the statistical test for the measures of first pass, second pass, and first fixation.

Table 31

*Results of Wilcoxon test for the measure of first pass*

		<b>CGEG- CTEG</b>	<b>CGEP- CTEP</b>	<b>CGT- CTT</b>
<b>L1G</b>	Z	-0,533	-0,889	-0,800
	Asymp.Sig. (2-tailed)	0,594	0,374	0,424
<b>L2G</b>	Z	-0,711	-1,423	-0,800
	Asymp.Sig. (2-tailed)	0,477	0,155	0,424
<b>L3G</b>	Z	-0,314	-0,943	-1,922
	Asymp.Sig. (2-tailed)	0,753	0,345	0,055*

N=35; L1G = 11; L2G = 11; L3G = 13

\*p<0,05

*Note: N= number of participants*

Table 32

*Results of Wilcoxon test for the measure of second pass*

		<b>CGEG- CTEG</b>	<b>CGEP- CTEP</b>	<b>CGT- CTT</b>
<b>L1G</b>	Z	-1,156	-1,156	-0,089
	Asymp.Sig. (2-tailed)	0,248	0,248	0,929
<b>L2G</b>	Z	-0,089	0,000	-1,600
	Asymp.Sig. (2-tailed)	0,929	1,000	0,110
<b>L3G</b>	Z	-1,363	-1,293	-1,433
	Asymp.Sig. (2-tailed)	0,173	0,196	0,152

N=35; L1G = 11; L2G = 11; L3G = 13

\*p&lt;0,05

*Note: N= number of participants*

Table 33

*Results of Wilcoxon test for the measure of first fixation*

		<b>CGEG- CTEG</b>	<b>CGEP- CTEP</b>	<b>CGT- CTT</b>
<b>L1G</b>	Z	-1,070	-1,245	-1,245
	Asymp.Sig. (2-tailed)	0,285	0,213	0,213
<b>L2G</b>	Z	-0,178	-0,889	-1,156
	Asymp.Sig. (2-tailed)	0,859	0,374	0,248
<b>L3G</b>	Z	-0,105	-1,363	-2,062
	Asymp.Sig. (2-tailed)	0,917	0,173	0,039*

N=35; L1G = 11; L2G = 11; L3G = 13

\*p&lt;0,05

*Note: N= number of participants*

As can be seen in Table 31, the comparison of the mean fixation time for the measure of first pass for the conditions CGEG-CTEG, CGEP-CTEP, and CGT-CTT resulted in a significant difference only for the L3G for the condition of the CGT. This result favors the cognate facilitation effect, since processing time was shorter for the cognate word, as compared to its control. As for Table 32, it can be seen that the

comparison of the conditions CGEG-CTEG, CGEP-CTEP, and CGT and CTT for the measure of second pass did not yield any significant  $p$  value. On the other hand, it can be seen in Table 33 that the comparison of the conditions CGEG-CTEG, CGEP-CTEP, and CGT-CTT for the measure of first fixation was significant for the L3G for the condition CGT. This result confirms the one obtained for the measure of first pass, also favoring the cognate facilitation effect. Next, Table 34 presents the results of the comparison of the three groups regarding each cognate condition CGEG, CGEP and CGT, for the measure of first pass.

Table 34

*Results of Mann-Whitney for the measure of first pass*

		<b>L1G-L2G</b>	<b>L1G-L3G</b>	<b>L2-L3G</b>
<b>CGEG</b>	Z	-3,842	-4,027	-0,029
	Asymp.Sig. (2-tailed)	0,000*	0,000*	0,977
<b>CGEP</b>	Z	-2,791	-3,331	-1,072
	Asymp.Sig. (2-tailed)	0,005*	0,001*	0,284
<b>CGT</b>	Z	-3,973	-3,911	-0,377
	Asymp.Sig. (2-tailed)	0,000*	0,000*	0,706

N=35; L1G = 11; L2G = 11; L3G = 13

\* $p < 0,05$

*Note: N= number of participants*

As can be seen in Table 34, the comparison of the L1G with the other two groups was significant for all of the cognate conditions. This result confirms the difference observed in fixation time for native and nonnative speakers. As for the comparison of the L2 and L3 groups, no condition yielded a significant  $p$  value. This shows that the two groups had similar fixation time for the measure of first pass for the three cognate conditions. Next, Table 35 presents the results of the statistical analysis for the comparison of the three groups in each cognate condition for the measure of second pass.



Table 35

*Results of Mann-Whitney for the measure of second pass*

		<b>L1G-L2G</b>	<b>L1G-L3G</b>	<b>L2-L3G</b>
<b>CGEG</b>	Z	-2,725	-1,419	-1,767
	Asymp.Sig. (2-tailed)	0,006*	0,156	0,077
<b>CGEP</b>	Z	-1,149	-1,072	-0,492
	Asymp.Sig. (2-tailed)	0,250	0,284	0,622
<b>CGT</b>	Z	-0,558	-0,087	-1,188
	Asymp.Sig. (2-tailed)	0,577	0,931	0,235

N=35; L1G = 11; L2G = 11; L3G = 13

\*p&lt;0,05

*Note: N= number of participants*

As can be seen in Table 35, the results of the Mann-Whitney test for the measure of second pass showed that the only significant comparison between groups was from the L1G with the L2G for the CGEG condition. Differently from the results of the measure of first pass, which were significant for the comparison of the L1G with the other two groups, for this measure, all three groups behaved similarly. This result might be due to the fact that the sentences remained on screen for 15s during the experimental session. Therefore, the fixation time for late comprehension measures, such as second pass are equivalent for the three groups. Next, Table 36 presents the results of the statistical analysis for the measure of first fixation, comparing the three groups in the three cognate conditions.

Table 36

*Results of Mann-Whitney for the measure of first fixation*

		L1G-L2G	L1G-L3G	L2G-L3G
<b>CGEG</b>	Z	-3,448	-3,564	-0,319
	Asymp.Sig. (2-tailed)	0,001*	0,000*	0,750
<b>CGEP</b>	Z	-1,609	-1,825	-0,145
	Asymp.Sig. (2-tailed)	0,108	0,068	0,885
<b>CGT</b>	Z	-3,973	-3,331	-2,115
	Asymp.Sig. (2-tailed)	0,000*	0,001*	0,034*

N=35; L1G = 11; L2G = 11; L3G = 13

\*p&lt;0,05

*Note: N= number of participants*

As can be seen in Table 36, the comparison of the L1G with the other two groups yielded significant  $p$  values for the cognate conditions CGEG and CGT. Regarding the comparison of the results of the L2 and L3 groups, the only significant  $p$  value was for the cognate condition CGT. This result is in line with the one previously reported, regarding the significant difference of mean fixation time for the CGT condition as compared to the CTT condition for the L3G. The significant difference between the L2 and L3 groups confirms the facilitation effect of the triple cognate for the L3G.

In short, the results of the statistical analysis showed that the comparison of the conditions CGT-CTT was only significant for the L3G for the measures of first pass and first fixation. For the measure of second pass, no significant differences between the means were found. The comparison of the results of the condition CGT between the groups L2 and L3 also yielded a significant  $p$  value ( $p<0,05$ ). These results suggest an effect of the triple cognate in the comprehension of the sentences in English. Nevertheless, no significant effect of the double cognates were found in the present study for either of the groups. Additionally, the results of the measure of first fixation corroborate the ones found for the measure of first pass.

Finding no significant differences between conditions for the control group can be interpreted as evidence that the experiment was correctly designed. That is, equivalent processing time for cognates and

controls for the L1G indicates no intervenient variable regarding the choice of the cognate-control pair. In addition, it is important to observe the significant difference between the L1 group (control) and the experimental groups. This shows that the experimental design was correct, since it is expected a faster processing time of native speakers as compared to non-native speakers. Another important result to be observed is the one related to the difference between cognates and controls: this difference favored the cognate facilitation effect. In other words, non-cognates have a higher processing cost. This result also confirms the hypothesis of the present study, which are discussed at the end of this chapter (section 4.7). The results of the eye-tracking experiment are discussed in the next subsection.

#### **4.3.4 Discussion of the results of the eye-tracking data**

The results of the eye-tracking experiment showed that the reading time of the native speakers was shorter than that of the nonnative speakers, at least when early comprehension measures (first pass and first fixation) were analyzed. The reading time of the L1G was consistent with the literature (Rayner, 1998) – approximately 200ms for the critical words. Nonnative speakers, on the other hand, took almost twice as much time to read the same words (300 to 400ms on average). This is evidence that the experiment was well designed since the native speakers of English read the cognate and control words, in 200ms, on average, which is indicated in the literature (Rayner, 1998). In addition, there seems to be no difference in any of the three conditions for the processing time of the cognate and control words for the control group. This also confirms the validity of the experiment, indicating the existence of no intervenient variable in the matching of the cognate-control pair of words.

Regarding the difference between conditions, the results of the eye-tracking experiment demonstrated some effect for the triple cognate among German, English, and Brazilian Portuguese for the trilingual speakers ( $p=0,05$  for the measure of first pass, and  $p= 0,03$  for the measure of first fixation). This effect was evident in the shorter processing time of these cognates as compared to their respective controls in the measures of first pass and first fixation. These results suggest that the triple representation of the cognate word in the trilinguals' languages shortens the path to the lexical access of these words, and this is reflected in a shorter processing cost/time.

These results are in line with other studies reported in the literature, which also found evidence for the cognate facilitation effect. The fact that for the L2G there were no significant differences between cognate and control for this specific condition (CGT) confirms that the results found are indeed the result of trilingualism and of the representation of this cognate word in the participants' three languages.

The results of the present study are in line with the ones found by Lemhöfer, Dijkstra and Michel (2004), in which triple cognates facilitated comprehension more than double cognates did. Nevertheless, the present study failed to find a significant effect of the facilitation of double cognates (for each of the groups  $p > 0,05$  for the comparison of mean fixation time between conditions CGEP and CTEP, and CGEG and CTEG). The results of the present study showed no difference between double cognates (CGEG and CGEP) and their respective controls, however, this result does not disconfirm the hypothesis of the cognate facilitation effect, since the opposite effect was also not observed. That is, the comparison of the conditions CGEP-CTEP and CGEG-CTEG did not yield significant differences; controls were processed neither at a slower nor at a faster rate than cognates, for each of the three groups.

Regarding other studies with cognates reported in the literature, the study by Poarch and Van Hell (2012) found evidence of the cognate facilitation effect for bilinguals and trilinguals. However, in their study, the focus was language production – naming pictures that represented cognates, not comprehension.

The studies by Dijkstra, Grainger and Van Heuven (1999), and Lemhöfer and Dijkstra (2004) also found evidence for the cognate facilitation effect in a lexical decision task when both orthography and semantics overlapped, as is the case of the present study, where cognates overlapped in both orthography and semantics. However, their studies also aimed at language production, while in the present study the eye-tracking experiment aimed at language comprehension.

Schwartz and Kroll (2006) investigated the cognate facilitation effect in high and low constraint sentences, where participants had to name the critical word. The sentences were presented one word at a time and reaction time was registered. The researchers found evidence for the cognate facilitation effect only for low constraint sentences, that is when the context of the sentence does not provide information for the critical word to be predicted, as in the experimental sentences of the present study. The study by Schwartz and Kroll (2006) focused on production, even though the input was provided through written text.

Along the same lines, Libben and Titone (2009) found evidence for the cognate facilitation effect for French-English bilinguals, using the eye movement recording technique, both for low and high constraint sentences, for early comprehension measures (first fixation and first pass). However, for late comprehension measures, their study also failed to find evidence of the cognate facilitation effect, as in the present study.

Titone, Libben, Mercier, Whitford & Pivneva (2011) also relied on the eye movement recording technique to investigate the cognate facilitation effect. They found that the effect was greater when the L2 was acquired earlier, additionally; the cognate facilitation effect decreased with high constraint sentences. This result suggests that when language comprehension rather than production is the focus of the study, the cognate facilitation effect may be influenced by other variables, such as the context where the sentence is embedded and the age of acquisition of the L2.

The extension of the cognate facilitation effect from nouns to verbs was investigated by Van Assche, Duyck and Brysbaert (2013), also using the eye-tracker. They found that the cognate facilitation effect was not modulated by verb tense, however, the cognate facilitation effect was only found for late comprehension measures (go-past), contrary to the present study and to the study by Libben and Titone (2009). Nevertheless, it has to be observed that Van Assche, Duyck and Brysbaert (2013) investigated the cognate facilitation effect with verbs, while both the present study and the one by Libben and Titone (2009) focused on nouns.

An interesting conclusion to be pointed out is the one of the study by Marian, Spivey and Hirsch (2003), who investigated spoken language processing using the eye movement recording technique. They concluded that even when the environment is monolingual, the two languages of the bilingual are activated.

Another study (Titone et al., 2011) that also relied on the eye movement recording technique to investigate lexical access found evidence for the cognate facilitation in a reading task in the participants' L1. This study showed that the L2 lexicon interferes with the L1. The results of the present study together with the ones by Titone et al (2011) and the ones by Marian, Spivey and Hirsch (2003) favor the view that even when the intention of the speaker is to use only one language, the lexicons of the other languages may be activated, causing some interference.

In short, it can be seen that the results of the present study are partially in line with those reported in the literature. The results of a

greater facilitation of triple cognates as compared with double cognates are supported in the literature. Nevertheless, the present study failed to find evidence for the cognate facilitation effect when double cognates – between Brazilian Portuguese and English, and between German and English – were analyzed. For this experimental condition, there was no difference between cognates and controls.

Eye movements are a good measure to infer cognitive processing, mainly comprehension, as in the present study, since, according to Rayner (1998), in more complex information processing tasks such as the ones involving sentence comprehension, the relationship between eye position and attention is very strong. However, at the same time, the measure provided by the eye movement recording technique is a very sensitive one. Therefore, one explanation that might be offered for the results of the present study is that the effect of double cognates was not strong enough to be demonstrated in this measure for such a small sample of participants. We can hypothesize that the triple cognates, having representations in the trilinguals' three languages, have a stronger facilitation effect than the double cognates, which was demonstrated in the present study. However, it cannot be stated that the double cognates have no facilitation effect. The most relevant part of this discussion is to understand how the results of this experiment contribute to the literature on lexical access and multilingualism. The results of the triple cognates suggest that lexical access is not restricted to the target language, contradicting the hypothesis that in sentence context lexical access would be restricted only to the target language, which in the case of the present study is English. Therefore, the results of this experiment favor the hypothesis of language non-selectivity, where all the languages of the trilingual are activated and compete for selection. Having presented and discussed the results of experiment 1, the next section presents the results of the second experiment carried out, the narrative production experiment.

#### 4.4 EXPERIMENT 2: NARRATIVE TASK

This experiment was designed with the main goal of analyzing the production of triple cognates in an oral task. Besides, this experiment was also designed in order to triangulate the results of the other two experiments, since the first experiment presented dealt with cognates in lexical access in language comprehension and the next experiment to be presented (section 4.5) deals with lexical access in

language production. Therefore, the main goal of this experiment was to submit trilingual speakers to cognates and to analyze the production of these words as compared to the bilingual speakers. A secondary goal of this experiment was to analyze whether there were instances of crosslinguistic influences in the participants' spontaneous oral production. That is, if the L1 (Brazilian Portuguese) or the L2 (German) influenced the oral production in English.

Narratives are a good means to collect data that are more spontaneous from language production. Therefore, the option to include this experiment in the present study. Participants were presented to four pictures whose main plot was a boy looking for a frog together with his dog. Participants had no time to prepare the story, only to organize the four pictures into the order they found more convenient.

The cognate words were taken from the database developed for the eye-tracking experiment. As already presented in the method chapter (section 3.6.2.1), there was a total of 25 items represented in the pictures of this story. From these items, 12 were CGEG (cognates English-German), 2 were CGEP (cognates English-Portuguese), 4 were CGT (Cognates English-German-Portuguese), and 7 were non-cognates.

The story narrated by participants was audio recorded and further transcribed (see Appendix D for transcriptions). Table 37 presents the results of the number of times that the cognate words from each condition appeared in the narrative produced by the participants from the L2 and L3G.

Table 37  
*Results of the narrative production experiment*

<b>Participants</b>	<b>Group</b>	<b>CGEG</b>	<b>CGEP</b>	<b>CGT</b>
P1	L2G	9	0	0
P12	L2G	5	0	2
P20	L2G	9	5	2
P24	L2G	9	2	1
P28	L2G	9	4	1
P3	L2G	22	0	3
P4	L2G	11	5	5
P5	L2G	3	5	0
P6	L2G	7	4	2
P7	L2G	4	5	3

P8	L2G	10	3	5
P9	L2G	8	0	1
<b>Total</b>		<b>106</b>	<b>33</b>	<b>25</b>
P10	L3G	10	0	1
P11	L3G	13	0	3
P13	L3G	11	1	0
P16	L3G	4	0	0
P21	L3G	9	5	3
P41	L3G	5	12	0
P42	L3G	15	0	0
P44	L3G	11	0	0
P49	L3G	29	8	2
P50	L3G	12	0	1
P51	L3G	0	2	0
P52	L3G	6	1	0
P53	L3G	4	8	1
P54	L3G	12	0	3
P55	L3G	8	3	2
P56	L3G	3	11	0
<b>Total</b>		<b>152</b>	<b>51</b>	<b>16</b>

N= 28; L2G: 12; L3G: 16

*Note: N= number of participants*

The results presented in Table 37 show that the L3G produced more cognates EG than the L2G (152 and 106). This result could indicate the effect of the foreign language German, facilitating the production of this type of cognate. As regards the other cognate types, the results are equivalent between groups. The L3G produced more cognates EP than the L2G (51 as compared to 33), however, for the triple cognates the L2G produced 25 cognates whereas the L3G only 16. Therefore, it is not possible to conclude whether these results are indeed due to the type of the cognate word or to the importance of the word in the story.

Regarding crosslinguistic influences, there were only a few instances in the narratives produced. From the 28 narratives produced,



in only 4, an instance of crosslinguistic influences was found. These four participants who showed some interference from the other non-target languages in their narratives were all from the L3G. The oral narratives produced by the participants from the L2G were all restricted to the target language, English. The instances of crosslinguistic influences are presented in examples 1 to 4:

Ex. 1 (P20 – L3G): *He **depair** to a mouse party in the cornfields...*

Ex. 2 (P16 - L3G): ***Dann**, as both the boy and his dog were asleep the mouse managed to get away...*

Ex. 3 (P51 – L3G): *...he wanted to take them off, **come é que fala isso?***

Ex.4 (P54 – L3G): *...he looked for the mouse in a place with seven trees and a...**Esqueci o nome disso aqui.***

The examples 1 to 4 show instances of crosslinguistic influences, that is, the influence of the non-target languages in the oral production of English. In example 1 the participant used the word form *depair* in his sentence, which is not a word in any of the trilinguals' languages. However, it can be inferred that this word form *depair* was a modification of the verb *deparar-se* from the participants' L1 – Brazilian Portuguese. This instance of crosslinguistic influence is very common in foreign language production; it occurs when the speaker cannot access the intended word in the target language and uses another from the non-target language instead. In the specific case of example 1, this instance of crosslinguistic influence had its form and/or pronunciation adapted into the target language, which can be classified as the phenomenon of foreignising (Cenoz, 2001). In example 2, the participant used the translation equivalent of the adverb *then* in German, which is *dann*. In this case, the participant might have accessed the German word faster than its English translation. This is an example of an instance of crosslinguistic influence classified as borrowing (Cenoz, 2001). The difference of these two phenomena, borrowing and foreignising, is that in the former one the word in the non-target language is used in its original form, with no modification/adaptation into the target language. On the other hand, whereas in examples 1 and 2 participants' influence of the non-target languages (L1 and L2) was demonstrated in a single word (*depair* – from Brazilian Portuguese, and *dann* – from German), in examples 3 and 4, the instance of crosslinguistic influence that occurred was a code switching. That is when the participant changes the language being used in the middle of the sentence and may also, later switch back to the target language

(Cenoz, 2001). All of the cases of crosslinguistic influences mentioned in this analysis – borrowing, foreignising, and code switching are classified as a transfer of form phenomena, that is when the speaker is influenced by a similar word/form from the non-target language (Ringbom, 2001).

In short, what can be concluded from this experiment is that there was not much influence of the non-target languages in the narrative oral production of the participants from the L2 and L3 groups. There were only a few instances of crosslinguistic influences and the cognates that were represented in the pictures did not seem to cause a great effect in the trilinguals' production. In the previous experiment, it was seen that even in a monolingual task, the presence of cognates influences language comprehension. This indicates that the lexicon of the other non-target languages is not completely deactivated even when not being required. However, in the present experiment, the same cognate words did not seem to affect lexical access during language production. This might indicate that at the level of proficiency of these participants (intermediate to advanced), their executive control is able to impede interference of the non-target languages, whereas in the eye-tracking experiment, cognitive processing indicated influence from the non-target languages, the present experiment pointed to more self-monitoring from the trilingual participants. The next section presents the results of the picture-naming task with cross-language priming.

#### 4.5 EXPERIMENT 3: PICTURE NAMING TASK WITH THE MASKED PRIMING PARADIGM

This experiment was designed in order to evaluate the influence of the non-target languages in the lexical access of English in a task focused on language production. The masked priming paradigm was chosen to prevent participants from developing learning strategies. In this experiment, participants had to name 72 pictures in English, as fast and accurately as they could. Before each of these pictures, the name of the picture to be named appeared on the computer screen for approximately 30ms, in English, Brazilian Portuguese or German.

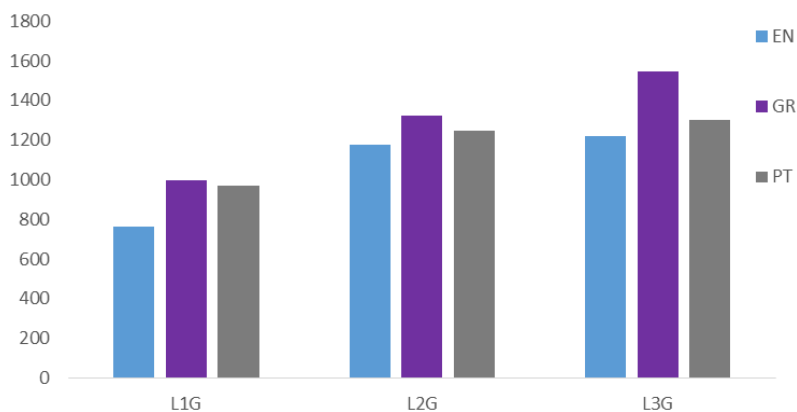
The independent variables of this experiment were of two types: group and priming word. The group variable was composed by the L1G, L2G and the L3G. The priming word could appear in any of the three languages: English, German or Brazilian Portuguese. In other words, there were three conditions for the presentation of the prime:

- 1- The name of the picture in the target language - English;
- 2- The translation equivalent of the name of the picture in German.
- 3- The translation equivalent of the name of the picture in the participants' native language – Brazilian Portuguese.

The dependent variable of this experiment was reaction time. It is assumed that the faster the response, that is, the shorter the participants starts uttering, the greatest the facilitation effect of the prime word. On the other hand, a delay in reaction time might be associated with an interference of the prime word. The next subsection presents the descriptive analysis of the present data, where the mean reaction time for each condition is presented.

#### 4.5.1 Descriptive analysis

This subsection presents the results obtained for the cross-language priming experiment with the masked priming paradigm. The results of reaction time of the three groups of participants in the three experimental conditions –prime word in English, German or BP – are presented and discussed. Figure 33 illustrates the behavior of the three groups in the three conditions of this experiment.



**Figure 33.** Reaction time for the three groups in the three conditions.

The analysis of Figure 33 shows that the control group (L1G) had the shortest reaction time from the three groups, irrespective of the prime word presented. This result confirms the design of the present study, where native speakers of English named pictures faster than nonnative speakers. By the graphic, it can also be observed that for the L1G, no difference was found in the reaction time when the prime word was presented in German or Brazilian Portuguese. On the other hand, the prime word in English apparently caused a faster response, which is an expected result, since the prime word in the target language activates the semantic/ conceptual representation of the word as well as its orthographic representation.

Additionally, according to Figure 33, for the three groups, the shortest reaction time occurred when the prime word was presented in English. The prime word presented in Brazilian Portuguese elicited a faster response than when presented in German. It also seems that the behavior of the L2 and L3 groups was very similar, except for the greater effect observed for the results of the prime word in German for the L3G, which is an expected result, since only the participants of this group knew German. Table 38 provides the descriptive statistics for this data, with the results of the mean, median, standard deviation, maximum and minimum scores for the three groups and conditions.

Table 38

*Reaction time for the picture-naming task for the three groups and three conditions*

	<b>PRIME WORD</b>	<b>EN</b>	<b>GR</b>	<b>BP</b>
<b>L1G</b>	<b>Mean</b> (SD)	759,99 (129,00)	1000,88 (139,37)	968,81 (140,11)
	<b>Median</b>	770,25	965,78	918,73
	Minimum	526,46	858,58	779,21
	Maximum	1048,43	1360,59	1285,52
<b>L2G</b>	<b>Mean</b> (SD)	1190,88 (313,26)	1323,90 (183,03)	1263,63 (275,48)
	<b>Median</b>	1113,16	1311,19	1252,15
	Minimum	839,05	1024,12	783,47
	Maximum	1848,33	1720,24	1822,93
<b>L3G</b>	<b>Mean</b> (SD)	1217,59 (232,37)	1546,05 (249,04)	1312,98 (220,82)
	<b>Median</b>	1155,57	1562,14	1370,43
	Minimum	890,80	1082,89	814,41
	Maximum	1757,65	1929,88	1608,05

N=41; L1G=13; L2G=12; L3G=16

*Note: N=number of participants; SD=standard deviation*

According to the results presented in Table 38, it can be seen that when the prime word was presented in English there was practically no difference between the reaction time of the participants from the L2G (1190ms) and the L3G (1217ms). This result shows that the behavior of the two groups was very similar. Moreover, for the L1G, the prime word in German caused a delay of 241ms, equivalent to 24% of the reaction

time (1000 – 759). When the prime word was presented in Brazilian Portuguese, for the L1G, there was a delay of 209ms equivalent to 21% (968-759) of the reaction time. This difference was a little bit smaller than the difference between English and German primes. These results show that the reaction time for the control group (L1G) did not differ when the presentation of the prime word was in Brazilian Portuguese or in German. It means that, for the L1G, there was not a large difference between the prime words in the non-target languages.

For the L2G, the presentation of the prime word in English, German or Brazilian Portuguese does not seem to yield large differences in reaction time. On the other hand, for the L3G, an increase of 329ms is observed, which corresponds to 21% (1546-1217) of the reaction time when compared to the time spent to name the picture when the prime word was in English or in German. For the L3G, this difference was not so large when the prime word was presented in Portuguese, as compared to English: only 95ms longer for the response with the prime word in Brazilian Portuguese.

Since it was not possible to control the knowledge of other languages of the native speakers of English, I decided to analyze whether this could be an intervenient variable in this experiment. For this reason, a comparison was made between the results of reaction time of the participants from the L1G who knew Brazilian Portuguese and the ones that had no knowledge of Brazilian Portuguese, the results were the following, as demonstrated in Table 39.

Table 39

*Comparison of the mean reaction time of participants from the L1G with/without knowledge of Brazilian Portuguese*

<b>Prime word</b>	<b>EN</b>	<b>GR</b>	<b>BP</b>
All of the participants from the L1G *	759ms	1000ms	968ms
Native speakers of English without knowledge of BP	740ms	1012ms	955ms

\*N=13; \*\*N=8

Note: N=number of participants

As can be seen in Table 39, even though knowledge of Brazilian Portuguese or other Latin languages was not controlled, it cannot be seen as an intervenient variable, since the results of the L1G were not altered when participants with knowledge of Brazilian Portuguese were removed from the analysis. The results of mean reaction time remained very similar when participants with knowledge of Brazilian Portuguese were removed from the analysis. For instance, when the prime word was presented in the target language – English – the mean reaction time was 759ms for all of the participants from the L1G, and 740ms for the participants without knowledge of Brazilian Portuguese. As for the other prime words (in German and Brazilian Portuguese), the mean reaction time did not differ: for the prime word in German, the mean reaction time was 1000ms for all of the participants from the L1G, and 1012ms when only the participants that have no knowledge of Brazilian Portuguese were considered. The same occurs when the prime word was presented in Brazilian Portuguese: when all of the participants from the L1G were considered, the reaction time was 968ms; when only the participants of the L1G without knowledge of Brazilian Portuguese were considered the mean reaction time was 955ms. These results of mean reaction time (759/740ms; 1000/1012ms; 968/955ms) indicate that knowledge of Brazilian Portuguese did not interfere with the results of the cross-language priming experiment. The next section presents the statistical analysis of this experiment, where the differences between the experimental conditions were analyzed in order to see if they were significant or not.

#### **4.5.2 Statistical analysis of the cross-language priming experiment**

This subsection presents the results of the statistical tests carried out in order to verify if the difference between the means observed in the descriptive analysis are significant or not. As already explained in section 4.3.3, before carrying out the statistical tests, the distribution of the data must be analyzed. In order to check for normality distribution, histogram, box plots –where outliers can be visualized – mean and median, skewness and kurtosis were analyzed. At last, the data was submitted to the tests of normality Kolmogorov- Smirnov and Shapiro-Wilk. In order for the data to be considered normally distributed, these tests cannot reach significance. In other words, their result cannot be below 0,05. According to the normality tests of Kolmogorov-Smirnov,

the data of the L1G and L3G could be considered as normally distributed. However, the data from the L2G was not normally distributed. For the normality test Shapiro-Wilk, none of the groups could have their data distribution considered normal. The results of the normality tests Kolmogorov-Smirnov and Shapiro-Wilk are presented in Table 40.

Table 40

*Results of the normality tests Kolmogorov- Smirnov and Shapiro-Wilk*

<b>Prime word</b>	<b>Group</b>	<b>Kolmogorov- Smirnov<sup>a</sup></b>	<b>Shapiro-Wilk</b>
EN	L1G	,200	,763
	L2G	,015*	,010*
	L3G	,200	,253
GR	L1G	,200	,047*
	L2G	,137	,489
	L3G	,200	,688
BP	L1G	,200	,445
	L2G	,066	,556
	L3G	,068	,023*

N=41; L1G=13; L2G=12; L3G=16

\*p<0,05

*Note: N=number of participants; SD=standard deviation*

According to the results of the normality tests Kolmogorov-Smirnov and Shapiro-Wilk presented in Table 40, the following data



was not normally distributed: in the condition of the prime word in the target language - English, the data of the L2G was not normally distributed according to both tests. For the condition of the prime word in German, the data of the L1G was not normally distributed according to the Shapiro-Wilk test. Finally, for the condition of the prime word in Brazilian Portuguese, the data of the L3G was not normally distributed according to the Shapiro-Wilk test. Therefore, I decided to use non-parametric tests in the analysis of the data.

The tests aimed at looking at the differences of the mean reaction time of the different conditions in the groups; also by comparing the results of the groups. For this reason, the following analysis was carried out. First, for each group, it was determined whether the differences between the primes in English, German and Brazilian Portuguese were significant. After that, the results of the L2 and L3 groups were compared.

In order to compare the means in each of the groups, the test carried out was Wilcoxon. Table 41 presents the results of the *p* value obtained for the pairs of conditions EN-GR, GR-PT and EN-PT for the three groups of participants.

Table 41  
*Wilcoxon test for the pairs of conditions*

<b>Group/Condition</b>		<b>EN-GR</b>	<b>GR-BP</b>	<b>EN-BP</b>
<b>L1G</b>	Z	-3,180	-1,293	-3,180
	Asymp.Sig. (2-tailed)	0,001*	0,196	0,001*
<b>L2G</b>	Z	-2,040	-1,726	-1,569
	Asymp.Sig. (2-tailed)	0,041*	0,084	0,117
<b>L3G</b>	Z	-3,413	-3,103	-1,655
	Asymp.Sig. (2-tailed)	0,001*	0,002*	0,098

N=41; L1G=13; L2G=12; L3G=16

*Note: N=number of participants*

According to Table 41, it can be seen that the differences of the mean reaction time were significant for all of the groups when the conditions of the prime word in English and German were compared. For the L1G, as expected, when the prime word appeared in English, the response of the native speakers was much faster than when it appeared

in GR or BP. This was confirmed by the significant results of the difference of the means between EN and GR and between EN and PT, but not between GR and BP. It can be assumed that for both the L2 and L3 groups there was some facilitation when the prime word was presented in BP, which is confirmed by the absence of a significant difference between the means of the prime in EN and BP. On the other hand, the response time of the L3G increased considerably when the prime word appeared in German, leading to the significant results of the mean differences between GR and BP and between GR and EN for this group.

Another step from this statistical analysis was to compare the results of the L2 and L3 groups. For that, the Mann-Whitney test was carried out, which is another non-parametric test. The results of this test are presented in Table 42.

Table 42

*Results of the Mann-Whitney test to compare groups across conditions*

		<b>L1G- L2G</b>	<b>L1G- L3G</b>	<b>L2G-L3G</b>
<b>EN</b>	Z	-3,916	-4,429	-0,836
	Asymp.Sig. (2-tailed)	0,000*	0,000*	0,403
<b>GR</b>	Z	-3,536	-4,298	-2,414
	Asymp.Sig. (2-tailed)	0,000*	0,000*	0,016*
<b>BP</b>	Z	-2,828	-3,421	-1,068
	Asymp.Sig. (2-tailed)	0,005*	0,001*	0,286

N=41; L1G=13; L2G=12; L3G=16

Note: N=number of participants

The results of Table 42 confirm the results presented in Table 41 regarding the effect of the foreign language German for the L3G, where there was a considerably greater reaction time for this condition. The comparison of the mean reaction time of the L2 and L3 groups when the prime word was presented in German yielded a significant  $p$  value, reiterating this effect of the foreign language. On the other hand, when the prime word was presented either in English or in Brazilian Portuguese the two groups behaved similarly. These results are discussed in the next subsection.

### 4.5.3 Discussion of the results of the cross-language priming experiment

The results of the cross-language priming experiment showed that there was a great effect of the foreign language German in the production of English of the trilingual participants. This effect was observed by means of a delay in the reaction time. In other words, German interfered in the production of English. When the trilingual speaker saw the name of the picture in German – even though the experiment was designed in a masked priming paradigm and most of the participants reported having not noticed the existence of any word before the presentation of the picture – the phonological representation of the word in German was activated. Consequently, the name of the picture in German was accessed faster than its translation equivalent in the target language, English. It was necessary to deactivate the foreign language first, in order to name the picture in English. This processing cost was reflected in the increase in the response time. This effect did not occur, however, when the prime word was presented in Brazilian Portuguese, the participants' native language, both for the bilinguals and the trilinguals.

There are many tentative explanations for this result. One hypothesis that could be proposed would be an extension of the assumptions of the RHM (Kroll & Stewart, 1994; see section 2.5.1 for further information regarding this model), in which the links between the native language and the foreign language would be stronger than the links between the two foreign languages. In other words, there would be an asymmetry in the lexical organization of the trilingual speaker. This would explain why the prime word in the L1 led to a faster access to the conceptual representation of the word to be named, whereas the prime word in German caused an increase in response time. There is an actual case of facilitation and interference going on in this experiment for the trilingual speakers.

Another explanation that might be offered for the results of the picture-naming experiment is that participants learned English in the L1 environment (Brazil). Consequently, when they did not know words in English, they resorted to their L1. The same process probably occurred with the learning process of the other foreign language – German that is, it can be hypothesized that during the learning process of these two foreign languages (German and English), the language of reference was always the native language - Brazilian Portuguese. In addition, when learning one of the foreign languages (German or English), it is possible

that few comparisons have been made to the other foreign language, both from the role of the teacher as of the learner. Therefore, it is possible that the learning process of the foreign language also affects the configuration of the mental lexicon. In case these participants had learned the L3 – English in a German-speaking environment, for instance, stronger links between the two foreign languages could have been established.

Therefore, it can be argued that the connections between English and Brazilian Portuguese are stronger than those between English and German, leading to faster response when the prime word was presented in Brazilian Portuguese than in German. Taking in consideration the assumptions of the RHM, it is possible that, with the increase of proficiency, the configuration of the trilingual mental lexicon will be altered; one of the foreign languages may reach a dominance role. In this case, the links from the other two languages (the native and the non-native) to this foreign language would become stronger.

In short, it can be argued that the results of this experiment support the claim of an asymmetry in the organization of the lexicon of multilinguals. That is, there are probably stronger links between L1-L2, and L1-L3, than between L2-L3. These results are in line with those found in the literature. For instance, Alvarez, Holcomb and Grainger (2003) found that the semantic priming effect was faster when the prime was in the L1 and the target in the L2, than in the reverse order. Sholl, Sankaranarayanan and Kroll (1995) also found evidence for this asymmetry in the effect of semantic priming, being this effect greater when the prime is in the L1 and the target in the L2.

On the other hand, Duñabeitia, Dimitropoulou, Uribe-Etxebarria, Laka, and Carreiras (2010) found symmetric effects of the semantic priming effect when the Spanish-Basque bilinguals had the same level of proficiency in the two languages.

It has to be observed that this experiment was designed as a means of excluding the interference of intervenient variables such as cognates. In addition, pictures whose names in German and/or Brazilian Portuguese resembled the target one in English orthographically or phonologically were excluded of the present study. Therefore, the only aspect to be considered in the analysis of this data is the semantic overlap among the primes and the target. In other words, the focus of this experiment is on the conceptual level of the mental lexicon. The results of this experiment suggest that both the native and the nonnative languages share a common conceptual system. This result is confirmed in the results of facilitation and interference reported previously.

Nevertheless, the opposite behavior of the trilingual group when the prime word was presented in Brazilian Portuguese or German seems to indicate some difference in the strength of the lexical connections among the native and the nonnative languages. It seems that the lexical links between L1/L2 words and L1/L3 words are stronger than the lexical links between L2/L3 words. This is an expected result due to the context where this study took place, where participants learned the foreign language in the environment of the L1, as already discussed in the previous paragraph.

Another point that must be taken into consideration is that phonological overlap between prime and target normally causes interference (Dijkstra, Grainger, Van Heuven, 1999). Even though, the present study did not deal with phonological overlap, the results of the present study suggest that the prime word in German activated the phonological representation of the word in German, and some extra time was necessary to deactivate this representation, causing an increase in the reaction time. When trying to find the name for the picture, several lexical candidates compete for selection (neighbors). When the prime was presented in German, the number of possible candidates increased, leading to a delay in reaction time.

Regarding the two most intriguing questions concerning lexical access and multilingualism, the results of this experiment suggest that the lexicons of the native language and the foreign language are more closely connected than the lexicon of the two or more foreign languages a speaker might have. Concerning selectivity/non-selectivity, it is not possible to make inferences on the basis of this experiment since the prime word activated the lexicon of the other language of the bilingual/trilingual. Therefore, even if the bilingual/ trilingual were in a monolingual mode<sup>5</sup>, the prime word would have caused an activation of the other language. Having presented the results of the three experiments applied to the present study, the next section is devoted to the general discussion of the results of this dissertation.

#### 4.6 GENERAL DISCUSSION

Using eye movement measures, reaction time, and transcription of speech production, the present study sought to elucidate how lexical access for trilinguals is different from that of bilinguals. The tasks

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<sup>5</sup> According to Grosjean (1998, p.136): “mode is a state of activation of the bilingual’s languages and language processing mechanisms”.

applied to the present study – sentence comprehension, picture naming, narrative – allowed the investigation of lexical access in processes of language production and comprehension with English as the target language.

In order to analyze lexical access of trilingual speakers in language comprehension, an eye tracking experiment was designed consisting of English sentences containing cognates among the participants' three languages (cognates English-German, English-Brazilian Portuguese, and English-German- Brazilian Portuguese). The results of this experiment showed that there was a significantly shorter fixation time for early comprehension measures (first pass and first fixation) when the condition of the triple cognate was presented to the trilingual speakers. The same behavior was not repeated with the bilingual speakers and the control group.

Cognates were also presented to participants in a narrative production experiment, where they were required to tell the story of four pictures whose main plot was a boy looking for a frog, together with his dog. The pictures contained cognates of the same type from the previous experiment. The results of the transcription of the participants' stories showed that the trilingual speakers produced more cognates between English and German than the bilingual speakers did. The analysis of instances of crosslinguistic influences in the narrative production of the L2 and L3G showed that for the L3G there was 1 instance of borrowing from the L2- German, 1 instance of foreignising from the L1-Brazilian Portuguese, and 2 instances of code-switching into the L1-Brazilian Portuguese. These results showed that both bilinguals and trilinguals were mostly in a monolingual mode, having little or no interference from the non-target languages.

Lexical access in language production was also analyzed in a cross-language priming experiment consisting of a picture-naming task. In this experiment, participants had to name 72 pictures that represented concrete objects. Before the presentation of the picture, a masked prime appeared on screen. This masked prime could be the name of the picture to be named in one of the three languages: English, German or Brazilian Portuguese. The results of this experiment showed facilitation for the primes presented both in the target language – English and in the native language - Brazilian Portuguese. Nevertheless, the prime word in German caused an increase in the response time of the trilingual speakers. This behavior was not observed for the bilingual group or for the control group.

In short, the results of the present study contributed with new data, in the Brazilian context, with a new language combination (Brazilian Portuguese, German, and English), favoring the hypothesis of language non-selectivity and of a shared conceptual system for the trilinguals' three languages. Language non-selectivity was favored, since, according to the eye-tracking experiment, triple cognates were processed faster than their respective controls. This is evidence that lexical access is not restricted only to the target language.

The results of the present study also favored the hypothesis of a shared lexicon for both the foreign language and the native language, since in the cross-language priming experiment, the native language caused a faster reaction time in picture naming, whereas the foreign language caused an increase in reaction time in language production. These results of both facilitation and interference indicate that the three languages accessed a common conceptual system.

However, the results of little interference of the non-target languages in the narrative production experiment indicate that, at this level of proficiency (intermediate to advanced), speakers of English both as a second and as a third language, have a greater capacity of inhibiting the other non-target languages. In other words, their executive control is able to suppress the non-target languages, making it possible for the bilinguals/trilinguals to perform a monolingual task, without the influence of the non-target languages.

Regarding the models of lexical access proposed in the literature, the results of the present study favored an asymmetry in the lexical organization of the trilingual speakers. The results of the cross-language priming experiment seem to suggest that the links between words of the nonnative languages are weaker than the links between native and nonnative language. This result would somehow favor the RHM, which also claims for an asymmetry in lexical organization.

The present study also found some evidence for the BIA+ model, as it favored non-selectivity, parallel access of the two/three lexicons. Moreover, the model claims for the cognate facilitation effect, which was found for the triple cognates in the present study. The cognate facilitation effect can also be taken as evidence in favor of the Multilingual Processing model, since in this model it is claimed that similarities among the languages can regulate language activation. Therefore, the presence of cognates – which overlap in orthography and semantics – can cause an activation of the other non-target languages, as it happened in the present study.

The result of the cross-language priming experiment, where it seems that the prime word in German activated its phonological representation, causing a delay in picture naming, could be taken as evidence in favor of the interactive models of speech production, where both selected and unselected lexical nodes activate their phonological representations.

In short, the results of the three experiments carried out in the present study showed that double cognates did not facilitate the comprehension of English sentences, both for the bilingual (L2) and the trilingual group (L3G). On the other hand, triple cognates demonstrated a significant facilitative effect in the comprehension of English for the L3G. However, in the narrative task, double and triple cognates did not seem to have a great influence on language production. Still concerning language production, prime words in German caused a greater processing cost for the trilingual speakers. The results of these three experiments suggest that there is an effect in the processing cost of the L3-English due to the foreign language – German (L2) both in language production as in language comprehension. In comprehension, the additional representation of the cognate word in the other foreign language- German, shortened the time for language comprehension, whereas in language production, the possible activation of the phonological representation of the German word caused an increase in processing cost. In the narrative, which is a more natural task, language production did not show a strong influence of the non-target languages. This indicates that bilinguals and trilinguals were operating in a monolingual mode and extra processing cost was demanded to inhibit the non-target languages. However, this could not be demonstrated in this type of experiment.

Regarding the comparison of lexical access of bilinguals and trilinguals, the results of the present study showed that both for processes of language production and comprehension, there were different results. These results reiterate what has already been stated in the literature, that investigating language processing in multilinguals is far more complex than investigating language processing in bilinguals. And the same models and assumptions for bilinguals cannot simply be applied to multilinguals because there are many more factors which make lexical access, processing and organization more complex when there is a third language involved, such as the learning process of the language, including the language learning environment, the similarity among the languages (in each linguistic aspect – phonology, syntax,



orthography and semantics), and the frequency of use of each of the multilingual languages.

Along the same lines, the results of the present study confirm the thesis presented in the introduction of this study, that processing of one or two languages is qualitatively different from processing of three or more languages. This was confirmed by the comparison of the results of the L2G and L3G in the three tasks carried out along this study. The two groups of L2 and L3 speakers of English were relatively homogeneous as regards their age of onset, vocabulary knowledge of English, age, and profile. Therefore, it is safe to assume that the differences observed in the experiments carried out in the present study are due to the experimental manipulation and not to any external/ intervenient variable.

All of these results are taken in consideration in the next section, whose main goal is to provide answers to the research questions presented in the beginning of this study, discussing them in the light of the hypotheses proposed.

#### 4.7 ANSWER TO THE RESEARCH QUESTIONS

This chapter ends with the restatement of the research questions that motivated the present study. Answers to the research questions are provided. In addition, the hypotheses proposed in the beginning of the study are confronted to the results reported in the previous sections. Concerning the following research question:

**Research question 1:** Which cognates are more facilitative in the comprehension of English as a target language: double cognates (between English and German and English and Brazilian Portuguese) or triple cognates (among English, German and Brazilian Portuguese)?

According to the results of Experiment 1, the eye-tracking experiment, there was an effect of the triple cognates for the L3G both for the measure of first pass and first fixation. On the other hand, the present study failed to find evidence favoring the cognate facilitation effect with the double cognates between Brazilian Portuguese and English and between German and English. Therefore, based on the results presented, the answer to this research question is that triple cognates are more facilitative than double cognates in the comprehension of English. Regarding the hypotheses proposed:

**Hypothesis 1A.** Double cognates between English and Brazilian Portuguese and English and German will have the same facilitative effect in the comprehension of English.

Hypothesis 1A was not confirmed, since there was no difference in processing cost among cognates between English and Brazilian Portuguese, and between English and German. Moreover, there was no evidence of the cognate facilitation effect for these cognates.

**Hypothesis 1B.** Triple cognates shall be more facilitative than double cognates.

Along the same lines, it can be stated that Hypothesis 1B was confirmed since the difference in the fixation time between triple cognates and their respective controls was greater than the difference between double cognates and their controls, meaning that triple cognates have a stronger facilitative effect in the comprehension of English sentences. Regarding the second research question proposed for the present study:

**Research question 2.** How is lexical access influenced by cognates among German, English and Brazilian Portuguese in the oral production of English?

The results of the narrative production experiment showed that the trilingual speakers produced more cognates between English and German than the bilingual speakers did. Nevertheless, as regards the other two cognate types (triple cognates and double cognates between English and Portuguese) there was not a great difference between the two groups, which means that the participants were mostly operating in a monolingual mode. That is, the non-target languages did not seem to exert a great influence in the participants (both bilinguals and trilinguals) oral production.

**Hypothesis 2.** Trilinguals will produce more cognates English-German and triple cognates than bilinguals will.

Hypothesis 2 was partially confirmed since trilinguals indeed produced more cognate words between English and German than the participants from the L2G did. However, the same effect did not occur for the triple cognates. As for the third research question of the present study:

**Research question 3.** Is there a difference in the semantic priming effect when presented in the native (Brazilian Portuguese), non-native

(German) or target language (English) for bilingual and trilingual speakers?

The results of the cross-language priming experiment suggest that there is a difference in the priming effect when the prime word is presented in Brazilian Portuguese (the native language), in English (the target language) or in German (the nonnative language). This conclusion is based on the results that showed that the presence of a prime word in German caused a delay in the participants' response. A possible explanation for this effect is that the prime word in German activated its phonological representation and an extra processing cost was necessary in order to inhibit this phonological representation and name the picture in English. The inhibition of the non-target language caused a greater cognitive effort, which was noticed in the increase in reaction time in the trilingual's response. This effect was not observed when the prime word was in English.

The results of the cross-language priming experiment are also consistent with the fact that lexical access to a more dominant language is faster. In this experiment, participants were native speakers of Brazilian Portuguese, whereas German and English were foreign languages. It is assumed that participants' knowledge in their native language is greater than in the foreign languages. Consequently, when the prime word was presented in Brazilian Portuguese, access to this concept was faster than in German. This might explain the difference in the reaction time between German and Brazilian Portuguese prime words. Regarding the hypothesis proposed:

**Hypothesis 3.** Primes in the target language will be more facilitative in picture naming than primes in the non-native language, which will be more facilitative than primes in the native language.

This hypothesis was only partially confirmed, since primes in the target language elicited a faster response than primes in the native language. In addition, primes in the nonnative language were the ones that caused the most delayed response.

The present chapter presented and discussed the results of three experiments carried out in order to investigate lexical access of bilinguals and multilinguals in processes of language production and comprehension. Experiment 1 consisted of a sentence comprehension task containing cognates in the participants' three languages (English, German and Brazilian Portuguese). Eye movements were monitored while participants performed this task. The results of this experiment showed that triple cognates facilitated the comprehension of English

sentences for the L3G. Experiment 2 consisted of a narrative production task, in which participants were presented to four pictures containing cognates among the participants' three languages. The results of this task did not show a great influence of the cognate words in the production of the trilingual participants. Experiment 3 consisted of a picture-naming task within the cross-language priming paradigm. The results of this task showed that the prime word being presented in the foreign language- German caused an increase in the trilinguals' reaction time. The results of the three experiments carried out in the present study were interpreted as favoring the non-selective view of lexical access as well as the existence of an asymmetry in the lexical organization of the trilinguals speakers, in which links between L1/L2 and L1/L3 are stronger than between L2/L3. The next chapter presents the conclusions of the present study, limitations, suggestions for further research, and some pedagogical implications of these findings.

## CHAPTER V

### FINAL REMARKS

This chapter presents the main findings of the present study together with the limitations, suggestions for future research and the pedagogical implications of the results of the present study.

#### 5.1 CONCLUSIONS

Three experiments were carried out in the present study in order to investigate lexical access of bilinguals and trilinguals during language production and comprehension of English. The perspective chosen to the analysis of lexical access of English was the cognate one. Cognates were chosen because they allow the observation of the processing of the three languages in an exclusively monolingual task. That is, due to their shared orthographic and semantic representation in the trilinguals' three languages, effects of processing cost observed in a monolingual task (in English for the purposes of the present study), might not be restricted to the target language.

Experiment 1 consisted of a sentence comprehension task, containing cognates in the participants' three languages, in which eye movements were recorded while participants performed the task. The results of this experiment showed no effects of facilitation of double cognates (cognates English-Brazilian Portuguese, and cognates English-German) on the comprehension of English, either for the L2 or for the L3 groups. On the other hand, triple cognates (among English-German-Brazilian Portuguese) showed a significant facilitative effect on the comprehension of English sentences for the L3G. This effect was not observed for the L2G. Regarding the results of the control group (L1G), they are in agreement with the ones reported in the literature, in which a native speaker of English fixates a word of approximately 8 characters on approximately 200ms (Rayner, 1998). In addition, the results of the control group were not influenced by the experimental manipulation of the task, which shows that no intervenient variables interfered in the design of the eye-tracking experiment.

Experiment 2 consisted of a narrative production task, whose main goal was to expose bilingual and trilingual participants to pictures that represented cognate words among the three languages (English-German-Brazilian Portuguese). In this experiment, participants needed to tell a story on the basis of four pictures whose main plot was a boy

looking for a frog, together with his dog. The stories narrated by the participants of the L2 and L3 groups were audio recorded. The analysis of the results of the transcription of these narratives showed that trilinguals produced more cognate words English-German than the bilinguals did. However, concerning the other cognate types (between English-Brazilian Portuguese, and among English-German-Brazilian Portuguese), both groups produced an equivalent amount of cognate words. Regarding crosslinguistic influences, the analysis of the transcribed data showed only a few instances for the L3G, 1 instance of borrowing from the L2 (German), 1 instance of foreignising from the L1 (Brazilian Portuguese), and 2 instances of code switching into the L1 (Brazilian Portuguese). These results indicated that, even though a greater processing cost might have been required for the trilingual participants to operate in a monolingual mode, the non-target languages (L1 and L2) did not exert a great influence in their oral production in English.

Experiment 3 consisted of a picture-naming task within the cross-language priming paradigm. In this experiment, there were 72 pictures to be named in English, which were preceded by masked primes that could be the name of the picture in the target language (English) or its equivalent translation in German or Brazilian Portuguese. The results of this experiment showed a significant interference of the foreign language- German in the oral production of the trilingual speakers. The prime word in German caused a significant increase in reaction time. These results were not observed for the L2G. In addition, the prime word in Brazilian Portuguese had an opposite effect; it facilitated picture-naming.

In short, the results of these three experiments showed that triple cognates, having representation in the trilinguals' three languages facilitated the comprehension of English sentences. Moreover, the influence of the non-target languages was not very evident in a more natural task – narrative production. Still regarding oral production, the results of the present study show that the prime word in German might have caused the activation of the phonological representation of this word, which interfered in naming the picture in English, resulting in an increase in reaction time. The results of the three experiments show that the process of lexical access of a trilingual is different from that of a bilingual. All of the trilinguals' languages are active in language production/comprehension, which was reflected in a difference in processing cost (shorter time for comprehension and longer reaction time for production). However, this difference was not evident in a more

natural task, such as the narrative. It seems that the executive control enabled bilinguals/trilinguals to inhibit the non-target language in order to operate most of the time in a monolingual mode for this type of task.

The results of the present study are in agreement with the hypothesis that all the languages of the trilingual speaker are activated even when the task is a monolingual one. Moreover, the results of the present study favor the non-selective view of lexical access and the existence of an asymmetry in lexical organization of the trilingual speakers, in which the lexical connections are stronger in the relation L1-L2, and L1-L3, than L2-L3.

These results contribute to the discussion regarding lexical access and the multilingual mental lexicon with a new language combination: Brazilian Portuguese-German-English. The use of three task genres (sentence comprehension, narrative, and picture-naming) covering processes of language production and comprehension also provide some insights into the lexical processing and organization of multilingual speakers. In addition, the present study contribute with new data regarding multilingualism in the Brazilian context. The next section presents the limitations of the present study and provides suggestions for further research.

## 5.2 LIMITATIONS AND SUGGESTIONS FOR FURTHER RESEARCH

This section presents the limitations of the present study and some suggestions for further research. The first aspect to be pointed out regarding the limitations of the present study concerns the small sample of participants for the three experiments carried out, but, mainly for the eye-tracking experiment, which provides a very sensitivity measure - fixation time. Therefore, for this experiment, the effect of having a small sample might have been greater than for the other two experiments. However, the criteria adopted to select participants - they could not speak other languages besides the ones requested for the present study - restricted the availability of a larger sample of participants.

Another limitation that can be pointed out for the two experiments that required a control group (the eye-tracking experiment and the cross-language priming experiment), was the lack of control for knowledge of other languages, besides the native one – English. Even though the results of the present study did not show interference from knowledge of other languages for the participants from the L1G, for

further studies, it would be advisable to control diversity of language knowledge of the control group.

For the three experiments carried out in the present study, it would have been very profitable to have a posttest. For the eye-tracking experiment, a post-test could have helped evaluating whether participants were familiar with the target words of the sentence comprehension task (both cognates and their respective controls) and on which level they knew these words. For instance, if they could understand the word, translate it or use it in a sentence. In addition, the posttest could help understand why double cognates showed no facilitative effect in the comprehension of the sentences presented. For the narrative production experiment, a posttest could indicate whether participants knew the vocabulary that represented the pictures. For the cross-language priming experiment, it should also have been evaluated in the posttest whether participants of the L3G knew the 72 pictures presented in the three languages. This information would help to confirm the results regarding the increase in reaction time when participants were presented with a prime word in German.

Regarding stimuli preparation of Experiment 1, the criteria adopted in the present study for the selection of the cognate words was overlap of meaning and orthography. Orthographic similarity was calculated on the basis of Van Orden (1987). In addition, in order for a word to be considered a cognate it needed to be the first translation option in the dictionaries consulted. However, other criteria could have been added to the selection of the cognate words, such as phonological overlap, even though this could have diminished the number of possible critical words to take part on the experimental sentences of the present study. Another criteria that could have been adopted in the selection of the critical words of Experiment 1 would be a similarity rating task, in which participants who do not know the foreign language need to guess the meaning of the given word. For instance, a Brazilian speaker that does not speak English would evaluate the cognate pairs English-Brazilian Portuguese, trying to guess the meaning of the cognate word. In case the word had its meaning easily guessed it could be considered a cognate. This was the procedure adopted by Kroll and Stewart (1994), however, in their study form similarity was not considered.

For Experiment 2 - the narrative production experiment, there could have been a more strict control on the number of pictures that represented cognate words from each condition (English-German; English-Brazilian Portuguese; English-German-Brazilian Portuguese).



In addition, the importance of cognate words in the story could have been controlled for.

For Experiment 3 - the cross-language priming experiment, there could have been unrelated primes (as in the pilot study), in order to compare the results of reaction time of related and unrelated primes in each of the languages, the target one – English, the native language – Brazilian Portuguese, and the non-native language – German.

Having discussed the limitations of the three experiments carried out in the present study, this section goes on with the suggestions for further research. The research area involving lexical access and the multilingual mental lexicon offers many possibilities for further research. Some of them are indicated as follows.

An interesting proposal for future studies on lexical access with multilinguals would be to evaluate the influence of the nonnative languages (L2 and L3) in the processes of comprehension/production of the native language (L1). An eye-tracking experiment with sentence comprehension could be designed in the participants' most dominant language, the L1. It could be analyzed if the same facilitative effects of the triple cognates found for a non-dominant foreign language (English) are extended to the native language (L1). This would be strong evidence favoring the non-selective view of lexical access.

Along the same lines, it could be designed a cross-language priming experiment in the participants' L1 in order to analyze the effects of the two foreign languages in the native language. Still regarding the cross-language priming experiment, it would be interesting to replicate the experiment of the present study in the other foreign language – German in order to analyze if English would have the same interference in naming pictures in German.

Moreover, the present study could be replicated using a new language combination, with Brazilian Portuguese-Spanish-English, for instance, in order to evaluate if the same effects of the foreign language-German are observed with a typologically closer language to the L1, that is more distant to the L3, in this case, Spanish.

Another suggestion of replication for all of the experiments of the present study would be to compare results of participants at different levels of proficiency. This would indicate whether the asymmetry observed for the trilingual lexical organization changes with the increase of proficiency, as postulated by the RHM.

Lexical access could also be investigated with the eye movement technique using another task type, such as the visual word paradigm, which deals with listening other than written comprehension. Still

regarding the eye movement technique, another possibility would be to investigate comprehension of homographs instead of cognates. In this case, it would be an investigation on the interference of these critical words in the comprehension of English, instead of facilitation. The next section presents the pedagogical implications of the present study.

### 5.3 PEDAGOGICAL IMPLICATIONS

This section covers the pedagogical implications of the present study. In other words, it is discussed how the results of the present study may inform language learning/teaching. Studies focusing on foreign language acquisition have the aim of understanding the processes involved in language processing. Thus, this comprehension might lead to the identification of possible means to help foreign language learning in classroom environments.

One of the instruments of the present study, the biographical questionnaire, gathered some information regarding participants' interest in learning English. This information might be interesting for foreign language teachers. Participants of the L2 and L3 groups reported having contact with English, before starting formal learning of the language, through the media, that is, movies, music, video game, internet, TV and radio. Regarding the purpose for learning English the greatest motivation of the students is professional or for improvement in the studies. Most of the participants reported having contact with native speakers of English; however, the majority of them has not been to an English speaking country. Regarding English input, most participant have contact with English by watching movies and listening to music in English.

Regarding the main goal of the present study, which was to investigate lexical access, it can be concluded that cognates have a special representation in the bilinguals'/multilinguals' languages. Thus, it is suggested that foreign language teachers use this facility in processing cognates to help students to integrate in the new language. In other words, introducing a new foreign language to the learner by means of presenting cognates seems to be a very interesting approach.

Moreover, the results of the present study indicate that all the linguistic knowledge of the multilingual plays a role in language production/comprehension. Therefore, in language teaching/learning, it is important to consider this background language knowledge and use it as a facilitator in language acquisition.

#### 5.4 A FINAL WORD

As already stated in the beginning of this dissertation we use words all the time in our daily life, and “we would be quite lost without them” (Aitchinson, 1987, p. 3). In order not to lose ourselves and being not able to communicate, to express our feelings, emotions, and wishes, all of the mechanisms described and analyzed in the present study are necessary. That is, lexical access processes need to be effective to allow us both to comprehend and to utter words. *Words*, these small units that carry meaning are an essential part of our lives.



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## APPENDIX A

### TERMO DE CONSENTIMENTO LIVRE E ESCLARECIDO

Universidade Federal de Santa Catarina  
Centro de Comunicação e Expressão  
Departamento de Língua e Literatura Estrangeiras  
Programa de Pós Graduação em Inglês: Estudos Linguísticos e Literários  
LabLing – Laboratório da Linguagem e Processos Cognitivos

### **PROJETO DE PESQUISA: INVESTIGANDO O ACESSO LEXICAL DE MULTILINGUES: UM ESTUDO SOBRE O PROCESSAMENTO DO INGLÊS COMO L3**

Caro(a) Senhor (a),

Eu, Pâmela Freitas Pereira Toassi, CPF: 049.746.099-80, RG: 5.054.943-0, aluna de doutorado do Programa de Pós Graduação em Inglês: Estudos Linguísticos e Literários, sob orientação da professora Dra. Mailce Borges Mota na Universidade Federal de Santa Catarina, tenho como objetivo desenvolver um estudo sobre a aprendizagem de línguas estrangeiras, no caso a língua inglesa, por falantes de outras línguas estrangeiras, requisito parcial para a obtenção do título de doutor(a) em Inglês – Estudos linguísticos.

Gostaria de convidá-lo a participar do meu estudo que busca investigar a aprendizagem do inglês por falantes de português e alemão. Os estudos nessa área visam não só compreender os processos envolvidos na aquisição de uma ou mais línguas estrangeiras, mas também desenvolver meios de aperfeiçoar o processo de ensino/aprendizagem da língua estrangeira. Peço que você leia este formulário de consentimento e tire todas as dúvidas que possam surgir antes de concordar em participar no estudo.

#### **Objetivo do estudo**

O objetivo geral deste estudo é analisar a influência das línguas precedentes na compreensão e produção lexical do inglês como língua estrangeira.

#### **Procedimentos**

Se você concordar em participar deste estudo, você será solicitado primeiramente a responder um questionário, para investigar o seu histórico de aprendizagem das línguas materna e estrangeira. Para

certificar o seu nível de conhecimento da(s) língua(s) estrangeira(s), você será solicitado a realizar um teste de proficiência. Você também será solicitado a realizar três tarefas:

Tarefa de leitura: Você lerá frases em inglês na tela do computador e responderá a perguntas de compreensão, com o auxílio do mouse. Durante esta tarefa de leitura, o movimento dos olhos será monitorado através do equipamento do rastreamento ocular. Esta tarefa terá duração de 30 minutos.

Tarefa de narrativa oral: Você irá criar uma história, em inglês, com base em algumas figuras. Esta narrativa terá seu áudio gravado. A tarefa terá duração de no máximo 5 minutos.

Tarefa de nomeação de figuras: Você irá nomear, em inglês, figuras de objetos concretos que aparecerão na tela do computador o mais rápido que puder. Esta tarefa terá o áudio e o também o tempo de resposta gravados. Esta tarefa terá duração de 10 minutos.

### **Benefícios**

A sua participação nos experimentos será voluntária e contribuirá para a pesquisa sobre a aquisição de línguas estrangeiras. Durante a pesquisa, você terá a oportunidade de praticar a língua inglesa e também terá uma avaliação do seu conhecimento da língua.

### **Riscos**

Nenhuma tarefa oferece risco físico ou moral para você.

### **Desconforto**

Durante a tarefa de leitura, você não deve executar movimentos bruscos, o que pode lhe acarretar um certo desconforto. Portanto, nos certificaremos que o ambiente do laboratório LabLing ofereça condições satisfatórias para a execução da tarefa, referentes à iluminação, temperatura e posicionamento adequado do monitor do computador de acordo com a sua altura e cadeiras confortáveis. As demais tarefas não acarretam desconforto a você.

### **Direitos dos participantes**

Você é livre para decidir se deseja participar ou não desse estudo. Como a participação é voluntária, você pode desistir a qualquer momento sem nenhum prejuízo para você.

### **Contatos**

Tendo qualquer dúvida sobre a pesquisa, você pode entrar em contato com Pâmela Freitas Pereira Toassi, pelo email [pam.toassi@gmail.com](mailto:pam.toassi@gmail.com) ou pelo telefone (48) 3304-3817, ou com a professora Dra. Mailce Borges Mota através do email [mailcemota54@gmail.com](mailto:mailcemota54@gmail.com), telefone (48) 3721-9288, ou no prédio do

Centro de Comunicação e Expressão – CCE, bloco B, sala 111, Universidade Federal de Santa Catarina, UFSC.

Você pode também entrar em contato com o Comitê de Ética em Pesquisa com Seres Humanos (CEPSH) da UFSC, no email cep@reitoria.ufsc.br ou no telefone (48)3721-9206. O CEPSH da UFSC fica localizado no Campus Universitário Reitor João David Ferreira Lima, bairro Trindade, Cep: 88.040-900, Florianópolis – SC.

#### **Compensação financeira**

Não existirão despesas pessoais ou compensações financeiras relacionadas à participação no estudo. Qualquer despesa adicional será absorvida pelo orçamento da pesquisa.

#### **Utilização dos dados:**

Os dados coletados nesse estudo serão acessados apenas pela pesquisadora e orientadora da pesquisa. Mesmo após os resultados se tornarem públicos, a sua identidade será totalmente preservada. Não haverá nenhuma informação que leve a sua identificação.

Para preenchimento do participante e da pesquisadora:

Declaro que li as informações do **Termo de Consentimento Livre e Esclarecido** e esclareci quaisquer dúvidas. Eu compreendo meus direitos como voluntário da pesquisa e concordo em participar deste estudo e em ceder meus dados para a pesquisa. Compreendo o objetivo do estudo bem como os procedimentos que serão realizados. Receberei uma cópia assinada deste formulário de consentimento.

Nome:

\_\_\_\_\_

–

Assinatura do Participante: \_\_\_\_\_

Assinatura da Pesquisadora Responsável: \_\_\_\_\_

Data: \_\_\_\_/\_\_\_\_/\_\_\_\_/

Uma via deste Termo de Consentimento Livre e Esclarecido fica com a pesquisadora e a outra com o participante.



## APPENDIX B

### Questionário - Trilíngues

UNIVERSIDADE FEDERAL DE SANTA CATARINA

Programa de Pós Graduação em Inglês: Estudos Linguísticos e Literários

Este questionário é parte do estudo intitulado “Investigando o acesso lexical de multilíngues: um estudo sobre o processamento do inglês como L3” que eu, Pâmela Freitas Pereira Toassi, estou conduzindo, sob a orientação da professora Dra. Mailce Borges Mota. Agradeço desde já sua participação, que é de extrema importância para a realização desse estudo.

(As informações deste questionário serão mantidas em sigilo.)

#### \*Obrigatório

**Data da entrevista: \***

Informações gerais

Exemplo: 03/05/2013 11h30

**Nome do participante: \***

Informações gerais

**Data de nascimento: \***

Informações gerais

**Idade: \***

Informações gerais

**Sexo: \***

Informações gerais

Feminino

Masculino

**Nacionalidade: \***

Informações gerais

**Local de Nascimento: \***

Informações gerais

**Nacionalidade dos pais: \***

Informações gerais

**Grau de escolaridade \***

Informações gerais

- Nenhuma escolaridade
- Ensino Fundamental: de 1° à 4° série
- Ensino Fundamental: de 5° à 8° série
- Ensino Médio incompleto
- Ensino Médio completo
- Superior incompleto
- Superior completo

**Formação: \***

Informações gerais

**Ocupação atual: \***

Informações gerais

**Telefones \***

Informação para contato

**Email \***

Informação para contato

**Você é: \***

Informações específicas

- Destro
- Canhoto
- Ambidestro

**Sua visão foi corrigida por cirurgia? \***

Informações específicas

Sim

Não

**Você usa óculos? \***

Informações específicas

Sim

Não

**Você usa alguma lente corretiva? \***

Informações específicas

Sim

Não

**Qual é a cor aproximada dos seus olhos? \***

Informações específicas

Azul

Castanho

Preto

Verde

**Você fala quantas línguas? Quais são? \***

Informações específicas

**Com que idade você começou a aprender o alemão? \***

Informações sobre o aprendizado do alemão

**Em que contexto você aprendeu o alemão? \***

Informações sobre o aprendizado do alemão

em escola de idiomas

na escola

em casa

no país em que a língua é falada

**Caso você tenha aprendido o alemão no país em que a língua é falada, diga o nome do país:**

Informações sobre o aprendizado do alemão

**Caso você tenha estudado essa língua em escola de idiomas, indique por quanto tempo.**

Informações sobre o aprendizado do alemão

- até 6 meses
- até 1 ano
- até 2 anos
- mais de 2 anos

**Você ainda estuda o alemão em escola de idiomas? \***

Informações sobre o aprendizado do alemão

- Sim
- Não

**Com que frequência você usa o alemão? \***

Informações sobre o aprendizado do alemão

- o tempo todo
- quase o tempo todo
- em certas ocasiões
- raramente
- nunca

**Como você usa o alemão? \***

Informações sobre o aprendizado do alemão

- para leituras no trabalho
- para pesquisas
- para ver filmes, ouvir músicas, jogar vídeo game, para leituras de lazer
- para conversar com família e amigos
- Outro:

**Você possui/ possuiu contato com falantes nativos de alemão? \***

Informações sobre o aprendizado do alemão

- Sim
- Não

**Você já esteve na Alemanha? \***

Informações sobre o aprendizado do alemão



- Sim
- Não

**Se sim, por quanto tempo?**

Informações sobre o aprendizado do alemão

- menos de 2 meses
- até 6 meses
- de 6 meses a 2 anos
- mais de 2 anos

**Como você avalia o seu nível de conhecimento no alemão? \***

Informações sobre o aprendizado do alemão

- Básico
- Intermediário
- Avançado

**Com que idade você começou a ter contato com a língua inglesa? \***

Informações sobre o aprendizado do inglês

- entre 1 e 7 anos
- entre 7 e 14 anos
- entre 14 e 21 anos
- após 21 anos

**Com que idade você iniciou o curso regular de inglês? \***

Informações sobre o aprendizado do inglês

- entre 1 e 7 anos
- entre 7 e 14 anos
- entre 14 e 21 anos
- após 21 anos

**Antes de iniciar o curso regular de inglês, como você tinha contato com o idioma? \***

Informações sobre o aprendizado do inglês

- através de filmes, músicas, jogos de vídeo game, internet, TV, rádio
- através de conversa com pessoa fluente em inglês ou falante nativo de in

- através da escola
- não tinha contato com o idioma

**Você continua tendo aulas de inglês? \***

Informações sobre o aprendizado do inglês

- Sim
- Não

**Como você avalia o seu nível de conhecimento no inglês? \***

Informações sobre o aprendizado do inglês

- Básico
- Intermediário
- Avançado

**Para qual propósito o conhecimento do inglês é importante para você? \***

Informações sobre o aprendizado do inglês

- para viajar
- por motivo profissional
- para aperfeiçoamento nos estudos
- por motivo de lazer
- Outro:

**Você dedica quanto do seu tempo para o estudo do inglês (com exceção do período em sala de aula, caso ainda tenha aulas do idioma)? \***

Informações sobre o aprendizado do inglês

- nenhum
- até 1h por semana
- até 2h por semana
- mais de 2h por semana

**Você possui/ possuiu contato com falantes nativos de inglês? \***

Informações sobre o aprendizado do inglês

- Sim
- Não

**Você já esteve em algum país de língua inglesa? \***

Informações sobre o aprendizado do inglês

- Sim
- Não

**Se sim, por quanto tempo?**

Informações sobre o aprendizado do inglês

- menos de 2 meses
- até 6 meses
- de 6 meses a 2 anos
- mais de 2 anos

**Em quais outras situações você tem contato com a língua inglesa? Assinale tantas alternativas quanto necessário. \***

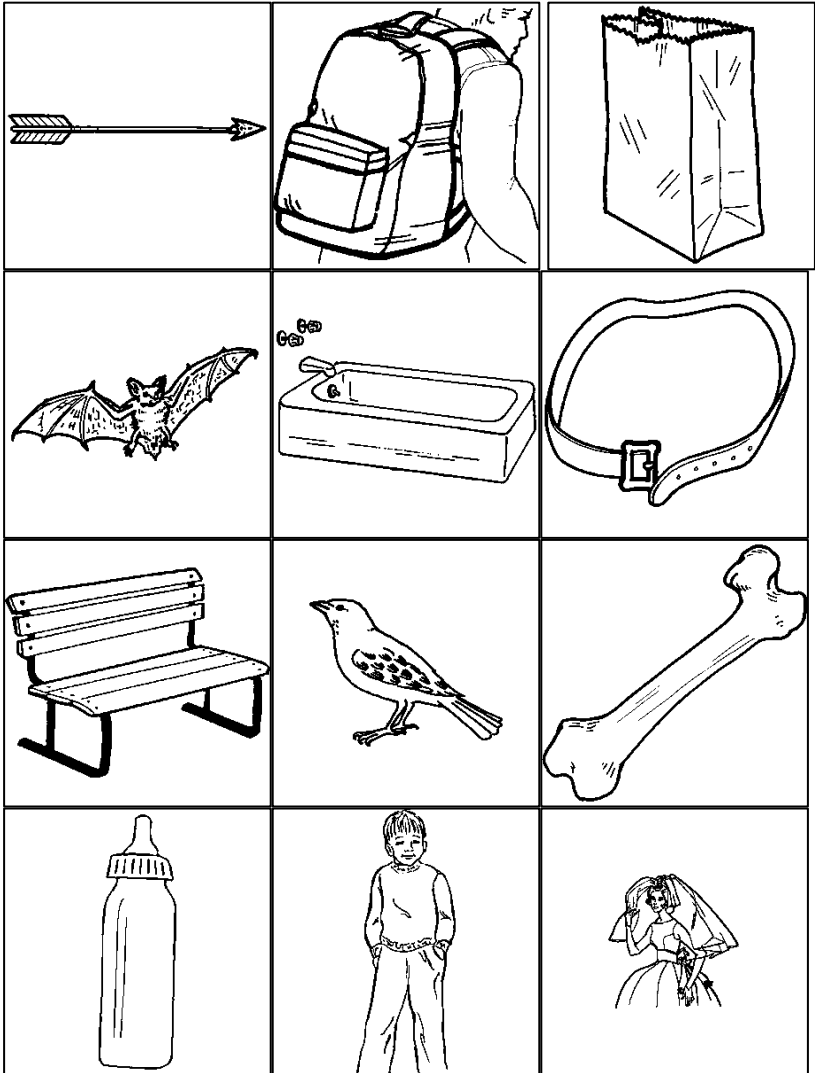
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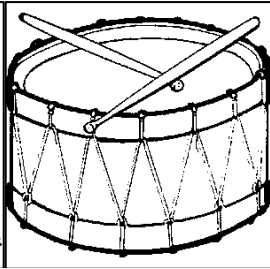
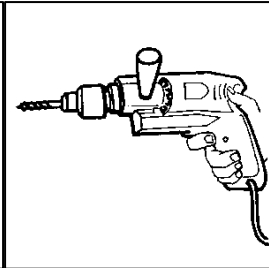
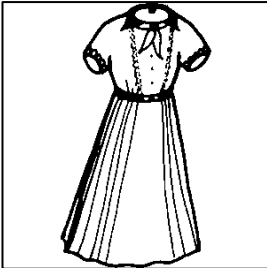
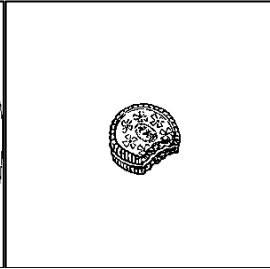
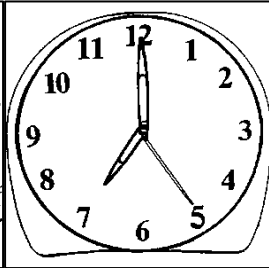
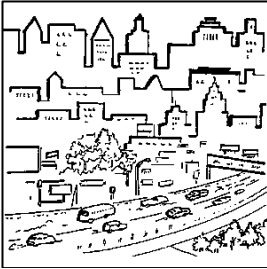
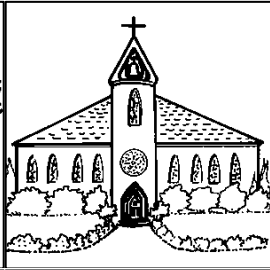
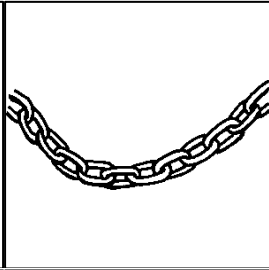
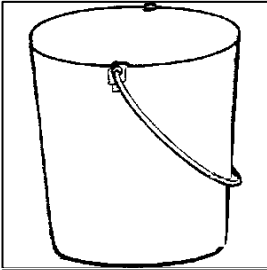
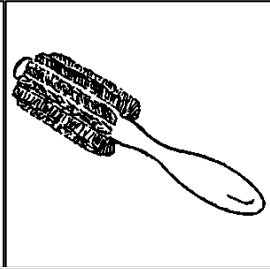
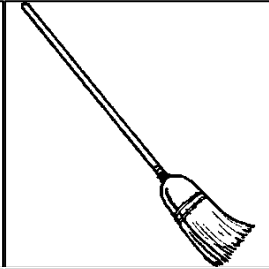
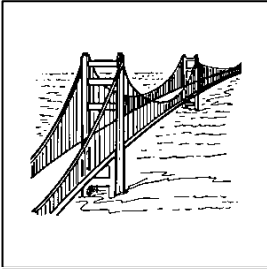
- tendo aulas de inglês
- vendo filmes
- ouvindo músicas em inglês
- jogando vídeo game
- falando com outros alunos ou falantes do idioma
- leituras
- Outro:

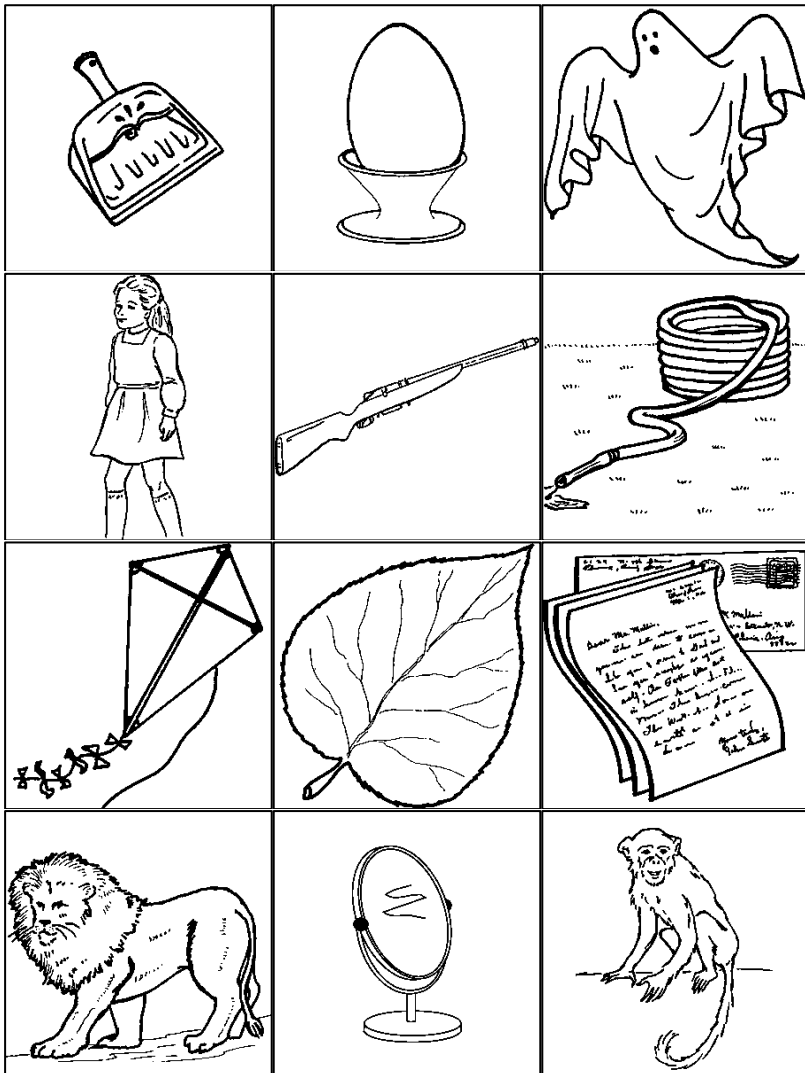


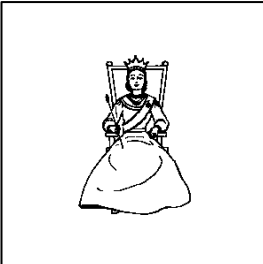
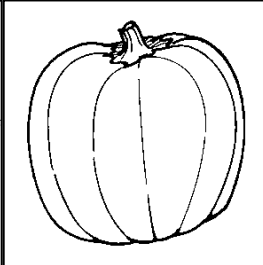
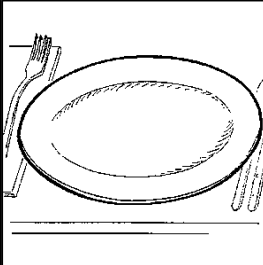
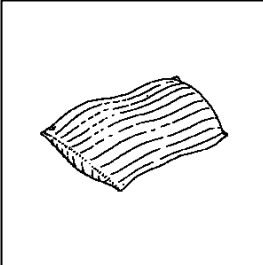
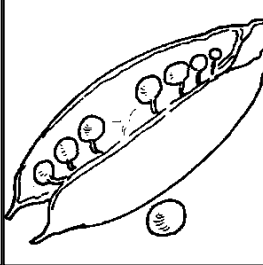
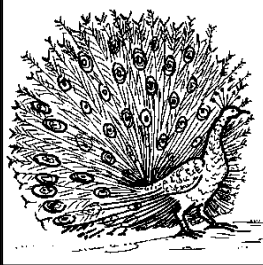
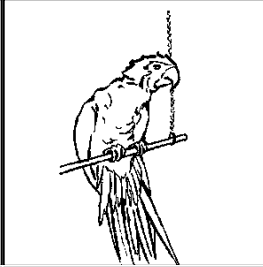
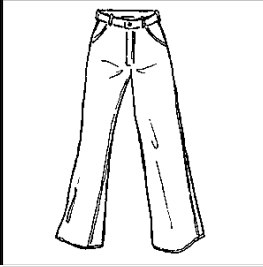
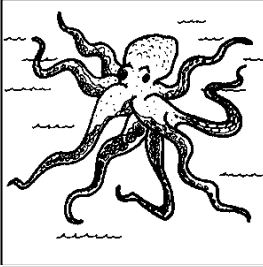
## APPENDIX C

Pictures of the priming experiment.

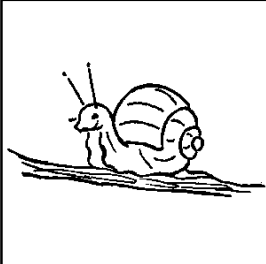
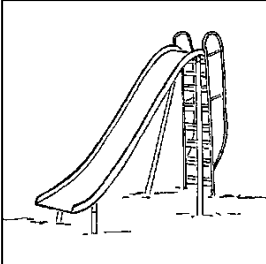
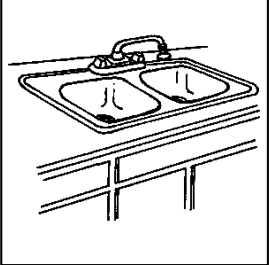
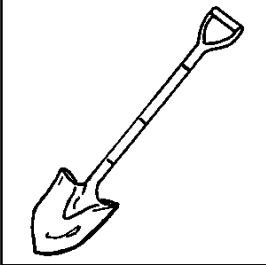
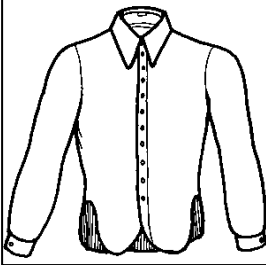
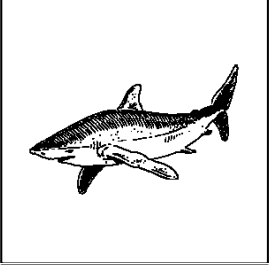
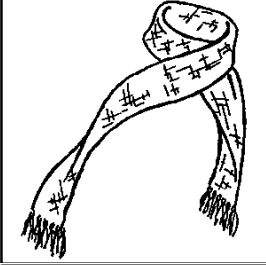
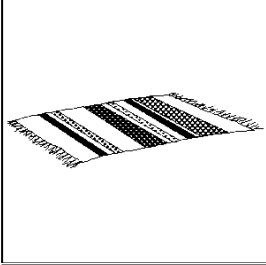
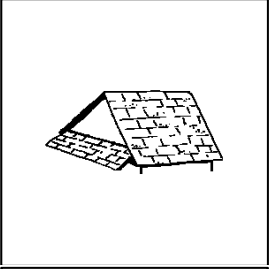
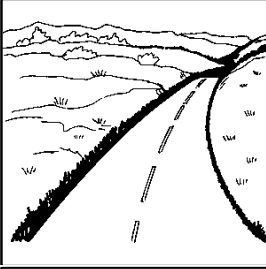
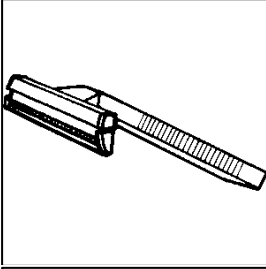


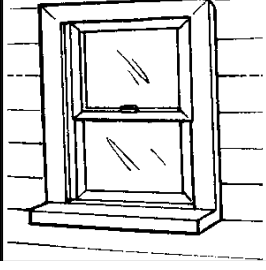
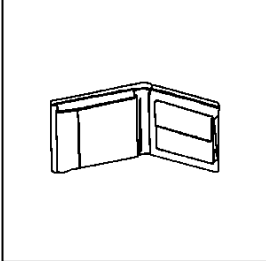
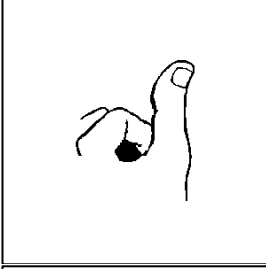
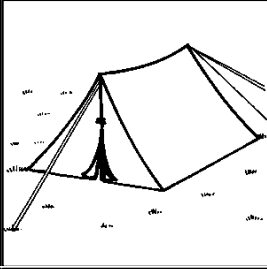
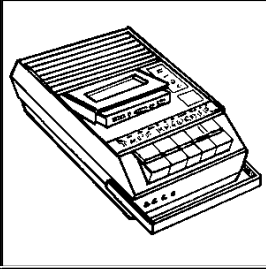
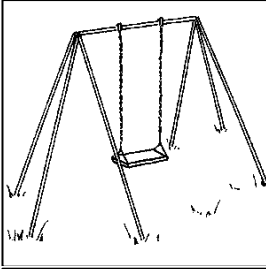
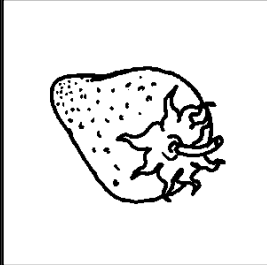
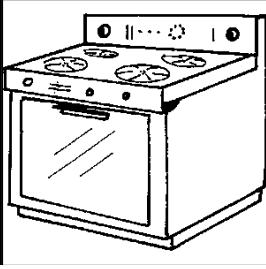
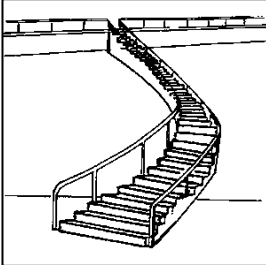












## APPENDIX D

Transcription of the narrative oral production experiment.

P01 – L2G

There was a boy, his name was John and he had a dog as a pet. He also like to play with some mice and he was feeding a mice with some cheese. It was a really beautiful day and he decided to take his dog for a walk. Out there, ah, there was a really beautiful tree with some apples. And he was calling, I think for his friend, he was wanting to find a friend. And, I don't know, there was ah ...and he couldn't find his friend so he walked his dog and went back home. It was night and he was so tired because he played all day long with his dog and his mice so he decided to go to bed and sleep. He was really, really tired. And his mice went out of his cage and looked for his other, his girlfriend. And they decided to throw a party, and eat a lot of cheese and drink some wine.

P03 – L2G

It was a Sunday morning and then, Toby is a dog of Tom. And every Sunday morning, Tom took his dog to a walk. And they went to the yard and the, when they spend the whole morning. Toby liked very much the corns and the trees. But then, they saw a little cat that looked like a lion behind the tree. And Tom didn't understand why Toby was so interested in that cat. He kept yelling for something around the corns. And then, but Toby just didn't stop looking at the little cat that looked like a lion. It was a sunny day but there was a moon in the sky. After they were in the yard, Tom come back to his room while Toby was next to his bed while because he had his own bed. Tom had also a little mouse and where, who he gave some cheese. Toby and this little mouse, called Fernando they get along very well. And that's why Tom picked a dog instead of a cat. And the, and suddenly Tom realized why Toby was so interested in the little cat back in the yard. He was trying to protect his little friend, Fernando. And then Tom went to sleep and Toby as well. What they didn't realize that every night his little mouse went down from the glass bottle, bottle glass. And the little mouse, Fernando, had another friend, called Tina, and they made throw a little party every night, under Tom's bed. And there was a party with wine, bananas and a lot of fishes that Fernando got from the Toby's food. Because Toby was a dog that liked food, fish very much. And then, when the morning

comes everything is back to normal. Fernando is back to the glass, Toby is back, is in is asleep and Tom is go to school.

#### P04 – L2G

Once, there was a little boy, who has this rat as a pet. He used to feed the cat, the rat, with cheese everyday and his dog would watch him do it. And the dog didn't do anything with the rat. And the rat was inside this glass and the boy would feed him inside the glass, everyday. One day, when the boy and the dog were sleeping, the rat managed to get away. He went outside the window and nobody saw him doing that. So, in the next morning, the boy woke up and realized that his mouse wasn't there anymore. He took his dog to the park to look for the mouse. He screamed, asking for it but he didn't answer and they couldn't find it anywhere. They found a lion, they found a balloon, a hot balloon, a hot air balloon in the air, but they couldn't find the mouse. While they were looking for it outside, the mouse was actually with a girlfriend having dinner, having wine, some fish, some bananas and some cheese, partying a lot.

#### P5 – L2G

So, ahm, once upon a time, there was a boy called John. John had a dog and he's also had a rat as pet animals. He used to feed the rat with cheese and play a lot with him. But one night, when John went sleeping, the rat got off his cage and jumped out of the window. So, John and the dog went out for looking for the rat, but couldn't find him. They tried to find him in the corn yard, they tried to find him near the apple trees. But he was nowhere to be found. So, the rat went out to meet his friend and had some party.

#### P6- L2G

Ok, so, Bob was a boy that had a few animals at home, some pets. One of these animals was a rat, that he kept in a jar or something. And sometimes, when he went away with his dog, which was named Bark, the cats at home, the rats at home, actually, they would make some parties, some very crazy parties with cheese and the light was on. They would drink wine on a table. They also had some bananas and they ate fish, believe me. Bob really liked to sleep also. And when he slept the rat would go on the window and to see the moon. But the dog wouldn't wake up because he liked to sleep as well. Sometimes Bob went on a ride with his dog and they would go to a camp where they would see some trees, some apple trees and there, there was some kind

of strange animal and corn plantations. They usually went out at night and there was also a balloon there. His bedroom was, had a type of tiger portrait, I don't know. And, let me see, Bob treated his pets very well, he gave food to all of them and he went on ride with them as I have already said.

#### P7 – L2G

There were two rats and they were having a party, eating cheese and they have already eaten fish and they didn't want bananas. But they were drunk and they have drunk a lot of wine. It happened because a boy who was the own of the rats went out with his dog to walk in the park. They saw a lion and then he started to look for this lion who was right after tree with apples. After that, he went back to home and start sleeping and as so as the dog start sleeping as well. The rat appeared in the window and the boy waked up and put the rat in a bottle and start feeding the rat.

#### P8 – L3G

There was a boy with his dog and he went to walk right next to a camp of ri. There was a balloon in the air. Actually, it was the night, the moon was very shiny. As he walked by a tree he saw a lion. This lion was staring at his dog. He was yelling something, out to everybody. Later the night, he got home and was really tired, then he went to sleep. But in his place there was this cute cat poster, right above his dog's nest. There was a big jar in the middle of the room and it was, the window was open. Then, this mouse came on and, unfortunately, they, it got stuck in the jar. Later on, in the morning, the boy woke up and saw the mouse trapped and tried to feed him with some cheese. The dog was awake with his tale. By seeing his tale you could see that he was really happy. And outside was a shiny sun with some clouds. But at the end of the day, the mouse got away from the jar and went to his home with his wife and he brought some cheese and wine, and loads of bananas and I guess they all ate some fishes.

#### P9 – L2G

So, one day, there was a boy, he was walking his dog and he was calling someone, probably a friend, or something like this. This place where they were, there was a cat, there were some trees. Then, after this, they went home, his dog was sleeping and there was a mouse, and he was trying to feed this mouse. He was giving cheese to him. They were in a room with a picture on the wall and it was a sunny day.

After that, he got sleepy, and so did his dog. So, both of them were sleeping. The mouse opened the window and probably called some of his friends. Sometime later, one of his friends came and they started a party, they were celebrating, eating cheese and drinking wine. They had eaten some fish and also some bananas.

#### P10 – L3G

This is the story about a boy named Luis. He had two pets, a dog and a mouse. In his room, there was a poster of a cat and a small window and everyday Luis fed the little mouse with cheese. But, one day, at night, while Luis was at sleep, the mouse ran away through the window and Luis didn't see it and the dog was also sleeping and didn't see it either. So, when Luis woke up in the morning, he saw that the little mouse was missing. So, he went outside to look for him. He yelled his name but couldn't find him. So, he went through the city and through the woods and he couldn't find him anywhere. The little mouse was actually with his brother and they were having a party, where he was having a lot of fun, eating cheese, fish, drinking wine and they partied all night.

#### P11 – L3G

One day, there was a guy who was sleeping on the bed. And then he had also a dog and there was a mouse coming into the room, but he was sleeping. And he had also a tiger poster on the wall and the mouse was on the window. And then the mouse got into a glass, I don't know, into a glass thing on the room. The guy woke up and he was trying to get the mouse out of this glass thing and he took some cheese on the fridge, one slice, and was trying to get the mouse out of this place. And then the dog woke up also and he was moving a lot and he wanted to go out to do, to go out to go, how can I say, to go for a walk. And then they were on the park, this guy was walking with the dog on the park. It was a beautiful day, and there was also a balloon on the sky. There was also a tiger behind the tree. He was like screaming to someone. And then, since they were not at home, another mouses came into the room, into the house. And they were like making a party, and drinking wine and eating cheese and bananas.

#### P12 – L2G

Once upon a time, there was a boy in a dark night and he went out with his dog to hunt a lion. Suddenly, he perceived that he was dreaming and he woke up and saw a mouse inside a bag in his bedroom.

He tried to feed the mouse with cheese. The mouse was so happy because of the food, he started to dance with his girlfriend, and they started to drink wine and eat bananas under the light of the bag.

P13 – L3G

The boy gave the cheese to the mouse he had inside a bottle. Then he took his dog outside to run. And there was a cat under a tree. While the boy was away with the dog, the rats had a party with the cheese and at the end of the day, the boy came back with his dog and fell asleep. And the mouse came back to his house. Probably wanting to have some cheese again. The guy had a picture of a tiger on his wall but he didn't have any cats around. That's why the mouse would come back everyday to his house to get cheese. But this time, but at some point, the boy stopped giving them cheese. So the mouse moved away and then, but then, the boy kept going for a walk with his dog everyday.

P16 – L3G

So, first there was a boy, he kept a little mouse as his prisoner in his bedroom. Dann, as both the boy and his dog were asleep the mouse managed to get away and to celebrate the mouse and his sister, they made a party, and they had a lot of fun while the little boy and his dog were searching for the mouse.

P20 – L3G

Ok, there was Bob and his dog. He was next to a cornfield and to a apple tree. He was just having fun and screaming out loud near the river, behind his house, watching the balloons. And was almost night, because the moon was starting to appear in the sky. He depair to a mouse party in the cornfields and they were having fun, eating cheese and drinking wine. And then he decided to take one of the rats because he always wanted to have a rat pet. And he took the rat and go home to put him into a bottle and he started to feed him. He had a poster of a cat and it was another pet he would love to have and his dog went to bed to sleep and the rat escaped and during the night, through the window and jumped out and come back to the party while they were sleeping.

P21 – L3G

There was a boy, he was asleep. Early morning, the moon was still on the sky and a rat was at his window. His dog, the boy's dog was also sleeping. Afterwards, the boy woke up and took his dog for a walk. In the field, there was a tree with lots of apples on it. A lion was under

the tree. There was a plantation of corn. The moon was still on the sky and a big balloon was also in the sky, where there were clouds. After that, the boy went home again and to his surprise he found a couple of rats dancing and eating cheese, drinking wine, eating fish and bananas in his house. He then, put the rat in a jar, and fed him with cheese. Now, the sun was in the sky, as we could see through the window. The dog also accompanied the boy while he was making these experiences with the rat.

#### P24 – L2G

There is this little boy and his dog and they are walking through the woods. It is during the night, there is the moon and some clouds. And the boy seems to be yelling at something. The dog sees a lion hiding behind the apple tree. Then, the boy goes home with his dog. He is going to feed, no, this one. He goes home and then he goes to sleep and he leaves the window open and a mouse come in. And in the morning, when the little boy wakes up, he finds the mouse, put him into a, inside of a cookie jar and then he starts to give cheese to the little mouse. And then another little mouse coming to the house and goes inside the cookie jar. And the two little mice start enjoying the cheese and the food that the little boy gives them.

#### P28 – L2G

A guy had a dog and a mouse and the mouse saw the picture of a cat in the room and he was afraid of all that. The guy used to keep him in a jar and he did not like that. So, when the boy slept and his dog too, the mice left the jar and gone out. So, he find another rat and he loved her and appreciated to eat cheese, fish, drink wine and had bananas too. And then, the guy woke up and realized that the mice had escaped and he was trying to find him. So, that is the phrase: when the cat is out, the rats play.

#### P41 – L3G

There was this boy, he was sleeping in his room with his dog. A beautiful dog, I think it is a beagle, and there is this, there was the image of a cat on the wall. And then, it was night and a rat came in the window, in the open window. And the rat was looking at the boy sleeping, the dog sleeping. And what happened then. The boy took the rat, because he thought it was a good pet, it was be funny to had a rat as a pet because he hadn't a cat and anyone would die, kill the rat or mouse, no, it is a rat. And then, at day, the boy captured the rat and



bring some cheese to him. It was a good pet. But the sad story is that the rat run away, the boy didn't understand why, so the boy keep looking for the rat at day, at night, for many days, looking in the house, looking in the neighborhood and even in the forest near from his house. At night, he called for the rat, which the name is, was Mickey, but he haven't found it. Actually, the rat was very happy, in his house, with his girlfriend or wife, eating the cheese that he stolen from the boy. And he was very happy too because the house, the rat's house was actually more beautiful than the boy's.

#### P42 – L3G

Once upon a time, there was a boy called Jimmy. Jimmy was a happy boy. He had a dog, and the dog was his very good friend. Jimmy had another pet as well, a mouse. So, one day, Jimmy decided to give some cheese to the mouse and the dog didn't really like the idea, because the dog was really jealous. So, while Jimmy was giving the cheese to the mouse, the dog was really angry. And was thinking about how the boy wasn't satisfied with his friendship. After the mouse had eaten the cheese, the boy went to bed, and has fallen asleep. During the night, while both the boy and the dog were asleep, the mouse has managed to run away. Yes, the mouse was a fugitive. So, the dog was having a bad dream, a nightmare, about how the mouse was becoming bigger and happier and was taking his place inside the house. Of course, it was all an illusion, as he would find out by the morning. By the morning, Jimmy had called the dog for a walk. The dog was very glad that he could go out on a walk with his very best friend. But, unfortunately, they were just looking for the lost mouse. While they were in their walk, the mouse had found his true love, a beautiful female mouse, and they were, they would share the cheese for the rest of their lives and be happy forever after.

#### P44 – L3G

Once upon a time, there was some tricky tricky mice and they were doing some tricks in the house. They were like, eating all of the cheese in the house, they were eating clothes also. And then, came a boy, and the boy had an idea. And this idea was to trap the mouse inside a glass and let it be. So, what the boy did. The boy did a trap and catch a mouse, catch the mouse. And then, he just got away and he left the dog taking care of the mouse in the glass. But the dog, suddenly, got asleep, and then, when the dog woke up there were no more mouse in the glass. And then they thought: ok, there is no more mice in the houses so, we

should do some walk. And then the boy took the dog out and they got in a field and they were happily ever after.

#### P49 – L3G

The man was sleeping in his room, bedroom. I can see that he had a cat, the cat, there is a picture of the cat in the wall. During that time, the dog was also sleeping, while a rat is on the window. We can see the half moon or growing moon through that window and an empty pot on that bed. He is also making noise while he is sleeping. So, as the cat ran away, the rats make fest, make party. So, we can see that there is a wine glass, two glasses and one wine bottle in a top of desk. A rat male and a rat female or a mouse, but it looks like a rat, actually. The, two of them are holding a cheese. We can see that on the ground, there is a bones of fishes, two bones of fishes and a bench of bananas also. Two of them out of that bench. So, we can see in the top of that place that the lamp is on, turned on. Actually, after waking up, he realizes that the cat went away and he was looking for the cat. In this picture, we can see that the cat is behind the apple tree. There is a balloon on the air. We can see that it is the same night, the growing moon is between two numbs. He was looking through a corn plantation. He is taking his dog with, but his dog actually is looking into cats' eyes and is not barking. Maybe, the dog doesn't like the cat, I don't know. Oh man, now, in that home, is a bright new day. We can see the sun rising through the window. Half of cheese is on the bed and he is feeding the rat. He is taking part of that cheese to feed the rat and the rat is inside the bottle. The dog is also shaking his, what is the name of this. And the cat picture continues on the wall.

#### P50 – L3G

In a house there was two mice that lived together, happy. And they eat a lot of cheese and drink wine and eat bananas. But one day, the owner of the house found the mouse and catch him. And put him into a glass. He loved this mouse and feed him everyday. He had a dog that loved this mouse too. And they always played with the mouse and feed him, and play with him. But one day, the mouse run away from the house. And the man and the dog went out to find him. They went to his garden but they didn't found the mouse. They looked in entire city from the mouse and but they didn't found him. One day, when the man and the dog were asleep, the mouse came back to their house and went back to his little house into the house with his wife.

### P51- L3G

Ok, once upon a time, there was a boy who was taking a walk with his dog and then he heard there were a few rats in his house and he wanted to take them off, come é que fala isso. Well, then he dreamed that he was supposed to capture them. So, he did, then, after a while he captured the rat, just one of them and kept feeding them.

### P52 – L3G

Once upon a time, there were a man and his dog. They were happy together. But there was a problem. The dog doesn't like very much cats. So, he, the man was not able to have a cat. And then, the mice saw his house as an opportunity. And the mice was, were very happy in the house with no natural enemy. And, one day, the man, kept one of the mice in a little jar and treated him with some cheese.

### P53 – L3G

The first scene we can see there is a boy and he is feeding a rat with cheese. So, the boy, he has also a dog and in the first picture it is during the day. So, there is also a, a picture of a cat in the wall. So, maybe, he has a rat as a pet and the dog is enjoying looking at the feeding. So, at night, when they went to sleep, the rat escape. So, they are trying to find the rat at night. They look at the cornfield. They look in some trees around the farm. Maybe there is a river here and they try to find the rat. And they found some animal. But I cannot say what is this animal, maybe it is a lion or a cat, I am not sure. But, at the last picture we can see that the rat found another rat and they are partying and they are eating the food of, the boy's food while they are looking for the rat.

### P54 – L3G

The boy had a pet mouse and a pet dog. He was feeding the mouse with cheese during the day. He had a tiger on the wall, a tiger, a picture of a tiger in the wall, on the wall. During the night, the frog, the frog no, the mouse, escaped and the boy was sleeping and the dog was sleeping. Next, the boy woke up during the night and found that the mouse was missing. And he started looking for the mouse. He was, he looked for the mouse in a place with seven trees and a...Esqueci o nome disso aqui. There was a lion behind the tree and a balloon on the sky, in the sky, but the boy did not find the mouse because the mouse were having a party, eating cheese, fish, drinking wine and eating banana with the light turned on.

### P55 – L3G

So, John had a pleasant afternoon with his little dog Scooby. They had a nice time walking through the park, searching for some apple and enjoying the blue sky. Scooby was actually scared with the possibility of meeting a bigger animal, you know, because. Well, he was really scared about big animals, you know. But then, John was not really interested about Scooby's fears, he was more interested on the cornfield at his left side. But it was a nice, pleasant afternoon. But then, they just got all too tired and decided to come back home to sleep a little bit. He was very tired. And then, well, they came back to house and he decided to sleep in his bedroom, where there was this big poster with a big fat cat, you know. And also Scooby was sleeping. And I think both of them started to dream with something alike. And, it had something to do with mouses and cheese and food. But more precisely, John dreamed that he and Scooby wake up and feed, feeded some of the rats that were living in his bedroom. And, it was funny, because this rat started to talk and it was very crazy. And, they decided to dance and to enjoy all this cheese that was suddenly available. And they also were, they were also drinking wine and discussing such philosophical themes. And incredibly enough these rats would also enjoy fish and bananas. We are not sure why.

### P56 – L3G

There was a boy with two pets. He had a dog and a rat. He used to feed the rat with cheese. Because the rat loved cheese. Then, one night the boy went to sleep and so did the dog. But the rat escaped from the boy and run out the house. When the boy noticed that the rat had escaped, he looked for the rat in the garden, and every place that he thought the rat could be. But the rat found another rat, a female rat and ate with her, his cheese and he was very happy because he found another female rat.