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First Language Lexical Activation during Second Language Sentence Comprehension in Highly Proficient Bilinguals

Thesis Report toward a
Master of Arts Degree in Cognitive Science

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Santiago, Chile
2013

Abstract

One of the most intriguing aspects of cognition is the way the bilingual brain deals with two languages. In this sense, a central question is whether knowledge of one language interferes in the processing of the other in everyday language use. The present thesis studied cross-language lexical interaction in highly proficient Spanish-English bilinguals who learnt English as a second language after age 10. A semantic incongruity task was used in which bilinguals read English sentences whose final words were either congruent or incongruent with the rest of the sentence context. While participants performed the task, their neural activity was recorded using electroencephalography (EEG). Event-related potentials (ERPs) were extracted and the semantic incongruity marker, N400, was used to assess electrical brain activity. Critical stimuli were English words whose Spanish translation equivalents shared an initial segment of their phonological representations with those of the most expected words for each sentence. For example, in the sentence "*My brother swept the floor with a...*", 'broom' is an expected and congruent final word, while 'foam' is an incongruent ending. However, the Spanish translation equivalents of these words, '**es**coba' and '**es**puma', respectively, start with the same syllable. Participants showed no differences in N400 amplitudes for incongruent words with this sound repetition compared with incongruent endings without it (e.g. broom-foam; **es**coba-**es**puma vs. broom-dessert; **es**coba-**po**stre). However, significant differences were found in N400 peak latencies, in which incongruent words that had this initial sound repetition peaked significantly later than incongruent words without phonological overlap. These results suggest a co-activation of English and Spanish words during second language word comprehension in sentence reading, supporting and extending the view that bilingual word processing is non-selective.

To Lady, who pushes me to go beyond my limits.

Acknowledgements

I am deeply grateful to Francisco Aboitiz for his support, and for allowing me to conduct this research in his lab and giving me the chance to learn about electroencephalography, as well as to Pablo Billeke, who patiently taught me this technique. Also, special thanks to my friends and colleagues, who generously helped me to administer the cloze probability tests used in this thesis.

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1 Introduction

The way bilinguals cope with two languages is an important focus of interest in cognitive science. In this sense, psycholinguistic research about the organisation and the dynamics of the bilingual lexicon has encountered important progress since the nineties, particularly in developing models about the interaction between lexical forms across the bilinguals' native and second languages, and whether these lexical forms have a common lexical system and/or a shared conceptual ground.

First, it has been proposed that words from the native language become activated during second language comprehension even in highly proficient bilinguals (Dijkstra and van Heuven, 2002). This means that lexical access in the bilingual brain is non-selective since lexical representations from the two languages of the bilingual are activated in parallel, regardless of the language specificity of the linguistic input. Several behavioural and neuropsychological studies support this theory of a cross-lingual lexical interaction during second language comprehension, either in reading tasks (e.g. Kerkhofs et al., 2006; De Bruijn et al., 2001; Schwartz et al., 2007; Schwartz and Kroll, 2006) or in listening tasks (e.g. Marian and Spivey, 2003; Thierry and Wu, 2007). A pivotal study is that of Thierry and Wu (2007) who studied late Chinese-English bilinguals in an experimental design where participants were required to decide if pairs of English words were related in meaning. They found a cross-language lexical access when they observed that the event-related brain potentials -specifically N400- were reduced when "concealed" Chinese translations for a given pair of English words shared initial sounds (e.g. train-ham in English; **huo** che-**huo** tui in Chinese, respectively) when compared with those Chinese translations that did not have this phonological overlap, independently of the semantic relatedness factor. Later on, it was concluded that this unconscious interference of the native language relied on the phonological representations of the translations equivalents and not on word orthography (Wu and Thierry, 2010).

Furthermore, it has been suggested that second language lexical forms are mediated by first language lexical representations in order to grasp meanings from L2 words (Kroll and Stewart, 1994). This would occur at early stages of language acquisition in which the bilingual's proficiency is low, what would suppose weak links from words to concepts in L2, thus needing L1 translation. As proficiency level increases, these L2 connections become stronger, so L1 translation activity decreases. In a behavioural study, Elston-Güttler and Williams (2008) found that polysemous German words (e.g. 'Tasche', which means 'bag' or 'pocket' in English) affected the interpretation of English words (e.g. bag; pocket) in German learners of English who had high levels of competence in L2. The German learners of English presented longer reaction times and higher error rates compared to English natives while reading English sentences. The authors drew the conclusion that although advanced learners might have had direct access to the conceptual level from L2 words shown by the high number of correct responses, L1 lexical representations (and thus the L1 meaning) were also co-activated due to increases in both reaction times and errors when compared to the control group. This might be deemed as evidence for an intermediate stage in which bilinguals are capable of accessing straight from L2 words to their corresponding meanings, but there might be still some residual effects from early lexicalisation patterns present at early stages of language acquisition (Elston-Güttler and Williams, 2008).

The use of electroencephalography has been of great help to uncover this alleged cross-lingual lexical interaction because it offers great temporal resolution, allowing researchers to observe online changes through the course of lexical processing by the range of milliseconds. Unfortunately, most of the electrophysiological studies that have investigated about this cross-lingual interference have used cognates or homographs (also called false friends, that is, words that have the same form across languages but different meaning) that explicitly activate the first language of the bilinguals within different experimental tasks. The use of cognates or false cognates is sufficient to create an artificial language mode in which bilinguals necessarily have to access words from the irrelevant language (Grainger et al., 2010). Therefore, to observe first language interference on the second language it is necessary that bilinguals be in a monolingual mode during those tasks that require the speaker to process different aspects of language (Grosjean, 2004). Moreover, a great part of this body of research has studied cross-lingual interference in tasks that involved reading of words out of sentence context. This is something difficult to find in common language use; therefore the results found so far about this lexical interference can be extended and improved with target words appearing embedded in sentence contexts.

The present thesis is therefore intended to study cross-lingual word interactions in highly proficient Spanish-English bilinguals who acquired English after age 10 (late bilinguals) with the technique of electroencephalography (EEG). More precisely, it tackles the question of a likely Spanish co-activation during sentence comprehension in English and how this activation is represented in neural processing changes. Importantly, this study seeks to explore the dynamics of the bilingual lexicon in a more typical language setting like the reading of sentences, contrary to the isolated word paradigm predominantly used in the EEG studies so far to the author's knowledge. Predictability of upcoming words has been shown as an amazing capability of the human brain in sentence comprehension processes, where context information is used to anticipate features of forthcoming items within a sentence (Federmeier, 2007). Consequently, top-down processing comes into play when sentence contextual constraints activate and deactivate words as reading unfolds over time. This is what occurs in everyday language and it is therefore important to observe if this alleged co-activation of L1 is still present while reading sentences in L2.

A semantic violation paradigm (in which incongruous words elicit a more negative brain related-potential than congruent words in sentences) was used in this research to examine this L1-L2 interaction. Critically, some of the incongruent words shared a phonological overlap in their translation equivalents in Spanish with the most expected words for each particular context. For example, in the sentence context *'My brother swept the floor with a...'* the most expected word is 'broom' ('escoba' in Spanish). It is hypothesised that if an unexpected word, such as 'foam' ('espuma' in Spanish), is presented as the final word there will be a change in the processing of that critical word at the neuronal level (assessed with the meaning-related EEG marker N400) since it shares initial sounds when translated into Spanish with that of the most expected word (**es**puma-**es**coba).

In the following chapters, a framework on general word processing will be exposed and discussed in relation to latest evidence that supports a more flexible and interactive word processing. Also, important insights into sentence comprehension will be discussed with a focus on contraints that sentences exert over this type of process. Then, the two most important models on lexical access in bilinguals will be exposed with behavioural and electrophysiological evidence in favour of both, together with a global view of language and its neuroanatomical correlates for bilingual language comprehension. All of this in virtue of a better understanding of bilingual word processing in sentence contexts and whether native language can affect second language comprehension of words.

2 Background

2.1. Word Processing

The human brain has the remarkable ability to identify words that belong to the lexical repertoire of a language almost automatically. Evidence has shown that it takes longer to reject legal pseudowords than strings of letters impossible to find in a target language as non-words (e.g. 'skern' and 'tlat' in English, respectively) (Fernández and Cairns, 2011). Particularly, the inadmissible phonotactics[1] of the word 'tlat' makes it easier to reject compared with 'skern', whose phonotactics is allowable in English. This shows that the brain is helped by phonotactic knowledge to access the lexicon at very early stages of word processing. Once a word has surpassed the phonotactics barrier it is suitable for lexical processing.

Traditional approaches to word processing (e.g. Forster, 1981) claim the existence of two discrete stages in word comprehension: lexical and post-lexical processing. During lexical processing, lexical entries stored in the mental lexicon are first recognised by means of a process in which the physical characteristics of the entering word should match with phonological and orthographic features of lexical entries through a search process. For example, whenever a person listens to the word 'cat', the beginning of the word's phonological representation -/kæ/- will be contrasted one by one to all possible candidates in the mental lexicon. Then, words such as 'carrot' and 'carriage' will be activated at a first step, but then discarded due to phonological mismatch. In connectionist models, however, word recognition and retrieval are differently processed as regards as type of computation, workload, and basic units of information. For example, in the localist

[1] Phonotactics is defined as those phonological combinations that are permissible in a language.

connectionist view postulated by McClelland and Rumelhart (1981) not only lexical items are accessed, but also sublexical information corresponding to letters and phonemes. Therefore, both types of information (lexical and sublexical) are activated during lexical access in a constant interaction. Importantly, word candidates are activated in parallel, that is, multiple lexical and sublexical items are processed at the same time whereby the best candidate that matches the entering word's features is finally retrieved. On the other hand, distributed connectionist models argue that lexical items are not discrete units of processing, but patterns of activation spread over a set of finite units (Seidenberg and McClelland, 1989). Thus, divergence between serial and connectionist stances on word processing relies on differences in the way words are first recognised and then retrieved during word processing.

Several lexical effects have been studied and accounted for differently by search and connectionist models of word recognition. For example, an interesting phenomenon in word processing is word neighbourhood wherein words are responded to more slowly if they have a larger number of words with similar orthography/phonology (e.g. 'string' and 'spring'). This evidence suggests that it is more difficult to retrieve words when they have more orthographic and/or phonological neighbours. Connectionist models would gently explain this by saying that multiple units of information can be activated at the same time, consequently the activation of one word can inhibit other words' activation, resulting in slower word recognitions (Field, 2005). Also, it is a well-known fact that frequent words are faster to be recognised than low-frequency words (Forster and Chambers, 1973). According to Forster (1979), words are stored in a sequential order, and more frequent words are so to say in the front line. Therefore, lexical information is more quickly available for high than for low-frequency words. On the other hand, from the distributed connectionist stance, it has been claimed that frequency effects can be explained by different patterns of activation, which are weighted more greatly for high than for low-frequency words (Seidenberg & McClelland, 1989). Another classic finding about word processing is semantic priming. This effect predicts that subjects will present faster reaction times when they identify the second word of a semantically-related word pair compared with an unrelated word pair (Meyer and Schvaneveldt, 1971). For example, when nurse is presented preceded by 'doctor', subjects are faster at indicating that 'nurse' is an acceptable word in the target language. On the contrary, if the semantically unrelated word 'cabin' precedes 'nurse', response times will increase for the second word. This priming effect has its roots on the idea that lexical items are stored as semantic networks that contain lexical items represented as nodes connected by associative pathways between semantically related words. Once a lexical item is activated, a spreading of activation covers nearby nodes (Collins and Loftus, 1975). So, whenever nurse is presented it will co-activate hospital, patient, and doctor, among others.

Either in search or in connectionist approaches to lexical access, the overall word processing is dual-stage. Both, serial and connectionist, diverge in the way words are found in the lexicon and how phonological, orthographic and functional features of words are retrieved so that they can be processed at a subsequent stage. But in both views, when /kæt/ and 'cat' meet the phonological and orthographical requirements of the lexical entry [CAT], respectively, semantic and syntactic information are activated to be processed in a post-lexical phase. Here, words make use of semantic and syntactic information to become integrated into the sentence and/or discourse context. This is considered a higher-order process whereby input information is combined with linguistic and non-linguistic (e.g. world knowledge) context information to form an online mental representation of the sentence/discourse in which the entering word is embedded (Kutas and Federmeier, 2011). Thus, words would relate to contexts in a post-lexical stage, after the word has been accessed.

Even though, in recent years, electrophysiology has contributed with groundbreaking evidence that disrupts the distinction between lexical and post-lexical stages (e.g. Lau et al., 2009). For example, Kutas and Federmeier (2011) propose that there are not rigid cut-off mechanisms in word processing as shown by the electrophysiological N400 component (see section 2.6.2 for further information about the nature of N400 as a neural index). They argue that the process generated after the stimulus has entered the system can be perceptual during the first 200 milliseconds, but then low-level and higher-order processes (lexical access and functional word-sentence integration, respectively) are better reckoned as parallel mechanisms that work jointly in a neural network that has been observed in the same time window around 400 milliseconds after target word onset. This view is relevant in the sense that it does not treat word processing as a serial, dual-stage scenario wherein the word meaning is extracted from a single unit and then compared with more global meaning settings, but as a process in which meaning is constructed over time recruiting a set of multi-modal resources, like world knowledge, acoustic and visual extra-linguistic cues, linguistic information and attentional demands.

2.2. Sentence Context Effects on Word Processing

Now that we have a general picture on how words are processed since the moment we read or listen to them, it is important to discuss the main effects that sentence contexts can exert over word processing. In this section, then, relevant evidence about how sentences can affect word processing in significant ways will be reviewed and discussed. As there are no studies on this topic with bilinguals, only studies with monolinguals will be considered.

A systematic finding about sentence effects on lexical processing is that responses to words that belong to congruent contexts are faster than words presented in neutral or incongruous sentences. For example, responses for 'treasure' are facilitated in "*The pirate found the treasure*" compared with the sentence "*The person liked the treasure*" (Morris, 2007). This effect is strongly linked to prediction of upcoming words during sentence reading. Prediction is an exceptional feature of the human brain that has benefits for several cognitive processes such as perception and attention (Bubic et al., 2010). In the case of sentence comprehension, the reader is able to anticipate forthcoming words given that a set of lexical, semantic and perceptual features of the likely words to appear is activated (Federmeier, 2009). This view of sentence comprehension allows combining perceptual word information with other available sources of information like the one provided by sentence context. Therefore, it can account for faster responses to predictable words and to words that are skipped more often in a predictive context (Morris, 2007) in which recognition of predictable words is speeded up.

Within the field of electroencephalography, important evidence has supported this anticipatory effect in sentence comprehension. For example, Federmeier and Kutas (1999) studied whether words from the same category of the most predictable word would present differences between them (e.g. 'palms' was the most expected word for a particular context, whereas 'pines' was the unexpected within-category word) and across words that did not belong to the same semantic category of the most expected target (e.g. 'palms' as most predictable and 'tulips' as not predictable and between-category word). They found that within-category words (pines) presented a smaller event-related N400 component than between-category words (tulips). This shows that it was easier to process words that shared semantic features with predictable words in sentence contexts than with words that had fewer or no overlapping features. Importantly, limitations imposed by strongly constraining contexts seem to be greater than those exerted by low-constraint contexts, then word processing is facilitated when sentence constraining levels are high. For example, when subjects read within-category words embedded in highly constrained sentences in the same

Federmeier and Kutas' study (2009), the N400 component was reduced compared with the same within-category words in low-constraint contexts (that is, contexts that could be completed with a higher number of possible words than in highly constraint sentences), but they were still smaller than between-category words in the same low-constraint sentences. This implies that predictive effects are present regardless of the constraining level of the sentence (i.e. high or low-constraint), but they are much stronger when words belong to highly constrained contexts. Another important piece of evidence comes from Delong et al.'s study (2005). In the same violation paradigm aforementioned by Federmeier and Kutas (1999), Delong and her collaborators found that articles' mismatches to the most predictable word in a sentence context also produced differences found in the N400 range. For example, in the sentence "*The day was breezy, so the boy went outside to fly an....*" there was a N400 time-locked to the presentation of the article 'an' since the most expected word is 'kite', which must be preceded by the indefinite article 'a'. This finding supports the indication that readers make use of context cues to narrow the number of likely upcoming words and that this prediction is present even before words actually appear in the word chain. It seems that we are constantly taking advantage of the mental representations the ongoing reading provides throughout sentence reading and that this information is accrued to make predictions of forthcoming words in advance.

However, Schwanenflugel and LaCount (1988) found that a facilitation effect appeared for unexpected (but plausible) words in behavioural experiments when the constraining level of the sentence was weak, but not when contexts were strongly constrained. According to them, highly constraint sentences establish a greater number of semantic restrictions and upcoming words should meet all of them in order to facilitate lexical processing. Accordingly, this view does not extend to unexpected words that only share a subset of these restrictions. These behavioural results are not consistent with the electroencephalographical study of Federmeier and Kutas (1999) in which unexpected words showed facilitatory effects when they shared only some of the semantic restrictions imposed by context. This disagreement between behavioural and electrophysiological findings led Federmeier et al. (2007) to study prediction of expected and unexpected words in both weakly and strongly constrained contexts. They found no differences for unexpected items in either sentence context. In particular, subjects showed N400 effects for all unexpected endings, regardless of the type of constraint sentences had. Nevertheless, there were differences between 500 and 900 milliseconds in which more positive waveforms were at frontal sites only when unexpected words appeared in strongly constrained sentences. According to the authors, these results indicate that restrictions the sentence context exerts over word processing leads to multiple effects, which are temporally differentiated. On one hand, the N400 electrophysiological marker would index the mismatch in which the appearing word does not relate to what was previously predicted based on the non-correspondence of the lexical and semantic restrictions imposed by the sentence context. On the other hand, there would be a later stage where this mismatch is identified as such and in which neural resources start working to adjust the prediction aforesaid (Federmeier et al., 2007) and this stage would be reflected in a frontal late positivity in the time window of 500-900 milliseconds.

Taken together, behavioural and electrophysiological evidence has supported the view that sentence context greatly affects the way words are processed while reading sentences as observed in faster word recognition times, high word skipping rates, and more reduced N400 components for word violation settings. In all of these cases, word prediction in sentences appears to be a critical factor that allows readers to activate semantic and lexical features. This useful psychological resource operates incrementally during the ongoing sentence reading by accumulating information necessary to anticipate words even long before they occur. Such effects, would show whether the lexical and semantic properties of the appearing word matches the features previously activated by the context or not, facilitating word comprehension (e.g. when words are easily skipped in reading) or permitting the reader match the new word encountered (e.g. when a negativity appears at 400 milliseconds). Note that for the purpose of this thesis, the latter is quite important since the N400 component would be considered as a marker that the target has been recognized as unexpected, probably at the very moment lexical access is at work together with the integration of the word's semantic and syntactic content.

2.3. Bilingual Lexicon Models

There are two leading models that predict distinct, yet related, bilingual comprehension phenomena: the Revised Hierarchical Model (RHM) and the Bilingual Interactive Activation Plus (BIA+).

First, the RHM was meant to explain L2 word processing in terms of translation performance and language proficiency differences. It assumes asymmetrical connections between L1 and L2 words, which are strong from L2 to L1 and weak from L1 to L2 (Kroll and Stewart, 1994). When L2-L1 word connections are strong, L2 words are assumed to bear weak connections with the conceptual level, what makes L1 lexicon necessary to achieve the meaning of L2 words (Figure 1). For example, Kroll and Stewart (1994) found that reaction times in translation tasks from Dutch (L1) to English (L2) were significantly longer than those from English to Dutch. This slower translation performance would show that L1-L2 translation was affected by semantic access and that L1 words were necessarily retrieved to mediate between the conceptual level and L2 lexicon in L2-L1 translations. Furthermore, this alleged L1 mediation to the conceptual system decreases when L2 proficiency increases, making the links between L2 words and the conceptual system stronger. For example, Sunderman and Kroll (2006) established that low and highly proficient English-Spanish bilinguals presented differences in deciding if two words were translation equivalents or not (e.g. cara-face / cara-table). For the "no" answers there were some form-related translation equivalents (e.g. cara-fact) that yielded higher reaction times for the low proficient bilinguals compared to the highly proficient bilinguals, suggesting that bilinguals with low L2 skills are more prone to activate L1 words in L2 comprehension. Therefore, the strength of the connections between L2 and L1 words and between L2 words and the conceptual level would depend on the bilingual's L2 proficiency.

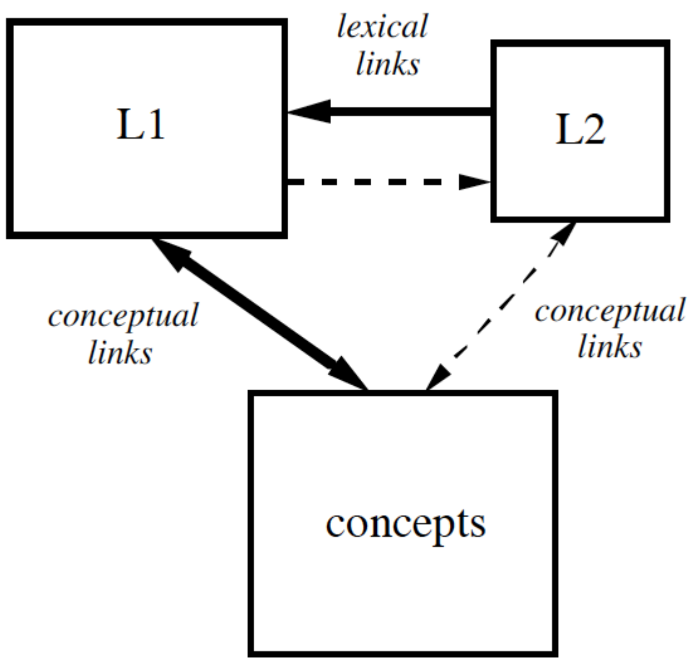

Figure 1. The Revised Hierarchical Model (taken from Kroll and Tokowicz, 2001)

On the other hand, the BIA+ does not tackle second language word processing from a translation and language proficiency stance as the RHM does. It states that highly proficient bilinguals have an integrated lexicon where there is parallel access of L1 and L2 words through processes of bidirectional inhibitory and excitatory connections between words from both languages (Figure 2) (Dijkstra and Van Heuven 2002). Accordingly, L2 lexical comprehension would be non-selective, that is, whenever a bilingual reads/listens to an L2 word, this lexical form will compete with other lexical forms from L1 and L2 altogether, and not only from the lexicon of the language the stimulus belongs to. This is extremely important because it highlights the limited bilingual's ability to control irrelevant language involvement during L2 comprehension. Phonological and orthographic information are activated at the beginning of second language comprehension, what gives information about the language to which the word belongs to, but this does not mean that the bilingual is in any control of the activation process during L2 comprehension.

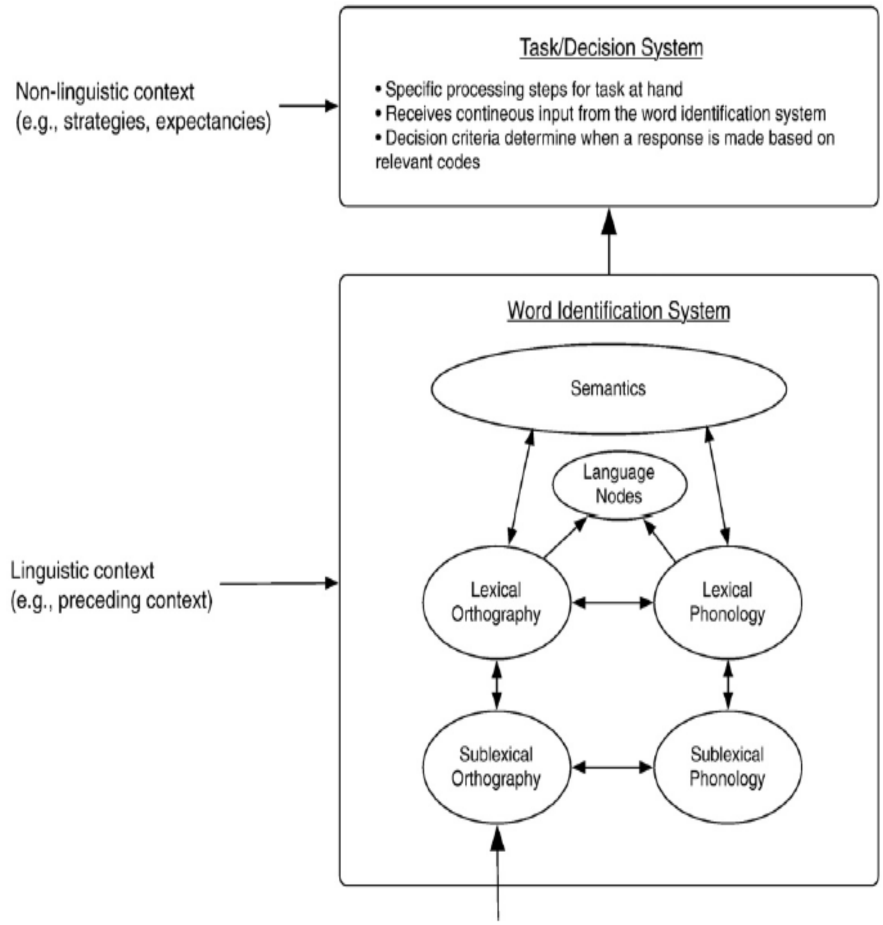

Figure 2. The Bilingual Interactive Activation Plus Model (taken from Dijkstra and van Heuven, 2010).

2.4. Evidence for Lexical Cross-language Interaction

In this section, relevant behavioural, electrophysiological, and eye-tracking evidence for non-selective word processing in bilinguals will be described. It is important to highlight the lack of studies that provide more ecological methods to validate non-selectivity as most studies have found parallel lexical activation in bilinguals using words out of context. These studies are going to be described first, and then studies using words in sentence contexts will be outlined, in which most of the electrophysiological studies have investigated this cross-lingual lexical interference with cognates or false friends, thus activating the native language explicitly.

2.4.1 Evidence for Second Language Word Processing out of Sentence Context

There is a general consensus that lexical access in the bilingual brain is non-selective and that words from both languages are accessed in parallel irrespective of the language the target word belongs to. In this sense, most of the studies that support this lexical non-selection in bilinguals have used cognates out of context in their experiments. Researchers have used paradigms such as naming and lexical decision mostly in semantic priming tasks (in which the preceding word primes the target word via their semantic relatedness). In these studies, it has been found that reaction times significantly decrease when subjects are presented with words that are cognates (e.g. doctor-doctor) or words with similar form (eco-echo) that have the same meaning across two languages when are compared to non-cognates (control words) (e.g. Dijkstra et al., 1999; Lemhöfer and Dijkstra, 2004). Authors have considered these results as indicators that cognates allocated in the second language activate first language representations, which share the same semantic representation to some extent, making the recognition of cognates faster than the recognition for non-cognates (Dijkstra et al., 2010; Van Assche et al., 2012).

Interlingual homographs, which share orthographic form but have different meanings in both languages, have also been vastly studied proving cross-lingual interaction in words presented out of sentential context. For instance, Dijkstra et al.

(1998) studied Dutch-English bilinguals in a go/no-go task (i.e. press a button only when the target word is an English word). The results showed that bilinguals responded significantly later when the English words were homographs, to which the authors interpreted that the activation of these homographs in the non-target language interfered in subjects' reaction times. Then, Dijkstra et al. (1998) argued for an inhibitory effect when bilinguals had contact with English and Dutch words in the same task and had to respond only to those from English. Moreover, Dutch-English bilinguals were studied in a functional magnetic resonance image (fMRI) study (van Heuven et al., 2008). They used a lexical decision task that was focused on English target only (press a 'yes' button if the target word is an English word and a 'no' button if the target word is a Dutch word) and another generalized lexical decision task intended to allow responses in Dutch and English (press a 'yes' button if the target is a correct English or Dutch word). The latter task had the advantage that avoided behavioural conflicts revealing conflicts at the neurofunctional level due to competition between the readings of the homographs in both languages (van Heuven and Dijkstra, 2010). Differences were shown in the pre-supplementary motor area and the anterior cingulate cortex only in the first task, which was deemed as evidence of response engagements. Importantly, differences were found in the left inferior prefrontal cortex (area associated to phonological and semantic processing) in both tasks. Thus, this study provided evidence at the neuroanatomical level that homographs from both languages were competing during the reading task. More evidence with homographs comes from an ERP study (Kerkhofs et al., 2006) in which Dutch and English homographs were presented in pairs of English words (e.g. heaven-angel) in a semantic priming task. N400 amplitudes were more negative for highly frequent Dutch words than for low-frequent Dutch words, whereas low-frequent English words presented more negative N400 amplitudes than highly frequent English words. This reverse pattern was explained in terms of a Dutch semantic interference that led to a difference in the N400 amplitude. Once again, this ERP evidence provided evidence for a competition between homographs across both languages, contributing to the bilingual non-selective lexical access posture.

Another important way to investigate about this cross-lingual interference is by using lexical neighbours. These are lexical forms that have the same word length but have one different letter (for example, *pork* and *fork* are intralingual neighbours in English) (Coltheart et al., 1977). In this context, it has been found that a high number of neighbours (i.e. a high neighbourhood density) in Dutch and English altogether greatly affected word recognition times in one language in Dutch-English bilinguals (van Heuven et al., 1998). Midgley et al. (2008) found similar results in an electrophysiological experiment. They studied French-English bilinguals and observed that when the neighbourhood density was high in the other language of the bilinguals (i.e. that language bilinguals were not reading in) N400 amplitudes were much greater than when this number of cross-lingual neighbours was low. Both studies indicate that words from both languages were activated, providing more evidence for parallel access in an integrated bilingual lexicon.

2.4.2. Evidence for Second Language Word Processing in Sentence Contexts

Only few studies have enquired into cross-lingual lexical interaction during second language sentence reading. For instance, Schwartz and Kroll (2006) studied Spanish-English bilinguals in a word recognition task by using cognates (e.g. piano) and homographs (e.g. pan) in highly and low-constrained sentences (according to the number of lexical candidates that can correctly complete a sentence in which a highly-constrained sentence will have a lower number of candidates). They found that the non-target language was active only when the sentence was low-constrained. No such facilitation was seen for highly constrained sentences, what suggests that bilinguals can make use of sentence context to limit this cross-language activation. Notably, this study included highly and low proficient bilinguals and both groups presented the same results, highlighting the importance of sentence context as a way to inhibit non-target language words. van Hell and de Groot (2008) found similar results in another behavioural study with Dutch-English bilinguals in which the cognate effects disappeared in lexical decision tasks and decrease in translation tasks when subjects read highly constrained sentences.

Elston-Güttler et al. (2005a) used electroencephalography to study word access in sentence contexts in German-English bilinguals. Subjects read sentences whose last words were homographs across both languages (e.g. 'gift' which means 'poison' in German). After a full English sentence was presented, a target word that was related in meaning with the homograph (e.g. poison) or that was not related at all (e.g. boss) appeared and subjects had to indicate if it was an English word or not. Reaction times considerably decreased when target words were related in meaning to homographs and N400 components were smaller than control words. Authors argued that this latter finding demonstrated that it was easier to process target words when homographs appeared, showing a difference in N400 amplitude. It is important to note that this homograph effect in sentence context existed only when subjects watched a movie in German before the task and during the first block of the experiment. In the second block and for subjects who watched an English film before the test instead, no homograph effects were elicited in reaction times or brain potentials. The authors concluded that global language context, that is, the language in which the experiment is set, can modulate interference of the first language in the second language at the lexical level for a certain period of time and that bilinguals can "zoom into" the second language of the experiment as it was demonstrated by the absence of homograph effects in the second part of the experiment with the German movie being shown prior the experiment. However, these results contrast with those found by Paulmann et al. (2006) who studied late German-English with the same stimuli used by Elston-Gütler et al (2005a). Here bilinguals showed faster reaction times and differences in N400 potentials irrespective of the language of the movie watched before the experiment.

In another experiment, Elston-Gütler et al. (2005b) studied how proficiency can affect this cross-lingual interaction with the same lexical decision paradigm with targets presented after full sentences in the subject's second language used by Elston-Gütler et al. (2005a). In this case, they used homonyms translated from German (L1) to English (L2) (e.g. 'pine' and 'jaw' in English both mean 'Kiefer' in German). Low proficient bilinguals showed faster reaction times and different N200 brain potentials (which has been indicated as a neural marker of orthographic processing) when target words (e.g. pine) were primed by homonyms (e.g. jaw) in words out of context and embedded in sentence context. However, fluent bilinguals presented these effects only when words were out of context. The authors concluded that low proficient bilinguals relied more on their first language lexical representations since second language words are still weak, what would be in line with the RHM model for bilingual word processing. Furthermore, context could help highly competent bilinguals to "block out" first language interference on second language processing.

Finally, important advances have been made recently by examining eye movements while reading sentences with the eye tracking method. For instance, Duyck et al. (2007) studied Dutch-English bilinguals who read low-constrained sentences that contained cognates at middle positions. There were faster first fixation durations, gaze durations, and cumulative region reading time for identical cognates but not for non-identical cognates. In addition to these results, cognate facilitation effects had been previously found when the same targets and controls were studied in isolation. Therefore, the authors concluded that context could modulate non-target language activation but only when lexical overlap was weak like in the case of non-identical cognates. These results were supported in a subsequent eye-tracking study using the same paradigm (Libben and Titone, 2009). French-English bilinguals read low and highly constrained sentences with homographs (e.g. 'coin' which means corner in French) at mid positions. The authors found early-stages of eye tracking indexes (e.g. first fixation duration, gaze duration, and skipping rates) and late-stages markers (e.g. go past time and total reading time) in both low-constrained sentences. Only early-stage differences were found in highly constrained sentences, which led the authors to conclude that non-selective access is still present for words during sentence reading, but that bilinguals can quickly resolve this facilitation at later stages of comprehension and focus on the target language with the aid of sentence context.

2.5. Second Language Comprehension in the Bilingual Brain: Neuroanatomical Perspectives

A question that immediately arises when thinking about language representation in the bilingual brain is whether the second language uses the same neural resources of the first language. Good ways to explore this question are the functional magnetic resonance imaging (fMRI), which measures changes of oxygen levels in blood flow across regions of the brain (Wager et al., 2007), and positron emission tomography (PET), which also measures blood flow, but through radioactive water that is administered into a vein (Abutalebi et al., 2005). Both techniques offer an excellent spatial resolution, permitting to observe activation of cerebral areas for different types of linguistic processing. Through the use of these methods, different studies have provided converging evidence that first and second languages are equally activated in the brain in terms of their spatial distribution, sharing classical language areas such as left frontal and temporo-parietal regions (Abutalebi, 2008). However, second language proficiency level and second language exposure can modulate the pattern of activation observed for the second language. In the following paragraphs, a brief outlook of experimental evidence supporting this overlapping brain activation will be given with a focus on sentence comprehension processing.

PET evidence has revealed a distinct neural organisation for L2 compared with L1 in bilinguals with low proficiency in their second language and who also learned it after adolescence (Perani et al., 1996). While subjects listened to stories spoken in both languages, L1 sentence processing recruited a higher number of regions, covering the angular gyrus, the superior and middle temporal gyri, and the temporal pole, mostly in the left hemisphere. By contrast, L2 sentence processing engaged only superior and middle gyri. In a subsequent experiment, Perani et al. (1998) investigated bilinguals with high proficiency in L2 while they listened to stories in L1 and L2 as well. In this occasion, language comprehension for both languages presented overlapping patterns of activation in areas such as the left superior and middle temporal gyrus, and the temporal pole. Interestingly, these latter results were found for early and late bilinguals, therefore Perani et al. (1998) concluded that proficiency is a significant factor that modulates neural resources used by L2 in comprehension tasks, at least in the auditory modality. As regards as sentence reading, Chee et al. (1999) used fMRI to see differences in early fluent English-Chinese bilinguals. They found similar patterns of activation in the left hemisphere for native and non-native languages, which included inferior and middle frontal gyri, superior and middle temporal gyri, temporal pole, superior parietal areas, occipital regions, and the anterior supplementary motor area. This study supports the previous findings by Perani et al (1998) and extends them to the visual modality, indicating that second language comprehension activates the same brain areas of the first language when bilinguals possess high competence in their second language.

Interestingly, in a following study Chee et al. (2001) contrasted high and low proficient English-Chinese bilinguals in a semantic judgment task. They found that fluent bilinguals presented a reduced spatial distribution, mostly in prefrontal and parietal areas. On the contrary, low proficient bilinguals, had a broader pattern of activation, comprising also right hemisphere areas and inferior frontal activation. These results did not agree with Perani et al.'s study (1996) aforementioned, in which low proficient bilinguals required fewer brain regions in second language comprehension. According to Chee et al. (2001) their results differed because of differences in tasks demands in which subjects were faced to a more difficult activity (semantic judgement) than passively listening to sentences. Therefore, it is possible that neural resources are used differently based on the requirements of particular tasks (Abutalebi et al, 2005). Besides, Rüschemeyer et al. (2005) studied Russian native speakers who were learners of German. Subjects listened to sentences in their native and non-native language that contained semantic and syntactic violations. Results revealed that fronto-temporal regions (including the inferior frontal gyrus) were activated only for semantic processing in the non-native language when compared with native language semantic processing. In a subsequent study, Rüschemeyer et al. (2006) used the same violation paradigm and the same stimuli in a reading experiment. They found the same results as in the listening task, although motor and visual regions were also activated in the reading experiment.

Apart from proficiency, level of exposure to the second language has been observed as another important variable that can influence L2 activation in the brain. In a fMRI study, Perani et al. (2003) found that Catalan-Spanish and Spanish-Catalan presented neuroanatomical differences correlated to their second language exposure in lexical retrieval tasks. Catalan-Spanish bilinguals, who reported less exposure to Spanish according to a post-hoc questionnaire, showed a more extended cortical activation than Spanish-Catalan bilinguals. Indeed, both groups presented activations in classic language areas, but only Catalan-Spanish speakers employed the left prefrontal cortex while retrieving lexical items.

Finally, it is important to note that age of second language acquisition appears not to be a crucial variable for neuroanatomical correlates of semantic aspects of language processing. For example, Wartenburger et al. (2003) studied Italian-German bilinguals who had learnt German before and after 6 years old. It was found that neural mechanisms differed for the first and the second language only when subjects processed grammatical violations, but it was not the case when they had to process semantic violations in Italian and German sentences. Particularly, a more extended activation was observed during non-native grammatical processing, and an overlapping organisation for the first and second languages when the age of acquisition varied. On the contrary, when groups of bilinguals were split depending on their German proficiency levels neural organisation for both types of processing was affected, showing a more extensive activation for non-native processing. This indicates that age of acquisition greatly affects cortical correlates for grammatical aspects of language but is not enough to modulate correlates of semantic processing by its own.

Overall, PET and fMRI evidence has shown converging evidence that first and second languages share a common cortical network for language comprehension when proficiency in the second language is high. On the contrary, when second language competence is low the brain apparently needs to recruit more areas than the ones needed by fluent bilinguals, including classic language areas homologues in the right hemisphere and prefrontal cortex. A more extended pattern of activation can also be seen in bilinguals who have less exposure to their second language, in which the prefrontal cortex also appears to be highly activated in comprehension tasks. According to Abutalebi (2008), prefrontal cortex activation goes hand in hand with language-related executive processes that permit bilinguals to have access control to phonological, grammatical, and semantic information from short and long term memory. This access would be already automatized in high proficient bilinguals or in bilinguals who are exposed to the second language on a regular basis. Consequently, the prefrontal cortex would not be needed during language comprehension when second language is sufficiently robust.

2.6. Event-related Potentials

In this study we used the technique of electroencephalography (EEG) to measure this likely first language lexical activation during second language processing. In EEG the electrical field of a group of neurons that fire synchronously in the same direction can be registered by placing electrodes on the surface of the scalp that measure how neurons polarize and depolarize (Kutas and Dale, 1997). These measures are oscillations in the voltage of a particular neural activity, which can be associated in time to different types of events, whether they are exogenous or endogenous to the subject, like the presentation of a word or reactions towards that word, respectively (Fabiani et al., 2007). These are called Event-Related Potentials (ERPs), which are formed by peaks and troughs generated after a stimulus presentation (Luck, 2005), allowing researchers to obtain neural indicators of different cognitive phenomena. To obtain these ERPs, it is first necessary to filter the EEG signal in order to reduce noise from any unwanted frequencies that are irrelevant to the measurements (Picton et al., 2000). Once the signal has been filtered, the trials corresponding to different experimental conditions are averaged for each subject separately, thus obtaining an ERP waveform. In cognitive neuroscience, this neuropsychological technique has been vastly used in the study of psychological processes like attention, semantic memory, and linguistic processing, as one can observe what occurs before, during and after an event of interest (Kutas and Federmeier, 2011). This is possible due to its great temporal resolution that permits to detect a great deal of cognitive processes as they unfold over time in the range of milliseconds. However, its spatial resolution is not as good as the neuroimaging techniques, like the functional magnetic resonance image (fMRI).

An important concept within this technique is that of ERP components. This can be defined as a reflection of ERP waveforms segments as they covary with experimental manipulations. These components can be of positive or negative polarity and are functionally associated to the presentation of specific stimuli, which interact across subjects, conditions and location on the scalp (Fabiani, Gratton, and Federmeier, 2000). Therefore, one can describe an ERP component by means of its amplitude voltage, polarity, latency, and topographic distribution over the brain. For example, if a positive peak is presented after 300 milliseconds following the presentation of a stimulus, this is going to be labelled as P300 (P for positive) and will mostly cover parietal areas. Likewise, a negative deflection presented around 170 milliseconds after stimulus onset will be known as N170 (N for negative) and will be usually presented at occipito-temporal areas.

Some of these ERP components are correlated to different linguistic processing. For example, P600 amplitude has been assumed to show syntactic violations (e.g. Osterhout and Holcomb 1992; Hahne 2001; Hahne and Friederici 2001) while N400 is expected to reveal semantic processing (Kutas and Hillyard 1980a; for a review see Kutas and Federmeier 2011). The present study will employ this N400 component as a critical dependant variable; hence, it is important to see it in more detail in the next section.

2.6.1. N400 Component

Whenever the brain faces a potentially meaningful stimulus it is going to show a negative deflection that peaks around 400 milliseconds after the presentation of that stimulus. It was first discovered by Kutas and Hillyard (1980a) when they were studying final sentence words expecting to find a P300 component, which is a wave elicited by unexpected stimuli. Some of the words they studied were semantically related to the sentence context (e.g. *I shaved off my moustache and beard*) while others were not (e.g. *He took a sip from the transmitter*). The latter stimulus showed significantly higher N400 amplitudes (i.e. more negative) at around 400 milliseconds after its presentation (Figure 3). This led the authors to conclude that this event-related potential would be a sign of semantic processing when subjects tried to match the semantic load of the final word with the preceding context. Importantly, this neural index was obtained by the semantic manipulation and it was not related to physical changes in the stimuli when the last word was presented in capital letters only ('BEARD' instead of 'beard') in the same paradigm (Kutas and Hillyard, 1980b). Moreover, N400 is associated to semantic processing and not to other dimensions of language. For example, grammatical errors do not elicit differences of the same kind when compared to semantic anomalies (Kutas and Hillyard, 1983).

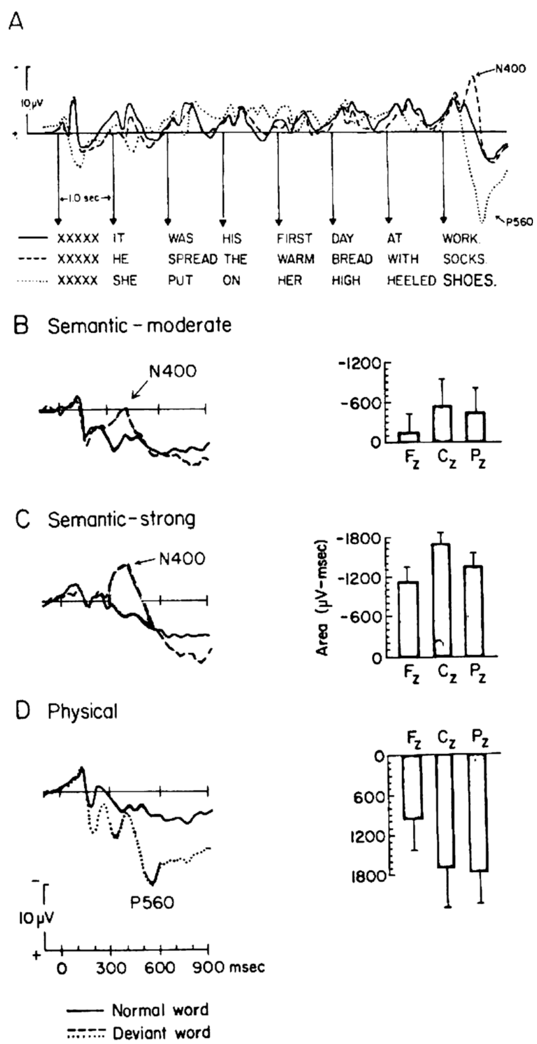

Figure 3. Larger N400 elicited by the incongruous sentence "He spread the warm bread with *socks*" (dashed line) compared with the congruous "It was his first day at work" (full line). Note that the third sentence did not show any N400, but a P560 to the physical change in the final word 'shoes' (taken from Kutas and Hillyard, 1980a).

Note that N400 effect is a difference wave. Then, it does not need to be a negative wave per se, but it is generally obtained through a point-by-point subtraction of waves corresponding to different experimental conditions (e.g. congruous versus incongruous words) (Kutas and Federmeier, 2011). Its time span goes from 200 to 600 milliseconds with a maximum amplitude near the 400 milliseconds after stimulus onset and its topographic distribution over the scalp is located at posterior sites, more specifically at centro-parietal areas. Remarkably, N400 has been observed in several types of tasks. For example, it is not necessary the target word be in a sentence, but N400 can also be elicited by isolated words in sematic priming tasks or when presented in a list of related words (e.g. Holcomb and Neville, 1990). Moreover, this ERP component is modality-independent since it has been observed in auditory and visual tasks, including linguistic settings, drawings, faces, video clips, pictures, and environmental sounds (for a review see Kutas and Federmeier, 2007; 2011). This shows that N400 is not only a neural marker of purely linguistic activity, but it is an index of a more general process in charge of potentially meaningful stimuli.

There are particular factors that affect the amplitude of this N400 effect. One of the most important is the expectancy level of a word in a sentence, defined in terms of cloze probability, which is the proportion of a word completing a sentence in an offline norming test (Kutas and Federmeier, 2011). Highly expected words (i.e. words with a high cloze probability) are supposed to show reduced N400 amplitudes in sentences compared to low expected words (i.e. words with low cloze probability) when the semantic relatedness factor remains constant (Kutas and Hillyard, 1984). For example, the target final word in the sentence *"The bill was due at the end of the hour"* would present a higher negativity compared to the ending in *"The bill was due at the end of the month"*. Both final words are equally congruous to the context, but 'hour' is less expected than 'month' for the same. Furthermore, low expected words are thought to present the same N400 amplitude notwithstanding the sentence constraining level. For example, the sentences *'The bill was due at the end of the hour', 'The dog chased our cat up the ladder', and 'He was soothed by the gentle wind' were* highly, mid, and low constrained, respectively, but across all final words no significant difference was shown in their N400 amplitudes. Thus, N400 effect is inversely correlated to the expectancy level of the target word: the higher the expectancy of a word, the smaller its N400 effect will be. Furthermore, concreteness can importantly affect N400 amplitudes. Particularly, it has been found that concrete words (e.g. table) elicit more negative N400 effects than abstract words (e.g. peace) while subjects read sentences with incongruent endings (West et al., 2000). Similarly, frequency of use of a word and semantic priming have been further indicated as important factors to bear in mind in N400 differences. It has been found that a high frequency of use can reduce N400 amplitude when target words are presented in a list (Rugg, 1990) or when semantic and syntactic constraints are low (Van Petten and Kutas, 1990). Also, when a previous word, picture or sound activates certain semantic features of the target, N400 amplitudes are smaller (e.g. Holcomb and Neville, 1990). Interestingly, the last two factors, frequency of use and semantic priming, are surpassed when targets are presented in sentence contexts. It seems that the semantic constraints that the sentence exerts over target words prevails during word level processing (Coulson et al., 2005; Kutas and Federmeier, 2011) Thus, top-down processing seems to overcome these two factors in sentence reading tasks.

2.6.2. What does N400 really index?

It is important to note that the nature of the N400 component is highly debated and evidence in relation to this topic has been divergent. For example, it has been claimed that N400 shows lexical processing at the very moment the brain access and retrieve a word (Deacon et al., 2000). Others have suggested that the N400 reflects post-lexical processing in an integrative fashion, combining functional characteristics of the word with sentence and/or discourse context (Brown and Hagoort, 1993; Hagoort et al., 2009) or even integration of word processing with world knowledge (e.g. Hagoort et al., 2004). While others have indicated that N400 can be elicited a multiple sentence/word process that includes lexical access and sentence/discourse integration altogether (e.g. Federmeier and Laszlo, 2009) (see section 2.1 about word processing).

Brown and Haggort (1993) studied the violation paradigm with lexical priming tasks in isolated words. Some of the preceding words were masked (that is, presented for really few milliseconds unnoticeable for the reader) and others unmasked. N400 component was observed in such cases in which the subject had conscious reading of the prime, but no N400 effects were seen when primes were masked, thus consciously imperceptible for the reader. This study showed, according to the authors, that only semantic integration could be indexed by N400 differences since integration is controlled and consciously-driven, so if there would have been lexical access processes (which are fast and automatic) involved, N400 effects would have been observed for unmasked primes as well. Later on, Haggort et al. (2009) further developed this idea of N400 as an index of a an integration process by saying that there is a unification process wherein meaning is assembled very quickly and that it is achieved through the semantic and syntactic features of the target word, the lexical entries stored in the lexicon, and different aspects of the language setting such as world knowledge, information about the speaker, co-occurring visual input, and discourse information. This unified theory on the nature of the N400 component can easily explain N400 differences found in discourse-level tasks and studies about pragmatics (Kutas and Federmeier, 2011).

On the other hand, proponents of the N400 as a lexical marker argue that N400 effects found for pseudowords could not be accounted for by an integrative view. Pseudowords are not found in the lexicon, thus they do not have a semantic component involved. Consequently, N400 would index orthographic and phonological analysis at a lexical level processing (Deacon et al., 2004).

A more moderate view is that proposed by Van Petten et al. (1999). In this study, sentence-embedded words were the target stimuli in the classic violation paradigm and researchers found that words that share the same initial syllable to the most expected word presented significant later N400 effect onsets than plain incongruous words and words that had phonological similarities with the most expected one only in the final part of the word. For example, in the frame sentence "*The highway was under construction, so they had to take a lengthy...*”, the word with the highest cloze probability (therefore, the most expected) is 'detour'. They found that when 'table' (plain congruous) or 'contour' (sharing the last part of the word) appeared as final words, the N400 elicited began at 200 milliseconds after stimulus onset. On the contrary, when 'detail' was presented (phonological sharing in the initial part of the word) N400 onset was at 375 milliseconds. This led the authors to think that semantic integration was being carried out before word recognition had already finished. Furthermore, Kutas and Federmeier (2000) studied semantic violations in sentences with words presented at the right or left visual field to see if there existed hemispheric differences for the N400 effect. They found a smaller N400 for words that belonged to the same category of the most expected word in the left hemisphere. For example, in the sentence frame “*Every morning John makes himself a glass of freshly squeezed juice. He keeps his refrigerator stocked with...* ", the most expected ending is 'orange'. When 'apple' appeared no differences were observed in the right hemisphere and left visual field compared with 'carrot', which does not belong to the same category of the expected final word. Differences, however, were observed in the left hemisphere and right visual field. Authors highlighted that these results provide evidence that hemispheres may have a different contribution to meaning construction whereby the left hemisphere has the important role of predicting forthcoming words with the information provided by the sentence during its progression, while the right hemisphere could assist post-lexical processing in integrating word characteristics with the sentence.

Based on the disagreement created in the N400 literature, some researchers (e.g. Kutas and Federmeier, 2011) have proposed that the N400 does not index lexical or post lexical effects per se, but a distributed and interactive process whereby lexical access and semantic integration co-occur in the same time window and in which meaning is dynamically constructed. In this sense, Kutas and Federmeier (2011) claim that the N400 has helped to blur the cut-off stages of lexical and post-lexical stages during word processing. Mechanisms such as word recognition, retrieval, and semantic/discourse integration can be intertwined in a neural network in charge of constructing meaning in a non-serial fashion. N400, then, would be a neural marker of a distributed, multimodal, and interactive comprehension system in which low and higher-order processes work in parallel and interactively.

3 Methodology

3.1. Hypothesis

H1: First language lexical knowledge interferes in L2 lexical comprehension during L2 sentence reading as a result of a co-activation of L1 words.

H2: This lexical interference from L1 to L2 is correlated with latency and/or amplitude differences of the ERP component N400.

3.2. Objectives

There are no studies to the author's knowledge about a lexical interference from the first language to the second language during sentence reading in L2 using electroencephalography. This study was intended to fill this gap because a) sentence reading is found in everyday language use and offers different dimensions of lexical processing compared to the isolated word paradigm commonly used in these studies and b) many of these EEG studies have used cognates or homonyms which explicitly activate L1 during reading. For these reasons, the present thesis has the following objectives:

1. Investigate how words from both languages interact in the bilingual's brain during online sentence reading comprehension in L2, avoiding the use of homonyms or cognates as critical stimuli that would explicitly activate L1.

2. Explore brain mechanisms that come at play in sentence reading and how sentence context may affect word processing online in highly proficient bilinguals while reading in the non-native language.

3. Explore lexical representations in the highly-proficient bilingual's brain and the links between these representations and the conceptual system.

3.3. Participants

Twelve Spanish-English bilinguals voluntarily participated in this study (6 women and 6 men). Their range of age was between 27 and 40 years old (M=30.6, SD= 3.8). They were all Chilean Spanish native speakers and highly fluent English speakers. After each experiment, a questionnaire was administered to subjects with questions about age they started to acquire English as a second language, age they reckoned they acquired high proficiency in English, their second language use, and a self-assessment of their proficiency in both first (Spanish) and second language (English) in a grading scale from 0 (none) to 10 (native proficiency) points (Table 1).

Age	30.6 (3.8)
Age of Onset L2 Acquisition*	15.9 (3.9)
Age of L2 Acquisition**	21.3 (3.1)
Days of L2 usage per week	5.3 (1.1)
Percentage L2 usage per day	40 (18)
L1 listening proficiency	10
L1 reading proficiency	10
L1 writing proficiency	9.8 (0.5)
L1 speaking proficiency	10
L2 listening proficiency	8.2 (0.8)
L2 reading proficiency	8.7 (0.7)
L2 writing proficiency	8.3 (0.9)
L2 speaking proficiency	8.5 (0.8)

Table 1. Main characteristics of Spanish-English bilinguals who participated in the study as expressed by mean values. Standard deviations are shown in parenthesis. *Age in which subjects started to learn English by means of formal English classes. **Age in which subjects acquired a high proficient English level.

Participants were all late learners of English as a second language. On average, subjects started to learn English formally (i.e. with formal classroom instruction) at 15.9 years old and reached high proficiency in English at 21.3 years old. All subjects acquired high fluency while studying at the university to become English Teachers. Subjects were active teachers of English as a second language at the moment of the experiments; therefore they used English as a second language on a regular basis when the experiments were run. Moreover, all of them had taken standardised international tests, either TOEIC or IELTS, that measure their proficiency in English, obtaining scores that confirm high proficiency in the target language. In order to have a unique reference for this proficiency level, TOEIC and IELTS scores were correlated to the Common European Framework of Reference[2] (see Table 2). Within this framework, subjects belonged to C1 and B2, which correspond to competent user with an effective operational proficiency and to independent user with vantage, correspondingly (see Table 3)

Subject	Test	Year	Score	CEFR Level
1	TOEIC	2011	975	C1
2	IELTS	2012	7.5	C1
3	TOEIC	2010	945	C1
4	TOEIC	2013	925	B2
5	TOEIC	2011	970	C1
6	IELTS	2012	8.0	C1
7	TOEIC	2011	880	B2
8	IELTS	2012	8.0	C1
9	TOEIC	2007	900	B2
10	TOEIC	2010	955	C1
11	TOEIC	2012	895	B2
12	TOEIC	2010	895	B2

Table 2. Tests taken by all subject and their corresponding correlation to the Common European Framework of Reference.

[2] As indicated on TOEIC's and IELTS' official websites www.etsglobal.org and www.ielts.org, correspondingly.

Level	User	Description
C1	Proficient	Can understand a wide range of demanding, longer texts, and recognise implicit meaning. Can express him/herself fluently and spontaneously without much obvious searching for expressions. Can use language flexibly and effectively for social, academic and professional purposes. Can produce clear, well-structured, detailed text on complex subjects, showing controlled use of organisational patterns, connectors and cohesive devices.
B2	Independent	Can understand the main ideas of complex text on both concrete and abstract topics, including technical discussions in his/her field of specialisation. Can interact with a degree of fluency and spontaneity that makes regular interaction with native speakers quite possible without strain for either party. Can produce clear, detailed text on a wide range of subjects and explain a viewpoint on a topical issue giving the advantages and disadvantages of various options.

Table 3. Description of two levels of the Common European Framework of Reference for languages according to the Council of Europe (2001).

3.4. Materials

One hundred and fifty English nouns were selected for this study. A sentential frame was created for every word with the objective that each noun was the most expected final word for each sentence (e.g. "My brother swept the floor with a **broom**"; see next section to have a detailed account on how congruous and expected words were obtained). Sentences were first created in Spanish to validate words and then translated in English by the author of this thesis. Each sentence was later proofread by a native English speaker. Another set of one hundred and fifty nouns was chosen as final incongruous words for the same sentential contexts. Critically, this second group of words contained a "hidden" phonological overlap in their Spanish translation equivalents with those Spanish translation equivalents from the first group (e.g. broom-*foam*; ***es****coba*-***es****puma*).

Finally, a different set of one hundred fifty nouns was selected as incongruous endings. This third set of words did not contain phonological overlaps in their Spanish translations with those from the first group; then, this third group of words served as the control condition (e.g. *broom-dessert*; ***es**coba-**po**stre*). Overall, three different sets of words were used as stimuli in this study: a) congruous and highly expected (C1), b) incongruous with phonological overlap between Spanish translations (C2), and c) incongruous without phonological overlap between Spanish translations (C3).

In order to avoid any L1 activation otherwise intended by the experimental manipulations, cognates were not used as final words in any of the three conditions. Likewise, phonological representations of the English words did not share initial sounds across conditions nor among their Spanish translation equivalents to avoid delays in the lexical retrieval process due to non-experimental changes in the stimuli. Also, English word frequency was matched across conditions according to lemma frequency rates in the CELEX database (available online at celex.mpi.nl) along with word length based on number of letters (see Table 4). Finally, words were matched in terms of concreteness scores obtained through an concreteness assessment test (see next section for details).

	Condition 1	**Condition 2**	**Condition 3**
Lexical Frequency	65.6 (90.6)	62.6 (93.8)	63.5 (91.1)
Word Length	5.3 (1.5)	5.5 (1.4)	5.3 (1.4)
Concreteness	4.1 (0.9)	3.8(0.9)	4.0 (0.9)

Table 4. Means for lexical frequency, word lenght based on number of letters, and concreteness. Standard deviations are shown in parenthesis.

3.5. Stimuli Validation

A cloze test was developed to measure cloze probability scores for each of the congruent words. Cloze probability is defined as the proportion of subjects that choose a word as the best completion for a sentence (Taylor, 1953). Therefore, this test allowed us to have an objective measure of the expectancy level that congruent words would have for each of the sentences they were created for. A list of 178 sentences was initially created and then divided into 4 sub-tests. Each sub-test was administered to 30 student volunteers from DuocUC Institute who did not participate in the electrophysiological study. Students were instructed to fill each sentence with the final word they thought best completed it. Only words with a cloze probability of 0.70 or higher were finally selected for the study, resulting in a list of 150 words (and their corresponding sentence frames) with a mean cloze probability of 0.91 (SD = 0.1).

Also, words that were finally used in the experiment were validated in relation to their concreteness mean scores as well. Originally, these scores were thought to be obtained from databases similar to the one we got frequency rates. Unfortunately, some of the words did not appear on English databases checked online. Therefore, we decided to make a test with words that had the highest cloze probability values in which subjects had to rate their concreteness in a scale from 1 (highly abstract) to 5 (highly concrete). Ten subjects, who did not participate in the electrophysiological study or the cloze probability test, completed this concreteness assessment. Results indicated that words had similar concreteness values across the three conditions (see Table 4).

Condition	Sentence	Spanish Translation
C1	My brother swept the floor with a broom.	**es**coba
C2	My brother swept the floor with a foam.	**es**puma
C3	My brother swept the floor with a dessert.	postre
C1	During the blackout, we had to light a candle.	**ve**la
C2	During the blackout, we had to light a poison.	**ve**neno
C3	During the blackout, we had to light a stem.	tallo
C1	My father is aware that smoking is harmful for his lungs.	**pu**lmones
C2	My father is aware that smoking is harmful for his fists.	**pu**ños
C3	My father is aware that smoking is harmful for his nets.	redes

Table 5. Examples of three sentence frames and their corresponding target words for congruous (C1), incongruous with Spanish overlap (C2), and incongruous without Spanish overlap (C3) conditions (target word are underlined). English target words are translated into Spanish and overlaps are in bold.

3.6. Procedure

Subjects sat in a dark and quite chamber, called Faraday cage, which is capable of reducing noise in the EEG signals by rejecting electrical interference from electronic devices outside the cage. Stimuli were presented in a 21" screen with a light grey background and 18-point black times new roman font. Subjects were instructed to read sentences and press '1' when the final word was congruent in relation to the sentence context or '2' when it was incongruous in a keypad specially adapted for the task. Each trial began with a fixation point at the centre of the screen for 200 milliseconds and then sentences were presented word by word for 300 milliseconds each and 500 milliseconds for all final target words. Additionally, these endings were shown in capital letters and followed by a stop. There were five blocks of thirty sentences each and breaks were provided between them. Subjects were instructed not to blink during the reading of the sentences unless extremely necessary. Also, they were told that after the presentation of each sentence the message "Press 3 to continue" would appear. They were instructed to blink and rest their eyes in theses mini-breaks within blocks and continue whenever they felt prepared to do so, avoiding excessive weariness and blinking during the trials. Subjects completed a twelve-sentence practise before the main task to get used to the task itself and to see if they understood the instructions.

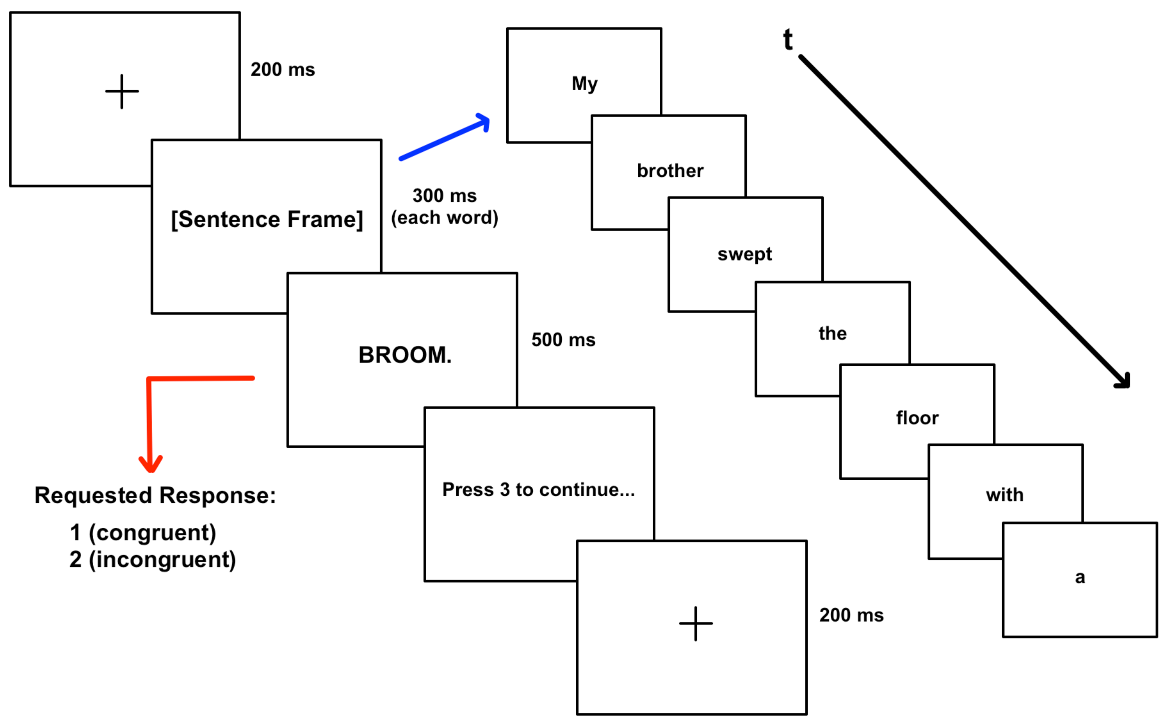

Figure 4. Example of an experimental trial. A fixation point was shown for 200 ms before each sentence. Then, a sentence frame was presented word by word at the centre of the screen for 300 ms each and after target words appeared for 500 ms.

3.7. Electrophysiological Recording

EEG signals were recorded with a 40-channels NuAmps EEG system (Compumedics Neuroscan). Impedances of each electrode were kept below 5 kΩ throughout the recording of the task. Electrodes were referenced to both mastoids and horizontal ocular movements (HEOG) and blinks (VEOG) were registered. Continuous data was digitized with a sampling rate of 1000 Hz and then resampled at 500 Hz to reduce file size. An off-line band-pass filter of 0.1Hz - 30Hz was later applied. EEG signals were then segmented 200 milliseconds before the presentation of the target word and 800 milliseconds after it. Trials with large artifacts were deleted and then an independent component analysis (ICA) was applied to remove components with blinks (no more than one component was removed from every subject). Then, an automatic artefact rejection process was used with the criterion of rejecting signals above the threshold of ±75 μV in segments of 200 ms and a moving window of 20 ms. None of the subjects had more than 15% of the trials rejected by this criterion. Trials from each condition were then averaged separately to obtain the event-related brain potentials for each. Pre-processing was done with EEGLAB and ERPLAB Matlab toolboxes. Analysis and statistics were done using LAN toolbox (lantoolbox.wikispaces.com) based on Matlab as well.

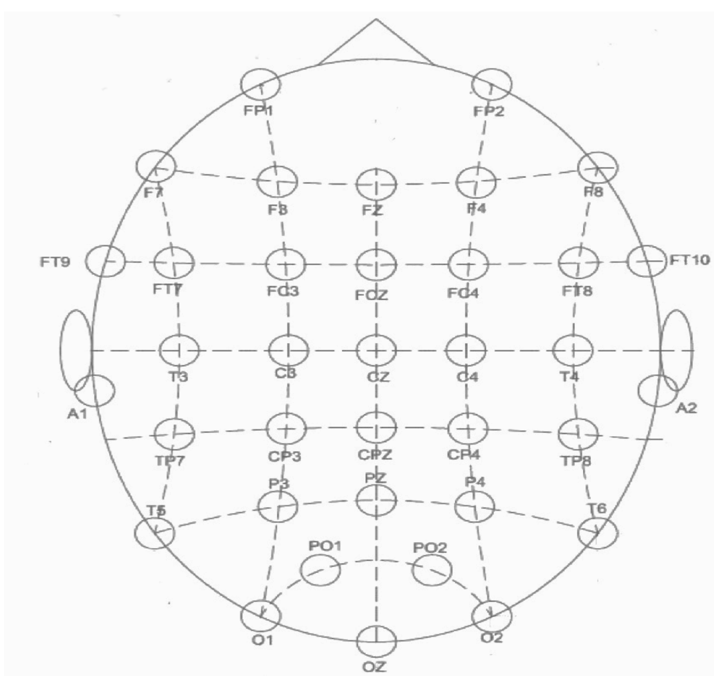

Figure 5. Electrodes distribution of the EEG cap used in this study.

3.8. Statistical Analysis

All event-related brain potentials were analysed with a two-tailed Wilcoxon signed-rank test for paired comparisons. In order to test for differences between conditions, a cluster-based procedure was used (Maris and Oostenveld, 2007). This method has the benefit that it controls the false alarm rate originated by the great number of comparisons made in EEG analysis with more conventional statistics (e.g. parametric statistics) in which numerous data from the spatiotemporal domain are entered into a t statistics. First, t-tests from every electrode were computed point by point at a pre-specified threshold (in this study this threshold corresponded to a 0.05 level of significance). Then, pairs that were selected by this criterion were clustered in terms of their spatial and temporal adjacency and a cluster-level statistics was therefore computed by summing all the t-tests of the pairs in every cluster. After that, a permutation test was carried out to solve the multiple comparisons problem aforementioned. In this test, trials from both conditions were pooled in one list and then a subgroup was randomly collected as they were from one condition and the remaining trials from the other condition. A t statistics was then computed from the newly created lists, taking the largest cluster-level statistics for each randomisation. This process was repeated 1000 times to increase accuracy and every cluster-level value was entered into a permutation distribution. Finally, this permutation was compared to the actual cluster-based statistics observed earlier with a Montecarlo method by estimating the proportion of larger permutation distributions, resulting in a cluster-level significance.

4 Results

4.1. Behavioural Results

Reaction times were measured from the presentation onset of the final target word until subjects pressed a response key. In this regard, there were no differences between both incongruent conditions (p=0.347). Likewise, no differences were shown between congruent and incongruent words with phonological overlap (p=0.347) and between congruent and incongruent words without this initial sound repetition (p=0.136).

In relation to error rates, subjects presented more errors in the congruent condition than in both incongruent with phonological overlap (p=0.037) and incongruent without this phonological match (p= 0.005). On the contrary, no difference was observed in error rates between incongruent words with phonological overlap and without it (p=0.273).

	Condition 1	Condition 2	Condition 3
RT	14241 (5454)	13745 (4646)	13644 (5343)
Errors	1.8 (1.5)	0.7 (1.0)	0.3 (0.5)

Table 6. Mean reaction times in milliseconds and mean error rates for each type of word. Standard deviations are shown in parenthesis.

4.2. Electrophysiological Results

4.2.1. N400 Amplitudes

To analyse differences between congruent and incongruent sentences we selected CZ as the main electrode of interest. This electrode has been considered as one of the channels where the N400 reaches its maximal amplitudes (Kutas and Van Petten, 1994; Kutas and Federmeier, 2011). In the following, clusters of two or more neighbouring electrodes will be reported as areas of significant differences as indicated by the cluster-level statistics.

First, sentences with incongruent endings and phonological overlaps in Spanish presented a clear N400 congruity effect. We found the earliest cluster-based difference at 210 milliseconds (p=0) time-locked to the last word onset. This difference continued over time until the last cluster, found at 661 milliseconds (p=0) (see Figure 6) with a maximal difference at about 527 milliseconds. At early stages of this N400 effect (between approximately 210 and 250 milliseconds), clusters of difference mostly comprised centro-frontal and centro-parietal areas. Around its maximal amplitude, cluster-level differences were also observed in frontal and occipital areas, and after 640 milliseconds clusters came back to cover central and parietal electrodes with a slight dominance over the right hemisphere. As is common for the N400 component, the greatest differences were presented at centro-parietal electrodes (see Figure 7).

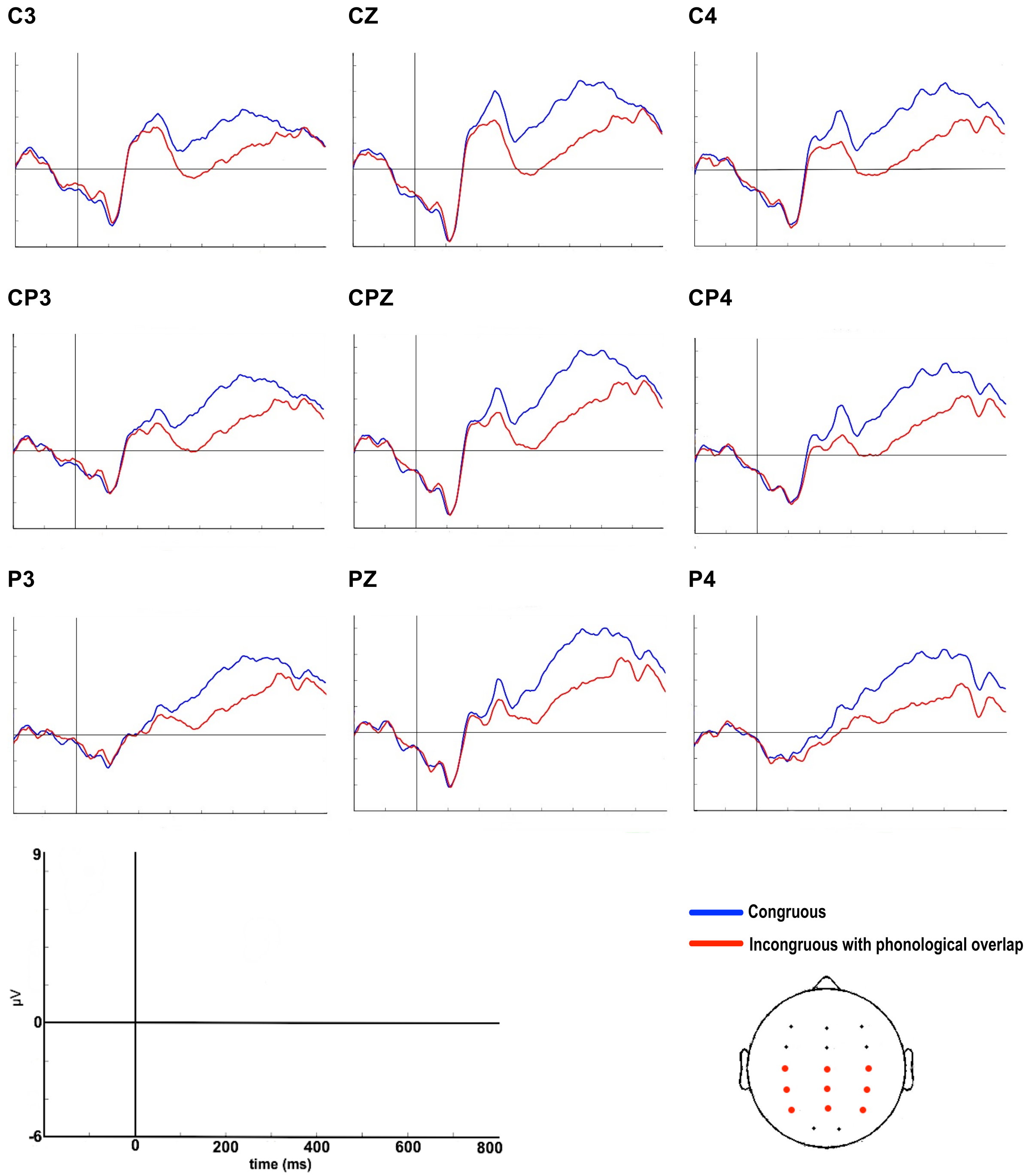

Figure 6. Grand average of event-related potentials for congruous words (blue line) and incongruous words that had phonological overlap in Spanish (red line) for nine centro-posterior electrodes.

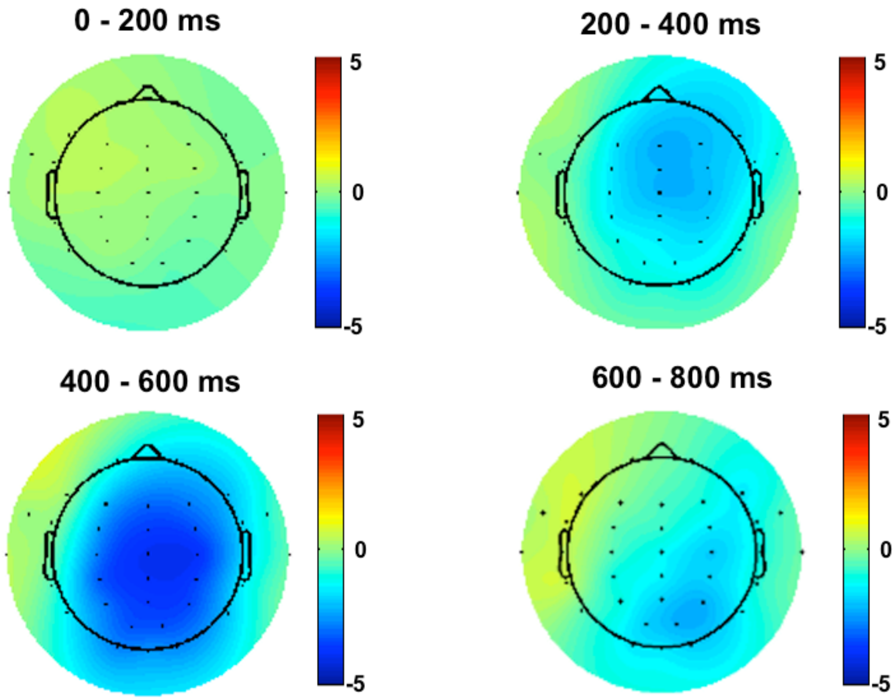

Figure 7. Topographic distribution of the N400 difference between congruous and incongruous endings with phonological overlap in Spanish.

On the other hand, sentences with no overlap in Spanish also presented a strong N400 effect in the region of interest compared with congruous endings. In this case, the first cluster of significant difference was found at 252 after last word onset (p=0). This difference was found over the time up to the last cluster at 659 milliseconds (p=0) and reached a maximal difference at 451 milliseconds, approximately (see Figure 8). Early phases of this N400 congruity effect mostly covered fronto-central and centro-posterior electrodes with a small dominance of the right hemisphere. Frontal and occipital electrodes were also included in clusters of significance when this N400 effect reached maximal amplitudes and at later stages only centro-parietal were into clusters of significance. Again, the largest differences were found at centro-parietal electrodes (see Figure 9).

4.2.2. N400 Difference Waves

In order to analyse differences in N400 amplitudes between incongruous endings with phonological overlap and incongruous endings without overlap, difference N400 waves were computed for each incongruent condition compared with congruent endings.

Results indicated that incongruent words with phonological overlap presented larger negativities compared with incongruous words with no overlap between 500 and 557 milliseconds post stimulus onset ($p=0.03$). More specifically, the cluster-level statistics showed that there was a significant cluster of difference at 500 milliseconds in electrodes C3 and CZ time-locked to the presentation of both incongruous words. Later, this cluster expanded up to include centro-parietal electrodes C3, C4, CP3, CPZ, P3, and PZ until 557 milliseconds. No other reliable difference was found in this contrast.

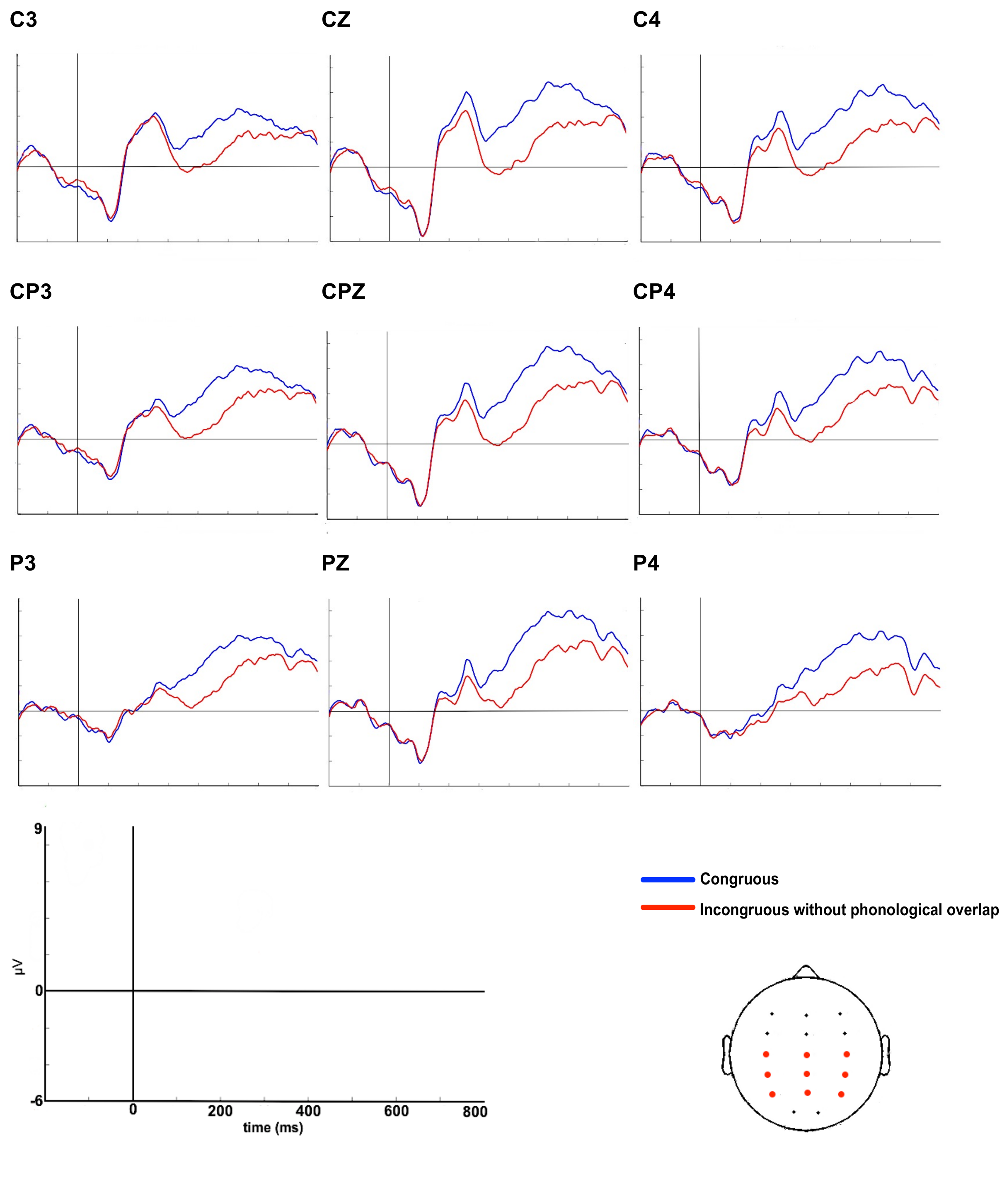

Figure 8. Grand average of event-related potentials for congruous words (blue line) and incongruous words with no phonological overlap (red line) for nine centro-posterior electrodes.

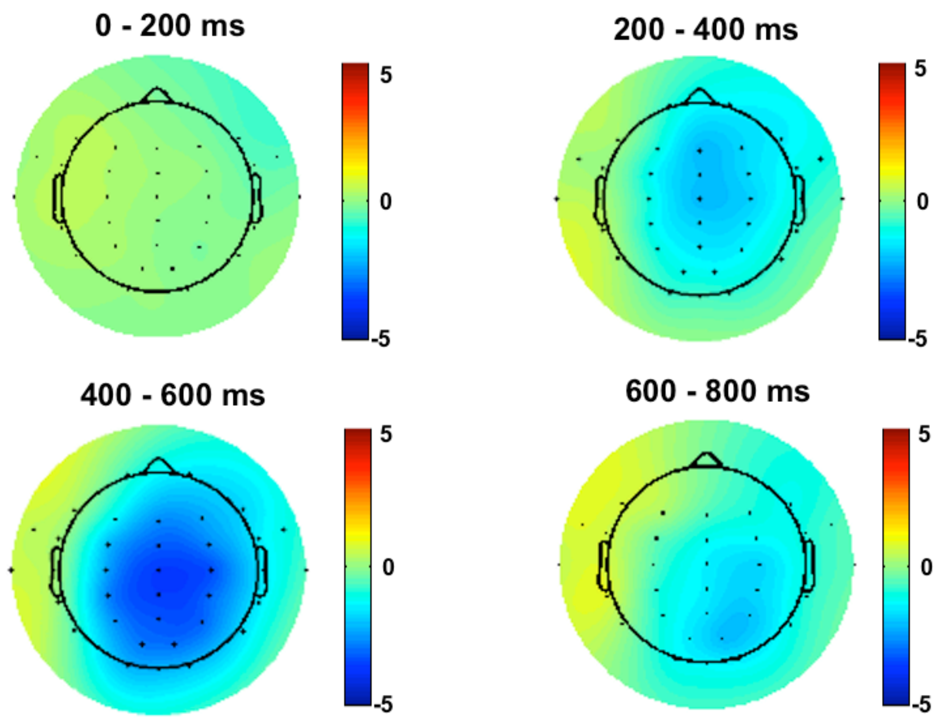

Figure 9. Topographic distribution of the N400 difference between congruous and incongruous endings without phonological overlap in Spanish in four time windows of 200 ms each.

4.2.3. N400 Peak Latency

N400 difference waveforms were obtained by subtracting C1 minus C2 and C1 minus C3 waveforms, respectively. In order to avoid detection of false peaks due to high frequency noise, a 5 Hz low-pass filter was applied on both ERP waveforms. As N400 waveforms have been observed to peak later in bilinguals than in monolinguals (e.g. Ardal et al., 1990; Hahne, 2001), the time window chosen to make the comparisons across both N400 was between 400 and 700 milliseconds.

Both N400 waveforms were averaged across centro-posterior sites (electrodes CP3, CPZ, CP4, P3, PZ, P4, PO1, PO2). It was found that the N400 component peaked earlier for C3 when compared to the N400 elicited by C2 (Wilcoxon signed rank test, p=0.0195). N400 for the incongruous with phonological overlap condition peaked at 539 milliseconds on average, while the N400 for the incongruous without phonological overlap peaked on average at 465 milliseconds at these sites. No difference was found at more central sites (electrodes C3, CZ, C4, CP3, CPZ, CP4) (Wilcoxon signed rank test, p=0.1553).

Further analysis revealed that this broad peak difference was led by differences in mid and right-line channels. Indeed, the largest differences were shown over right centro-posterior areas (electrodes C4, CP4, and PO2) (Wilcoxon signed ranked test, p=0.0117) and mid-line centro-posterior sites (electrodes CPZ and PZ) (Wilcoxon signed test, p=0.0205). On the contrary, there was no difference over left centro-posterior areas (electrodes C3, CP3, PO1) (Wilcoxon signed ranked test, p=0.4248).

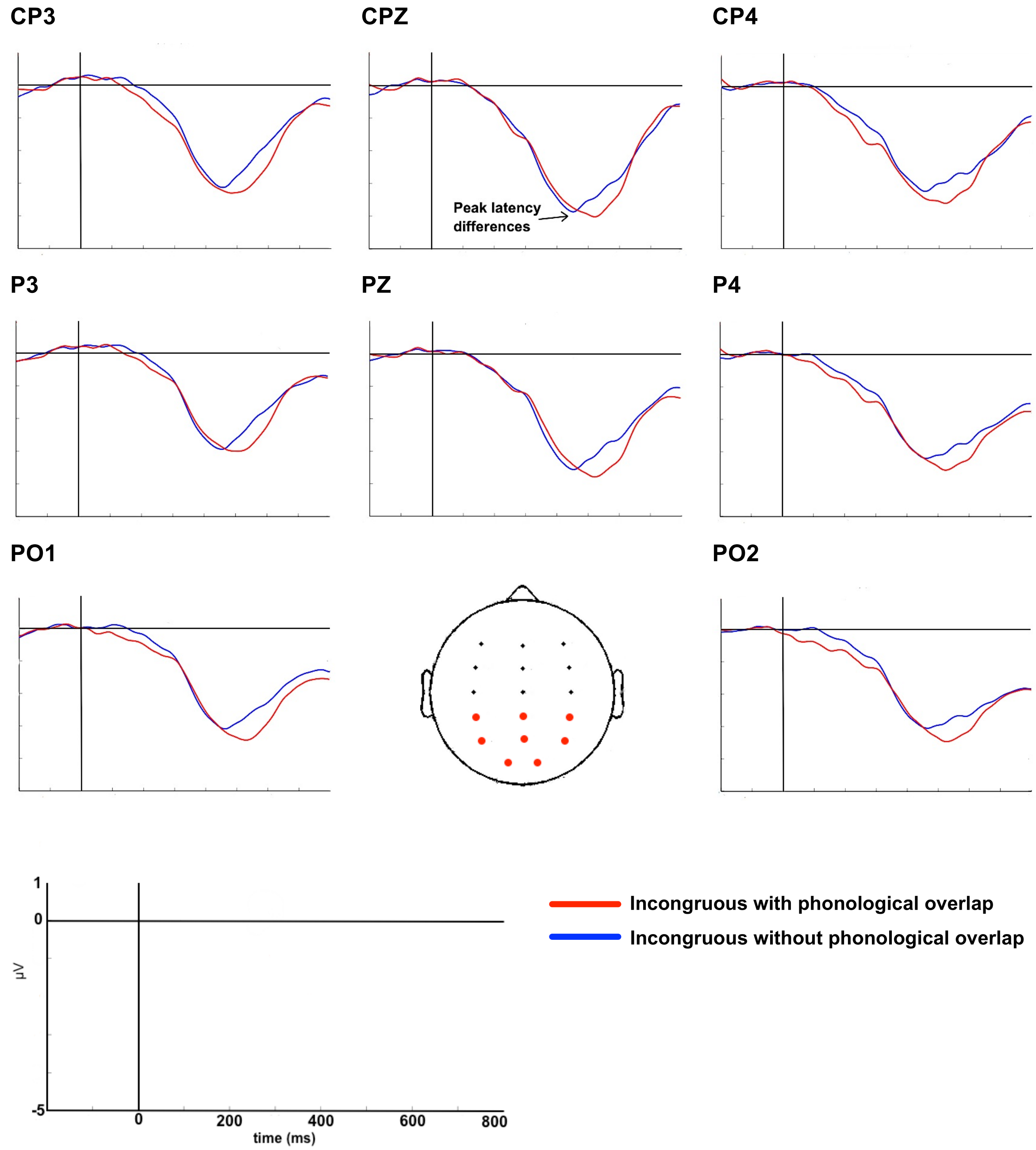

Figure 10. N400 difference waveforms at each of the eight centro-posterior electrodes for the incongruous with phonological overlap (red line) and the incongruous without phonological overlap (blue line) words.

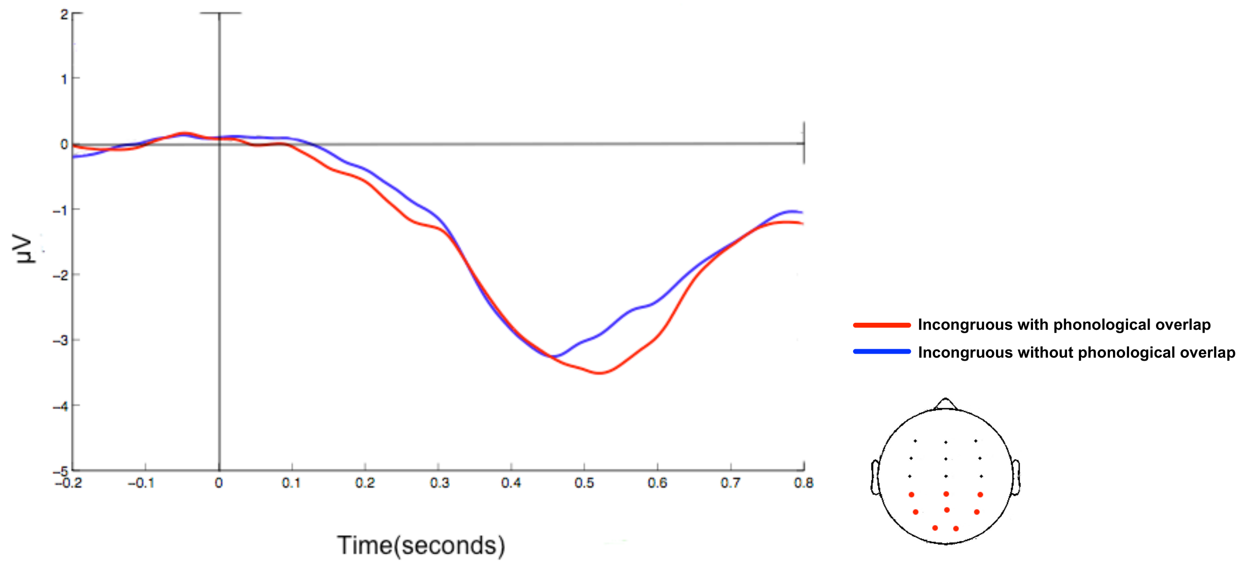

Figure 11. Averaged N400 difference waveforms across the eight centro-posterior electrodes for the incongruous with phonological overlap (red line) and the incongruous without phonological overlap (blue line) words.

5 Discussion

5.1. Behavioural Responses

No differences were found for reaction times across incongruous words. This shows that bilinguals were insensitive to the experimental manipulations in this study in which it was expected that subjects should have unconsciously translated words that shared initial representations with those most expected. Likewise, bilinguals' responses were unaffected by congruity effects since no significant differences were elicited by reaction times for incongruous compared with congruous endings.

On the other hand, bilinguals showed significantly higher error rates for congruous than for incongruous words. An explanation of this result is that congruous words could have generated higher uncertainty than incongruous endings in bilinguals, since the latter were blatant semantic violations, thus easier to reject as congruous endings. However, the overall number of errors was not high for congruous words (M=1.8), what indicates that subjects did not have problems in understanding sentences and target words.

5.2. N400 Amplitude

This thesis studied N400 effects elicited by the classic violation paradigm of sentence incongruent endings. Both, incongruent words with Spanish-translated initial phonological overlap and words without it showed negativities in the 200-700 milliseconds time window compared with congruent words. This N400 latency is longer than the commonly N400 incongruity effect observed in the literature, which spans from 200 until 600 milliseconds after the onset of the written word. Nonetheless, it is in agreement with previous studies with bilinguals in which N400 has lasted longer (e.g. Ardal et al., 1990; Hahne, 2001) and peaked later in both early and late bilinguals during second language processing (Weber-Fox and Neville, 1996). This could indicate that bilinguals took longer to process the semantic component of words and fit their functional characteristics with the immediate growing information from the sentences they belonged to.

A cluster-level comparison between both N400 waves elicited by incongruent words showed significant amplitude differences in a very short timing between 500 and 557 milliseconds after word onset, being more negative for the incongruous stimuli with phonological overlap. This difference cannot be regarded as a N400 difference per se across both incongruous conditions for two reasons. First, the time window where the differences were found is too delayed to reflect N400-related effects. For example, in previous studies with bilinguals, N400 waveforms have shown amplitude differences within the 350-500 ms time window (Thierry and Wu, 2007). In our case, differences were out of this time frame. Secondly, the timing of this N400 difference coincides with the latency in which the average N400 peak was found for words with phonological overlap (M=539 ms). Therefore, these larger negativities would be accounted for by differences in peak latencies between both incongruous stimuli.

It is important to notice that no other difference was observed across incongruous words, particularly smaller negativities related to the N400 component for incongruous words with overlaps. This is not in agreement with previous findings in which English words that shared hidden Chinese phonological representations presented significant smaller N400 negativities (Wu and Thierry, 2010). One of the reasons that may explain why this difference was not found here is that subjects were presented isolated words contextualized only by the preceding word using a semantic priming task in that study. On the contrary, the present study used words embedded in high-constraint sentences as indicated by the cloze probability measures of the target words. Words from the non-relevant language might be more difficult to be activated when they are presented in sentential context because semantic constraints are imposed to a greater extent during sentence reading processes than when they are pre-activated by a sole associative semantic pathway. Sentence context could restrict the number of lexical candidates that may become activated and consequently reduce the possibility that words from the language that is not being used interfere in L2 comprehension processes. For example, Schwartz and Kroll (2006) studied how cognates facilitated activation of the non-relevant language in sentence contexts. They found this cognate facilitation in low-constraint sentences but not in high-constraint sentences. This indicates that the degree of semantic constraint changes the cross-lingual word activation, what is line with the results of our experiment as regards as N400 amplitude.

5.3. N400 Latency

Even though no differences were observed across incongruent word conditions in relation to N400 amplitudes, important differences were found regarding peak latencies of the N400 component. Incongruous words that had phonological overlaps in their Spanish translations with those of the most expected words showed later N400 peak latencies compared to those words that did not have this phonological repetition. Although this difference was not observed in central areas as is common for the N400 component (Kutas and Van Petten, 1994; Kutas and Federmeier, 2011), it is still concordant with previous findings of N400 semantic congruity effects in sentence reading tasks with monolinguals, in which significance levels were found in more posterior sites (e.g. Federmeier and Kutas, 1999; Federmeier et al., 2007). This peak shift was also found to be lateralised over the right hemisphere, which is in agreement with the typical N400 congruity effect (Kutas and Federmeier, 2011) and with previous studies of N400 found during sentence reading (e.g. Federmeier and Kutas, 1999). Indeed, this N400 peak delay was significant in right hemisphere sites and not over left channels, what suggests a slight lateralisation of this N400 peak shift.

On average, the N400 peak was 74 milliseconds later for those words with a Spanish-translated phonological overlap in the broader difference found on the scalp (centro-posterior). This suggests that in this study bilinguals had interference of their first language (Spanish) while processing lexical items embedded in sentence contexts in their second language (English). The rationale behind this is that through sentence reading, bilinguals predicted an English noun (e.g. 'broom') as likely candidate of a word to come guided by the semantic and syntactic constraints of the sentence and, probably at the same time, its Spanish translation equivalent was also activated (e.g. 'escoba'). In such cases in which the word was semantically deviant (e.g. 'foam') but with a phonological overlap with the most expected in Spanish ('**es**coba'-'**es**puma'), subjects unconsciously translated the visually presented English word into its Spanish translation equivalent. Then, as both Spanish translation equivalents were already activated, that is, the one predicted during sentence reading and the one actually read on the screen, it took longer to recognise and access to the corresponding lexical entry because both Spanish words were competing. Accordingly, the incongruous target with overlap was identified as a semantic violation later as it shared that initial portion of its Spanish-translated phonological representation with the Spanish translation equivalent of the most expected word for a given context. On the contrary, English target words that had no phonological overlap were identified earlier as a deviant stimulus, thus showing a peak more similar to the common N400 peak for incongruity effects (at 465 milliseconds on average).

These results contribute evidence in favour of a non-selective lexical processing in bilinguals. As Elston-Güttler and Williams (2008) suggested, there might be still some residual effects of a translation stage even in highly proficient bilinguals as it is the case of this study. The Revised Hierarchical Model (Kroll and Stewart, 1994) was first developed to account for translation differences in bilinguals who had low proficiency skills in their second language, in which bilinguals access the translation of a second language word to retrieve its meaning, and advocates for a gradual vanishing of this reliance on first language translation as proficiency increases. In this study, even highly proficient bilinguals unconsciously co-activated second language words online, which is in agreement with results found in semantic priming tasks with fluent bilinguals using isolated words (Thierry and Wu, 2004; Thierry and Wu, 2007; Wu and Thierry, 2010). It is noteworthy that first language word activation could not be based on a translation activity with the objective of accessing the meaning of the target incongruent word, since all participants were fluent in English. Maybe, native words could have been just co-activated in the prediction originated during sentence reading and at the moment subjects read target words, indicating that words from both languages are stored in a single lexicon.

Moreover, findings of this study are in line with delayed N400 onsets for initial sound repetitions in Van Petten et al. (1999). In that study, monolinguals presented later N400 onsets for deviant words that had a phonological overlap with the most expected final word in a sentence using intralingual overlaps (e.g. **do**lphins-**do**llars). Our results extend Van Petten et al.'s findings to the bilingual domain and suggest that matching the incoming word with the previous context is done in parallel and interactively with lexical access, even for second language comprehension. Importantly, differences in N400 peaks found in our study cannot be accounted for an explicit activation of participant's native language because cognates and homographs were not used as target words. Therefore, bilinguals were not exposed to a dual-code task that could have triggered an unwanted Spanish activation.

One interesting observation of the N400 effect in both types of words is that both peaks were late. Typical N400 component maximum peak is between around 400 ms after target stimuli have been presented (Kutas and Federmeier, 2011). Both N400 effects found in this study peaked after this time window (539 ms for the incongruous with overlap and 465 ms for the incongruous without overlap on average). This pattern has previously been seen in studies with bilinguals in sentence reading tasks (Ardal et al., 1990; Hahne, 2001). For example, in Ardal et al (1990) French-English bilinguals presented mean N400 amplitude effects 40 ms longer in bilinguals compared with English monolinguals speakers. In Hahne (2001) Russian-German bilinguals presented delayed N400 peaks of about 100 ms for semantic congruent endings in sentence reading processing. This shows that bilinguals might take longer to match the semantic content of target words with the contexts they are embedded when they read sentences in their second language. In this study, all bilinguals were highly proficient in their second language and had acquired it after adolescence. It might be the case that bilinguals who acquired their second language after puberty have weaker lexical representations that are more difficult to access during reading processing. As N400 has been indicated as a neural marker of a parallel lexical and post-lexical processing (Kutas and Federmeier, 2011), the peak latencies shown in this study could show a delayed matching and access process for L2 words as a consequence of the late acquisition age of all subjects and not language proficiency, which was held constant as indicated by subjects' self-assessment scores. Furthermore, all participants of this study live in a country where their first language is spoken; therefore they have obviously less daily exposure to their second language. Even though rates of language exposure were obtained in relation to frequency of use weekly and within a day, language exposure was a very difficult variable to handle since they corresponded to very subjective measures and scores showed great deviation. Perhaps, language exposure would have modulated both N400 waveforms (i.e. an earlier N400 than the actually shown which would be more similar to the N400 highly documented in the literature) if the same experiment had been done in a country where the second language was spoken. Then, this potential less exposure to their second language may be another factor to ponder in the overall late N400 shown for both incongruent endings in this study.

6 Conclusion

Our results suggest the existence of a L1-to-L2 cross-lingual lexical interference during L2 sentence reading in which words from both languages are co-activated in highly proficient Spanish-English bilinguals. Therefore, this study contributes with important evidence about bilingual word processing because it expands the view that bilingual lexical comprehension is non-selective. Non-selectivity in bilingual word processing has only been found for words out of contexts. In our study, words from both languages were activated in sentence contexts, which makes the results more ecological. This implies that sentence constraints did not inhibit the activation of words from the irrelevant language as reading was taking place. On the contrary, the English expected and the English incongruent words with phonological overlap were co-activated along with their Spanish counterparts as shown by a delayed N400 peak for incongruent endings with this sound repetition.

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Annex 1 - Cloze Probability Tests (4)

Edad:		**Sexo**:	M	F	**Lateralidad**:	Diestro	Zurdo	**Nacionalidad**:	

Instrucciones: La siguiente encuesta pretende obtener información acerca de las palabras más comunes para ciertos contextos oracionales. Para este efecto, por favor completa cada oración con la palabra que, según tu criterio, mejor concuerde con el resto de la oración (por ejemplo: "Mi tía estaba leyendo un <u>libro</u>").

Importante: No hay respuestas correctas o incorrectas.

1. El arquero atajó el balón de un tiro de esquina dando un gran _______________.
2. En la mañana, no se veía nada en la carretera debido a la espesa _______________.
3. Mi abuela tiene casi cien años, pero goza de muy buena _______________.
4. Le pregunté al conserje dónde estaba la sala de profesores y me dijo que estaba en el tercer _______________.
5. El cantante no le permite a los periodistas entrar al hotel porque no quiere conceder ninguna _______________.
6. Los mejores zapatos y cinturones son los que están hechos de _______________.
7. Después de cada comida, uno tiene que cepillarse los _______________.
8. Acabo de encontrar una billetera en la tienda y ahora me gustaría regresársela a su _______________.
9. Durante las vacaciones, nada me relaja más que leer un buen _______________.
10. Antes de cenar me lavé las manos con agua y _______________.
11. En nuestro viaje a Europa tomamos con nuestra cámara miles de _______________.
12. Carlos le va a pedir matrimonio a Margarita así que fue a la joyería a comprarle un _______________.
13. Para poder atravesar el río fue necesario construir un _______________.
14. Con mi familia salimos a comer el domingo pasado a las dos de la tarde, por lo que mi mamá no tuvo que preparar el ________________.
15. En la fiesta de Halloween el jurado premiará al que tenga el mejor y más llamativo _______________.
16. Quiero que el primer concierto de mi banda salga perfecto, así que creo que necesitamos tener un día más de _______________.
17. El niño ensució el piso al entrar a la cocina porque tenía sus zapatos llenos de _______________.
18. El edificio donde vivo se movió como gelatina durante el devastador _______________.

19. Ese perro, que se rasca sin parar, debe estar lleno de ______________.
20. El profesor hablaba tan bajo que no se le entendía ni una sola _______________.
21. Mi amigo se fue de vacaciones, así que voy a su casa todos los días a alimentar a su enorme _________________.
22. Después de la cena romántica, Carlos llamó al mesero para pedir la _______________.
23. Al ver que tenía quemaduras en su rostro y espalda, los doctores determinaron que tenía quemado el cuarenta por ciento de su _______________.
24. Me demoré en comprar el helado porque no podía elegir el _______________.
25. Pablo estuvo todo el día al lado del teléfono esperando una importante _______________.
26. Hoy no pude abrir la puerta de mi casa porque se me olvidó mi ______________.
27. Se escuchaba mucho ruido de la calle así que mejor cerré la _______________.
28. La cachetada en su cara le dejó roja su _______________.
29. Mi novia es vegetariana así que en la cena no podremos servir _______________.
30. Para mantener encendida la fogata tuvimos que recolectar más _______________.
31. Mi hermano barrió el piso con la _________________.
32. Después de cambiarme de ropa en el camarín, dejé todas mis pertenencias dentro del _______________.
33. Cuando voy al parque me gusta recostarme en su verde _______________.
34. Lo que más quiero es ver al asesino de mi padre tras las _______________.
35. Cuando estaba cortando las rosas de mi jardín me pinché el dedo con una _______________.
36. Quiero tomarme un café caliente así que voy a poner la _______________.
37. La confianza es lo más importante en una relación de pareja, así que es mejor siempre decir la _______________.
38. Al no encontrar a la niña desaparecida las autoridades decidieron suspender la _______________.
39. En la Grecia antigua, era común creer en más de un _______________.
40. Ricardo juega tenis, fútbol y voleibol, por lo que se puede decir que es un amante de los _______________.
41. Luego de declarar al acusado inocente, el juez le otorgó su _______________.
42. En la cena, Cristian cortó la carne con el _________________.
43. Hoy mi pequeña sobrina aprendió a tomar sopa sola con su _______________.
44. Ella aún estaba llorando, así que le pasé un pañuelo para que secara sus ____________.
45. Iba a prender el fuego para el asado pero no recordaba dónde había dejado la caja de _______________.

¡Muchas gracias por tu participación!

Edad:		Sexo:	M	F	Lateralidad:	Diestro	Zurdo	Nacionalidad:	

Instrucciones: La siguiente encuesta pretende obtener información acerca de las palabras más comunes para ciertos contextos oracionales. Para este efecto, por favor completa cada oración con la palabra que, según tu criterio, mejor concuerde con el resto de la oración (por ejemplo: "Mi tía estaba leyendo un libro").

Importante: No hay respuestas correctas o incorrectas.

1. Mi padre sabe que fumar es dañino para sus ______________.
2. La operación al estómago le dejó a mi mujer una horrible _______________.
3. Para los dolores de espalda o musculares, es importante frotarse con una _______________.
4. El asesino fue condenado a pasar treinta años encerrado en la _______________.
5. Quiero tomar sol, así que para las próximas vacaciones vamos a ir a la _________________.
6. Cuando andes en bicicleta siempre tienes que usar casco para proteger tu _________________.
7. Vicente se portó muy mal conmigo así que creo que me debe una _______________.
8. Cuando tuve el ataque al corazón, sentí un dolor en el lado izquierdo de mi _________________.
9. Para cancelar la operación en el computador debes apretar escape en tu _______________.
10. En el mar, el nadador fue mordido por dos grandes y feroces _________________.
11. Antes de salir, mi tía revisó si había echado su maquillaje y documentos en la _______________.
12. Cuando vi a la Catalina con falda corta me di cuenta que tiene unas lindas y largas _______________.
13. Estaba listo el diseño del vestido, sólo faltaba comprar la _______________.
14. Ingenieros de la NASA encontraron problemas antes del lanzamiento del _________________.
15. Los secuestradores le pusieron a la mujer una mordaza en su _______________.
16. En las noticias dijeron que el león del circo se escapó de su ______________.
17. Tuvimos que parar el auto porque se nos pinchó un neumático y tuvimos que cambiar la ______________.
18. Mi sobrino tiró la pelota contra la ventana y quebró el ______________.
19. De tanto practicar los pasos y los movimientos, finalmente aprendimos el _______________
20. El bebé de Ricardo casi se cae de su _________________.
21. Pedro anotó en su agenda el día del aniversario para no olvidar esa importante _______________.
22. El niño aprendió que apretando la ubre de la vaca uno puede sacar ______________.
23. Esta tela es delicada, así que ten cuidado cuando planches los puños y el cuello de tu _________________.

24. El nuevo programa de concursos necesita un rostro renovado que lo conduzca, por lo que es necesario cambiar al _______________.
25. El trabajador estaba tan hediondo que el jefe lo mandó a darse una _______________.
26. No me pusieron anestesia cuando me sacaron la muela, por lo que sentí mucho _______________.
27. Durante el apagón, tuvimos que prender una _________________.
28. Cuando vamos al parque me gusta acostarme en el pasto y mirar hacia el _______________.
29. La mesera trajo los platos, los vasos y las botellas en una inmensa _______________.
30. Cuando nos sentamos en el parque se me cayó la billetera del _______________.
31. Nuestro hijo se rasca a cada rato su cabeza por lo que debe tener ______________.
32. Los montañistas se encontraban muy emocionados al llegar por fin a la _______________.
33. Antes de depilar mis piernas, caliento ligeramente la _________________.
34. Roberto compró lechuga, apio, repollo y limón para prepararse una deliciosa _______________.
35. Era una noche estrellada mientras en el lago se reflejaba la luz de la ______________.
36. Para colgar el cuadro en la pared tuve que hacer un hoyo con un _______________.
37. Me tuve que ir antes que la película terminara así que me perdí el ______________.
38. Después del temporal de anoche, la cordillera amaneció completamente cubierta de _______________.
39. Cuando tengas los ojos irritados, es importante echarse _______________.
40. Han pasado cuarenta y seis minutos del segundo tiempo así que el árbitro está a punto de tocar el ______________.
41. Para la fiesta de graduación, Sofía se compró un hermoso y elegante _______________.
42. En vez del ascensor, Francisco prefirió subir por la _______________.
43. El cazador apuntó su rifle al animal pero no tuvo el valor suficiente para apretar el _______________.
44. Tienes que mirar para ambos lados cuando cruces la ____________.
45. Mi mamá compró una torta y unas velas para celebrar mi ______________.

¡Muchas gracias por tu participación!

Edad:		Sexo:	M	F	Lateralidad:	Diestro	Zurdo	Nacionalidad:	

Instrucciones: La siguiente encuesta pretende obtener información acerca de las palabras más comunes para ciertos contextos oracionales. Para este efecto, por favor completa cada oración con la palabra que, según tu criterio, mejor concuerde con el resto de la oración (por ejemplo: "Mi tía estaba leyendo un **libro**").

Importante: No hay respuestas correctas o incorrectas.

1. El solista cantó por treinta minutos, por lo que el público se quejó del concierto por su corta _______________.
2. Tenía tanto sueño en la clase que fui al baño a lavarme la _______________.
3. Para dormir bien es importante tener un colchón firme y una cómoda ____________.
4. Quería escribir el recado, pero no encontré ninguno de mis dos ____________.
5. En el karaoke todos se sabían la letra de la última ______________.
6. Mi tío quería apostar en el hipódromo, así que me preguntó si sabía cuál era el mejor _______________.
7. Me di cuenta que tenía una espinilla cuando me miré al _________________.
8. Llegó la hora de que la larva se convierta en una colorida _______________.
9. Matías se agachó para amarrar los cordones de sus ____________.
10. Como no alcazaba con mis manos, le pedí a Jessica que me rascara la _______________.
11. Mi abuela dice que mi chaleco abrigador está hecho de _________________.
12. Debido a la herida de bala, el policía perdió mucha _______________.
13. Pese a las graves heridas que tiene el hombre accidentado, su vida está fuera de _______________.
14. El profesor se cayó de espalda cuando intentaba sentarse en su _______________.
15. Cada noche, mi mamá coloca su anillo de matrimonio dentro de su respectiva _________________.
16. El libro explica que los vampiros comúnmente muerden a sus víctimas en el _______________.
17. Juan siempre usa la ropa arrugada así que sería una buena idea comprarle una ______________.
18. La policía recuperó mi auto robado, pero no pudo arrestar al ____________.
19. La foto de nosotros que me regalaste la quiero poner en un lindo _______________.
20. Según los diseñadores de ropa, usar cinturones de color sobre pantalones negros está pasado de ______________.
21. Perdí diez mil dólares en el casino esta noche así que no he tenido buena ______________.

22. Al llegar al campamento lo primero que hicimos fue instalar la _______________.
23. Mi hijo se despertó llorando en la noche porque estaba teniendo una _______________.
24. Para que se quede dormida mi pequeña hija, cada noche le leo un _______________.
25. Para protegerse la cabeza, los motociclistas siempre deben usar _______________.
26. En la mañana, mi hermana fue al salón de belleza a teñirse el _________________.
27. El refrigerador es tan grande que no cabe en la _________________.
28. Después de almuerzo mi señora y yo usualmente dormimos una _______________.
29. Antes de soplar las velas de mi cumpleaños pedí tres _______________.
30. Había comenzado a llover, así que José se detuvo para abrir su _________________.
31. El cuidador del zoológico le dio al elefante un saco de _________________.
32. Mientras Rosa cosía el pantalón, se enterró en el dedo un pequeño _______________.
33. En mis clases de pintura siempre uso agua con un poco de diluyente para lavar los ______________.
34. Jaime llegó a casa con un ojo morado y un diente roto porque estuvo metido en una ______________.
35. Mi hermana quiere estudiar medicina porque siente una necesidad de ir a los hospitales y sanar a los _______________.
36. Encontré un gusano cuando pelaba esta roja _________________.
37. Mi mamá está tomando propóleo y mucha agua porque tiene tos y dolor de _______________.
38. Susana sacó la basura por la puerta principal de la _________________.
39. Antes de la sesión de fotos, la modelo entró al camarín a cambiarse de _______________.
40. El sacerdote fue tan compasivo que comienzo a pensar que tiene un gran _________________.
41. No me gusta quedarme en la casa de mi amigo porque sólo puedo dormir en mi _________________.
42. La casa no tenía timbre, así que tuve que tocar la _______________.
43. Antes de entrar al edificio el agente del FBI se identificó mostrando su ____________.
44. Cuando era pequeño todos me traían en mi cumpleaños muchos _______________.
45. Tendremos que lavar esta camisa porque en la manga tiene una tremenda ____________.

¡Muchas gracias por tu participación!

Edad:		Sexo:	M	F	Lateralidad:	Diestro	Zurdo	Nacionalidad:	

Instrucciones: La siguiente encuesta pretende obtener información acerca de las palabras más comunes para ciertos contextos oracionales. Para este efecto, por favor completa cada oración con la palabra que, según tu criterio, mejor concuerde con el resto de la oración (por ejemplo: "Mi tía estaba leyendo un <u>libro</u>").

<u>Importante: No hay respuestas correctas o incorrectas.</u>

1. Culpo a la aerolínea de haber perdido mis dos ____________.
2. Mi hermano fue multado por la policía por manejar a gran _______________.
3. La selección nacional de basquetbol ganó la medalla de oro olímpica para su ______________.
4. El unicornio es una criatura mitológica que se caracteriza por tener en su cabeza un _______________.
5. Para actuar como caballero medieval tuve que aprender a usar el escudo y la _______________.
6. Tengo clases de ocho de la mañana a ocho de la noche, por lo que tengo un pésimo _______________.
7. Antes de enterrar a mi perro primero cavé un hoyo con la ______________.
8. El remache del tenista fue tan fuerte que el oponente no le pudo pegar a la ______________.
9. Se me caían los pantalones, así que me tuve que poner un _______________.
10. Mientras reparaba el techo, mi papá se martilló accidentalmente su _________________.
11. No tenía plata para un regalo, así que para su cumpleaños sólo le envié una _______________.
12. Estoy preocupado porque mi gato no atrapa ni un solo _________________.
13. Esta casa es sólida porque está hecha de _________________.
14. No puedo comer esta ensalada con una cuchara, así que llamaré al mesero para que me traiga un _________________.
15. En el rodeo Bernardo fue corneado por un _________________.
16. Estos libros viejos encontrados en el ático están cubiertos de _______________.
17. Mi abuelo necesita constantes cuidados médicos en la casa, así que tendremos que contratar a una ______________.
18. Juan cree que es un mito que los conejos coman sólo _________________.
19. Cuando voy al trabajo en bicicleta siempre llego mojado por mi _______________.
20. Para pedirle matrimonio a Elisa, Gustavo se agachó y se puso de _______________.
21. Esta mañana, Esteban se sirvió leche y cereal al _________________.
22. Me gusta comprar en esa panadería porque siempre tienen el pan caliente recién salido del _______________.

23. La oficina era un sauna así que prendimos el aire acondicionado porque nadie soportaba el ______________.

24. Yo ya he sacudido el mueble y aspirado la ________________.

25. Mi papá quiere la escalera hecha de roble porque cree que es la mejor _______________.

26. Las ostras a la parmesana son un exquisito plato de _______________.

27. Para aprenderme mejor los contenidos de la prueba siempre hago un _______________.

28. Ver a toda mi familia reunida para navidad me llena de _______________.

29. Con estas bajas temperaturas es mejor protegerse el cuello con una _______________.

30. Solíamos escuchar la música tan fuerte que siempre teníamos problemas con nuestro ________________.

31. No pude imprimir los documentos porque a la impresora se le acabó la ______________.

32. Mi hija cortó el papel en dos usando tus ________________.

33. El mesero nos atendió tan mal que decidimos no dejarle _______________.

34. Mañana es la prueba del libro y voy recién en el tercer _______________.

35. Contando desde abajo, el nido está en la segunda ________________.

36. Mi mamá siempre llora cuando pica una ________________.

37. Mientras estaba en la montaña pisé una piedra y me torcí mi ______________.

38. José se rehusó a sacarse los zapatos para entrar a la mezquita porque tenía hoyos en los _______________.

39. Mi hermanito nació ayer así que mis abuelos vendrán hoy a conocer a su nuevo ______________.

40. No sabía que era calva hasta que se quitó su rubia ____________.

41. Luis estaba atrasado para una importante reunión por lo que a cada rato miraba su _______________.

42. Por estar comiendo apurado durante el almuerzo me mordí la _______________.

43. Tuve que comprar esta escalera porque tengo que arreglar esa gotera en el ________________.

¡Muchas gracias por tu participación!

Annex 2 - Cloze Probability Values of Expected Words (in Spanish)

N	Expected Word	Cloze Probability
1	SALTO	0,87
2	SALUD	0,83
3	PISO	1,00
4	ENTREVISTA	0,87
5	CUERO	1,00
6	DIENTES	1,00
7	DUEÑO	0,90
8	JABÓN	1,00
9	FOTOS	1,00
10	ANILLO	0,93
11	PUENTE	0,70
12	ALMUERZO	1,00
13	DISFRAZ	1,00
14	ENSAYO	0,73
15	BARRO	0,87
16	TERREMOTO	0,77
17	PULGAS	0,90
18	PERRO	0,73
19	CUENTA	1,00
20	SABOR	0,97
21	LLAMADA	1,00
22	LLAVE	1,00
23	MEJILLA	0,80
24	CARNE	0,97
25	LEÑA	0,87
26	ESCOBA	0,97
27	CASILLERO	0,70
28	PASTO	0,90
29	REJAS	1,00
30	ESPINA	0,93
31	TETERA	0,97
32	VERDAD	1,00
33	BÚSQUEDA	0,93
34	DIOS	1,00
35	DEPORTES	1,00
36	LIBERTAD	1,00
37	CUCHILLO	1,00

38	CUCHARA	0,90
39	LÁGRIMAS	1,00
40	FÓSFOROS	0,93
41	PULMONES	0,97
42	CICATRIZ	0,87
43	CÁRCEL	0,90
44	PLAYA	0,93
45	DISCULPA	0,73
46	PECHO	0,93
47	TECLADO	0,93
48	TIBURONES	0,80
49	CARTERA	0,93
50	PIERNAS	0,97
51	TELA	0,87
52	COHETE	0,97
53	BOCA	1,00
54	JAULA	0,93
55	RUEDA	1,00
56	VIDRIO	0,97
57	BAILE	1,00
58	CUNA	0,90
59	FECHA	0,83
60	LECHE	1,00
61	CAMISA	0,80
62	DUCHA	0,90
63	DOLOR	1,00
64	VELA	0,93
65	CIELO	0,97
66	BANDEJA	1,00
67	BOLSILLO	0,93
68	PIOJOS	0,83
69	CERA	0,97
70	ENSALADA	1,00
71	LUNA	1,00
72	FINAL	0,97
73	NIEVE	0,93
74	GOTAS	0,80
75	VESTIDO	0,90
76	ESCALERA	1,00
77	GATILLO	1,00
78	CALLE	0,97

79	CUMPLEAÑOS	0,97
80	ALMOHADA	0,83
81	LÁPICES	0,83
82	CANCIÓN	0,90
83	CABALLO	0,80
84	ESPEJO	1,00
85	MARIPOSA	0,97
86	ZAPATOS	0,90
87	ESPALDA	0,93
88	LANA	0,93
89	SANGRE	0,97
90	PELIGRO	0,90
91	SILLA	0,90
92	CUELLO	0,97
93	PLANCHA	0,97
94	LADRÓN	0,73
95	MODA	0,97
96	SUERTE	0,83
97	CARPA	0,97
98	PESADILLA	0,97
99	CUENTO	0,97
100	CASCO	1,00
101	PELO	0,73
102	COCINA	0,97
103	SIESTA	1,00
104	DESEOS	1,00
105	PARAGUAS	0,93
106	ALFILER	0,77
107	PINCELES	0,80
108	PELEA	0,73
109	MANZANA	0,90
110	GARGANTA	0,70
111	CASA	0,87
112	CAMA	0,80
113	PUERTA	0,90
114	REGALOS	0,83
115	MANCHA	0,97
116	VELOCIDAD	1,00
117	PAÍS	0,70
118	CUERNO	1,00
119	ESPADA	0,97

120	PALA	0,90
121	PELOTA	0,93
122	CINTURÓN	0,93
123	DEDO	0,73
124	RATÓN	0,77
125	TENEDOR	0,93
126	TORO	0,93
127	POLVO	0,90
128	ENFERMERA	0,93
129	ZANAHORIAS	0,80
130	RODILLAS	0,93
131	DESAYUNO	0,80
132	HORNO	1,00
133	CALOR	1,00
134	ALFOMBRA	0,70
135	MADERA	0,83
136	RESUMEN	0,73
137	BUFANDA	0,97
138	VECINO	0,83
139	TINTA	0,97
140	TIJERAS	0,87
141	PROPINA	0,97
142	RAMA	0,90
143	CEBOLLA	0,83
144	TOBILLO	0,83
145	CALCETINES	0,97
146	NIETO	0,93
147	PELUCA	0,73
148	RELOJ	0,97
149	LENGUA	1,00
150	TECHO	0,93

Annex 3 - Target Words

	Congruent Condition		Incongruent Condition with Phonological Overlap		Incongruent Condition without Phonological Overlap	
N	**English Word**	**Spanish Word**	**English Word**	**Spanish Word**	**English Word**	**Spanish Word**
1	shirt	camisa	bell	campana	tool	herramienta
2	house	casa	face	cara	water	agua
3	breakfast	desayuno	fate	destino	jacket	chaqueta
4	finger	dedo	right	derecho	growth	crecimiento
5	broom	escoba	foam	espuma	dessert	postre
6	mirror	espejo	season	estación	bush	arbusto
7	knife	cuchillo	square	cuadrado	pride	orgullo
8	cradle	cuna	blame	culpa	napkin	servilleta
9	dog	perro	weight	pesa	answer	respuesta
10	hair	pelo	fish	pez	church	iglesia
11	wig	peluca	glue	pegamento	balloon	globo
12	chest	pecho	fishing	pesca	smell	olor
13	shovel	pala	clown	payaso	brake	freno
14	umbrella	paraguas	duck	pato	thread	hilo
15	rocket	cohete	harvest	cosecha	worm	gusano
16	door	puerta	town	pueblo	business	negocio
17	candle	vela	poison	veneno	stem	tallo
18	ink	tinta	shyness	timidez	celery	apio
19	ankle	tobillo	bacon	tocino	hate	odio
20	bull	toro	screw	tornillo	knot	nudo
21	fork	tenedor	velvet	terciopelo	swing	columpio
22	roof	techo	witness	testigo	steel	acero
23	onion	cebolla	eyebrow	ceja	bear	oso
24	wax	cera	pork	cerdo	rainbow	arcoiris
25	key	llave	flame	llama	soil	tierra
26	mouse	ratón	trace	rastro	wound	herida
27	rug	alfombra	cotton	algodón	boss	jefe
28	pillow	almohada	storage	almacenamiento	challenge	desafío
29	carrots	zanahorias	stilts	zancos	hoses	mangueras
30	street	calle	head	cabeza	girl	niña

31	apple	manzana	butter	mantequilla	elbow	codo
32	stain	mancha	hammer	martillo	cough	tos
33	wool	lana	maze	laberinto	clover	trébol
34	thief	ladrón	whip	látigo	row	fila
35	pencils	lápices	tins	latas	clocks	relojes
36	tears	lágrimas	bricks	ladrillos	clouds	nubes
37	mud	barro	flag	bandera	label	etiqueta
38	tray	bandeja	rod	barra	doll	muñeca
39	grass	pasto	step	paso	belief	creencia
40	bed	cama	letter	carta	game	juego
41	cheek	mejilla	goal	meta	smoke	humo
42	pocket	bolsillo	forest	bosque	meal	comida
43	mouth	boca	edge	borde	team	equipos
44	chair	silla	meaning	significado	birth	nacimiento
45	nap	siesta	mermaid	sirena	fireman	bombero
46	truth	verdad	summer	verano	garden	jardín
47	spoon	cuchara	rope	cuerda	wire	alambre
48	pain	dolor	sunday	domingo	mistake	error
49	glass	vidrio	trip	viaje	wave	ola
50	wood	madera	husband	marido	earth	tierra
51	bridge	puente	inch	pulgada	journey	viaje
52	wishes	deseos	toes	dedos	loans	préstamos
53	sports	deportes	wastes	desechos	lawyers	abogados
54	soap	jabón	vase	jarrón	wolf	lobo
55	cage	jaula	syrup	jarabe	garlic	ajo
56	country	país	word	palabra	eye	ojo
57	shoes	zapatos	pumpkins	zapallos	badges	insignias
58	knees	rodillas	clothes	ropa	birds	pájaros
59	lunch	almuerzo	soul	alma	rain	lluvia
60	pin	alfiler	clam	almeja	dew	rocío
61	purse	cartera	singer	cantante	arrow	flecha
62	meat	carne	race	carrera	winter	invierno
63	bill	cuenta	summit	cumbre	fan	ventilador
64	dress	vestido	window	ventana	tree	árbol
65	speed	velocidad	advantage	ventaja	dinner	cena

66	story	cuento	body	cuerpo	war	guerra
67	freedom	libertad	book	libro	question	pregunta
68	butterfly	mariposa	suitcase	maleta	orange	naranja
69	beach	playa	silver	plata	uncle	tio
70	socks	calcetines	drawers	cajones	feathers	plumas
71	tent	carpa	hip	cadera	ghost	fantasma
72	jail	cárcel	burden	carga	toy	juguete
73	costume	disfraz	fun	diversión	bishop	obispo
74	apology	disculpa	handicap	discapacidad	chess	ajedrez
75	horn	cuerno	notebook	cuaderno	sailor	marinero
76	leather	cuero	string	cuerda	prayer	oración
77	keyboard	teclado	veal	ternera	parrot	loro
78	earthquake	terremoto	cobweb	telaraña	octopus	pulpo
79	kettle	tetera	weave	tejido	couch	sofá
80	fabric	tela	ceiling	techo	straw	paja
81	horse	caballo	box	caja	fear	miedo
82	drops	gotas	sparrows	gorriones	anthems	himnos
83	locker	casillero	snail	caracol	plug	enchufe
84	helmet	casco	puppy	cachorro	wallet	billetera
85	moon	luna	struggle	lucha	flesh	carne
86	tongue	lengua	reader	lector	brain	cerebro
87	firewood	leña	slowness	lentitud	peanut	maní
88	god	dios	address	dirección	frame	marco
89	teeth	dientes	amusement	diversión	strawberry	frutilla
90	blood	sangre	priest	sacerdote	gold	oro
91	jump	salto	tailor	sastre	folder	carpeta
92	sky	cielo	figure	cifra	teacher	profesor
93	date	fecha	happiness	felicidad	layer	capa
94	scar	cicatriz	ribbon	cinta	kick	patada
95	belt	cinturón	heaven	cielo	rice	arroz
96	summary	resumen	cabbage	repollo	ladder	escalera
97	watch	reloj	queen	reina	sugar	azúcar
98	interview	entrevista	sickness	enfermedad	boundary	límite
99	salad	ensalada	charm	encanto	pet	mascota
100	flavour	sabor	wisdom	sabiduría	needle	aguja

101	fashion	moda	engine	motor	cat	gato
102	luck	suerte	dream	sueño	farm	granja
103	milk	leche	reading	lectura	wind	viento
104	trigger	gatillo	suede	gamuza	mist	neblina
105	throat	garganta	hook	gancho	witch	bruja
106	matches	fósforos	shapes	formas	bones	huesos
107	pictures	fotos	bottoms	fondos	eggs	huevos
108	presents	regalos	shelters	refugios	graves	tumbas
109	bars	rejas	kings	reyes	leaves	hojas
110	nightmare	pesadilla	toll	peaje	spark	chispa
111	danger	peligro	movie	película	library	biblioteca
112	stairs	escaleras	writers	escritores	jokes	bromas
113	thorn	espina	shield	escudo	drill	taladro
114	back	espalda	wife	esposa	death	muerte
115	sword	espada	frost	escarcha	liver	hígado
116	sharks	tiburones	chalks	tizas	grapes	uvas
117	scissors	tijeras	puppets	títeres	dungeons	calabozos
118	floor	piso	skin	piel	attempt	intento
119	lice	piojos	whistle	pito	riddle	adivinanza
120	shower	ducha	peach	durazno	jam	mermelada
121	owner	dueño	length	duración	bread	pan
122	wheel	rueda	noise	ruido	sand	arena
123	birthday	cumpleaños	snake	culebra	honey	miel
124	rehearsal	ensayo	delivery	entrega	moustache	bigote
125	nurse	enfermera	january	enero	flight	vuelo
126	snow	nieve	kid	niño	magazine	revista
127	grandson	nieto	fog	niebla	beetle	escarabajo
128	branch	rama	while	rato	daughter	hija
129	iron	plancha	dish	plato	sheep	oveja
130	lungs	pulmones	fists	puños	nets	redes
131	fleas	pulgas	dots	puntos	noodles	fideos
132	heat	calor	ability	capacidad	desk	escritorio
133	song	canción	path	camino	taste	gusto
134	dust	polvo	bean	poroto	laugh	risa
135	health	salud	exit	salida	pump	bomba

136	dance	baile	toilet	baño	cheese	queso
137	ball	pelota	loss	pérdida	army	ejército
138	fight	pelea	request	pedido	heel	talón
139	legs	piernas	stones	piedras	weapons	armas
140	oven	horno	schedule	horario	kiss	beso
141	kitchen	cocina	heart	corazón	son	hijo
142	ring	anillo	host	anfitrión	corn	maíz
143	call	llamada	tyre	llanta	file	archivo
144	end	final	party	fiesta	week	semana
145	tip	propina	average	promedio	cold	frío
146	neighbour	vecino	sale	venta	wing	ala
147	scarf	bufanda	donkey	burro	award	premio
148	search	búsqueda	owl	búho	daisy	margarita
149	brushes	pinceles	hints	pistas	coins	monedas
150	neck	cuello	guilt	culpa	screen	pantalla

Annex 4 - Sentence Frames (most expected word in capital letters)

N	SENTENCE
1	This fabric is delicate so be careful when ironing the cuffs and collar of your SHIRT.
2	Susan took out the trash through the front door of the HOUSE.
3	This morning, Steve had milk and cereal for BREAKFAST.
4	While repairing the roof, my dad accidentally hammered his FINGER.
5	My brother swept the floor with the BROOM.
6	I realized I had a pimple when I looked at myself in the MIRROR.
7	At dinner, Chris cut the meat with the KNIFE.
8	Richard’s baby almost fell off from his CRADLE.
9	My friend went on vacation, so I go to his house everyday to feed his huge DOG.
10	In the morning, my sister went to the beauty salon to dye her HAIR.
11	I didn't know she was bald until she took off her blonde WIG.
12	When I had a heart attack, I felt a pain on the left side of my CHEST.
13	Before burying my dog, I first dug a hole with the SHOVEL.
14	It had started to rain, so Joey stopped to open his UMBRELLA.
15	Engineers from NASA found issues before the launch of the ROCKET.
16	The house didn't have a bell, so I had to knock on the DOOR.
17	During the blackout, we had to light a CANDLE.
18	I couldn't get the documents printed because the printer ran out of INK.
19	While at the mountain, I stepped on a rock and twisted my ANKLE.
20	In the rodeo, Bryan was horned by a BULL.
21	I can’t eat this salad with a spoon so I’ll ask the waiter to bring me a FORK.
22	I had to buy this ladder because I have to fix that leak on the ROOF.
23	My mom always cries when she chops up ONION.
24	Before shaving my legs, I slightly warm up the WAX.
25	Today I couldn't open my house door because I forgot my KEY.
26	I'm worried because my cat doesn't catch a single MOUSE.
27	I've already dusted the shelf and vacuumed the RUG.
28	To sleep well, it's important to have a firm mattress and a good, comfortable PILLOW.
29	John thinks it’s a myth that rabbits only eat CARROTS.
30	You have to look both ways when walking across the STREET.
31	I found a worm when I was peeling this red APPLE.
32	We'll have to wash this shirt because on the sleeve there is a big STAIN.

33	My grandmother says my warm sweater is made of WOOL.
34	The police returned my stolen car but couldn't arrest the THIEF.
35	I wanted to write down the message, but I couldn't find either of my two PENCILS.
36	She was still crying, so I handed her a tissue to dry her TEARS.
37	The kid got the floor dirty when entering the kitchen because his shoes were covered in MUD.
38	The waitress brought the dishes, glasses, and bottles on a big TRAY.
39	When I go to the park I like to lie down on the green GRASS.
40	I don't like to stay over at my friend's because I can only sleep in my BED.
41	The slap to his face left him with a red CHEEK.
42	When we sat down at the park, my wallet fell out of my POCKET.
43	The kidnappers put a gag on the woman's MOUTH.
44	The teacher fell flat on his back when he was trying to sit on his CHAIR.
45	After lunchtime, my wife and I usually take a NAP.
46	Trust is the most important thing in a relationship, so it's always better to tell the TRUTH.
47	Today my little niece learnt how to eat soup with her SPOON.
48	I was without an anaesthetic when I had my tooth taken out so I felt much PAIN.
49	My nephew threw the ball against the window and broke the GLASS.
50	My dad wants the stair made of oak because he thinks this is the best WOOD.
51	To cross the river it was necessary to build a BRIDGE.
52	Before blowing out the candles for my birthday, I made three WISHES.
53	Richard plays tennis, football, and volleyball, so we can say that he loves SPORTS.
54	Before dinner, I washed my hands with water and SOAP.
55	On the news they said the circus lion escaped from its CAGE.
56	The national basketball team won the olympic gold medal for their COUNTRY.
57	Matthew bent over to tie the laces of his SHOES.
58	To propose Elise, Gustav first bent down and got on his KNEES.
59	We ate out with my family last Sunday at two so my mom didn't have to cook LUNCH.
60	While Rose was sewing the pants, she pricked herself with a small PIN.
61	Before leaving, my aunt checked if she had put her documents and make up in her PURSE.
62	My girlfriend is a vegetarian, so for dinner we won't be able to serve MEAT.
63	After the romantic dinner, Charles called the waiter to ask him for the BILL.
64	For the prom, Sophie bought a gorgeous and elegant DRESS.
65	My brother got a traffic ticket for driving at high SPEED.
66	To get my daughter to sleep, every night I tell her a STORY.
67	After finding the defendant innocent, the judge gave him his FREEDOM.

68	It's time for the larva to become a colourful BUTTERFLY.
69	I want to sunbathe so for the next holidays we're going to the BEACH.
70	Joseph refused to take his shoes off to enter the mosque because he had holes in his SOCKS.
71	When arriving at the camp, the first thing we did was to set up the TENT.
72	The murderer was sentenced to spend thirty years in JAIL.
73	At the Halloween party, the jury will reward the guest with the best and most striking COSTUME.
74	Vincent behaved really badly to me so he owes me one APOLOGY.
75	The unicorn is a mythological creature that on his head we can find a HORN.
76	The best shoes and belts are the ones made of LEATHER.
77	To cancel the operation in your computer you have to press escape on your KEYBOARD.
78	The building where I live moved like jelly during the devastating EARTHQUAKE.
79	I want to have a hot coffee so I'll put on the KETTLE.
80	The dress design was ready so we just needed to buy the FABRIC.
81	To bet at the racetrack, my uncle asked me if I knew which was the best HORSE.
82	When you have sore eyes, it's important to put eye DROPS.
83	After changing clothes in the changing room, I left all my stuff in the LOCKER.
84	To protect their heads, motorcyclists must always wear a HELMET.
85	It was a starry night while the lake reflected the light of the MOON.
86	As I was eating in a rush at lunch I bit my TONGUE.
87	To keep the campfire lit we had to gather more FIREWOOD.
88	In ancient Greece, It was common to believe in more than one GOD.
89	After every meal, you have to brush your TEETH.
90	Due to the bullet wound, the policeman lost lots of BLOOD.
91	The goalkeeper caught the ball from a corner kick by doing a great JUMP.
92	When we go to parks I like to lie down on the grass and look at the SKY.
93	Matthew wrote down the anniversary day on his agenda to not forget that important DATE.
94	The stomach surgery left my wife with a horrible SCAR.
95	My pants were about to fall off so I had to put on a BELT.
96	To learn the contents of the test better I always make a SUMMARY.
97	Louis was late for an important meeting so he was constantly looking at his WATCH.
98	The singer doesn't allow journalists in the hotel because he doesn't want to grant a single INTERVIEW.
99	Robert bought lettuce, celery, cabbage, and lemon to make himself a delicious SALAD.
100	It took me time to buy ice cream because I couldn't choose the FLAVOUR.
101	According to dress designers, wearing coloured belts over black pants is out of FASHION.

102	I've lost ten thousand dollars at the casino tonight so I haven't had good LUCK.
103	The kid learnt that by squeezing the cow's udder you can get MILK.
104	The hunter aimed his rifle on the animal but didn't have enough courage to pull the TRIGGER.
105	My mom is taking propolis and lots of water because she has a cough and a sore THROAT.
106	I wanted to light the fire but I couldn't remember where I left the box of MATCHES.
107	In our trip to Europe, with our camera we took thousands of PICTURES.
108	When I was a kid, on my birthday everybody used to bring me lots of PRESENTS.
109	What I want the most is to see my father's murderer behind BARS.
110	My son woke up crying in the night because he was having a NIGHTMARE.
111	Despite the serious wounds of the injured man, his life is no longer in DANGER.
112	Instead of taking the lift, Francis preferred going up on the STAIRS.
113	When I was picking the roses from my garden, I pricked my finger with a THORN.
114	As I couldn't reach it with my hands, I asked Jessie to scratch my BACK.
115	To act as a medieval knight, I had to learn how to use the shield and the SWORD.
116	While at sea, the swimmer was bitten by two big and fierce SHARKS.
117	My daughter cut the paper in two pieces with your SCISSORS.
118	I asked the janitor where the teacher's room was and he said it's on the fourth FLOOR.
119	My son's head is always itching so he must have LICE.
120	The worker was so foul-smelling that his boss sent him off to take a SHOWER.
121	I just found a wallet at the store and now I'd like to return it to its OWNER.
122	We had to stop the car because we got a flat tire and had to change the WHEEL.
123	My mom bought a cake and some candles to celebrate my BIRTHDAY.
124	I want my band's first concert be perfect so I think we need one more day of REHEARSAL.
125	My grandfather needs constant health care at home so we will have to hire a NURSE.
126	After last night's storm, this morning the mountain appeared all covered with SNOW.
127	My little brother was born yesterday so my grandparents are coming today to see their new GRANDSON.
128	Counting from below, the nest is on the second BRANCH.
129	John always wears wrinkled clothes so it would be a good idea to buy him a new IRON.
130	My father is aware that smoking is harmful for his LUNGS.
131	That dog, scratching itself non-stop, must be full of FLEAS.
132	The office was a sauna, so we turned on the air conditioning because nobody could stand the HEAT.
133	At the karaoke place, everybody knew the lyrics of the last SONG.
134	These old books found in the attic were all covered with DUST.
135	My grandmother is almost one hundred, but she enjoys very good HEALTH.

136	After practicing the steps and the movements a lot, we finally learnt the DANCE.
137	The tennis player's smash was so strong that the opponent couldn't hit the BALL.
138	Jimmy came home with a black eye and a broken tooth because he was involved in a FIGHT.
139	When I saw Katherine wearing a short skirt I realised she has beutiful long LEGS.
140	I like to buy at that bakery because they always have hot bread right out of the OVEN.
141	The refrigerator is so big that it doesn’t fit in the KITCHEN.
142	Charles is going to propose Margareth so he went to the jewellery's to buy her a RING.
143	Paul was all day next to the phone waiting for an important CALL.
144	I had to leave before the movie finished so I missed the END.
145	The waiter's service was so awful that we decided not leave any TIP.
146	We listened to music so loud at the old house that we always had problems with our NEIGHBOUR.
147	With these low temperatures it's better to cover your neck with a SCARF.
148	After not finding the lost girl, authorities decided to cancel the SEARCH.
149	In my painting classes I always use water with a little solvent to wash the BRUSHES.
150	The book explains that vampires usually bite their victims on the NECK.

Annex 5 - Questionnaire to Gather Information about Participants

Age:		Sex:	M	F	Nationality:		Handedness:	Left	Right

Age of English acquisition*:					
How old were you when you started acquiring English as a second language? :					
How many days do you use English a week?					
During those days you use English, how often do you use it a day (from 0% to 100%)?					
Have you taken an English international test like TOEIC, IELTS, TOEFL, etc.?		Year:		Score:	
Grade in a scale from 1 (none) to 10 (native) the following:	Proficiency level for listening in English:				
	Proficiency level for reading in English:				
	Proficiency level for writing in English:				
	Proficiency level for speaking in English:				
Grade in a scale from 1 (none) to 10 (native) the following:	Proficiency level for listening in Spanish:				
	Proficiency level for reading in Spanish:				
	Proficiency level for writing in Spanish:				
	Proficiency level for speaking in Spanish:				

*Based on your current English proficiency level