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Automatic activation of translation equivalents in bilingual visual word recognition

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Preface

The expansion of foreign language learning all around the world has been mainly motivated by the outstanding possibilities for financial, scientific and cultural interactions outside national borders provided by the technological advances of the 20th century (electronic communication, internet, transportation). Even in countries with more than one official language, the current tendency is to apply a certain amount of classroom time, either as an intra or as an extra-curricular activity, to the teaching of a foreign language, in order for students to become bilingual[1] or multilingual speakers. The rapid intrusion of this "need for bilingualism" in the modern society has also led many individuals to get back to the classroom and learn another language in adulthood. Worldwide, the various ways in which foreign languages are being taught, variable amounts and mediums of exposure, and different ages of acquisition, have created a growing bilingual society of bilinguals of different types. The most prominent type of bilinguals are the so-called unbalanced bilinguals, individuals with a dominant native language (L1), used in most of their everyday activities and a less dominant second language (L2) learned for a more

[1]Throughout this dissertation the term bilingual will be used to refer to individuals across the entire second language proficiency span and irrespectively of whether or not the two languages were acquired simultaneously or not. Both these variables, critical to the focus of this dissertation, will be defined accordingly for each of the different bilingual groups tested.

specific educational, labour or cultural integration purpose. At the other end of the spectrum, the so-called balanced bilingualism is found, usually present in societies with more than one official languages (e.g., the Basque Country, Belgium, Canada), in which bilinguals have acquired both languages roughly from birth and are equally dominant in both of them. *The present dissertation focuses on unbalanced bilinguals to examine how effects of automatic co-activation of translations take place during bilingual visual word recognition across the L2 proficiency span and for different types of translation equivalents.*

The interest of translation processing in bilingual research has been initially motivated by the way in which a second language is acquired, given that the learning of an L2 by associating the newly learnt L2 word to its L1 translation equivalent represents the most common L2 teaching strategy (e.g., Comesaña, Perea, Piñeiro, & Fraga, 2009). This extended L2 teaching strategy is grounded on the idea that the more effective way to learn the meaning of a new word is by establishing a direct relationship between this new word and another one, already known, representing the same concept. However, as the proficiency level of bilinguals increases, the need for making reference to the L1 to communicate in the L2 decreases. This progressive independence of the L2 from the L1 could be reflected in the way in which L2 words are processed and represented in relationship to both their L1 translations as well as to their corresponding conceptual representations, as the proficiency in this non-dominant language increases.

In order to unravel how the relationship between translations develops through the L2 proficiency continuum, the set of data presented in this dissertation was acquired using a paradigm which holds the great advantage of "masking" the translation manipulation: *the masked translation priming paradigm*. In this variation of the well-known masked priming paradigm, participants are only aware of the presence of one of the two words of the translation pair, thus eliminating the influence of potential strategic processing. In further detail, this PhD project describes a set of behavioural experiments in which the masked translation priming paradigm is used to study *how cognate and non-cognate masked translation priming effects* *are manifested in unbalanced bilinguals of different levels of L2 proficiency*. The masked translation priming effect refers to a processing advantage obtained when targets are preceded by their translation equivalents as compared to when they are preceded by unrelated words of the non-target language of a bilingual. In the case of the non-cognate masked translation priming effect, the critical prime-target translation pairs exhibit only a semantic overlap (e.g., the Spanish *casa* and the English *house*). In the case of the cognate masked translation priming effect, the advantage appears while processing words either completely or partially overlapping at the formal level to their translation counterpart (e.g., the Spanish *guitarra* and the English *guitar*). Evidence so far, in both the language production and comprehension domains, has shown that the processing of cognates is more efficient than that of non-cognates due to the co-existence of formal and semantic overlap across cognate translations, leading to the establishment of the so-called *cognate effect* (i.e., a L2 cognate word like *guitar* is processed faster and more accurately than a L2 non-cognate word like *house*). Non-cognate masked translation priming effects with unbalanced and relatively highly proficient bilinguals have been found to produce an asymmetric pattern across the two translation directions known as the *non-cognate masked translation priming asymmetry*. This asymmetry is reflected as a larger facilitative effect when the L1 word of the translation pair is presented subliminally (e.g., *casa*, for a Spanish dominant Spanish-English bilingual) and the lexical decision is made on the L2 translation, presented subsequently (e.g., *HOUSE*), as compared to when the order of presentation of translations is reversed. Moreover, the formal overlap across cognates has been found to boost masked translation priming effects making them more prominent than non-cognate effects. Still, whether cognates produce an asymmetric pattern of masked translation priming effects across the two translation directions, similar to the one obtained with non-cognate translations, is yet to be established. Even more critically, it is still unclear whether the pattern of activation of the lexico-semantic links involved in masked translation priming effects is modulated across the L2 acquisition process, and, if this is indeed so, whether the presence of formal overlap across translation equivalents modulates the obtained effects.

After closely revising the rich masked translation priming literature as well as the theoretical approaches on how translation processing takes place (Chapters 1-4), I first aimed at testing *whether lexico-semantic links across non-cognate translations are active and functional at low levels of L2 proficiency* and at identifying the pattern of masked translation priming effects emerging across the two translation directions (L1-to-L2 and L2-to-L1) with individuals who had just started acquiring a second language in adulthood (Chapter 6). Once this pattern was established, two large-scale studies were conducted with three carefully selected groups of unbalanced bilinguals of different levels of L2 proficiency each, in order to test a straightforward prediction regarding the processing of translations across the L2 proficiency span: *the more proficient a bilingual becomes in the non-dominant language, the less the co-activation of translations should be affected by the translation direction.* This prediction stems from the general proposal put forward by most models of bilingual lexico-semantic organization that L1 and L2 processing become more comparable to each other as the exposure to the L2 increases. According to this proposal, the gradual resemblance of L2 processing to L1 processing would manifest as both an increased ease of L2 processing as well as an increasing independence in the activation of L2 words from their L1 translations. In other words, the more proficient bilinguals become in their L2, the less asymmetric masked translation priming effects should be across the two translation directions. In addition, as proficiency in L2 increases, we should expect a reduced processing benefit due to the formal overlap across two translations to emerge as a matter of increased L2 proficiency, potentially leading to a different pattern of masked translation priming effects for cognate as compared to non-cognate translations. To empirically test these predictions, the first of the two large-scale studies described aimed at testing *whether non-cognate masked translation priming effects are modulated by L2 proficiency* (Chapter 7) and the second one at testing *whether cognate masked translation priming effects are modulated by L2 proficiency* (Chapter 8).

Through this empirical work on the automatic co-activation of cognate and non-cognate translation equivalents, I intended to examine the influence of the level of L2 proficiency on the lexico-semantic organization of bilinguals and to add further evidence to the increasing amount of data suggesting a close interdependence of the two languages in the bilingual brain. As part of the experimental designs applied to address each of the research issues, *masked identity priming effects as well as masked priming code-switching effects across different stages of unbalanced bilingualism were also explored.*

Before describing in detail each of the experiments performed (Part 2: The Experiments), and discussing the implications of the findings (Part 3: Final Remarks), the reader is presented with a General Introduction (Part 1) reviewing the masked priming methodology, the masked priming effects reported in the monolingual and bilingual literature, as well as the evidence on the influence of L2 proficiency on translation processing. Finally, a summary of the way the existing theoretical proposals of bilingual lexico-semantic organization interpret the evidence on cognate and non-cognate processing and their predictions regarding the influence of L2 proficiency on masked translation priming effects is provided.

PART 1

General Introduction

CHAPTER 1

The masked priming paradigm: a window to automatic word processing

The present chapter aims at introducing the reader to the basic processes underlying visual word recognition in both monolinguals and bilinguals and at describing in detail the paradigm most widely used to unravel early and automatic effects of word recognition: the masked priming paradigm. This experimental paradigm, though initially used to examine short-lived orthographic, phonological and semantic effects that take place within a few hundred milliseconds during reading in monolinguals, has been lately applied to bilingual visual word recognition. As will be described in detail, bilingual masked priming research has provided new insights into the organization of the bilingual lexico-semantic system and into the cross-language interactions across the different levels of representation. Besides, by combining the masked priming paradigm with the recordings of the electrophysiological brain activity during L1 and L2 reading, researchers have recently started to identify the time-course of these fast and automatic effects of cross-language interactions.

1.1. Monolingual and bilingual visual word recognition

An initial view on bilingual visual word recognition assumed that similar mechanisms underlay bilingual and monolingual reading. In other words, it was believed that when a word is presented to a bilingual in his/her native language, its recognition would not be affected by the knowledge of a second language and vice versa. This idea was based on the proposal that the two languages of a bilingual are stored separately, have different neuroanatomical substrates, and do not interact (e.g., Evans, Workman, Mayer, & Crowley, 2002; Kroll & Stewart, 1994; Kroll & de Groot, 1997, Paradis, 1997). However, as will be described in detail in the following sections, when bilinguals read in a given language both languages are activated and interact with each other at different processing levels.

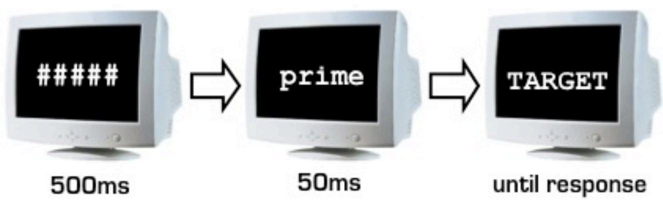
Schematically, it is proposed that monolingual visual word recognition takes place in a hierarchically structured sequence, starting from the visual processing of low-level letter features, moving to single letter level and then to the phonemes onto which the letters map. Following letter recognition, bigram, syllabic and morphological processing take place, giving then rise to the activation of the whole word form representation (orthographic and phonological) stored in the mental lexicon and finally to its meaning. Given that visual word recognition is a bottom-up process mostly delimited by the characteristics of the input stimulus, the flow of activation throughout this structure has been proposed to proceed in a feed-forward manner. Still, following the principles of McClelland and Rumelhart's Interactive Activation Model (1981), most theories of visual word recognition have by now incorporated strong top-down connections from the semantic to the lexical level as well as inhibitory connections within the lexicon (Coltheart, Rastle, Perry, Langdon, & Ziegler, 2001; Grainger and Jacobs, 1996; Perry, Ziegler, & Zorzi, 2007).

Evidence so far suggests that this hierarchical structure as well as the interactions across the different levels of representations is plausible for both monolingual and bilingual visual word recognition, at least for alphabetic languages and for bilinguals whose two languages share the same alphabet. In this line, most models of bilingual lexico-semantic organization assume the existence of a common conceptual store for both languages (see French & Jacquet, 2004, for review). However, there is an ongoing debate as to whether the two languages also share a common lexical store or not. Even though there is still not a consensus in this respect, most researchers have acknowledged the existence of strong interactions across the L1 and L2 lexical representations, thus assuming that even if there is indeed such a separation it is only representational and not functional.

1.2. The masked priming paradigm

When trying to examine how the processes underlying visual word recognition in both monolinguals and bilinguals take place within such a short amount of time (around 300ms from word presentation), researchers are faced with the additional problem of having to identify such automatic and rapid processes while individuals are performing some kind of judgment on the words they are reading. In other words, given that experimental tasks in most cases entail processes other than those purely related to word recognition results are usually "contaminated" by these strategic, mnemonic or attention processes, thus hampering the identification of some of the short-lived purely visual word recognition effects. An experimental paradigm that has been designed to overcome this limitation is the *masked priming paradigm* (Forster & Davis, 1984; Forster, Davis, Schoknecht, & Carter, 1987). In its most widely used version, this paradigm consists of the presentation of a pattern mask (e.g., #####) for 500ms, followed by the brief presentation of a word in lowercase–the prime- for 30-60ms and then followed by the uppercase target word on which participants have to perform a judgment (Figure 1). Critically, the rapid presentation of the prime, along with its immediate masking by the target, result in participants being unaware of the prime's existence, thus preventing the contamination of its processing by task or attention-related cognitive processes. Importantly, while eliminating such strategic influences, masked primes have been found to be processed from the visual percept or sub-lexical levels of word processing up to the semantic level, as shown by numerous masked priming studies reporting significant effects with primes and targets only semantically related (e.g., *doctor-NURSE*; Perea & Gotor, 1997). Finally, some aspects of word processing are so automatic and rapidly occurring that can only be obtained under masked priming conditions. For example, if the prime is orthographically related to the target (e.g., *hideous-HIDEOUT*), a benefit on target processing is only obtained with implicitly presented masked primes (Colombo, 1986; Forster et al., 1987; Humphreys, Evett, Quinlan, & Besner, 1987; Martin & Jensen, 1988).

Figure 1. Sequence and timing of events in the masked priming paradigm.



1.3. Critical masked priming effects in monolingual visual word recognition

The hundreds of masked priming experiments reported so far in the experimental psychology literature (more than 500 PubMed entries) have consistently shown that despite the fact that participants are unable to report seeing the prime, there is a processing benefit observed on target processing when primes and targets share some of their features as compared to when they are unrelated. Overall, masked priming effects are thought to result from a match between the activation of the representation of the prime to that of the subsequently presented target, which can take place at the feature, sub-lexical, lexical or semantic level of representation. The most consistently reported masked priming effect so far is the "identity priming effect" which consists on a 50-100ms facilitative effect for uppercase targets preceded by their exact repetition in lowercase (e.g., *house-HOUSE*; Forster & Davis, 1984; Misra & Holcomb, 2003; Perea & Rosa, 2000). Masked identity priming effects are very robust, since the prime-target overlap is extended from the sub-lexical/graphemic to the lexical and semantic levels. When the overlap between prime and targets is limited to the formal level (i.e., a partially shared orthographic and phonological representation) form priming effects emerge, largely depending on the prime's lexicality (e.g., Forster et al., 1987). When the prime is a higher frequency orthographic neighbour[2] of the target there is competition between the prime and target's lexical representation leading to the higher-frequency neighbour inhibitory effect (e.g., Carreiras, Perea & Grainger, 1997). Instead, with a comparable nearly complete formal overlap between a nonword prime and the target the effect is facilitative (e.g., Forster & Veres, 1998). With nonword either relative position (e.g., *csn-CASINO*) or transposition primes (e.g., *caniso-CASINO*) facilitative effects emerge with respect to unrelated relative position primes (e.g., *nml-CASINO*) and substitution primes (e.g., *caviro-CASINO*), respectively (e.g., Duñabeitia & Carreiras, 2011; Perea & Lupker, 2003; 2004; Grainger & Whitney, 2004). When the overlap is further limited to the phonological level, facilitative effects emerge with both word and nonword primes (e.g., *made-MAID* and *mayd-MAID*; see Rastle & Brysbaert, 2006, for review).

[2] Orthographic neighbours are words differing by a single letter, respecting length and letter position. For instance, the orthographic neighbours of the word *bed* are *bet*, *led*, *bid* (Coltheart, Davelaar, Jonasson, & Besner, 1977).

Finally, a number of studies have confirmed that the processing of the masked prime is extended up to the semantic level, by reporting significant effects with primes and targets with related meaning. With morphologically related prime-target pairs, which have partial formal and semantic overlap, facilitative effects have been observed with polymorphemic primes and targets made of the primes' root lexemes (e.g., *darkness-DARK*; e.g., Rastle, Davis, Tyler & Marslen-Wilson, 2000), with derived primes and derived targets sharing their root (e.g., *darkness-DARKEN*; Pastizzo & Feldman, 2004), and with derived prime and target words sharing their affix (e.g., *darkness-HAPPINESS*; Duñabeitia, Perea & Carreiras, 2008). With prime-target pairs sharing exclusively semantic features, associative/semantic masked priming effects emerge (e.g., *doctor-NURSE*; e.g., Perea & Rosa, 2002), while Duñabeitia, Perea and Carreiras (2009) have also identified semantic effects with primes that are associates of the target's phonological neighbours (e.g., in Spanish, *miel* [honey]-*OVEJA* [sheep], which is a phonological neighbour of the prime's semantic associate *ABEJA* [bee]).

It should be noted that despite the fact that the vast majority of these effects have been reported using the lexical decision task, a dual choice task in which participants have to decide whether the target is an existing word or not, the masked priming paradigm has been combined with a large variety of experimental tasks to show numerous effects. Instances of such effects are the masked onset priming effect (e.g., Dimitropoulou, Duñabeitia, & Carreiras, 2010; Kinoshita, 2003), or the masked phonological syllabic priming effect (Carreiras, Ferrand, Grainger, & Perea, 2005), which have only been obtained when participants are asked to overtly name targets. By identifying this wide range of phenomena taking place at the earliest stages of visual word recognition, the masked priming paradigm has been established as a fundamental tool in teasing apart the different processes involved in recognizing single words (see Kinoshita & Lupker, 2003, for a review).

1.4. Masked priming effects in bilingual visual word recognition

After the first masked priming effects were reported in the monolingual literature, researchers examining bilingual word recognition started using the masked priming paradigm to compare L1 to L2 reading and, critically, to explore automatic cross-language interactions taking place during the early stages of reading. In a rapidly increasing pace, numerous studies have now used this subliminal priming technique to explore whether L1 and L2 reading are interconnected throughout the different processing levels, starting from the sub-lexical to the semantic level. In these studies, primes belong to either of the two languages of bilinguals while targets always belong to the same language (e.g., *duck-HOUSE* vs. *pato* [duck]-*HOUSE*; e.g., Chauncey, Grainger, & Holcomb, 2009). The fact that in the masked priming paradigm participants are only aware of the presence of the target creates in the participants' eyes a monolingual context, avoiding the contamination of the effects by strategic processes related to the involvement of both languages in the task. Given that masked priming effects reflect the ease of activation of the target by the prior presentation of the prime, when the manipulation involves a prime-target language change, the obtained effect is interpreted as evidence of language non-selective lexical activation.

One of the first studies to include cross-language masked priming manipulations was reported by Bijeljac-Babic, Biardeau and Grainger (1997). These authors aimed at comparing the effects of higher frequency orthographic neighbours within (L2) and across languages with French-English bilinguals of different levels of English (L2) proficiency (e.g., *blue-BLUR* vs. desk-*BLUR*, or *huit* [eight]-*QUIT* vs. *vers* [glass]-*QUIT*). The results revealed significant inhibitory higher frequency neighbour effects for French-English neighbours, but only for the more competent bilinguals. This effect did not differ in magnitude to the within-language (L2) higher frequency neighbour inhibitory effect obtained, suggesting that lexical competition among orthographic neighbours takes place in a similar way within and across languages, and that words from one language become automatically co-activated when processing the other. Furthermore, they reported what afterward termed as a *masked priming code-switching cost*, an overall cost in the bilinguals' performance in trials involving a prime-target language switch as compared to same language prime-target pairs.

Shortly after this first masked priming evidence of language non-selective lexical activation, several studies appeared which, following a similar rationale, tested the classical monolingual masked priming effects under cross-language masked priming conditions. The main aim of these studies was to identify the word processing levels at which prime-target overlap would lead to language non-selective activation, and to isolate the levels at which representations of both languages would be stored in a common buffer. In this line, Brysbaert and colleagues (Brysbaert, Van Dyck, & Van De Poel, 1999; Van Wijnendaele & Brysbaert, 2002) examined the influence of cross-language phonological overlap with Dutch-French bilinguals. Brysbaert et al. (1999) using Dutch (L1) nonword primes which, if pronounced in French (L2), sounded like the Dutch targets (e.g., *soer*, which according to the French grapheme-to-phoneme correspondences would be pronounced as the French word *SOURD* [deaf]). The authors found significant cross-language masked phonological priming effects with this type of cross-language L1 pseudohomophonic primes. Van Wijnendaele and Brysbaert (2002) extended these findings by showing the same cross-language phonological effect with L2 pseudohomophonic primes and L2 targets (see also Brysbaert & Van Wijnendaele, 2003). Duyck, Diependaele, Drieghe, & Brysbaert, (2004) further showed that these cross-language masked phonological priming effects were not affected by the level of L2 proficiency of the participants. Nevertheless, given that the languages tested shared their alphabets, the prime-target pairs used in these studies had unavoidably considerable orthographic overlap, in addition to the intended phonological overlap. The co-existence of this orthographic overlap indicated that the pure phonological nature of these effects was yet to be established. To this end, Dimitropoulou, Duñabeitia and Carreiras (2011) examined whether effects of cross-language phonological overlap are affected by the additional presence of orthographic overlap. To study pure phonological and ortho-phonological effects in a within-subject design the authors combined Greek and Spanish, two languages with partially overlapping scripts and grapheme-to-phoneme correspondences and tested both priming directions (i.e., L1 primes and L2 targets and vice versa). This way, they were moreover able to use existing words of both languages (i.e., cross-language homophones) and not pseudohomophones. The authors found significant bi-directional facilitative masked priming effects when the cross-language overlap was limited to the phonological level. However, these effects disappeared in the additional presence of orthographic overlap. This pattern of effects suggests that there is fast and automatic language non-selective activation of the phonological code during the initial stages of visual word recognition but that this is dependent on the orthographic properties of the input stimulus.

Abundant masked priming evidence that cross-language formal (orthographic or phonological overlap) accelerates the recognition of L1 and especially of L2 words comes also from studies reporting one of the effects of central focus of the present study: the *cognate masked translation priming effect*. In the majority of the cases, these studies have shown that the processing benefit observed for targets briefly preceded by their translation equivalent is significantly larger when these are cognates as compared to when they are non-cognates (e.g., for Dutch-English bilinguals, *bakker* [baker]-*BAKER* vs. *jongen* [boy]-*BOY*; De Groot & Nas, 1991; Duñabeitia, Perea, & Carreiras, 2010; but see Kim & Davis, 2003), indicating that the presence of formal overlap on top of the match at the conceptual level between prime and target, leads to a faster recognition of the target. Critically, this cognate benefit emerging under masked priming conditions has also been reported in cross-script manipulations, in which the formal overlap of the cognates was limited to the phonological level of representation (Gollan, Froster, & Frost, 1997; Voga & Grainger, 2007; see Chapters 2 and 4 for a detailed description of the cognate masked translation priming reports and their theoretical interpretation). In a similar vein, de Groot and Nas (1991) tested whether the ortho-phonological overlap present in Dutch-English semantically related prime-target pairs would trigger cross-language masked semantic/associative priming effects. They obtained significant effects only for associates with a cognate translation equivalent (e.g., *zilver* [silver]-*GOLD*) and not for non-cognates (e.g., *jongen* [boy]-*GIRL*), thus showing that formal overlap considerably enhances effects of cross-language semantic overlap (but see Perea, Duñabeitia, & Carreiras, 2008).

The mediation of cross-language formal overlap in the co-activation of semantically related words of the two languages has been also demonstrated in recent studies examining cross-language morphological priming. First, Diependaele, Duñabeitia, Morris and Keuleers (2011) tested derivational masked morphological priming effects (e.g., *walker-WALK*) with bilingual groups of different levels of English (L2) proficiency and showed that morphological decomposition takes place in a comparable manner in L1 and in L2. In a following study, Duñabeitia, Dimitropoulou, Morris and Diependaele (2012) sought to detect cross-language morphological priming effects for derived words with two groups of bilinguals with different levels of L2 proficiency. Results from both groups demonstrated the existence of between-language masked morphological priming, exclusively found for cognate prime-target pairs (e.g., *estudiante* [student]-*STUDY*) and not for non-cognates (e.g., *doloroso* [painful]-*PAIN*). However, a similar cross-language morphological repetition priming effect with non-cognates has been reported by Zhang, van Heuven and Conklin (2011), testing compounds and not derived words with a group of Chinese-English bilinguals. In their experiments both primes and targets were L2 words, (e.g., *east-THING*) which when translated into Chinese were morphologically related (e.g., 东 - 东西). Finally, Duyck (2005) examined whether masked translation and masked associative/semantic priming effects would be triggered by the presence of cross-language phonological overlap. Testing Dutch-English bilinguals, the author found significant masked associative/semantic priming effects when the primes were pseudohomophones of the target's translation (e.g., *ruch* pronounced as *rug* [back]-*BACK*) as well as of when the primes were pseudohomophones of one of the target's associates (e.g., *pous* pronounced as *paus* [pope]-*CHURCH*).

Effects of automatic cross-language activation have also been obtained with words overlapping exclusively at the semantic level (i.e., non-cognate translations) and even with words of the two languages with a more distant semantic relationship (i.e., cross-language associates). Non-cognate masked translation priming effects, which will be extensively described in continuation (see Chapter 2), have been so far reported in different tasks, with different types of bilinguals and with various language combinations, independently of whether these shared a common script and writing system or not. The consistency of these purely semantic effects appearing in the absence of any formal overlap corroborates the fact that semantic overlap alone is sufficient to trigger the co-activation of both languages and that translation equivalents automatically activate each other. Even stronger evidence of the effectiveness of these cross-language lexico-semantic links has been provided by findings of cross-language masked associative priming effects. Even though, cross-language associative priming effects have been somewhat elusive (e.g., Basnight-Brown & Altarriba, 2007; de Groot & Nas, 1991), more recent studies have been able to obtain these effects by extending the duration of the presence of the prime on the screen, or by maintaining a very short prime duration and testing extremely proficient bilinguals. Schoonbaert, Duyck, Brysbaert and Hartsuiker (2009) tested unbalanced but relatively proficient Dutch-English bilinguals and obtained significant masked associative/semantic priming effects but only when the primes, though still subliminally presented, remained on the screen for more than the typical 50ms (either for 100 or for 250ms). Notably, under the standard prime duration of 50ms, Perea et al. (2008) tested simultaneous and balanced Spanish-Basque bilinguals and found significant symmetrical bi-directional masked cross-language associative/semantic priming effects. Even more surprisingly, for this type of bilinguals, these effects did not differ in magnitude to those elicited by semantically related primes and targets of the same language (see also Dimitropoulou, Duñabeitia, Laka, & Carreiras, 2012, for a replication using event related potentials, ERPs).

CHAPTER 2

Empirical evidence on translation processing

2.1. Translation processing in bilingual word production

The relevance of the processing of translation equivalents in understanding how the bilingual lexico-semantic system is organized was first highlighted in bilingual production studies. These aimed to identify the way in which the words of both languages in bilinguals are connected to each other and to their semantic representations (e.g., Potter, So, Von Eckhardt, & Feldman, 1984). The initial line of reasoning was based on the fact that word production is mandatorily conceptually mediated, while word comprehension can be also achieved through lexical recognition. These early bilingual production studies used the picture naming or the translation production task to identify key facts about translation processing. One of most critical findings reported was a consistent asymmetric pattern of effects in the translation production task: semantic interference was only observed when producing the L2 translation of an L1 word and not vice versa (Kroll & Stewart, 1994). This finding, which was soon replicated by other studies, suggested that only

L1-to-L2 translation (forward translation) was semantically mediated, while translating in the opposite direction (L2-to-L1, backward translation) could take place without the activation of the shared semantic node (e.g., Altarriba & Mathis, 1997; Talamas, Dufour & Kroll, 1999). Yet this finding has been challenged, and recently Kroll and colleagues (Kroll, Van Hell, Tokowicz, & Green, 2010), while initially advocating the absence of semantic mediation in backward translation, have acknowledged the existence of semantic activation in this translation direction too. The second key result was that backward translation was easier to perform as compared to forward translation (e.g., Kroll, Michael, Tokowicz, & Dufour, 2002). This result was interpreted as evidence showing another asymmetry in the connections between translation equivalents; the existence of more efficient or stronger connections between L2 words and their L1 counterparts as compared to L1 words and their L2 translations. Finally, in a picture naming study Costa, Sebastián-Gallés and Caramazza (2000) identified what was termed as the cognate effect, that is a processing advantage observable when naming pictures whose names in the two languages were largely formally overlapping cognates (e.g., *guitar* and *guitarra*) as compared to non-cognates (e.g., *house* and *casa*). In fact, the magnitude of this cognate effect has been found to be more consistently obtained when bilinguals are naming in their L2 than in their L1 (Christoffels et al., 2007; Costa et al., 2000; Costa, 2005; Ivanova & Costa, 2008; Kroll et al., 2002).

2.2. Translation processing in bilingual visual word recognition

2.2.1. Evidence from non-cognate translations

Building upon the findings first reported in bilingual word production studies, researchers further tested whether analogous processing of translations exists when bilinguals read words in their dominant and non-dominant languages. Evidence from the translation recognition task has revealed that, similar to the asymmetry observed in the translation production task, bilinguals are faster at recognizing the L1 translation of L2 words than the opposite (Ferré, Sánchez-Casas & Guasch, 2006). Moreover, the evidence of concreteness and imageability effects, even with low proficient bilinguals when translating L2 words, has indicated the existence of direct L2 semantic access, established from the early stages of L2 acquisition (e.g., Duyck & Brysbaert, 2004; 2008; Van Hell & De Groot, 1998).

Importantly, bilingual visual word recognition studies have revealed that translation equivalents are automatically activated during reading. Even though the initially conducted unmasked priming studies with translation equivalents did not provide conclusive evidence on the activation of the shared semantic representation (significant effects reported by Chen & Ng, 1989; Cristoffanini, Kirsner, & Milech, 1986; Jin & Fischler, 1987; Kerkman, 1984 and non-significant effects reported by Kirsner, Brown, Abrol, Chadha, & Sharma, 1980; Kirsner et al., 1984; Scarborough et al., 1984), more recent studies have been far more revealing in this respect by using experimental paradigms free form strategic influences. As seen, Zhang et al. (2011) have recently provided an instance of automatic activation of translation equivalents by using the masked priming paradigm. In this study, Chinese-English bilinguals were presented with English prime-target pairs which shared the first morpheme of their Chinese translation. Although this overlap was completely hidden, participants performed better when presented with these pairs as compared to when presented with unrelated English primes and targets, showing that the Chinese translation of the English primes and targets was automatically activated despite the fact that the reading context was completely monolingual.

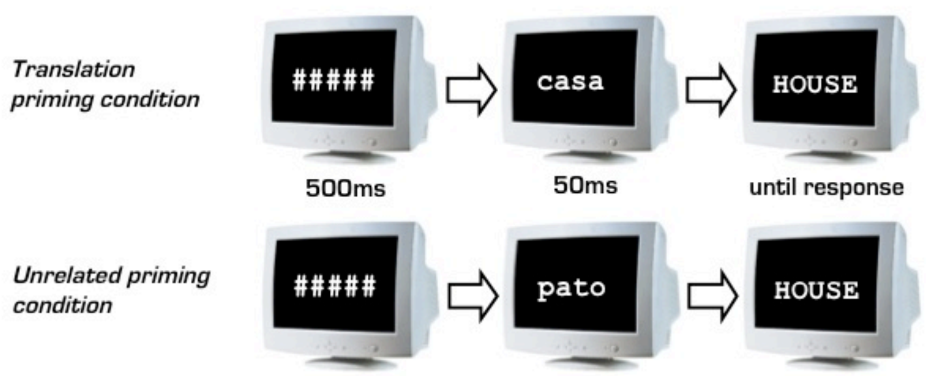
2.2.2. Evidence from cognate translations

One of the most consistent and widely studied effects within the bilingual visual word recognition literature is the cognate effect (e.g., Dijkstra, Grainger, & van Heuven, 1999; Lemhöfer & Dijkstra, 2004; Lemhöfer, Dijkstra, & Michel, 2004; see Sanchez-Casas & Garcia-Albea, 2005, for review). So far, a cognate advantage has been found with cognates of varying degrees of formal overlap ranging from complete (identical cognates e.g., *piano-piano* in English and in Spanish) to minimum (e.g., non-identical cognates, e.g., *guitar-guitarra*) up to cross-script cognates, sharing only part of their phonological segments and none of their orthographic segments (e.g., Bowers, Mimouni, & Arguin, 2000). Importantly, the magnitude of the cognate effect has been found to depend on the degree of ortho-phonological overlap, being significantly more pronounced for identical cognates as compared to non-identical cognates (e.g., Cristoffanini et al., 1986) and significantly increasing as a matter of increased formal overlap (e.g., van Asche, Duyck, Diependaele, & Hartsuiker, 2009). Yet, the cross-language formal overlap that characterizes cognates does not always lead to more effective processing. Dijkstra, Miwa, Brummelhuis, Sappelli, and Baayen (2010) examined whether the cognate effect obtained during bilingual reading is affected by task demands. In line with previous evidence gathered in the lexical decision task, the performance of Dutch-English bilinguals performing lexical decisions improved as a matter of increased form overlap, from non-cognates to partially overlapping cognates and to identical cognates that showed a marked processing advantage. However, this increasing facilitative effect of orthographic overlap was reversed in a language decision task, where cognates caused interference, with the larger inhibition arising with identical cognates. Finally, when bilinguals were engaged in a progressive demasking task, only identical cognates produced a facilitative effect of form overlap. Just as in the bilingual word production literature, generally the cognate effect is more pronounced in L2 reading, though it has been also obtained in pure L1 contexts (e.g., De Groot, Delmaar, & Lupker, 2000; van Asche et al. 2009; van Hell & Dijkstra, 2002; van Hell & De Groot, 1998).

2.3. Masked translation priming effects

The most extensively used experimental paradigm to study the processing of translation equivalents in reading is the masked translation priming paradigm. By combining the masked priming procedure with translation processing, researchers study how L1 and L2 target words are processed when participants are only subliminally presented with their cognate or non-cognate translations. This way, the so-called *masked translation priming effect* has been established, which is defined as the benefit obtained when processing words briefly preceded by their translation as compared to when they are preceded by a semantically and formally unrelated word of the non-target language (e.g., *casa-HOUSE* vs. *pato* [duck]-*HOUSE*; see Figure 2). Masked translation priming effects are mostly reflected in reaction times, an effect ranging from 9 to 40ms, and less in accuracy data. Despite the numerous reports of significant masked translation priming effects, the effect has received different interpretations. Some researchers propose that the masked translation priming effect is dependent on the effective processing of the masked primes up to the semantic level, from where the activation is then fed back to the target word, facilitating its processing in the translation condition as compared to the control condition (e.g., Dijkstra & van Heuven, 2002; Kroll & Tokowicz, 2005). From another point of view, the effect is thought to reflect the automatic activation of a direct link between the representations of a given concept in the two languages, without presupposing the pre-activation of the shared semantic node by the masked prime (e.g., Jiang & Forster, 2001).

Figure 2. Schematic representation of the masked translation priming paradigm.



To date, significant masked translation priming effects have been demonstrated in around 15 published studies reporting more than 30 experiments.

These studies have examined the processing of cognates and non-cognates in either one or both translation directions (backward and/or forward translation), have utilized different tasks, tested different language and script combinations, and have even varied the sequence and the timing of the masked priming events. Still, despite these often reported significant masked translation priming effects, the pattern of the effects obtained across the two translation directions, across the bilingual groups tested, and across the different experimental settings applied is far from consistent.

In further detail, de Groot and Nas (1991) were the first to report significant masked translation priming effects with both cognate and non-cognate translations in a lexical decision task. However, when Sánchez-Casas, Davis and García-Albea (1992) tested non-cognate translations in a semantic categorization task they failed to find the effect. This discrepancy seemed initially puzzling, and it was not until 1997 that the reason behind this difference was identified by Gollan and colleagues. This study tested for the first time, cognate and non-cognate masked translation priming in both translation directions. The results partly replicated de Groot's and Nas' findings, in that significant masked translation priming effects were found in the forward translation direction with both cognates and non-cognates (see also Duñabeitia, Perea et al., 2010; Kim & Davis, 2003; Voga and Grainger, 2007). Still, when the backward masked translation priming direction was tested, the effects disappeared. This finding was in line with the null effect reported by Sánchez-Casas et al., since these authors had only tested backward masked translation priming.

With the exception of a recent study by Davis, Sánchez-Casas, García-Albea, Guasch, Molero, and Ferré (2010), only reporting significant cognate masked translation priming effects, the rest of the studies testing both cognates and non-cognates have reported significant masked translation priming effects with both types of translation equivalents, at least in the forward translation direction. However, the overall pattern of their findings is relatively unclear regarding i) the magnitude of the cognate effects as compared to the non-cognate effects, and even more so regarding ii) the magnitude of the cognate effects obtained across the two translation directions.

Table 1
Description of the published lexical decision studies testing cognate masked translation priming effects.

Study	Languages*	L1→L2 (ms)	L2→L1 (ms)	Pattern **
Davis et al., 2010	Spanish-English (Exp. 1)	29	20	symmetric
	English-Spanish (Exp. 1)	18	21	symmetric
	Spanish-English (Exp. 1)	27	18	symmetric
	Spanish-English (Exp. 1)	33	1 n.s.	asymmetric
	Spanish-English (Exp. 2)	21	36	symmetric
De Groot & Nas, 1991	Dutch-English (Exp. 2)	58	39	-
	Dutch-English (Exp. 3)	48	-	-
	Dutch-English (Exp. 4)	64	-	-
Duñabeitia, Perea et al., 2010	Basque-Spanish	62	44	asymmetric
Gollan et al., 1997	Hebrew-English (Exp.1&3)	53	9 n.s.	asymmetric
	English-Hebrew (Exp. 2&4)	142	4 n.s.	asymmetric
Voga & Grainger, 2007	Greek-French (Exp. 2)	50	-	
	Greek-French (Exp. 3)	48	-	-
Kim & Davis, 2003	Korean-English (Exp. 1)	34	-	-

Note: * The dominant language is presented first and the non-dominant second; ** The symmetry/asymmetry distinction is only made for the studies testing both translation directions; The hyphen (-) indicates that only one translation direction was tested.

As seen in Table 1, out of the five studies reporting significant masked translation priming effects with cognate and non-cognate translations, only in the study by Kim and Davis (2003) did these effects not differ in magnitude. Still, in another two studies testing cognate and non-cognate masked translation priming effects, though a cognate status by relatedness interaction was present suggesting larger effects for cognates as compared to non-cognates, this interaction emerged in the absence of any significant non-cognate effects (Davis et al., 2010; Sánchez-Casas et al., 1992). Moreover, while Duñabeitia, Perea et al. (2010) and Gollan et al. (1997) found an increased magnitude for cognate masked translation priming effects in the L1→L2 translation compared to the L2→L1 translation direction, Davis et al. (2010; in four out of the five groups tested) and De Groot and Nas (1991) did not report such an asymmetry, although they found a numerical difference in the expected direction. Out of the two studies reporting larger L1→L2 effects than L2→L1, only Duñabeitia and colleagues, who tested balanced and simultaneous bilinguals, obtained this asymmetry in the presence of a significant L2→L1 cognate masked translation priming effect, thus adding further variance to the existing pattern of cognate masked translation priming effects.

Unlike the case of cognate masked translation priming effects, the pattern of effects first obtained by Gollan et al. (1997) with non-cognate translations across the two translation directions has established the most consistent finding in the masked translation priming literature, *the non-cognate masked translation priming asymmetry,* and has set the ground for extensive experimentation on its nature. This asymmetry has since been replicated several times in studies using lexical decision tasks showing overall reliable masked translation priming effects in the forward translation direction and smaller or null effects for backward translation. Although the non-cognate masked translation priming asymmetry has so far survived different language and script combinations as well as changes in the masked priming procedure (e.g., backward masking, differences in prime duration, etc.), results have not always been consistent (see Table 2).

Interestingly, non-cognate masked translation priming studies using tasks other than a lexical decision task have not reported this pattern of effects. Grainger and Frenck-Mestre (1998) were the first to provide empirical evidence of the task-dependency of the non-cognate masked translation priming asymmetry testing backward non-cognate translation with English-French bilinguals performing either a lexical decision or a semantic categorization task ("is it an animal or not?") on English (L1) targets. As expected, they obtained a non-significant effect in the lexical decision task but surprisingly significant effect in the semantic categorization task. This significant backward masked translation priming effect was initially assumed to result from the explicit semantic component present in the semantic categorization task, which could have somehow facilitated the semantic processing of the primes (see also Finkbeiner, Nicol, Forster, & Nakamura, 2004; Wang & Forster, 2010). However, this interpretation was dropped when Jiang and Forster (2001) demonstrated significant backward non-cognate masked translation priming effects with Chinese-English bilinguals performing an episodic old-new recognition task on

Chinese (L1) targets, a task that does not entail such a strong semantic component. In fact, when using this task, the pattern of effects was virtually reversed, since only L2-to-L1 masked non-cognate priming effects emerged, in the absence of an L1-to-L2 effect[3].

Even more relevant for the purposes of the present research project are the reports of absence of the non-cognate masked translation priming asymmetry in three recent studies using the lexical decision task (Basnight-Brown & Altarriba, 2007; Davis et al., 2010; Duñabeitia, Perea et al., 2010; Duyck & Warlop, 2009). With the exception of Davis et al. (2010), who failed to find any significant non-cognate masked translation priming effects across the two translation directions, the rest of these studies have reported significant bi-directional effects of comparable magnitude. Critically, for the studies by Basnight-Brown and Altarriba (2007) and by Duyck and Warlop (2009) one could argue that the surprising pattern of effects could have been influenced by the presence of longer prime processing times; this could not have been the case with the study by Duñabeitia, Perea et al. (2010), in which the standard 50ms prime duration was used (see Table 2).

On the whole, the pattern of masked translation priming effects reported across existing studies is far from consistent. The non-cognate masked translation priming asymmetry found in most of the lexical decision studies is sometimes manifested as a unidirectional significant masked translation priming effect (i.e., only L1-to-L2 effects) and others as bi-directional effects of different magnitudes (i.e., larger L1-to-L2 and smaller L2-to-L1 effects). Of critical importance, sometimes the asymmetry is replaced by symmetric bi-directional non-cognate masked translation priming effects. In sum, the pattern of cognate masked translation priming effects is also still to be established.

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[3] Given that the present Dissertation does not investigate the task-dependency of masked translation priming effects, in all the experiments reported with both cognates and non-cognates participants performed lexical decisions, in line with the vast majority of the existing masked translation priming studies.

Table 2
Description of the published lexical decision studies testing non-cognate masked translation priming effects.

Study	Languages	L1→L2 (ms)	L2→L1 (ms)	Pattern
Basnight-Brown & Altarriba, 2007	Spanish-English (Exp.2)	33	24	symmetric
Davis et al., 2010	Spanish-English (Exp. 1)	-10 n.s.	0 n.s.	symmetric
	English-Spanish (Exp. 1)	-13 n.s.	4 n.s.	symmetric
	Spanish-English (Exp. 1)	-24 n.s.	-15 n.s.	symmetric
	Spanish-English (Exp. 1)	0 n.s.	-10 n.s.	symmetric
	Spanish-English (Exp. 2)	0 n.s.	9 n.s.	symmetric
	Spanish-English (Exp. 3)	3 n.s.	-	-
De Groot & Nas, 1991	Dutch-English (Exp.3)	35	-	-
	Dutch-English (Exp.4)	40	-	-
Duñabeitia, Perea et al., 2010	Basque-Spanish	16	20	symmetric
Duyck & Warlop, 2009	Dutch-French	48	26	symmetric
Finkbeiner et al., 2004	Japanese-English (Exp.2)	-	-4 n.s.	-
Gollan et al., 1997	Hebrew-English (Exp.1&3)	36	9 n.s.	asymmetric
	English-Hebrew (Exp.2&4)	52	-4 n.s.	asymmetric
Grainger & Frenck-Mestre, 1998	English-French	-	-3 n.s.	-
	English-French	-	2 n.s.	-
	English-French	-	10	-
Jiang, 1999	Chinese-English (Exp.1)	45	13	asymmetric
	Chinese-English (Exp.2)	68	3 n.s.	asymmetric
	Chinese-English (Exp.3)	-	4 n.s.	-
	Chinese-English (Exp.4)	-	7 n.s.	-
	Chinese-English (Exp.5)	-	-2 n.s.	-
Jiang & Forster, 2001	Chinese-English (Exp.1)	-	8 n.s.	-
	Chinese-English (Exp.3&4)	41	4 n.s.	asymmetric
Kim & Davis, 2003	Korean-English (Exp.1)	40	-	-
Schoonbaert et al., 2009	Dutch-English (Exp.1&2)	100	19	asymmetric
	Dutch-English (Exp.1&2)	28	12	asymmetric
Schoonbaert et al., 2011	English-French	70	24	asymmetric
Voga & Grainger, 2007	Greek-French (Exp.2)	23	-	-
	Greek-French (Exp.3)	22	-	-
Williams, 1994	German-English (Exp.2B)	21	-	-
	Italian-English (Exp.2B)	45	-	-
	French-English (Exp.2B)	45	-	-

The inconsistencies and empirical gaps observed in the masked translation priming literature comprise the main empirical motivation for running the experiments reported in the present PhD project and more precisely for testing how L2 proficiency could have been involved in the pattern of the masked translation priming effects obtained so far. In the following chapters, the rationale behind this hypothesis and the evidence supporting a potential role of L2 proficiency on translation processing as well as the theoretical motivations for testing this hypothesis are discussed in detail.

CHAPTER 3
L2 lexico-semantic processing and L2 proficiency

Non-native language proficiency is the variable most widely studied in the bilingual literature. Studies manipulating the level of L2 proficiency in bilinguals have been motivated by a general effort of the bilingual research community to identify the factor that determines the observed processing differences between L1 and L2, as well as the differences in L2 processing across bilinguals at different stages of L2 acquisition (e.g., Hoshino, Dussias, & Kroll, 2010; Leonard et al., 2011; Perani et al., 1998). Despite the extensive research interest that L2 proficiency has received, its exact definition, the best way to quantify it, and to isolate it from other potentially confounded factors, have not been yet established. For the sake of parsimony, throughout the present research project L2 proficiency will be quantified both in terms of amount of exposure to L2 as well as in terms of subjectively rated levels of L2 competence (see Part 2).

Overall, the existing evidence has revealed that L2 proficiency is the critical factor underlying the extent to which neural responses of bilinguals are comparable across their two languages over and above other factors, such as the age of L2 acquisition and more so in comprehension than in production (for a review, see Abutalebi, Cappa, & Perani, 2001; see also Chee, 2006; Perani et al., 1998). L2 proficiency also influences performance in numerous semantic and lexical tasks on L2 words (e.g., Chee, Hon, Lee, & Soon, 2001; Chee, Soon, Lee, & Pallier, 2004; Elston-Guettler, Paulmann, & Kotz, 2005; Mechelli, Crinion, Noppeney, O'Doherty, Ahsburner, Frackowiak, et al., 2004; Meschyan & Hernandez, 2006; Xue, Dong, Jin, Zhang, & Wang, 2004). Moreover, although L2 proficiency is clearly a determinant factor in the way L2 words are processed and interact with the existing L1 lexico-semantic system, whether L2 proficiency modulates effects of automatic activation of translation equivalents is still to be examined.

In order to guide the reader through the empirical and theoretical motivation underlying the hypothesis that L2 proficiency could be critically involved in the pattern of masked translation priming effects, in the present Chapter, first the evidence on how L2 proficiency modulates the ease of lexico-semantic access in the second language during L2 reading and during translation processing is briefly reviewed. Then, the potential existence of a dependency in the pattern of masked translation priming effects obtained so far on the level of the L2 proficiency of the bilinguals is discussed in detail.

3.1. Effects of L2 proficiency on L2 lexico-semantic access

The assumption that masked translation priming could be influenced by the level of L2 proficiency in bilinguals is further supported by the large amount of evidence, gathered by studies exploring the processing of semantic associates and translation equivalents, indicating that whether or not lexico-semantic activation in the non-dominant language will take place effectively, comparable to that of the dominant language, depends on the level of competence in the L2. To this aim, it has been shown that less proficient bilinguals perform worse than more proficient ones in tasks requiring the lexico-semantic activation of L2 items, such as picture naming, semantic judgment or semantic categorization tasks (e.g., Chee, et al., 2001; Chen & Leung, 1989; Sunderman & Kroll, 2006).

3.1.1. Evidence from bilingual word production studies

Although the processing of translation equivalents has been extensively studied in word production tasks, the impact of the level of L2 proficiency on the pattern of lexico-semantic effects has been found to be more pronounced in word recognition tasks. In a seminal study, Weber-Fox and Neville (1996) compared L2 learners to L2 monolingual native speakers during L2 sentence reading and found modulations on the timing and the distribution of event-related potential (ERP) effects; an electrophysiological method used to determine neural signatures associated with cognitive processing which allows fine-grained temporal resolution. Favreau and Segalowitz (1983) found greater semantic priming during L2 reading, for the more proficient bilinguals as compared to the less proficient, particularly at short stimulus onset asynchronies (SOA). Ferré and colleagues (2006) reported that both early and late high proficient Spanish (L1)-Catalan (L2) bilinguals suffered from interference in a translation recognition task when two words were semantically related to each other, while less proficient late bilinguals were more sensitive to a formal overlap between the two words (but see De Groot & Poot, 1997, for contrasting evidence). All together, these findings suggest that as L2 proficiency increases, the asymmetries in the lexico-semantic processing of L1 and L2 words decrease.

Despite the fact that L2 lexico-semantic activation seems to be costlier for less proficient bilinguals, an increasing amount of evidence has shown that even at earliest stages of L2 acquisition bilinguals can directly activate the meaning associated with a given L2 word, with a relative ease depending mostly on the lexical (e.g., frequency) and sub-lexical (e.g., ortho-phonological properties) characteristics of the test items and the task requirements (e.g., Altarriba & Mathis, 1997; Dufour & Kroll, 1995; Duyck & Brysbaert, 2004; 2008; McLaughlin, Osterhout, & Kim, 2004; Sunderman & Kroll, 2006; see Kroll et al., 2010; Li, 2009; van Heuven & Dijkstra, 2010, for recent reviews).

More relevant for the purposes of the present dissertation is the evidence showing different effects at varying levels of L2 proficiency in tasks involving the activation of translation equivalents. Kroll and colleagues (2002) found that unbalanced bilinguals were faster in the production of the L1 translation of an L2 word, than vice versa and that this asymmetry was smaller with a more proficient group. In the same task, Chistoffels, de Groot and Kroll (2006) replicated this asymmetric pattern with two groups of Dutch dominant Dutch-English bilinguals, though the asymmetry was in the opposite direction (faster performance in L1→L2 translation direction). Still, just like Kroll and colleagues, Christoffels et al. reported an attenuation of the asymmetry for the more proficient bilinguals. In addition, most word production studies have consistently shown faster responses to cognate than to non-cognates in the L2, while only a part of them have found a cognate effect in the L1 (e.g., Caramazza & Brones, 1979; Costa et al., 2000; Kroll et al., 2002; Poarch & van Hell, 2012; Schwartz, Kroll, & Diaz, 2007). These cognate effects are in most cases asymmetric: larger effects in the L2 than in the L1. Kroll et al., (2002) obtained such an asymmetric pattern of cognate effects with two groups of English-French bilinguals of different levels of L2 proficiency performing a reading aloud task. However, the group exhibiting the larger cognate effect when reading aloud L2 words was the less fluent one. The same difference in the magnitude of the L2 cognate effect across the two groups of bilinguals tested was also present in a translation production task. However, in this task the L1 and L2 cognate effects were of comparable magnitude. Although, Poarch and van Hell (2012) also obtained asymmetric L1 and L2 cognate effects (i.e., larger L2 effects) with five groups of German-English bilingual children of different levels of L2 competence performing a picture-naming task, they did not find any modulation of the L2 cognate effect depending on the L2 proficiency. The only difference associated to the level of L2 proficiency of each group was the absence of the L1 cognate effect for the less proficient group. Baus (2010; Published PhD) explored the influence of a brief period of L2 linguistic immersion by comparing German-Spanish bilinguals to Spanish monolinguals in a longitudinal study. Among the central findings was a facilitative picture naming cognate effect present for immersed bilinguals at both testing periods (less and more L2 exposure) when naming in L2. Interestingly, after just four months of immersion an L1 cognate effect also appeared, suggesting that L1 naming also benefitted from the similarity with the L2 translation equivalent. Hence, word production studies have so far mostly shown differences in the processing of L1 and L2 translations associated with the degree of exposure in the non-dominant language of the bilinguals tested.

3.1.2. Evidence from bilingual visual word recognition studies

In the comprehension literature, there is consistent evidence showing that the performance of low proficient bilinguals in the translation recognition task is more sensitive to the resemblance of L2 words to their L1 translation and less to their semantic features, while the opposite is true for more competent groups of bilinguals (e.g., Ferré et al., 2006; Sunderman & Kroll, 2006; Talamas et al, 1999; but see de Groot & Poot, 1997; Thierry & Wu, 2007). In a lexical decision priming study with purely L2 stimuli Elston-Güttler et al. (2005) collected concurrently electrophysiological and behavioural data from two groups of German-English bilinguals with different levels of proficiency in English (L2). Targets (e.g., *jaw*) were preceded either by the L2 homonym of their L1 translation (*pine*, with *jaw* and *pine* corresponding to the word *kiefer*, in German) or by an unrelated L2 prime (e.g., *oak*). Both groups of bilinguals suffered from interference effects caused by the activation of the L1 translation of the homonym L2 prime, as shown by the lexical decision latencies. However, this interference was present only in the ERP recordings of the less proficient group, suggesting that for this group the L1 activation was more pronounced.

The evidence gathered in bilingual language comprehension studies with cognate translations is largely in the same line. First, the cognate benefits obtained in the dominant language are usually more elusive or smaller than those obtained in the non-dominant language, suggesting a larger reliance on the processing of the lexical form when reading L2 words (e.g., De Groot et al., 2000; Dijkstra et al., 1999; Lemhöfer & Dijkstra, 2004; Lemhöfer et al., 2004; van Hell & De Groot, 1998; van Hell & Dijkstra, 2002). In the study by Van Hell and Dijkstra (2002) cognate processing was examined with Dutch-English-French trilinguals of different levels of L2 proficiency. Results showed significant L2 cognate effects for all the bilingual groups tested, but a significant L1 cognate effect only for the most proficient bilingual group. These findings suggest that a relatively high level of L2 proficiency is needed in order to benefit from the formal overlap across cognates when reading in the dominant language. Nevertheless, Brenders, van Hell, and Dijkstra (2011) recently tested cognate effects in the lexical decision task with children of different levels of L2 proficiency. The authors found that the asymmetric pattern of the cognate effects was not modulated as a matter of L2 proficiency (i.e., larger cognate effects in the non-dominant language than in the dominant one).

Differential lexico-semantic effects depending on the level of L2 proficiency of the bilinguals have been also obtained using the masked priming paradigm, though as mentioned not testing the processing of translations. Using L2 semantically related prime-target pairs, Frenck-Mestre and Prince (1997) found that significant masked semantic priming effects, comparable to those obtained with native speakers, emerged only with highly proficient bilinguals and not with bilinguals who were less proficient in the L2. By mixing the prime-target languages, Bijeljac-Babic, Biardeau, and Grainger (1997) found different patterns of cross-language lexical activation with more and less proficient French (L1)-English (L2) bilinguals. The authors obtained a larger inhibitory effect for French targets preceded by higher frequency English orthographic neighbours (e.g., *mile-MIEL*, meaning *honey* in French) with proficient bilinguals as compared to beginning French-English bilinguals performing a lexical decision task. More closely related to the cross-language activation of translations under masked priming conditions is the evidence showing different patterns of associative/semantic cross-language priming effects with bilinguals of different levels of L2 proficiency. Studies testing relatively high proficient unbalanced bilinguals have reported asymmetric effects. Duyck (2005) obtained a significant masked priming effect with L2 targets preceded by L1 primes which were pseudohomophones of the targets' semantic associates but not with L1 targets. Schoonbaert et al. (2009) obtained significant bi-directional effects with fluent unbalanced bilinguals which were, however, larger in the L1→L2 priming direction. Similar to what has been reported in the non-cognate masked translation priming literature, this asymmetry depending on the target language was eliminated when even more proficient bilinguals were tested (but see Basnight-Brown & Altarriba, 2007). Finally, Perea et al., (2008) found bi-directional and symmetric associative/semantic effects with simultaneous and balanced Basque-Spanish bilinguals.

Overall, the most consistent findings reported across the bilingual literature regarding the way the level of L2 competence affects lexico-semantic effects are that: i) early in the L2 acquisition process the retrieval of L2 words and the activation of their corresponding meaning seems to be more effortful than for more proficient bilinguals, while the reliance on the activation of the lexical form of their L1 translation equivalent is larger; ii) the processing of L2 words involves the activation of their L1 translation more so than vice versa leading to asymmetries in findings; and, iii) as the L2 proficiency level increases, asymmetries in the processing of L1 and L2 words are attenuated (e.g., the influence of the activation of the L2 translations becomes more visible during L1 processing).

3.2. Masked translation priming and L2 proficiency: Existing evidence

As seen, masked translation priming effects have been so far examined using different tasks and types of translations, yielding different patterns of effects. The most consistent finding reported across the existing masked translation priming studies is the non-cognate masked translation priming asymmetry reported across the vast majority of the lexical decision studies. The asymmetric pattern obtained with non-cognate translations could seem initially surprising given that one might expect that these effects would be unaffected by translation direction. However, taking into account the fact that all the studies reporting asymmetric masked translation priming effects tested bilinguals who had acquired the L2 much later than the L1 and who were clearly less proficient in their L2 than in their L1, namely unbalanced bilinguals, clarifies this pattern of asymmetries (see Tables 3 and 4 for a review of the characteristics of the bilinguals participating in the behavioural cognate and non-cognate masked translation priming studies). Hence, it becomes feasible to assume that processing differences between primes of the dominant and the non-dominant languages would lead to these differential effects across the two translation directions. This explanation of the asymmetry would therefore lead to the prediction that when there is not such a representational L1-L2 unbalance, or when this L1-L2 unbalance is attenuated, namely with very highly proficient or with balanced bilinguals, the asymmetry should vanish. In support of this proposal, Basnight-Brown and Altarriba (2007) found symmetric effects (33ms in the L1→L2 and 24ms in the L2→L1 translation direction) with very highly proficient early Spanish-English bilinguals who had undergone a language dominance shift. Thus, even if this group was not composed of balanced bilinguals, the fact that they had become proficient in their L2 up to the extent of reporting being more competent in this language as compared to the native one, seems to have led to this symmetric pattern of masked translation priming effects. Even stronger evidence in support of this proposal, was recently reported by Duñabeitia, Perea and colleagues (2010). These authors tested simultaneous balanced Basque-Spanish bilinguals who were constantly exposed to both of their languages. They found significant and symmetric bi-directional effects across the two translation directions (16 and 20ms, in the L1→L2 and L2→L1 translation direction, respectively), which were also replicated in a study using the event-related potential technique (ERPs) with bilinguals of the same characteristics (Duñabeitia, Dimitropoulou, Uribe-Etxebarria, Laka, & Carreiras, 2010).

The only non-cognate masked translation priming lexical decision studies so far reporting evidence against a critical influence of the level of L2 proficiency in the pattern of masked translation priming effects are a study by Duyck and Warlop (2009) testing low proficient bilinguals and a study by Davis et al. (2010), directly investigating the influence of L2 proficiency on masked translation priming effects. Duyck and Warlop tested a group of late and low proficient Dutch-English bilinguals and found significant effects in both translation directions. Unexpectedly, and in spite of their large numerical difference (48 vs. 26ms in the L1→L2 and L2→L1 translation direction, respectively), the two effects were not significantly different from each other. Nevertheless, in the light of this surprising pattern the authors themselves suggested that what might be leading to this symmetry could be a potential lack of statistical power.

Davis and colleagues (2010) examined the pattern of non-cognate masked translation priming effects across the L2 proficiency range (Experiment 1) by testing i) two groups of relatively proficient unbalanced bilinguals (a Spanish- and an English- dominant), ii) a group of Spanish-English beginners, and iii) a group of Spanish-English balanced bilinguals, performing lexical decisions on the same L1 and L2 targets. Throughout the different bilingual groups tested across the two translation directions and the different control conditions used, the authors did not find any significant non-cognate masked translation priming effects. Considering the existing literature, the complete absence of non-cognate masked translation priming, even in the forward translation direction and even for the balanced bilinguals, is unexpected. Moreover, the fact that, unlike the common practice of using formally and semantically unrelated words of the non-target language to test masked translation priming effects, the authors use of nonword form-related and form-unrelated baselines prevents us from drawing further conclusions regarding the influence of L2 proficiency on the non-cognate masked translation priming effects.

With regard to the less extensively studied cognate masked translation priming effects, considering the diversity of the bilinguals tested, as well as the fact that the critical cognate translations tested in three out of the six cognate masked translation priming studies held only phonological overlap to their counterpart (i.e., cross script cognates), the potential validity of cross-study comparisons regarding the influence of L2 proficiency on cognate masked translation priming effects is limited. Out of the six cognate masked translation priming studies, only two have examined bilinguals of levels of L2 competence different to the most commonly tested unbalanced high proficient bilinguals (see Table 3). Furthermore, throughout the four studies testing this type of bilinguals on automatic cognate processing, the most consistent finding is the presence of a significant priming effect in the L1→L2 translation direction. The two studies exploring both translation directions have reported asymmetric effects, but only De Groot and Nas (1991) found this asymmetry in the presence of a significant L2→L1 effect. In fact, unlike what could have been expected based on the pattern observed with non-cognate translations, Duñabeitia, Perea et al. (2010) replicated this asymmetry with native-like balanced bilinguals. Lastly, in the first experiment reported by Davis et al. (2010), cognate masked translation priming effects were examined across bilingual groups who differed in their L2 competence. Results for the more proficient bilingual groups tested (two groups of relatively high proficient and one group of balanced bilinguals) revealed significant effects in both the L1→L2 and the L2→L1 translation direction, which did not differ in magnitude (see also Experiment 2, of the same study for a similar pattern). In the case of the less proficient bilinguals however, a significant cognate masked translation priming effect emerged only with L1 primes and L2 targets, in line with previous studies suggesting that a considerable level of L2 competence is required for L1 reading to benefit from the formal overlap with its L2 translation (e.g., Kroll et al., 2002). Though the findings reported by Davis and colleagues (2010) indicate the absence of a close dependency between cognate masked translation priming effects and L2 proficiency, as previously mentioned, they cannot be taken as conclusive due to a number of methodological issues (e.g., nonword control primes; L1/ L2 speed-accuracy trade off, etc.).

In the light of the above-described findings, it is considered decisive to establish the influence of the level of L2 competence on the pattern of both cognate and non-cognate masked translation priming effects.

Table 3

Description of the published cognate lexical decision studies testing masked translation priming effects and of the reported characteristics of the bilinguals tested.

Study	Languages *	L2 AoA	L2 proficiency	Prime	Blank	Post-mask	L1→L2	L2→L1	Pattern **
Davis et al., 2010	English-Spanish (Exp. 1)	Late	High	57	-	-	18	21	symmetric
	Spanish-English (Exp. 1)	Late	High	57			29	20	symmetric
	Spanish-English (Exp. 1)	Late	Low	57	-	-	33	1 n.s.	asymmetric
	Spanish-English (Exp. 1)	Late	Balanced	57	-	-	27	18	symmetric
	Spanish-English (Exp. 2)	Late	High	57	-	-	21	36	symmetric
De Groot & Nas, 1991	Dutch-English (Exp.2)	-	Medium	40	20	-	58	39	-
	Dutch-English (Exp.3)	-	Medium	40	20	-	48	-	-
	Dutch-English (Exp.4)	-	Medium	40	20	-	64	-	-
Duñabeitia, Perea et al., 2010-	Basque-Spanish	Simultaneous (0-3yrs)	Balanced	50	-	-	62	44	asymmetric
Gollan et al., 1997	Hebrew-English (Exp.1&3)	Late	High	50	-	-	53	9 n.s.	asymmetric
	English-Hebrew (Exp.2&4)	Late	High	50	-	-	142	4 n.s.	asymmetric
Voga & Grainger, 2007	Greek-French (Exp.2)	Late	High	50	-	-	50	-	-
	Greek-French (Exp.3)	Late	High	50	-	-	48	-	-
Kim & Davis, 2003	Korean-English (Exp. 1)		High	50	-	-	34	-	-

Table 4

Description of the published non-cognate lexical decision studies testing masked translation priming effects and of the reported characteristics of the bilinguals tested.

Study	Languages	L2 AoA	L2 proficiency	Prime	Blank	Post-mask	L1→L2	L2→L1	Patt
Basnight-Brown & Altarriba, 2007	Spanish-English (Exp.2)	Early (4.6 yrs)	Very high	100	-	-	33	24	symmetric
Davis et al., 2010	Spanish-English (Exp. 1)	Late	High	57	-	-	-10 n.s.	0 n.s.	symmetric
	English-Spanish (Exp. 1)	Late	High	57	-	-	-13 n.s.	4 n.s.	symmetric
	Spanish-English (Exp. 1)	Late	Low	57	-	-	0 n.s.	-10 n.s.	symmetric
	Spanish-English (Exp. 1)	Late	Balanced	57	-	-	-24 n.s.	-15 n.s.	symmetric
	Spanish-English (Exp. 2)	Late	High	57	-	-	0 n.s.	9 n.s.	symmetric
	Spanish-English (Exp. 3)	Late	High	57	-	-	3 n.s.	-	-
De Groot & Nas,	Dutch-English	-	Medium	40	20	-	35	-	-

1991	(Exp.3)								
	Dutch-English (Exp.4)	-	Medium	40	20	-	40	-	-
Duñabeitia, Perea et al., 2010-	Basque-Spanish	Simmultaneous (0-3yrs)	Balanced	50	-	-	16	20	symmetric
Duyck & Warlop, 2009	Dutch-French	Late (11 yrs)	Low	56		56	48	26	symmetric
Finkbeiner et al., 2004	Japanese-English (Exp.2)	Late	High	50	-	150	-	-4 n.s.	-
Gollan et al., 1997	Hebrew-English (Exp.1&3)	Late	High	50	-	-	36	9 n.s.	asymmetric
	English-Hebrew (Exp.2&4)	Late	High	50	-	-	52	-4 n.s.	asymmetric
Grainger & Frenck-Mestre, 1998	English-French	-	Very high	14	-	13	-	-3 n.s.	-
	English-French	-	Very high	29	-	13	-	2 n.s.	-
	English-French		Very high	43	-	13	-	10	-
Jiang, 1999	Chinese-English (Exp.1)	Late	High	50	-	-	45	13	asymmetric
	Chinese-English (Exp.2)	Late	High	50	-	-	68	3 n.s.	asymmetric
	Chinese-English (Exp.3)	Late	High	50	50	-	-	4 n.s.	-
	Chinese-English (Exp.4)	Late	High	50	50	150	-	7 n.s.	-
	Chinese-English (Exp.5)	Late	High	50	50	150	-	-2 n.s.	-
Jiang & Forster, 2001	Chinese-English (Exp.1)	Late	High	50	50	150	-	8 n.s.	-
	Chinese-English (Exp.3&4)	Late	High	50	-	-	41	4 n.s.	asymmetric
Kim & Davis, 2003	Korean-English (Exp.1)	Late	Medium	50	-	-	40	-	-
Schoonbaert et al., 2009	Dutch-English (Exp.1&2)	Late (12 yrs)	High	50	50	150	100	19	asymmetric
	Dutch-English (Exp.1&2)	Late (12 yrs)	High	50	-	50	28	12	asymmetric
Schoonbaert et al., 2011	English-French	Late (12 yrs)	High	100	-	20	70	24	asymmetric
Voga & Grainger, 2007	Greek-French (Exp.2)	Late	High	50	-	-	23	-	-
	Greek-French (Exp.3)	Late	High	50	-	-	22	-	-
Williams, 1994	German-English (Exp.2B)	-	High	40	10	-	21	-	-
	Italian-English (Exp.2B)	-	High	40	10	-	45	-	-
	French-English (Exp.2B)	-	High	40	10	-	45	-	-

3.3. Masked translation priming andL2 proficiency: Can we make sense of the findings?

As can be appreciated, several studies have shown modulations of L2 processing and cross-language activation at the lexico-semantic level as a function of L2 proficiency. Nevertheless, so far the influence of the bilinguals' level of L2 proficiency on cognate and non-cognate masked translation priming effects has not been examined. In fact, most authors have opted for testing rather highly proficient unbalanced bilinguals who had acquired the L2 much later than their L1 (late childhood or adolescence), while a very small number of studies have intentionally examined masked translation priming effects with low or very highly proficient bilinguals (see Tables 3 and 4). Importantly, even by taking into account these isolated pieces of evidence to extract the pattern of masked translation priming effects obtained across different levels of L2 proficiency, the reader would rapidly realize the existence of a number of issues preventing him from drawing any reliable cross-study conclusions in this regard.

The most important limitation is the *diversity of the bilingual groups tested* (see Altarriba & Basnight-Brown, 2007). Some studies have used objective measures to define the level L2 competence of the bilinguals (e.g., Jiang, 1999; Jiang & Forster, 2001) others subjective measures (e.g., Davis et al., 2010; Duñabeitia, Perea et al., 2010; Duyck & Warlop, 2009; Schoonbaert et al., 2009), while others have only provided a scarce description of the linguistic history of their participants (e.g., Grainger & Frenck-Mestre, 1998; Kim & Davis, 2003). These, rather rough descriptions, bring to light the fact that even in the studies where the bilinguals tested had indeed a uniform level of L2 proficiency, their linguistic background (L1 or L2 background; e.g., Finkbeiner et al., 2004; Jiang, 1999; Jiang & Forster, 2001; Voga & Grainger, 2007), their age of L2 acquisition or the context in which L2 was acquired were underspecified. Importantly, numerous studies have shown that the age at which L2 is acquired is critically involved in the ultimate attainment of the L2 (e.g., Guillon-Dowens, Vergara, Barber, & Carreiras, 2010; Kotz & Elston-Güttler, 2004; Mackay & Flege, 2004; Munro, Flege, & MacKay, 1996; Silverberg & Samuel, 2004). Recent evidence also suggests that being immersed in an L2 context, as a number of bilingual groups participating in masked translation priming studies were (e.g., Basnight-Brown & Altarriba, 2007; Davis et al., 2010; Grainger & Frenck-Mestre, 1998; Jiang, 1999), greatly influences the representational relationship between L1 and L2 (Linck, Kroll & Sunderman, 2009; Nosarti, Mechelli, Green & Price, 2010; Segalowitz & Hulstijn, 2005).

Furthermore, there are considerable differences in the *size of the bilingual samples* tested, with the number of participants ranging from 3 (Williams, 1994) to 76 (de Groot & Nas, 1991). This, along with an analogous variability observed in the number of experimental items presented (ranging from 9 to 60 items per priming condition) could be influencing the pattern of effects obtained due to statistical power differences. Finally, while most studies have used the same set of translation pairs to test both translation directions (inversing the prime-target language; e.g., Gollan et al., 1997; Schoonbaert et al., 2009), only Davis et al (2010) and Duñabeitia, Perea, et al., (2010) have opted for testing twice the same bilinguals (see also Duñabeitia, Dimitropoulou, et al., 2010). These between subject designs add a considerable amount of variance in the response latencies, which could be further influencing the pattern of the effects obtained across the two translation directions.

The second crucial limitation in performing any kind of cross-study comparison to establish the pattern of masked translation priming effects at different levels of L2 competence is the *different language combinations* examined each time. As can be seen in Tables 3 and 4 a large number of studies have used combinations of Romance languages (e.g., Spanish-English, Dutch-English, Dutch-French, etc.) with almost completely overlapping graphemes and phonemes as well as partly overlapping lexicons (i.e., large number of cognates). One study has combined partly overlapping scripts (Greek and Roman) while others have used languages involving completely distinct alphabets (Hebrew and Roman) or even different writing systems (logographic and alphabetic). This variation in script combinations is particularly problematic when examining cognates, since within-script manipulations cognates largely share both their orthographic and phonological representations, while in cross-script manipulations the formal overlap is limited at the phonological level. The potential influence of the script and language combinations used in the effects obtained across the different lexical decision masked translation priming studies can be appreciated in the effects reported so far in the L2→L1 direction with both cognate and non-cognate translations. Critically, although some of the within-script combinations have not yielded significant effects in this translation direction, all the studies that have shown significant L2→L1 masked translation priming effects have examined languages with a common alphabet. Due to this inconsistency, whether having the same or different scripts modulates the effects is still an issue under discussion (see Gollan et al., 1997; Hoshino, Midgley, Holcomb, & Grainger, 2010).

Finally, the *masked priming methodology* used each time could be also shadowing the effects caused by the level of L2 proficiency of the bilinguals. Jiang (1999) tested and rejected the hypothesis that having extra time for processing the prime by including a blank or a post-mask facilitates the appearance of the otherwise elusive L2→L1 non-cognate masked translation priming effect. This conclusion is further supported by the significant within-language repetition priming effects obtained with words of the non-dominant language as well as by the significant L2→L1 non-cognate masked translation priming effects obtained using a 50ms SOA, which suggest that 50ms are enough to effectively process the L2 primes (e.g., Davis et al., 2010; De Groot & Nas, 1991; Gollan et al., 1997; Jiang, 1999). However, it is noteworthy that significant masked translation priming L2→L1 effects have mostly emerged in studies using SOAs longer than 50ms (see Tables 3 and 4). Schoonbaert, Holcomb, Grainger, & Hartsuiker (2011) have recently obtained significant bi-directional non-cognate masked translation effects both behaviourally and in specific ERP components by presenting the prime for 100ms and adding a 20ms post-mask too (see also Basnight-Brown & Altarriba, 2007, for evidence of significant L2→L1 effects following a similar procedure). In the light of their results and in spite of the existence of conflicting evidence the authors concluded that *"increasing participants' proficiency in L2 or increasing prime–target SOA can be thought of as having the same influence on the amount of processing of briefly presented L2 prime words"* (p. 6).

Even if one oversees these limitations, in an effort to identify the pattern of effects obtained across bilingual groups as a matter of their L2 proficiency level, the evidence reported is far from being conclusive. As previously mentioned, the masked translation priming asymmetry is the predominant finding reported in the vast majority of the studies testing relatively highly proficient unbalanced bilinguals, although some of these studies have obtained significant effects in both translation directions when testing both cognates and non-cognates, while others only with L1 primes and L2 targets. Even more surprisingly, testing bilinguals at the lower L2 proficiency range, Duyck and Warlop (2009) demonstrated bi-directional non-cognate masked translation priming effects, which did not significantly differ from each other. In fact, even the symmetric effects obtained using non-cognates with bilinguals of the highest levels of L2 proficiency that possibly indicate an influence of L2 proficiency on masked translation priming effects, are unclear as to whether an equal level of proficiency in the L1 and in the L2 is needed for symmetry to emerge. The two studies reporting symmetric effects have tested bilinguals who in one case were very highly proficient but unbalanced and in the other balanced (Basnight-Brown & Altarriba, 2007; Duñabeitia, Perea, et al., 2010; see also Duñabeitia, Dimitropoulou et al., 2010, for an ERP replication). In the study by Duñabeitia, Perea et al. (2010) with balanced bilinguals an inconsistency has also been found across cognate and non-cognate effects, since the symmetric pattern was only present for non-cognate translations, while for cognates an asymmetric pattern was reported across the two translation directions. This cognate asymmetry has also been found with unbalanced bilinguals. However, just like with non-cognate translations, this pattern has once more entailed either significant bi-directional effects (De Groot & Nas, 1991) or uni-directional L1→L2 effects (Gollan et al., 1997). Finally, though in most studies testing cognate and non-cognate masked translation priming effects with balanced and unbalanced bilinguals, the effects obtained with cognates exceed in magnitude those obtained with non-cognates, this has not always been the case (see Kim & Davis, 2003).

CHAPTER 4
Theoretical approaches on translation processing

Due to the large amount of existing evidence on translation processing, as well as the fundamental role of matching translations between the native and the non-native language in the process of L2 acquisition, the processing of translation equivalents has been included in the core structure of the most influential models of bilingual lexico-semantic organization. Similarly, the way the structure of the bilingual lexicon is modified as the level of L2 proficiency increases has also been taken under consideration in many models' predictions. As will be explained in detail, the relationship between L2 proficiency and translation processing has been granted a central role in the most cited bilingual model, the Revised Hierarchical Model (RHM; Kroll & Stewart, 1994), while several others have made predictions about how L2 proficiency could modulate translation processing. Starting from the RHM, the present Chapter will introduce separately each of the most influential bilingual models, describe their interpretations of the well-established non-cognate masked translation priming asymmetry, and will present their predictions on how masked translation priming effects should manifest with cognates and non-cognates at different levels of L2 proficiency.

It should be noted that, apart from the three models described in continuation, several other theoretical proposals have been put forward to specifically explain either the non-cognate masked translation priming asymmetry (e.g., The Sense Model, Finkbeiner et al., 2004; Wang & Forster, 2010; the Episodic L2 Hypothesis, Forster & Jiang, 2001; Witzel & Forster, 2012) or the cognate processing advantage (Distributed Features Model: de Groot, 1992; Thomas & Van Heuven, 2005; morphological account: Sánchez-Casas et al., 1992; Sánchez-Casas & García-Albea, 2005). However, given that the ultimate goal of the present dissertation is to shed light on the lexico-semantic organization of the bilingual lexicon, and not only to explain specific sets of experimental findings in isolation, the plausibility of these narrower interpretations of the effects would not be discussed.

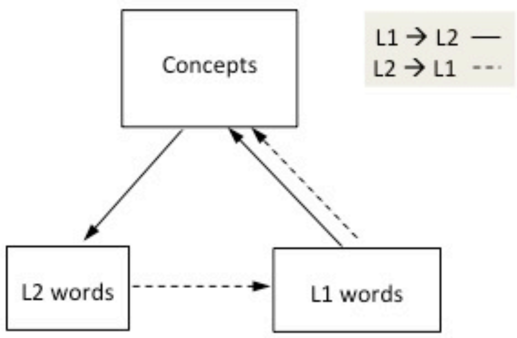
4.1. The Revised Hierarchical Model

A model initially designed to account for the processing of translation equivalents in word production at different levels of L2 proficiency is the Revised Hierarchical Model (RHM) put forward by Kroll and colleagues (e.g., Kroll & Stewart, 1994; Kroll et al., 2010; Kroll & Tokowicz, 2001; 2005). In its most recent version, the RHM posits that L1 and L2 words are stored in functionally separate lexicons that are linked to a common semantic/conceptual store. Critically, the progressive increase in L2 proficiency is reflected in the way L2 words are linked to the conceptual level and to their L1 translation equivalents. Early in the L2 acquisition process there are strong L2-to-L1 connections but weak connections between concepts and their corresponding L2 word forms (see Figure 3). Due to this pattern of lexico-semantic connections, low proficient bilinguals need to activate the L1 translation equivalent to retrieve the corresponding L2 word, while at the same time they are slower at accessing the meaning of L2 words as compared to that of L1 words. As the level of L2 proficiency increases, the lexical and semantic connections of L2 words become gradually more comparable to those of L1 words, up to the extent of becoming symmetrical, when the bilingual reaches the highest levels of L2 proficiency (i.e., balanced bilinguals). The strongest evidence in support of the so-called *developmental hypothesis* of the RHM comes from studies showing that for low proficient bilinguals, L2→L1 translation is faster than L1→L2 due to the effective activation of the L1 word by its L2 translation equivalent, while for more proficient bilinguals this translation asymmetry is attenuated. In a similar fashion, reports of an increase in influences from semantic variables (e.g., concreteness, imageability) and a decrease of influences from sub-lexical and lexical variables (orthographic or phonological) during L2 processing as bilinguals become more proficient, have also provided support to the RHM's developmental hypothesis of increasingly strong semantic connections of L2 words (e.g., Talamas et al., 1999).

In spite of the fact that the RHM was initially designed to account for bilingual word production and not for bilingual visual word recognition findings (though it has been extensively cited in word comprehension studies, see Brysbaert, Verreyt, & Duyck, 2010), Kroll and colleagues offered an explanation of the non-cognate masked translation priming asymmetry within the framework of their model mostly based on the assumption that masked primes activate the conceptual node shared with the targets, facilitating the processing of the target (Kroll & de Groot, 1997; Kroll & Tokowicz, 2001). They proposed that when testing unbalanced bilinguals this semantic activation would be more effective with L1 primes as compared to L2 primes due to the stronger links between L1 words and concepts, and thus larger masked translation priming effects would emerge in the L1→L2 translation direction. Following the model's central assumption of a progressively more symmetric pattern of L1 and L2 lexico-semantic links as a matter of increased L2 proficiency, the RHM would predict that the non-cognate masked translation priming asymmetry would gradually attenuate as the level of L2 competence would increase and eventually be eliminated with balanced native-like bilinguals (e.g., Dimitropoulou et al., 2012; Duñabeitia, Perea et al. 2010; Duñabeitia, Dimitropoulou et al., 2010).

Following the same rationale, the RHM would also predict a similar asymmetric pattern of cognate masked translation priming effects as the one expected for non-cognates for unbalanced bilinguals (i.e., larger L1→L2 than L2→L1 effects). Critically, in line with the proposed weakening of the L2→L1 lexical connections as bilinguals become more proficient in their second language, a progressively more symmetric pattern of cognate masked translation priming effects across the two translation directions is also expected as the level of L2 proficiency increases.

Figure 3. L1 and L2 lexico-semantic interactions according to the Revised Hierarchical Model (Kroll & Stewart, 1994).



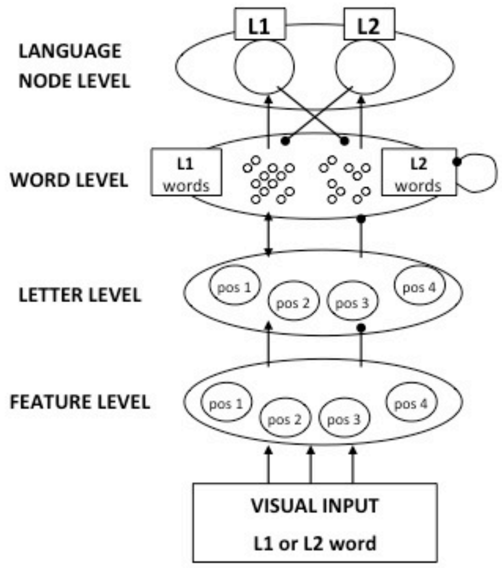
Note: Continuous lines represent strong connections; dotted lines represent weaker connections.

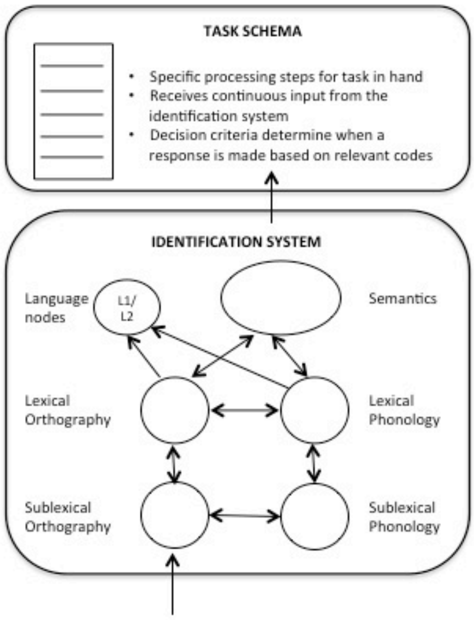
4.2. The Bilingual Interactive Activation Models

Similar predictions as the ones sketched by the RHM are also made by the Bilingual Interactive Activation models (BIA and BIA+; e.g., Dijkstra & van

Heuven, 1998; 2002; van Heuven, Dijkstra, & Grainger, 1998). Masked translation priming effects and their potential modulation by the level of L2 proficiency offer an ideal experimental setting for testing the validity of the BIA models since these models were designed to account for the bilingual visual word recognition findings and they have effectively simulated masked priming effects of cross-language lexico-semantic activation across different levels of L2 proficiency (e.g., Dijkstra & Van Heuven, 1998; 2002). The BIA models, which operate based on the same principles as their predecessor, the Interactive Activation model of monolingual visual word recognition (McClelland & Rumelhart, 1981), propose that words of both languages are stored in a single unified lexicon, thus accounting for the cross-language lexico-semantic interactions repeatedly reported (see Figure 4).

Figure 4. (a) The BIA, and (b) the BIA+ models





(a). BIA model

(b). BIA+ model

Note: Arrows represent excitatory connections; filled circles represent inhibitory connections.

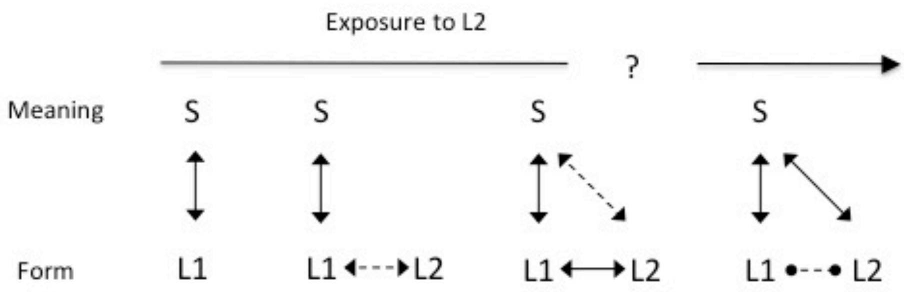
According to the BIA framework, processing asymmetries between L1 and L2 words observed with unbalanced bilinguals are caused by differences in their relative frequency and/or recency of use of L1 and L2 words. For this type of bilingual, L2 words are generally encountered less frequently than L1 words leading to lower resting levels of activation and costlier recognition than for L1 items. However, as the L2 proficiency level increases and bilinguals become more exposed to L2 words, their activation thresholds decrease and they become more easily accessed. As a consequence, their recognition becomes more similar to that of L1 words. Within the context of the masked translation priming, this progressive increase in L2 word encounters is proposed to be reflected in the ease with which the L2 masked primes are activated and activate their corresponding semantic nodes. At higher levels of L2 proficiency, when the L2 primes are the non-cognate translation equivalents of the targets, the pre-activation of the shared meaning would facilitate the processing of the target, thus gradually assimilating the effects obtained with L1 primes and L2 targets.

From the perspective of the BIA models, cognates differ from non-cognates only in that they share more orthographic and/or phonological features, but do not have a different representational status (e.g., Dijkstra, Grainger, & Van Heuven, 1999; Voga & Grainger, 2007). According to this account, the cognate facilitation effect emerges because both orthographic and semantic overlapping representations become activated upon the presentation of one of the readings of the cognate, thus predicting larger cognate effects as a matter of increased orthographic or phonological overlap (e.g., Van Asche et al., 2009). Given that cognate processing depends on the extent of formal overlap and on the relative frequency with which bilinguals would have encountered them, the predictions regarding how L2 proficiency might influence cognate processing as well as how cognate masked translation priming effects should be manifested across the two translation directions are similar to those proposed for non-cognate translations. In further detail, following the same rationale as the one put forward to explain the non-cognate masked translation priming asymmetry, an asymmetric pattern of effects would be predicted with cognates, with larger L1-to-L2 effects, than vice versa.

Moreover, highly proficient bilinguals are proposed to show overall faster recognition times and an attenuation of the masked translation priming asymmetry as compared to less proficient ones. Finally, the overlap at the lexical level of representation between the two readings of the cognates would further speed up the word recognition process, thus leading to larger masked translation priming effects for cognates than for non-cognates.

Very recently, the developmental BIA-d model (Grainger, Midgley, & Holcomb, 2010), a new theoretical approach combining some of the critical functional principles of the RHM and the BIA models has been put forward. The BIA-d model was designed to account for the findings revealing changes in L2 lexico-semantic access and L1-L2 interactions throughout the L2 proficiency span. In its initial formulation, the BIA-d model has focused on the processing of non-cognate translations. At the early stages of L2 acquisition newly learnt L2 words are connected via excitatory connections to their L1 translation as well as to their corresponding meaning. These connections are strengthened with increased exposure via Hebbian learning mechanisms, based on the structure and premises of the RHM's developmental account. However, as the L2 proficiency increases and bilinguals reach "a magic moment" in L2 acquisition, L2 words become integrated into the L1 lexicon and their recognition proceeds in the frequency-dependent way proposed by the BIA models. The BIA-d posits that at this point, the strength of the connections between translation equivalents starts to decrease and the top-down inhibitory control of language activation becomes more effective, thus leading to a more autonomous L2 processing (see Figure 5). With regard to the masked translation priming effects, the BIA-d model proposes that they reflect ease of direct semantic access of the test items, hence explaining the asymmetries observed in unbalanced bilinguals in a way similar to that of the RHM. Accordingly, since throughout the proficiency continuum the excitatory connections of L2 words to their meaning become gradually stronger, thus more comparable to those of L1 words, the BIA-d would predict that as L2 proficiency increases, the masked translation priming asymmetry should be gradually attenuated.

Figure 5. Modulation of L1-L2 lexico-semantic links with increased exposure to L2 according to the BIA-d model.



Note: Continuous lines represent strong connections; dotted lines represent weaker connections; filled circles represent inhibitory connections; arrows represent excitatory connections.

Despite the fact that the BIA-d does not make explicit reference to the processing of cognate translations, it does not either propose that their processing should be qualitatively different to that of non-cognates. Hence, according to this version of the model one could a priori predict that the same pattern that holds for non-cognate masked translation priming effects across the L2 proficiency span also holds for cognate translations.

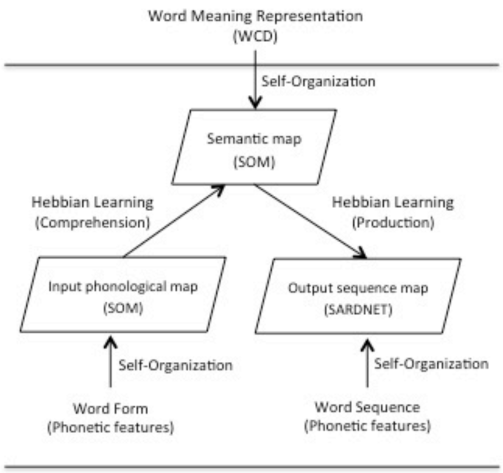
4.3. The DevLex II model

DevLex is a self-organizing neural network of bilingual processing based on co-occurrences (Hebbian learning) of phonological and semantic representations, which become co-activated via associative links (see also Hernandez, Li, & MacWhinney, 2005; Li & Farkaš, 2002). This model predicts the expansion of the L2 lexicon with extensive training (i.e., increased proficiency), but it proposes that it is the L2 AoA what mainly defines the functional properties of the L2 lexicon. In further detail, as opposed to the well-defined lexica of simultaneous or early L2 bilinguals, the L2 lexicon of late bilinguals would be poorly defined and "parasitically" related to L1 representations (Zhao & Li, 2010; see Figure 6). In fact, in the latest version of DevLex II, the authors presented the results of a series of simulations confirming this distinction across early (or simultaneous) and late L2 learning, by showing that the age of L2 acquisition significantly modified the distance in the semantic space between the translation pairs in the simulated L1 and L2 lexica (Zhao & Li, 2010). However, the model also suggests that after extensive L2 training, the L2 lexicon would be expanded and a finer tuning of the semantic system would be achieved.

Although DevLex II has not simulated masked translation priming effects or cognate vs. non-cognate processing, a number of inferences could be drawn from the model's basic working principles. First of all, the model would predict the appearance of cognate effects (overall performance on cognate vs. non-cognate targets), as well as larger masked translation priming effects for cognates over non-cognates, since translation equivalents with higher cross-linguistic similarity are more closely represented in the simulated lexica. Second, DevLex II would predict larger cognate benefits in the non-dominant language, since the simulations performed so far have shown that only L2 processing and not L1 processing, is susceptible to the effects caused by cross-language formal or semantic similarity (Zhao & Li, 2010).

With regard to the influence of L2 proficiency on the expected pattern of cognate and non-cognate masked translation priming effects, the model would predict comparable effects for all groups of unbalanced and late bilinguals and a different pattern only for early or simultaneous bilinguals. Taking into account that according to DevLex II the bilingual characteristic defining cross-linguistic interactions is the L2 age of acquisition and not the L2 proficiency, the model would predict comparable effects (cognate benefits as well as cognate and non-cognate masked translation priming effects) for all groups of unbalanced and late bilinguals and a different pattern only for early or simultaneous bilinguals. Furthermore, for late L2 learners the model would predict asymmetric masked translation priming effects across the two translation directions. In the backward translation priming direction, the nodes corresponding to the briefly presented L2 primes will not be activated strongly enough (namely, activation would be too diffuse) to cause the activation of their L1 translations, leading to less pronounced masked translation priming effects (Li & Farkaš, 2002). Nonetheless, it should be noted that the model does not make explicit predictions regarding masked translation priming effects.

Figure 6. The DevLex II model



CHAPTER 5

Research aims and overview of the experiments

The present dissertation aims to shed light on the way in which the lexico-semantic system of bilinguals operates by examining the patterns of automatic activation of translation equivalents in unbalanced bilinguals with different levels of L2 proficiency. The influence of this critical variable will be examined in order to identify whether L2 proficiency is involved in the fast and automatic cross-language lexico-semantic interactions, taking place when bilinguals perform mental translations. Through a series of nine masked translation priming lexical decision experiments the current research project is aimed at addressing the following central question: *Is the pattern of automatic cross-language lexico-semantic activation of translation equivalents dependent on the level of L2 proficiency of the bilinguals?*

5.1. Research aims

The question of how L2 proficiency influences masked translation priming effects could initially seem relatively narrow. However, this research question has a direct impact on two of the central lines of research in the bilingual literature: a) to which extent L1 and L2 processing can become comparable as bilinguals become more proficient in their L2 and b) how L1 and L2 word forms interact with each other and with their corresponding concepts. These questions have been motivated by two major findings reported so far by researchers studying bilingual word processing. First, evidence suggesting that less proficient bilinguals rely more on their L1 when processing their L2 as compared to more proficient ones, and that there are clear processing asymmetries when bilinguals of different levels of L2 proficiency are asked to perform semantic tasks in their dominant and non-dominant language. Second, the fact that bilinguals have been found to activate automatically both of their languages even when reading in just one of them and independently of whether it is the L1 or the L2. This relatively recent finding has opened a new line of research in bilingual reading since, in the last two decades, many researchers have dedicated their efforts in identifying the conditions under which words in one language can activate words in the other language and whether these effects of cross-language interaction are triggered by their formal (orthographic, phonological) or their semantic similarity, greatly delimiting models describing the organization of the bilingual lexico-semantic system.

Furthermore, the experimental outcomes of this research project have direct implications at the empirical level, since they aim at establishing a clear pattern of masked translation priming effects across the range of L2 proficiency of unbalanced bilinguals[4], and, in this sense, addressing the diverse contrasting findings reported

[4] When testing early balanced bilinguals, a symmetric pattern of masked translation priming effects has been already established both at the behavioural as well as the electrophysiological level (see Duñabeitia, Perea et al., 2010; Duñabeitia, Dimitropoulou, et al., 2010).

across the masked translation priming literature, with cognates and non-cognates (see Chapter 3).

In further detail, the nine experiments composing the empirical part of this dissertation (Part 2: The Experiments) have been divided into three blocks according to the central empirical questions they aim to address. Experiments 1-3 (Chapter 6) aim at establishing a clear pattern of non-cognate masked translation priming effects across the two translation directions with relatively low proficient and late bilinguals. The remaining six experiments (4-9) aim at examining the influence of the level of L2 competence of unbalanced bilinguals on masked translation priming effects, and are presented as two separate sets (large-scale studies). Each of these two large experimental blocks involved the testing of three different groups of unbalanced bilinguals with different degrees of L2 competence: relatively low, medium and relatively high. In the first of these two blocks (Experiments 4-6; Chapter 7) we aimed at testing whether the L2 proficiency of unbalanced bilinguals affects the pattern of non-cognate masked translation priming effects across the two translation directions. In the following three experiments (Experiments 7-9; Chapter 8), the same question regarding the influence of L2 proficiency on masked translation priming effects is addressed, but focusing on the pattern obtained with cognate translations. This way, we systematically examine whether the additional formal overlap across cognate translations further modulates the effects.

The experimental hypotheses tested in the present dissertation have straightforward theoretical implications, since they are directly related to the way in which L1 and L2 words are represented in the bilingual lexico-semantic system in reference to each other and to their corresponding semantic representations. The bilingual models previously reviewed suggest different ways in which the level of L2 proficiency of the bilinguals affects the pattern of automatic co-activation of translation equivalents. Though as seen for both cognate and non-cognate translations they all acknowledge the existence of a symmetric pattern of masked translation priming effects for balanced bilinguals and an overall asymmetric pattern for unbalanced bilinguals, only the RHM and the BIA (+, -d) models propose that the asymmetry should be attenuated as a matter of increased L2 proficiency. Still, the RHM would predict that for unbalanced bilinguals the asymmetry should be exhibited in the absence of an effect in the backward translation direction, while the BIA models would predict a gradually larger L2-to-L1 effect as the L2 proficiency increases. Finally, the DevLex II model would predict asymmetric effects, which would in principle be stable throughout the L2 proficiency continuum, as long as the bilinguals tested have acquired their L2 late in life.

5.2. Overview of the experiments

Chapter 6: *Non-cognate masked translation priming effects with low proficient bilinguals*

- Experiment 1 (a & b): Non-cognate masked translation priming with low proficient bilinguals
- Experiment 2 (a & b): Non-cognate masked translation priming with low proficient bilinguals following Duyck and Warlop's (2009) methodology
- Experiment 3: Monolingual control group

Chapter 7: *Does L2 proficiency modulate non-cognate masked translation priming effects?*

- Experiment 4 (a & b): Evidence from low proficient bilinguals
- Experiment 5 (a & b): Evidence from medium proficient bilinguals
- Experiment 6 (a & b): Evidence from high proficient bilinguals

Chapter 8: *Does L2 proficiency modulate cognate masked translation priming effects?*

- Experiment 7 (a & b): Evidence from low proficient bilinguals
- Experiment 8 (a & b): Evidence from medium proficient bilinguals
- Experiment 9 (a & b): Evidence from high proficient bilinguals

PART 2

The Experiments

CHAPTER 6

Non-cognate masked translation priming effects with low proficient bilinguals

6.1. Summary of the experiments

The three experiments presented in Chapter 6 are directed at establishing a clear pattern of non-cognate masked translation priming effects at the early stages of L2 acquisition by testing two groups of late and low proficient Greek-Spanish bilinguals. To this end, in *Experiment 1*, a group of late and *low* proficient Greek-Spanish bilinguals performed lexical decisions on Spanish (sub-experiment 1a) and on Greek targets (sub-experiment 1b) in order to establish the pattern of non-cognate masked translation priming effects (i.e., non-cognate translation vs. cross-language unrelated priming conditions) as well as the pattern of within language L1 and L2 repetition priming effects (i.e., within-language repetition vs. within-language unrelated priming conditions). In *Experiment 2*, a different group of Greek-Spanish bilinguals with the same characteristics as those who completed Experiment 1 (late and *low* proficient bilinguals) was tested across the two translation directions (Spanish targets: sub-experiment 2a and Greek targets: sub-experiment 2b). Participants were presented with the exact same experimental materials used in Experiment 1 but the sequence of masked priming events was modified to replicate the procedure followed by the only existing non-cognate masked translation priming study conducted with low proficient bilinguals (Duyck and Warlop, 2009), to allow for a more direct comparison of our findings to those reported by Duyck and Warlop. In *Experiment 3*, a Spanish monolingual group without any knowledge of Greek was presented with the materials used in sub-experiments 1a and 2a (Spanish targets) in order to identify a potential presence of lower level features across our materials (i.e., visual overlap).

6.2. Experiment 1 (a & b): Non-cognate masked translation priming with <u>low</u> proficient bilinguals

6.2.1. Experiment rationale and design

As described in the General Introduction, the importance of examining the pattern of non-cognate masked translation priming effects at low levels of L2 competence lies in the existing non-cognate masked translation priming literature. The initially reported masked translation priming asymmetry has been found to be eliminated only with early and balanced native-like bilinguals (Basnight-Brown & Altarriba, 2007; Duñabeitia, Perea, et al., 2010), in line with the predictions made by the most influential model of bilingual lexico-semantic organization. Considering this pattern of results, one would consequently expect an asymmetric pattern in groups of low proficient L2 learners. However, in the only study so far examining masked translation priming effects in a lexical decision task with low proficient bilinguals, Duyck and Warlop (2009) obtained a very different pattern of results. The authors tested a group of 24 Dutch-French bilinguals who started learning French after the age of 11 and reported on average a low proficiency level in that language (3.9 on a scale from 1 to 7, with higher values representing better linguistic competence). Interestingly, they found significant priming effects in both translation directions (48ms and 26ms in forward and backward translation, respectively) that were not statistically different to each other, despite their large numerical difference. The authors argued that these results provided evidence of a lack of a qualitative difference in the lexico-semantic architecture of the dominant and the non-dominant languages and of direct conceptual access of L2 words even at early stages of L2 acquisition (in line with Duyck & Brysbaert, 2004; 2008; see also Schoonbaert, Duyck, Brysbaert, & Hartsuiker, 2009). This pattern of effects obtained with late and low proficient bilinguals can be considered as unexpected first, due to the lack of an asymmetry across the two translation directions and second, due to the significant L2-to-L1 translation effect. Based on the magnitude difference of the effects (22ms) one could argue that they are clearly not symmetric. However, the apparent absence of an interaction between Target language and Prime language ($p>.11$) indicates that the expected asymmetry is not present. (Note, however, that this lack of asymmetry could have been caused by a lack of statistical power since only 24 participants completed the experiment). This discrepancy between most pieces of preceding evidence and the findings by Duyck and Warlop suggests that it would be prudent to take another look at this issue and to further examine how exactly a low level of L2 proficiency affects masked translation priming effects and whether inter-lingual lexico-semantic connections are active and functional at low levels of L2 proficiency, due to the importance for a better understanding of how interlingual lexico-semantic links are established in the process of L2 acquisition.

In order to address these issues, in the present experiment, a group of late and low proficient Greek (L1)-Spanish (L2) bilinguals was tested in a cross-script masked translation priming lexical decision task (see also Finkbeiner et al., 2004; Gollan et al., 1997; Jiang, 1999; Jiang & Forster, 2001; Kim & Davis, 2003; for further evidence of cross-script masked translation priming with high proficient bilinguals). The same group of bilinguals performed lexical decisions on Spanish (L2; Experiment 1a) and Greek (L1; Experiment 1b) target words preceded by their non-cognate translation equivalents (see also Voga & Grainger, 2007, for further evidence with the same Greek-Roman script combination). The use of the same experimental group in studying both translation directions is aimed at achieving an accurate measure of the magnitude of the observed effects while minimizing possible variability due to individual differences. Furthermore, several priming conditions were included in both experiments for control purposes. These consisted of two unrelated priming conditions with words in the two languages concerned (for which we expected null priming effects) and a within-language repetition condition. The latter condition was included in order to compare any possible translation priming effects against a condition which has been repeatedly shown to lead to robust masked priming effects (see Nievas, 2010, for a recent review). The comparison of each related condition (identity and translation) to its corresponding baseline aims at uncovering language-related and language-independent processes. Moreover, the inclusion of these control conditions allows for the creation of perfectly balanced experimental lists, with half of the primes belonging to one of the languages and the other half to the other. This way no processing advantage is provided to one of the languages of the participants (see Altarriba & Basnight-Brown, 2007). Note that, this 2x2 fully crossed experimental design has been previously applied in the study of masked translation priming effects with bilingual samples (Gollan et al., 1997; Midgley, et al., 2009; Perea et al., 2008).

With regard to the pattern of *masked identity priming effects*, significant effects are expected at first with L1 targets. This could be the case for L2 targets as well, if one considers that the identity priming effects are mostly motivated by the complete overlap between primes and targets at the sub-lexical level. If this is indeed so, then, no differences in the magnitude of the L1 and L2 masked identity priming effects are expected. Still, there is considerable evidence indicating the existence of a lexico-semantic component in masked identity priming effects (e.g., Midgley et al., 2009). In this case, and in line with what the BIA framework would predict, larger effects would be expected for L1 than for L2 targets.

The inclusion of equal amount of primes belonging to the target and non-target languages preceding the Spanish (L2) and the Greek (L1) targets offer a great opportunity to investigate the pattern of an effect widely neglected in the behavioural masked priming literature: the *masked priming code-switching effect*. Code-switching costs have been manifested mostly in word production but also in some recent ERP masked priming reading studies as costlier processing of pictures or words preceded by an item of the non-target language as compared to when they were preceded by items of the same language (e.g., Chauncey, Grainger, & Holcomb, 2008; 2011; Costa, Santesteban, & Ivanova, 2006, for review). Out of these studies, the ones testing unbalanced bilinguals have reported a dependence of the code-switching effects on the direction of the code-switch (larger cost from L2→L1, than vice versa), while those testing balanced bilinguals have reported symmetric effects (e.g., Costa et al., 2006; Duñabeitia, Dimitropoulou, et al., 2010). However, the only behavioural masked priming study examining code-switching costs reported symmetric effects with native-like balanced bilinguals (Perea et al., 2008).

Finally, due to the inconsistent pattern of *non-cognate masked translation priming effects* reported so far with low proficient bilinguals (Duyck & Warlop, 2009), straight-forward predictions on whether significant effects would emerge in both translation directions would emerge (forward and backward) and whether the non-cognate masked translation priming asymmetry would be obtained (larger forward than backward effect) cannot be made. Hence, the only significant masked translation priming effect expected with low proficient bilinguals would be the L1-to-L2 one.

6.2.2. Method

Participants

The same group of Greek-Spanish bilinguals completed Experiments 1a and

1b. Forty two native Greek speakers, students of Spanish in Athens, participated voluntarily in these experiments. All the participants had lived only in Greece and were either in the process or had recently acquired their college degree. They were late learners of Spanish and had an overall low level of proficiency in that language. In order to test their degree of exposure and level of proficiency in Spanish, they all completed a Greek version of the Language Experience and Proficiency Questionnaire (LEAP-Q; Marian, Blumenfeld & Kaushanskaya, 2007). According to their answers, they had all started learning Spanish as adults and had been receiving Spanish lessons for around 3 years. Their mean level of Spanish proficiency, as calculated by their self-ratings, was of 5.4 (±1.5) on a 0-to-10 scale (10 representing the highest level of proficiency; for further information regarding the level of proficiency of the participants and their degree of exposure to Spanish see Table 5). None of them were exposed to the Spanish language in any context (family, professional, etc.) other than the language school in which they were receiving classes at the moment of the testing. Finally, 28 out of 42 participants reported also having knowledge of English. All the participants were living in Greece at the moment of testing (L1 environment).

Table 5

Characteristics of the bilinguals who participated in Experiment 1 and their mean level of Spanish (L2) proficiency as calculated by their self-ratings. Standard deviations are provided within parentheses.

Age	25.0 (3.4)
Years of education	16.1 (0.9)
Age of 1st exposure	22.3 (3.4)
Years of exposure	2.8 (0.8)
Hours of exposure per week	5.0 (1.8)
Level of exposure (scale 0 to 10)*	4.5 (2.9)
Percentage of time of exposure	12 (8.2)
General level of proficiency (scale 0 to 10)**	5.4 (1.5)

*0= never, 10= always; **0= low proficiency, 10=high proficiency

Materials

For Experiment 1a we selected fifty-six Spanish words as targets, taken from the Spanish LEXESP database (Sebastián-Gallés, Martí, Carreiras & Cuetos, 2000). These words had a mean frequency of 96.75 occurrences per million (range: 7-391) and a mean number of 5.34 letters (range: 3-10; Davis & Perea, 2005). These targets were presented in uppercase and were preceded by lowercase primes that were: i) the same as the target (identity condition, e.g., *salud-SALUD*; [health]), ii) the Greek non-cognate unique translation of the target (e.g., *υγεία-SALUD*), iii) a Spanish unrelated word (e.g., *fuego* [fire]-*SALUD*) or, iv) a Greek unrelated word (e.g., *επαφή* [contact]-*SALUD*). The Greek primes in the translation condition were selected from the GreekLex database (Ktori, Van Heuven & Pitchford, 2008) and had a mean frequency of 47.5 appearances per million (range: 1-290) and a mean number of 6.23 letters (range: 4-11). Two external judges with an excellent competence in the two languages confirmed that the Greek words selected as translations for the Spanish words were in fact the unique (or most common) translations. The primes of the within-language unrelated condition were matched as closely as possible to the target words in both frequency and number of letters while the Greek primes in the between-language unrelated condition were matched to the Greek related primes (see Table 6). An additional set of fifty six orthographically legal nonwords in Spanish (e.g., *CÉDEMO*) was also created. None of the nonwords was an actual word in Greek, and they were preceded by either Greek or Spanish prime words, matched in length and frequency to the primes of the word trials.

Table 6

Examples and characteristics of the word materials used in Experiments 1-3[5].

	Priming condition				Targets	
	Spanish		Greek			
	Repetition	Unrelated	Repetition	Unrelated	Spanish	Greek
	salud (health)	fuego (fire)	υγεία (health)	επαφή (contact)	SALUD (health)	ΥΓΕΙΑ (health)
Frequency	96.8	96.9	47.5	47.4	96.8	47.5
Length	5.3	5.4	6.2	6.2	5.3	6.2

Note: Frequency: Frequency per million appearances; *Length*: Number of letters.

In Experiment 1b the fifty six target words used were the Greek translations of the Spanish targets used in Experiment 1a. These targets were preceded by primes in the same conditions as in Experiment 1a (see Table 6). In relation to the targets, primes were: i) the same as the target (identity condition, e.g., *υγεία-ΥΓΕΙΑ* [health]), ii) the Spanish non-cognate unique translation of the target (e.g., *salud* [health]-*ΥΓΕΙΑ*), iii) an unrelated word in Greek (e.g., *επαφή* [contact]-*ΥΓΕΙΑ* [health) or iv) an unrelated word in Spanish (e.g., *fuego* [fire]-*ΥΓΕΙΑ*). An additional set of fifty six orthographically legal nonwords in Greek (e.g., *ΖΕΛΛΗ*) was also created for the purposes of the lexical decision. None of the nonwords was an actual word in Spanish, and they were all preceded by the same set of Greek and Spanish primes as the nonwords in Experiment 1a. Four lists of materials were constructed for each sub-experiment (1a and 1b) so that each target appeared only once in each list, but each time in a different priming condition. Different participants were randomly assigned to each of the lists.

[5] The monolingual Spanish participants of Experiment 3 were only presented with the block of Spanish targets used in sub-experiments 1a and 2a.

Procedure

Participants completed the two sub-experiments (1a and 1b) in two experimental sessions, with at least a three-day gap between them. The order of the sessions was counterbalanced across participants. Both sessions were held individually in a quiet room. Stimuli presentation and recording of response times were controlled by a PC. The experiments were run using DMDX (Forster & Forster, 2003). Reaction times were measured from target onset until a response was given or for a maximum of 2500ms. In each trial, a forward mask consisting of a row of hash marks (#'s) was presented for 500ms. The length of the row of hash marks was defined on a trial-level basis, keeping it the same as the length of the longest string (prime or target). Next, the prime was presented in lowercase and stayed on the screen for 50ms (3 cycles; each cycle corresponding to 16.6ms on the CRT monitor). The prime was immediately followed by the presentation of the target stimulus in uppercase. Masks, primes and targets were presented in the center of the screen. The target remained on the screen until the participants responded, or for a maximum of 2500ms. Participants were instructed to press, as quickly and accurately as possible, one of two buttons on the keyboard to indicate whether the uppercase letter string was a legitimate word or not in the test language. They were not informed of the presence of lowercase items, and none of them reported (after the experiment) conscious knowledge of the existence of any prime. Trial presentation was randomized across participants. In each experimental session, each participant received a total of 12 practice trials (6 words and 6 nonwords) prior to the 112 experimental trials. In Experiment 1a the instructions (and the interactions with the participants) were given in Spanish and in Experiment 1b in Greek. Each experimental session lasted approximately 14 minutes.

Please note that, with the exception of Experiment 2 where the sequence and timing of masked priming effects was modified, throughout the experiments described in the present dissertation (Experiments 1 and 3-9), the timing and sequence of masked priming events as well as the rest of the experimental procedure was exactly the same as in Experiment 1 (see Figure 1 and for a schematic representation of the masked priming sequence followed).

Data analyses

Two of the participants were discarded after completing both sessions since they reported in the off-line language proficiency questionnaire having spent relatively long seasons in Spain in the recent past. Thus, analyses were performed on the data collected from the remaining 40. Mean latencies for correct responses and error rates are presented in Table 7. ANOVAs based on participant and item response latencies and error percentages were conducted based on a 2 (Relatedness: related, unrelated) x 2 (Prime language: Spanish, Greek) x 4 (List: list 1, 2, 3, 4) design. The factor List was included as a dummy variable (Pollatsek & Well, 1995).

6.2.3. Results and Discussion

1a: Spanish (L2) targets

ANOVAs on the reaction times revealed a main effect of Relatedness: target words preceded by their Spanish repetition or Greek translation were responded to faster (46ms) than words preceded by unrelated primes [$F1(1,36)=43.21$, $MSE=1929$, $p<.001$; $F2(1,52)=31.67$, $MSE=3597$, $p<.001$]. The main effect of Prime language was also significant, with targets preceded by a Spanish prime being responded to faster (29ms faster) than those preceded by a Greek prime [$F1(1,36)=19.62$, $MSE=1662$, $p<.001$; $F2(1,52)=14.15$, $MSE=3300$, $p<.001$]. The interaction between the two factors was significant [$F1(1,36)=5.93$, $MSE=1794$, $p<.05$; $F2(1,52)=8.19$, $MSE=2786$, $p<.01$], showing that the repetition and the translation priming effects significantly differed in magnitude from each other (62 and 29ms, respectively). Planned pairwise comparisons showed that both effects were significant [repetition: $F1(1,36)=39.51$, $MSE=1943$, $p<.001$; $F2(1,52)=37.49$, MSE=3183, p<.001; translation: F1(1,36)=9.67, MSE=1780, p<.01; F2(1,52)=5.43, MSE=3200, p<.05].

ANOVAs on the error data revealed a main effect of Prime language, with target words preceded by Greek primes (both related and unrelated) being more accurately recognized (2.4% less errors) than those preceded by related and unrelated Spanish primes [$F_1(1,36)=6.44$, MSE=36, p<.05; $F_2(1,52)=7.25$, MSE=45, p<.05. No other effects on the error rate analysis were significant, all ps>.11].

1b: Greek (L1) targets

ANOVAs on the reaction times revealed a main effect of Relatedness: Greek target words preceded by their Greek repetitions or by their Spanish translations were responded to faster (21ms faster) than those preceded by unrelated words [F1(1, 36)=9.62, MSE=1848, p<.01; F2(1, 52)=7.25, MSE=3075, p<.01]. The main effect of Prime language was also significant, with targets preceded by Greek primes being responded to 27ms faster than those preceded by Spanish primes [F1(1,36)=9.54, MSE=3009, p<.01; F2(1,52)=12.97, MSE=2686, p<.01]. Given the significant interaction between the two factors, pairwise comparisons were conducted [F1(1,36)=13.92, MSE=2010, p<.01; F2(1,52)=10.07, MSE=3938, p<.01]. When primes were identical repetitions of the targets, participants responded 47ms faster as compared to when primes were unrelated words [F1(1,36)=33.30, MSE=1357, p<.001; F2(1,52)=19.84, MSE=3061, p<.001]. On the contrary, when targets were preceded by their Spanish translations, there was no significant difference as compared to when they were preceded by Spanish unrelated words (a negligible -5ms difference; both ps>.58).

ANOVAs on the error data showed a significant effect of Relatedness, which was marginally significant in the analysis by items [F1(1,36)=4.35, MSE=11, p<.05; F2(1,52)=3.48, MSE=18, p>.07]. This effect indicated that participants responded more accurately (2.4% less errors) when targets were preceded by related primes (either in Greek or in Spanish) compared to when they were preceded by unrelated primes of both languages. The rest of the effects were not significant (all ps>.51).

Table 7
Mean lexical decision times (in ms, RT) and error rates (%E) for word targets in Experiments 1a and 1b. *Identity priming* was measured as the difference between the target repetition and the same language unrelated priming conditions, *Translation priming* was measured as the difference between the across languages repetition and across languages unrelated priming conditions, and *Switch cost* as the difference between the different language and the same language priming conditions.

	Spanish targets (L2)				Greek targets (L1)			
	Spanish primes		Greek primes		Greek primes		Spanish primes	
	Rep.	Unrel.	Rep.	Unrel.	Rep.	Unrel.	Rep.	Unrel.
RT	703	765	748	777	667	714	720	715
%E	6.1	8.0	3.9	5.4	1.1	2.3	1.3	2.1

	Priming effects			Priming effects		
	Identity	Translation	Switch cost	Identity	Translation	Switch cost
RT	62	29	29	47	-5	27
%E	1.9	1.5	2.4	1.2	0.8	0.0

Note: Rep.: Repetition; *Unrel.*: Unrelated.

The main finding of Experiment 1 (1a and 1b) was a clear asymmetric pattern of masked translation priming effects with late and low-proficient Greek-Spanish bilinguals. On the one hand, when primes were the Greek (L1) non-cognate translation of the Spanish (L2) targets (e.g., *υγεία-SALUD*; Experiment 1a), a 29ms significant facilitative effect emerged. On the other hand, when the language order was reversed (i.e., L2 primes –L1 targets, e.g., *salud-ΥΓΕΙΑ*; Experiment 1b), no translation priming was obtained. The null translation priming effect found in Experiment 1b cannot be attributed to a lack of effective processing of L2 primes, since there was a significant within-language repetition priming effect for L2 words, which did not differ in magnitude to that found in Experiment 1a for L1 words (62 and 47ms in Experiments 1a and 1b, respectively). It should be also noted that consistent code switching effects emerged in both language directions: higher processing costs in all the between-language conditions (related and unrelated) compared to the within language conditions (29 and 27ms in Experiments 1a and 1b, respectively; see Chauncey et al., 2008; von Studnitz & Green, 1997).

The pattern of results obtained by the separate analyses of Experiments 1a and 1b was further confirmed by a post hoc combined analysis considering Target language as a factor. This analysis corroborated the asymmetric pattern of the masked translation priming effects by showing a significant interaction of Target language and Relatedness in the between-language priming conditions [$F1(1,36)=4.79$, $MSE=2514$, $p<.05$; $F2(1,52)=3.98$, $MSE=3507$, $p=.05$]. Contrarily, the magnitude difference between the two within-language repetition priming effects (Spanish and Greek targets) was not significant (both $ps>.21$), ensuring that there was an efficient processing of both L1 and L2 primes. Thus, the persistence of the asymmetric masked translation priming effect with the present group of bilinguals, who only had limited and very recent exposure to L2, provides evidence for the existence of active and functional inter-lingual connections even at early stages of L2 acquisition (e.g. Duyck & Brysbaert, 2004; Schoonbaert et al., 2009). Furthermore, we also found an overall cost associated with the low level of knowledge in Spanish of our bilinguals: participants took more time (44ms) and made more errors (4.1%) when responding to Spanish targets (all $ps<.05$).

The pattern of effects obtained in Experiments 1a and 1b fully replicate previous evidence from bilinguals with a higher level of L2 linguistic competence and suggest that the inter-lingual connections are active and functional even when L2 has been recently acquired and when the proficiency level is remarkably low.

Crucially, our results are in clear contrast to those recently reported in the only study that has so far examined masked translation priming effects at low levels of L2 proficiency. In this study, Duyck and Warlop (2009) tested a group of low proficient Dutch-French bilinguals and found significant bi-directional masked translation priming effects (48ms in the forward and 26ms in the backward translation direction) that were not statistically significant from each other (i.e., the interaction between Target language and Prime type was not significant). Thus, the present results clearly contrast with those presented by Duyck and Warlop.

6.3. Experiment 2 (a & b): Non-cognate masked translation priming with low proficient bilinguals following Duyck and Warlop's (2009) methodology

6.3.1. Experiment rationale and design

In order to provide more conclusive evidence regarding the reasons leading to the observed discrepancy between the results of Experiment 1 and those obtained by Duyck and Warlop (2009) and to clearly identify the pattern of masked translation priming effects obtained at early stages of L2 acquisition, another cross-script masked translation priming lexical decision experiment was carried out. In Experiment 2 (a & b) we examined the potential influence of the somewhat unusual timing and sequence of masked priming events used by Duyck and Warlop, in their study testing low proficient bilinguals. The authors presented the forward mask only for 56ms while they interpolated a 56ms backward mask between the prime (presented for 56ms) and the target. Such a brief presentation of the forward mask is not usually found in the masked priming literature. Moreover, it could be argued that such a brief presentation of the forward mask could have enhanced prime visibility. With regard to the use of a 56 ms backward mask, one might argue that it could add processing time to the primes, facilitating their effective activation (see DelCul, Baillet & Dehaene, 2007, for a discussion on how different SOAs might affect prime processing). This way, participants could have had enough time to access L2 words, leading to similar masked translation priming effects in both translation conditions. Still, evidence so far has not been conclusive on whether including or not a backward mask modulates the pattern of masked translation priming effects obtained in the lexical decision task. Some studies using a backward mask have found significant L2-to-L1 masked translation priming effects (e.g., Basnight-Brown & Altarriba, 2007; Schoonbaert et al., 2009), while others have not found this effect (e.g., Finkbeiner et al., 2004; Jiang, 1999, Exp.4 and 5; Jiang & Forster, 2001).

In Experiment 2 (a & b) a different group of late and low proficient Greek-Spanish bilinguals was presented with the same set of materials used in Experiments 1a and 1b. However, following the procedure of Ducyk and Warlop, the forward mask was presented for only 50ms and an additional 50ms backward mask was interpolated between the prime and the target. If our results replicate those of Experiments 1a and 1b, that is, if a significant masked translation priming effect is obtained only with Greek (L1) primes and Spanish (L2) targets, this would suggest that the masked translation priming effect reported by Duyck and Warlop for low proficient bilinguals is independent of the additional processing time provided to the prime by the inclusion of a backward mask (see also Jiang, 1999). If, on the contrary, symmetrical and bi-directional masked translation priming effects in both translation directions are obtained, this would suggest that even at low levels of L2 proficiency when participants have more time to process the primes the otherwise elusive backward masked translation priming effect emerges.

6.3.2. Method

Participants

A different group of Greek-Spanish bilinguals, matched as closely as possible to the group who took part in Experiments 1a and 1b, completed Experiments 2a and 2b. Forty-four native Greek speakers with normal or corrected-to-normal vision participated voluntarily in these experiments. Participants reported having either completed college studies or being at the process of acquiring their college degree. Just as in Experiment 1, 35 participants (out of 44) also reported having some knowledge of English. All the participants were learning Spanish at the "Instituto Cervantes" of Athens and were living in Greece at the moment of testing (L1 environment). All the participants completed the same questionnaire as the participants of Experiment 1. According to their answers, they were all late learners of Spanish and had been learning the language for nearly 3 years in the same formal context. Furthermore, none of them was exposed to the Spanish language in any context (family, professional, etc.) other than the language school in which they were receiving classes. They had in overall a low level of proficiency in Spanish (mean: 5.3±1.5 on a 0-to-10 scale, with 10 representing the highest level of proficiency; see Table 8).

Table 8
Characteristics of the bilinguals who participated in Experiment 2 and their mean level of Spanish (L2) proficiency as calculated by their self-ratings. Standard deviations are provided within parentheses.

Age	26.1 (5.0)
Years of education	15.2 (1.7)
Age of first exposure	23.2 (5.1)
Years of exposure	2.8 (1.0)
Hours of exposure per week	5.5 (2.0)
Level of exposure (scale 0 to 10)*	3.8 (1.7)
Percentage of time of exposure	10.4 (6.8)
General level of proficiency (scale 0 to 10)**	5.3 (1.5)

*0= never, 10= always; **0= low proficiency, 10=high proficiency

Materials

The materials used in sub-experiments 2a and 2b were the same as in sub-experiments 1a and 1b, respectively (see Table 6).

Procedure

The sequence and the timing of events were the same as the one followed by Duyck and Warlop (2009). In further detail, each trial started with the presentation of a forward mask consisting of a row of hash marks (#'s) for 50ms (3 cycles; each cycle corresponding to 16.6ms on the CRT monitor). Next, the prime was presented in lowercase for 50ms. The prime was followed by the presentation of a backward mask consisting of a row of hash marks (#'s), which stayed on the screen for another 50ms. Finally, the target stimulus appeared in uppercase for a maximum of 2500ms or until a response was given. The rest of the procedure followed was exactly the same as in Experiments 1a-1b.

Data analyses

Since the design was exactly the same as in the previous experiments, the same analyses were performed.

6.3.3. Results and Discussion

Mean latencies for correct responses and error rates are presented in Table 9.

2a: Spanish (L2) targets

ANOVAs on the reaction times revealed a significant main effect of Relatedness, with Spanish targets preceded by their repetitions or translations being responded to 49ms faster than when they were preceded by unrelated primes [$F1(1,40)=41.28$, $MSE=2524$, $p<.001$; $F2(1,52)=34.28$, $MSE=3204$, $p<.001$].

Furthermore, the main effect of Prime language was also significant: participants responded faster (33ms faster) to targets preceded by Spanish primes as compared to targets preceded by Greek primes [$F1(1,40)=18.50$, $MSE=2627$, $p<.001$; $F2(1,52)=4.60$, $MSE=11426$, $p<.05$]. Finally, there was a significant interaction between Relatedness and Prime language, indicating that the identity priming effect significantly differed from the translation priming effect [$F1(1,40)=8.99$, $MSE=1459$, $p<.01$; $F2(1,52)=4.39$, $MSE=3018$, $p<.05$]. In further detail, participants responded 66ms faster to targets when primes were their exact repetition as compared to when primes were Spanish unrelated words [$F1(1,40)=22.35$, $MSE=3013$, $p<.001$; $F2(1,52)=36.32$, $MSE=2745$, $p<.001$]. Moreover, participants responded 31ms faster when primes were the non-cognate Greek translation of the targets, as compared to when primes were Greek words that were unrelated to the targets [$F1(1,40)=22.35$, $MSE=970$, $p<.001$; $F2(1,52)=6.73$, $MSE=3477$, $p<.05$].

ANOVAs on the error rates showed a main effect of Relatedness which only approached significance in the analysis by items, showing that participants responded more accurately (1.8% less errors) to targets preceded by related primes (either in Spanish or in Greek) compared to unrelated Spanish or Greek primes [$F1(1,40)=2.19$, $MSE=58$, $p>.14$; $F2(1,52)=3.75$, $MSE=43$, $p>.05$]. No other effects were significant (all $ps>.40$).

2b: Greek (L1) targets

ANOVAs on the reaction times revealed a main effect of Relatedness: targets preceded by related primes (i.e., identical primes and translation equivalents) were responded to faster (19ms faster) than targets preceded by unrelated primes in both languages, [$F1(1,40)=11.06$, $MSE=1807$, $p<.01$; $F2(1,52)=9.50$, $MSE=2794$, $p<.01$]. Furthermore, there was a main effect of Prime language, which was significant only in the analysis by participants: targets preceded by Greek primes were responded to faster (16ms faster) than targets preceded by Spanish primes [F1(1,40)=7.45, MSE=1447, p<.01; F2(1,52)=1.29, MSE=3709, p>.26]. Importantly, the interaction between Relatedness and Prime language was significant [F1(1,40)=23.51, MSE=1331, p<.001; F2(1,52)=22.83, MSE=2578, p<.001]. Participants responded 48ms faster to targets preceded by their exact repetitions in Greek as compared to when they were preceded by unrelated Greek primes [F1(1,40)=49.13, MSE=1031, p<.001; F2(1,52)=26.68, MSE=2770, p<.001]. Contrarily, responses to targets preceded by their Spanish non-cognate translation did not differ from their responses to targets preceded by unrelated Spanish words (i.e., a non-significant 6ms difference, both ps>.27).

ANOVAs on the error rates showed a significant main effect of Prime language: participants responded more accurately (1.3% less errors) to targets preceded by Greek primes as compared to targets preceded by Spanish primes, [F1(1,40)=6.74, MSE=11, p<.05; F2(1,52)=5.88, MSE=16, p<.05]. The rest of the effects were not significant (all ps>.55).

Table 9

Mean lexical decision times (in ms, RT) and error rates (%E) for word targets in Experiments 2a and 2b and net *Identity priming, Translation priming* and *Switch cost* effects.

	Spanish targets (L2)				Greek targets (L1)			
	Spanish primes		Greek primes		Greek primes		Spanish primes	
	Rep.	Unrel.	Rep.	Unrel.	Rep.	Unrel.	Rep.	Unrel.
RT	736	802	787	818	665	713	708	702
%E	9.7	11.0	8.4	10.6	1.3	1.8	2.9	2.8

	Priming effects			Priming effects		
	Identity	Translation	Switch cost	Identity	Translation	Switch cost
RT	66	31	33	48	-6	16
%E	1.3	2.2	0.9	0.5	-0.1	1.3

Note: Rep.: Repetition; *Unrel.*: Unrelated.

The results obtained in Experiment 2 (a & b) fully replicated those of Experiment 1 (a & b). A non-cognate masked translation priming effect was found only in the forward translation direction (L1 primes and L2 targets), while no effect was observed in the backward translation direction (L2 primes and L1 targets). Moreover, just as in sub-experiments 1a and 1b, significant and equivalent bi-directional masked identity priming effects were obtained. This pattern of effects was further corroborated by a combined analysis of sub-experiments 2a and 2b, in which Target language was included as a factor. In further detail, Target language significantly interacted with Relatedness in the between-language priming conditions [both $F1(1,40)=11.38$, $MSE=1307$, $p<.01$; $F2(1,52)=6.30$, $MSE=3477$, $p<.05$], confirming the asymmetric pattern of masked translation priming effects obtained across the two translation directions. In contrast, Target language did not interact with Relatedness in the within-language priming conditions (both $ps>.16$), showing that the two repetition priming effects did not differ from each other.

The results of sub-experiments 2a and 2b disregard the influence of the specific masked priming procedure followed by Duyck and Warlop (2009) as being responsible for the bi-directional masked translation priming effects they obtained. The fact that we once more found a clearly asymmetric pattern of translation effects with a significant effect only in the L1-to-L2 translation direction, even when presenting the forward mask for 50ms and adding a backward mask suggests that the reason for the discrepancy between the two studies so far examining masked translation priming effects at low levels of L2 competence is not the additional processing time provided to the primes by the backward mask or the enhanced prime visibility due to the shortening of the exposure duration of the forward mask.

6.4. Experiment 3: Non-cognate masked translation priming – Monolingual control group

6.4.1. Experiment rationale and design

An additional Spanish monolingual group was tested with exactly the same materials as in Experiments 1a and 2a (Spanish targets). With this control experiment we expected to identify any potential influence of lower level features across our materials (e.g., visual overlap), or any other uncontrolled factor that could have led to the facilitation effects in the between-language related condition from Experiment 1a (i.e., the masked translation priming effect). The only possible effect to be expected would be the within-language repetition priming (e.g., *salud-SALUD*), considering the null knowledge of Greek of this test sample. Furthermore, a cost related to the change of script was also expected for those targets preceded by Greek primes, since this group had no previous exposure to the Greek script. Such an effect would be somewhat analogous to the code switching effects obtained with our bilingual group.

6.4.2. Method

Participants

Thirty two undergraduates from the University of La Laguna (Spain) completed this experiment for course credit. All participants were native Spanish monolinguals and had no previous exposure to Greek.

Materials

The same set of materials as in Experiments 1a and 2a was used.

Procedure

The procedure followed was the exact same as in Experiment 1a.

Data analyses

Since the design was exactly the same as in the previous experiment, the same analyses were performed.

6.4.3. Results and Discussion

Incorrect responses (3% of the data) and reaction times less than 250ms or greater than 1500ms (0.2% of the data) were excluded from the latency analyses. Mean latencies for correct responses and error rates are presented in Table 10.

ANOVAs on the reaction times revealed a main effect of Relatedness: target words preceded by their repetition (either in Spanish or Greek) were responded to faster (23ms faster) than those preceded by an unrelated word [$F1(1,28)=10.11$, $MSE=1710$, $p<.01$; $F2(1,52)=11.10$, $MSE=2894$, $p<.01$]. Besides, a main effect of Prime language was also significant, with targets preceded by Spanish primes being responded to faster (35ms faster) than those preceded by Greek primes [$F1(1,28)=37.73$, $MSE=1064$, $p<.001$; $F2(1,52)=25.96$, $MSE=2521$, $p<.001$]. Importantly, the interaction between the two factors was significant [$F1(1,28)=14.15$, $MSE=722$, $p<.001$; $F2(1,52)=7.05$, $MSE=3192$, $p<.05$]. When primes were identical repetitions of the targets (within-language repetitions) participants responded 42ms faster as compared to when primes were unrelated Spanish words [$F1(1,28)=28.38$, $MSE=953$, $p<.001$; $F2(1,52)=13.48$, $MSE=4020$, $p<.01$]. On the contrary, when targets were preceded by their Greek translations there was no significant difference as compared to when they were preceded by Greek unrelated words (a non-significant 6ms difference, both $ps>.55$).

ANOVAs on the error data did not reveal any significant effects (all ps>.14).

Table 10
Mean lexical decision times (in ms, RT) and error rates (%E) for word targets in Experiment 3 as well as net Identity priming, Translation priming Switch cost effects.

	Priming conditions				Priming effects		
	Spanish primes		Greek primes				
	Rep.	Unrel.	Rep.	Unrel.	Identity	Translation	Switch cost
RT	591	633	644	650	42	6	35
%E	1.1	2.7	2.9	2.9	1.6	0.0	1.0

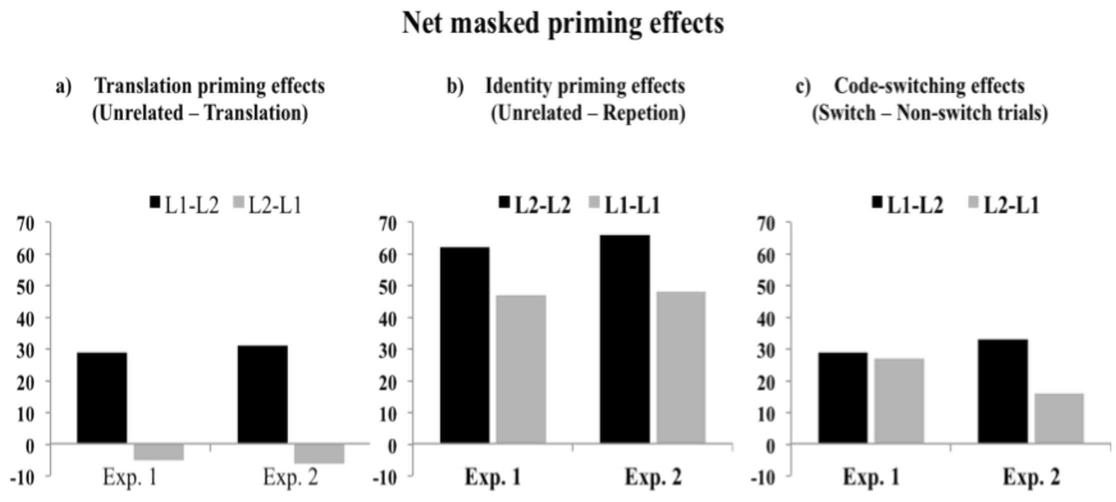
Note: *Rep.*: Repetition; *Unrel.*: Unrelated.

As expected, the only significant effects obtained with the Spanish monolingual group were the within-language repetition priming effect (i.e., Spanish words preceded by identical primes), as well as a significant cost associated to the language and script switch, for those Spanish target words preceded by (related or unrelated) Greek masked primes. The findings of this monolingual control experiment confirmed that the forward masked translation priming effects of Experiments 1a and 2a were not the result of potentially uncontrolled variables or of any specific properties of the test materials used.

6.5. Experiments 1-3: Discussion of the findings

The main findings of Experiments 1-3, was a clear-cut asymmetric pattern of non-cognate masked translation priming effects found with two different groups of late and low-proficient Greek-Spanish bilinguals. In Experiment 1, participants responded faster to Spanish (L2) target words when they were briefly preceded by their Greek (L1) translation equivalents (Experiment 1a), as compared to when primes were unrelated Greek words (namely, a significant forward non-cognate masked translation priming effect). However, participants responded equally fast and accurately to Greek (L1) targets preceded by their Spanish (L2) translations or by unrelated Spanish words (Experiment 1b; namely, a null backward masked translation priming effect). Crucially, the exact same asymmetric pattern of translation effects was also obtained with another group of low proficient Greek-Spanish bilinguals presented with the same set of materials but with a different sequence and timing of events (Experiment 2). In further detail, when the forward mask was presented for 50ms and an additional 50ms backward mask was included, a facilitative masked translation priming effect was obtained only when Spanish (L2) targets were preceded by their Greek (L1) translations as compared to when they were preceded by unrelated Greek words (Experiment 2a). On the contrary, there was not any significant benefit when Greek (L1) targets were preceded by their Spanish (L2) translations as compared to when they were preceded by unrelated Spanish words (Experiment 2b). In contrast to the translation effects, the omnipresent significant within-language masked repetition priming effects obtained in both Experiments 1 and 2 with Greek and Spanish targets were always symmetric. A similar symmetric pattern was also found for the code switching costs, obtained when participants responded to targets preceded by primes of the opposite language (translation and unrelated) as compared to when responding to same-language prime-target pairs (see Figure 7, for a summary of the critical effects obtained in Experiments 1 and 2). The control experiment held with Spanish monolingual participants who did not have any previous experience with the Greek script (Experiment 3) confirmed that the Greek-to-Spanish masked translation priming effects obtained with the bilingual participants were not due to uncontrolled factors, since the only significant priming effects obtained with these monolinguals were the within-language identity priming effect and the code-switching cost.

Figure 7. Summary of the net masked priming effects (in ms) obtained in Experiments 1 and 2: a) masked translation priming effects b) masked identity priming effects and c) code-switching effects.



6.5.1. Masked identity priming effects

The more consistent and robust effects obtained in the Experiments reported so far were the masked identity priming effects. These effects were in all cases larger than the non-cognate masked translation priming effects and comparable in magnitude for L1 and L2. The inclusion of this full-priming control condition was considered to be crucial, since it could determine whether the expected absence of a non-cognate masked translation priming effect with L2 primes and L1 targets could result from the ineffective processing of L2 masked primes by low proficient bilinguals as the ones tested in Experiments 1 and 2. As shown by the significant L2 masked identity priming effects, this was not the case. The activation of the sub-lexical levels of representation proposed by the BIA/BIA+ models (e.g., Dijkstra & Van Heuven, 2002) could account for the significant L2-to-L2 repetition priming obtained (Experiments 1a and 2a), if one assumes that these effects are mainly sub-lexical in nature. In the within-language repetition condition primes and targets are semantically and visually identical to each other. Given the interactive nature of the BIA/BIA+ models, in this condition, upon prime presentation the representations corresponding to the target would be activated throughout the sub-lexical, lexical and semantic levels via feed forward connections and would in turn send activation to the lower levels via feedback connections, thus boosting the masked priming effects obtained in the L2-L2 repetition condition. However, following the same line of reasoning, the BIA framework would predict larger repetition priming effects for L1 items compared to L2 items and especially for low-proficient bilinguals, contrary to what we found (see also Gollan et al., 1997). According to the operation principles of the BIA models, such an asymmetry across the two repetition priming effects (L1 and L2) would result from the fact that feedback sent from the lexical to the sub-lexical levels would be stronger for L1 words than for L2 words, since the L1 lexical representations get more rapidly activated.

6.5.2. Masked code-switching costs

Throughout this set of experiments, significant code-switching costs emerged in both prime-target language directions. Critically though, these masked priming code-switching effects have not received reliable empirical support since only a handful of masked priming studies have combined within and across-language priming conditions and even less have included prime language as a factor in the analyses reported (Perea et al., 2008). The reliable switching costs obtained throughout the present series of experiments reveal that language membership is computed in a fast and automatic manner independently from whether the code change has been consciously perceived. This is also confirmed by previous ERP masked priming studies showing that the processing of this information starts as early as 200ms after target onset (e.g., Chauncey et al., 2008; Midgley et al., 2009). These findings provide support to the BIA's and BIA-d's postulation that switch-cost effects emerge early in the visual word recognition process and could thus be reflecting inhibition of the lexical representations of the non-target language (e.g., Chauncey et al., 2008; Lam & Dijkstra, 2010; Van Heuven et al., 1998), rather than resulting from the operation of a post-lexical language control mechanism as the Inhibitory Control model and partly the BIA+ models propose (e.g., Abutalebi &

Green, 2007). For bi-scriptal unbalanced bilinguals the influence of script alternation between prime and target could be overwriting any processing asymmetries between the dominant and the non-native language since the script-related information is processed very early in the visual word recognition process (see Hoshino et al., 2010, for cross-script masked translation priming ERP effects). This potential influence of the prime-target script alternation in the symmetric pattern of the code-switching costs could be further supported by the fact that the code-switching cost also obtained with the monolingual Spanish participants of Experiment 3, was of comparable magnitude as those obtained with the two bilingual groups (35ms). Due to their monolingual status, the processing cost found in the cross-language priming conditions should not be thought to reflect the functioning of a post-lexical language control mechanism, since for this control group the Greek primes could not have a lexical representation (i.e., they could have been processed as nonsense symbol strings). Rather, the code-switching cost could have only resulted from the change in the visual features between primes and targets, inherent to the change of script.

6.5.3. Non-cognate masked translation priming effects

Regarding the asymmetric pattern of non-cognate masked translation priming effects, obtained with the two low proficient bilingual groups (Experiments 1 and 2), results are totally consistent with previous masked translation priming lexical decision studies examining either both or one translation directions in relatively high proficient bilinguals (e.g., Gollan et al., 1997; Jiang & Forster, 2001; Voga & Grainger, 2007). Moreover, some of the most influential models of bilingual lexico-semantic organization predicted that the asymmetric pattern of the masked translation priming would persist in non-fluent low proficient bilinguals. More precisely, the presence of a forward translation priming effects obtained in the absence of a backward effect with both groups of Greek-Spanish bilinguals could provide support to the hypothesis proposed by the RHM and the BIA-d models that, at low levels of L2 proficiency, L2 words cannot activate the corresponding conceptual node and hence provide a processing advantage to their L1 translations (e.g., Grainger et al., 2010; Kroll et al., 2002; Talamas et al., 1999). Nevertheless, our data is not conclusive on whether translating in the L2 to L1 direction is only based on word association, as the RHM proposes (e.g. Kroll & Stewart, 1994; Sholl, Sankaranarayanan, & Kroll, 1995). The null effects we obtained for L2 primes and L1 targets could initially support this hypothesis, if it is assumed that the lack of a priming effect in the lexical decision task provides evidence of the existence of weak direct connections of L2 words to their meanings. However, such a conclusion would be rather inconsistent with the fact that facilitative backward masked translation priming effects have been repeatedly obtained in the episodic recognition and the semantic categorization tasks (e.g., Grainger & Frenck-Mestre, 1998; Finkbeiner et al., 2004; Jiang & Forster, 2001; Wang & Forster, 2010). Furthermore, a number of studies have shown that L2 words access concepts directly and effectively and that these lexico-semantic links are developed early in the L2 acquisition process (e.g. Altarriba & Mathis, 1997; de Groot & Poot, 1997; La Heij, Hooglander, Kerling, & Van der Velden, 1996; Schoonbaert et al., 2009). Crucially, in a recent masked translation priming ERP study Midgley and colleagues (2009) found that the within-language repetition priming effect for L2 words involved lexico-semantic processing, since it resulted in a modulation of the N400 ERP component (i.e., more negative-going waves for unrelated L2 primes compared to related L2 primes), which is typically though to reflect lexico-semantic processing (see Kutas & Hillyard, 1980). Consequently, the significant within-language repetition priming effects for L2 words that we found with both groups of bilinguals (e.g. *salud-SALUD;* Experiments 1a and 2a) could be considered as evidence supporting the hypothesis of efficient semantic processing of L2 masked primes at low levels of L2 proficiency. Nonetheless, it should be noted that this line of reasoning is based on the assumption that repetition priming effects stem mainly from higher order lexico-semantic processing and not from lower level formal overlap between primes and targets, even though the evidence in this regard is not yet conclusive (see also Alvarez, Holcomb & Grainger, 2003; Jiang, 1999).

As stated in the General Introduction, the persistence of the asymmetric masked translation priming effects we obtained was also predicted by some of the computationally implemented models of bilingual memory organization. For instance, the DevLex II model (e.g., Zhiao & Li, 2006; Hernandez et al., 2005) proposes that during the early stages of L2 acquisition the associative links between L1 and L2 words are incomplete and that only L1 words are semantically defined. Although the authors of the model do not make explicit predictions regarding masked translation priming effects, this difference in the organization of L1 and L2 nodes could suggest that only L1 masked primes can effectively activate their associated meaning and consequently their corresponding L2 translation equivalents. However, as said the DevLex II simulations run with translation equivalents were not based on the masked priming methodology, thus precluding any conclusions regarding the validity of these predictions.

The BIA and BIA+ models also offer a good account of our results. Importantly, the BIA and BIA+ models are the only computational models of bilingual memory organization that have so far successfully simulated masked priming effects across different levels of L2 proficiency (e.g., Dijkstra & Van Heuven, 1998; 2002). Furthermore, the difference between the overall level of activation of L1 and L2 words they propose can perfectly explain the mono-directional masked translation priming effect we obtained. Likewise, considering the cross-script nature of our study, and therefore that the sub-lexical representations of the words do not overlap, we believe that the additional sub-lexical feature and letter levels incorporated within the BIA/BIA+ models are required in order to account for our results. In further detail, the models propose that the larger the overlap at the feature and letter level between the words in L1 and L2 is, the better the L2 orthographic representations will be established. In the case of the present study, the orthographic representations of Spanish (L2) words will be less well established, since they will not receive any activation from the sub-lexical levels each time Greek (L1) words are encountered. Moreover, at initial stages of L2 acquisition, L2 words would have been encountered only a very limited number of times, making their orthographic representations even more unstable and their activation costlier. This idea could also account for the overall processing cost for L2 words we obtained.

To sum up, the unidirectional (L1-to-L2) masked translation priming effects found in two groups of late and low proficient bilinguals are in agreement with most pieces of preceding evidence as well as with the predictions of most models of bilingual lexico-semantic organization. Nevertheless, these results are in clear contrast to the findings reported by Duyck and Warlop (2009), who found a significant backward masked translation priming effect with low proficient Dutch-French bilinguals and did not replicate the typical asymmetric pattern observed between the L1-to-L2 and L2-to-L1 translation priming effects. Experiment 2 (a & b) tested whether similar bi-directional masked translation priming effects would emerge with a group of low proficient Greek-Spanish bilinguals presented with the Greek-Spanish materials used in Experiment 1 mimicking the procedure followed by Duyck and Warlop. In contrast to their findings and in line with the results of Experiment 1, we obtained a significant masked translation priming effect in the L1-to-L2 direction while a null effect was found in the L2-to-L1 direction. The fact that the addition of a backward mask and the shortening of the exposure duration of the forward mask did not modulate our findings is in line with a number of previous studies showing that additional prime processing time is not sufficient to eliminate the masked translation priming asymmetry (e.g., Finkbeiner et al., 2004; Jiang, 1999; Jiang & Forster, 2001).

Having shown that these differences in the sequence and the timing of masked priming effects are not responsible for the different pattern of results obtained in the Duyck and Warlop study (2009) and the present study, there still remain other potential reasons that should be considered. First, it should be noted that although the authors did not obtain a significant Target Language by Prime Type significant interaction, the 22 ms difference in the magnitude of the two masked translation priming effects (L1→L2 and L2→L1) cannot allow completely denying the existence of a difference. This, in combination with the relative lack of statistical power due to the reduced number of participants (24), and the fact that a large number of experimental conditions (8 conditions) were included in the initial design[6], suggests that the effects may have not been symmetric and that a plausible lack of statistical power in the experiment could have led to the obtained results. Furthermore, a clear difference between the two studies that could have influenced the pattern of the effects is the number of intervening scripts: Duyck and Warlop used intra-script manipulations (i.e., Roman script) while the present study involved a cross-script manipulation (i.e., Greek and Roman scripts). A potential role of the script manipulation on masked translation priming effects could be predicted by models assuming the existence of sub-lexical levels of representations, such as the BIA/BIA+ models (e.g., Dijkstra & Van Heuven, 2002). Within these frameworks, it is assumed that for within-script manipulations, every time a word in a given language is presented, activation from the sub-lexical levels would also spread to words in the other language, due to the shared orthographic code. Consequently, the L2 orthographic representations as well as the inter-lingual links between L1 and L2 lexical representations of mono-scriptal bilinguals would be better established, since they would receive activation whenever an L1 word is encountered, via bottom-up and top-down excitatory connections between the letter level and the word level. On the contrary, under cross-script conditions, the L2 orthographic representations would be less stable and would benefit to a lesser extent from the presentation of L1 items due to their mismatching sub-lexical segments. Dijkstra and Van Heuven stated that for biscriptal bilinguals no effects of cross-language orthographic interactions are expected. To illustrate this point, the authors used as an example the Chinese-Latin script combination and suggested that in this case there should be two separate sub-lexical orthographic stores, which will get activated in a language-specific way (Dijkstra & Van Heuven, 2002, p.183). Following this line of reasoning, a backward masked translation priming effect such as the one reported by Duyck and Warlop, could be obtained more easily in an

[6] Duyck and Warlop (2009) initially included a prime size manipulation, to explore masked translation priming effects obtained with primes of different font sizes.

intra-script manipulation as compared to cross-script manipulations (but see Forster & Jiang, 2001; Gollan et al., 1997, for proposals of a beneficial role of script change in masked translation priming).

It is noteworthy that significant backward masked translation priming effects have been so far reported exclusively in studies testing mono-scriptal bilinguals (Basnight-Brown & Altarriba, 2007; Duñabeitia, Perea, et al., 2010; Duyck & Warlop, 2009; Schoonbaert et al., 2009; Schoonbaert et al., 2011). However, it should be also noted that there are also studies that have explored mono-scriptal bilinguals and have not obtained that effect (e.g., Davis et al., 2010; Grainger & Frenck-Mestre, 1998; Sánchez-Casas et al., 1992). On the contrary, with the exception of the first out of five experiments reported by Jiang (1999) with Chinese-English bilinguals, cross-script lexical decision studies have not obtained significant L2-to-L1 masked translation priming effects (e.g., Finkbeiner et al., 2004; Gollan et al., 1997; Jiang, 1999; Jiang & Forster, 2001). Still, when bi-scriptal bilinguals are asked to perform either a semantic categorization or an episodic recognition task, the otherwise elusive L2-to-L1 effect is found (e.g., Finkbeiner et al., 2004; Jiang & Forster, 2001; Wang & Forster, 2010). In summary, it seems feasible to assume that script variation could be a critical factor that determines the appearance of the backward masked translation priming effect in the lexical decision task. Nevertheless, any conclusion drawn at this regard should be taken with caution, since the influence of the script has not been yet examined in isolation from other confounds (e.g., L2 proficiency level or age of L2 acquisition, L2 AoA hereafter).

CHAPTER 7

Does L2 proficiency modulate non-cognate masked translation priming effects?

7.1. Summary of the experiments

The present set of experiments (Experiments 4-6) examined whether the non-cognate masked translation asymmetry repeatedly obtained in the lexical decision task with unbalanced bilinguals, is dependent on the level of L2 proficiency by testing three groups of Greek-English late and unbalanced bilinguals of different levels of English proficiency. The exclusive focus on unbalanced bilingualism was motivated by the straightforward symmetric pattern of effects already reported with balanced native-like bilinguals (Duñabeitia, Perea et al., 2010; Duñabeitia, Dimitropoulou et al., 2010). Furthermore, unbalanced bilingualism represents the larger part of the worldwide bilingual community. Due to the interest in performing cross-experiment comparisons across this set of experiments (4-6) to establish the pattern of non-cognate masked translation priming effects across the L2 proficiency continuum, a major effort was placed in the participant selection process. Following both subjective and objective criteria of L2 proficiency, 108 Greek native speakers, who were in different moments of acquiring English as their second language at the British Council in Athens (Greece) were selected and assigned to one of three groups tested (36 participants per group): i) low proficient bilinguals (*Experiment 4*), ii) medium proficient bilinguals (*Experiment 5*), and iii) high proficient bilinguals (*Experiment 6*). They were all presented with the same materials and asked to perform lexical decisions on both English (L2) targets (sub-experiments 4a, 5a and 6a) and Greek (L1) targets (sub-experiments 4b, 5b, and 6b). The thorough participant selection as well as the use of the same language combination, of the same experimental materials and procedure across the three experiments, allowed for a direct comparison of the way in which the level of L2 proficiency of unbalanced bilinguals affects the pattern of non-cognate masked translation priming effects.

7.2. Experiment rationale and design

In order to empirically address the issue of whether L2 proficiency modulates non-cognate masked translation priming effects, we conducted three lexical decision experiments, carefully designed to overcome the limitations previously enumerated. Throughout this series of experiments all the variables proposed to influence non-cognate masked translation priming effects were kept constant and we exclusively manipulated the level of L2 proficiency of the participants. In further detail, after a thorough selection process (see Participant selection subsection) 108 Greek-English unbalanced bilinguals were assigned to one of three proficiency groups: a relatively low, a medium and a relatively high proficiency group. Our biggest effort was placed in establishing a clear L2 proficiency distinction across the three groups, based on both subjective and objective measures, and in ensuring that the L2 history of the three groups was otherwise identical. To examine the pattern of masked translation priming effects emerging across both translation directions as well as the relationship between them (i.e., asymmetry) while eliminating any between-subject variability, each group of bilinguals was tested twice using the exact same large sets of English and Greek materials in two separate experimental sessions. The critical translation pairs used to test both translation directions were frequent one-to-one non-cognate Greek-English translations (e.g., *ribbon* and its Greek translation *κορδέλα*), thus ensuring that even the low proficient bilinguals would be familiar with the English items. Finally, to further refine the experimental design, for each target language we added a within-language repetition priming condition along with its corresponding within-language control (i.e., identity priming effect, e.g., *ribbon-RIBBON* vs. *desire-RIBBON*; e.g., Forster & Davis, 1984; Perea & Rosa, 2000). The use of a within-language full priming condition against which cross-language effects can be compared provides valuable insights into the representational relationship of L1 and L2 words (see Altarriba & Basnight-Brown, 2007). This is more so when testing low proficient bilinguals, since obtaining significant L2 identity priming effects certifies the effective lexical activation of the less frequently encountered L2 words (Gollan et al., 1997; Jiang, 1999; for the same 2x2 design applied in the study of masked translation priming effects).

Overall, we expected to observe a gradually improved performance in English (L2) as a matter of increased proficiency, with progressively shorter latencies and fewer errors from low to medium and to high proficient bilinguals (see de Groot & Poot, 1997).

With regard to the *masked identity priming effects* we expected to obtain significant effects (i.e., shorter latencies for targets primed by their exact repetition than for targets primed by unrelated words of the same language) of comparable magnitude in L1 and in L2 across the three L2 proficiency levels (e.g., Gollan et al., 1997; Present dissertation, Exp. 1-3). Furthermore, considering previous L2 masked priming studies, showing invariant morphological or form priming effects across different levels of proficiency, we did not predict any modulation in the size of the

L2 masked identity priming effect across the three groups of bilinguals (see also Diependaele et al., 2011; Duyck et al., 2004).

Regarding the effects of major interest, the *non-cognate masked translation priming effects*, we expected to obtain significant forward masked translation priming effects for the three proficiency groups (Experiments 4a, 5a and 6a), as has been typically the case in the lexical decision masked translation priming literature irrespectively of the level of L2 proficiency of the bilinguals tested (see Table 4, for review). Predictions on whether or not we would also obtain an effect in the opposite translation direction are less clear-cut given the inconsistent previous evidence (see above). Following different rationales, the RHM and the BIA models would predict that such an effect could potentially exist at high levels of L2 proficiency, when the processing of L2 words is more comparable to that of L1 words (see Dijkstra, 2007). If the models' predictions regarding the appearance of the L2→L1 effect at high L2 proficiency levels are confirmed and there is indeed such an effect with the high proficiency group (Experiment 6b), then it could also be expected that for this group this effect could be of comparable magnitude to that of the L1→L2 masked translation priming effect. If, in contrast to the predictions of the RHM and the BIA models, the level of L2 proficiency of an unbalanced bilingual does not affect the L2→L1 masked translation priming effect, then asymmetric effects across the two translation directions (i.e., larger effects in forward as compared to backward translation) should be expected for the three proficiency groups.

Finally, the inclusion of equal amount of primes belonging to the target and non-target languages preceding the English (L2) and the Greek (L1) targets, as well as the substantial statistical power of our design, offer an ideal setting for exploring the pattern of *masked priming code switching costs* obtained at different levels of L2 proficiency. The existing behavioural evidence gathered with paradigms other than the masked priming, suggests that the effects are larger in the L2-to-L1 direction (see Costa et al., 2006) when unbalanced bilinguals are tested. Masked priming

ERP studies have also showed a similar asymmetric pattern for unbalanced bilinguals reflected as differences mostly in the timing of the N250 and N400 effects (Chauncey et al., 2008; 2011). Furthermore, in the only behavioural masked priming study testing masked code-switching costs, symmetric effects emerged across the two language directions with balanced native-like bilinguals (Perea et al., 2008). With the exception of Experiments 1 and 2 of Chapter 6, no other behavioural studies have explored masked code-switching costs with unbalanced bilinguals. In these experiments a symmetric pattern of switching costs was found with the two late and low proficient bi-scriptal bilingual groups who completed Experiments 1 and 2. Considering that this symmetric pattern emerged with low proficient bilinguals, who in principle experience a clear L1 vs. L2 representational asymmetry, we expected to obtain symmetric effects across the two directions of language switch for the three groups of bilinguals tested.

7.3. Method

7.3.1. Participant selection

To ensure the correct assignment of each participant to his/her corresponding L2 proficiency level as well as the homogeneity of each of the groups to be tested, we opted for assessing the L2 proficiency with both objective and subjective measures. In order to obtain an objective measurement of their proficiency, all the native Greeks comprising the three groups were English learners of different levels at the British Council in Athens. This way, apart from making sure that all the bilinguals were exposed to the same type of English input, we were able to identify three distinct levels of English proficiency based on the placement of the bilinguals in three different English courses according to the British Council standards: relatively low, medium and high proficiency groups. This grouping was made based on thorough spoken and written entry tests as well as on the participants' academic progress in the British Council. The entry tests were administered upon students' first registration and consisted of a written (vocabulary, grammar and comprehension subtests) and a spoken part. The spoken part of the test was a brief interview during which each student was evaluated on his/her communication skills in English through their answers on a series of open questions. Based on these measures the British Council teaching team indicated that the most clear-cut proficiency distinction was found across the students who were in the process of undertaking one of the three available ESOL Examinations supervised by the University of Cambridge: the First Certificate in English (FCE), the Certificate of Advanced English (CAE) and the Certificate of Proficiency in English (CPE).

Once the groups had been identified following the British Council standards, the subjective criterion was applied. The prospective participants answered a number of questions regarding their linguistic and educational background and gave their self-ratings on different measures of proficiency in English by completing a Greek version of the Language Experience and Proficiency Questionnaire (LEAP-Q; Marian et al., 2007). This questionnaire confirmed that all the participants had only lived in Greece, that English was their second language both in terms of proficiency and in order of acquisition, and that they were exposed to it only within the context of the British Council. The three proficiency groups were furthermore matched in a number of different variables (mean age of acquisition, age of first exposure to print, chronological age; see Table 11 for a detailed description of the three groups of bilinguals).

Table 11
Characteristics of the three groups who participated in the experiments and their mean level of English (L2) proficiency as calculated by their self-ratings and by the British Council entry tests. Standard deviations are provided within parentheses.

	Proficiency level		
Variables controlled (all ps>.20)	Low (Exp. 4)	Medium (Exp. 5)	High (Exp. 6)
Age	22.0 (8.6)	24.0 (8.1)	24.3 (5.3)
Age of 1st exposure to English	7.7 (2.0)	7.6 (2.6)	7.1 (2.2)
Age of 1st exposure to English reading	8.8 (1.9)	8.6 (2.4)	8.6 (2.3)
Proficiency placement criteria			
British Council measures			
Cambridge ESOL level	CPE	CAE	FCE
Spoken entry test performance*	5-6	7-8	9
Self ratings (all ps<.01)			
Speaking **	5.4 (1.0)	6.8 (1.2)	7.6 (1.3)
Reading **	6.3 (1.6)	7.4 (1.0)	8.5 (1.0)
Listening **	5.8 (1.8)	7.4 (1.2)	8.2 (1.2)
Overall proficiency **	5.8 (1.4)	6.8 (1.0)	7.6 (0.9)
Hours of exposure/week	8.4	13.7	19.2

Note: *1=no verbal communication possible, 9=complete, fluent, effective communication; **0=low proficiency, 10=high proficiency.

7.3.2. Materials

Exactly the same experimental materials were used in the three experiments (4-6). For sub-experiments 4a, 5a and 6a we selected 232 English (L2) as word targets (e.g., *RIBBON*) from the CELEX database (Baayen, Piepenbrock, & van Rijn, 1995). These targets were preceded by primes that were: i) their exact repetition (e.g., *ribbon-RIBBON*), ii) an English unrelated word (e.g., *desire-RIBBON*), iii) their non-cognate Greek translation equivalent (e.g., *κορδέλα-RIBBON*) or, iv) a Greek unrelated word (e.g., *φυλακή-RIBBON; φυλακή* is the Greek word for *prison*). All the words used throughout the study were nouns or adjectives. All the conditions were matched in mean frequency per million and length. All the Greek words were taken from the GreekLex database (Ktori et al., 2008). The selected English-Greek non-cognate pairs were indicated to be the predominant translations of each other by two Greek external judges with a native-like level of competence in English (see Table 12 for a full description of the materials). For the purposes of the lexical decision task, an additional set of 232 pronounceable nonwords was created, by replacing two of the target words' letters (e.g., *GOMY*). In order to have the exact same amount of English and Greek primes throughout the experiment, the nonwords were preceded half by Greek prime words and half by English prime words, matched in length and frequency to the primes of the word targets (mean frequency: 97 appearances/million, mean length: 6.2 letters).

In Experiments 4b, 5b and 6b we used as the critical non-cognate translation pairs the same ones as in Experiments 4a-6a, but this time the Greek primes of the translation condition served as targets and the English targets as translation primes. Just as in Experiments 4a-6a with the English targets, the Greek target words were preceded by i) their exact repetition (e.g., *κορδέλα-ΚΟΡΔΕΛΑ*), ii) a Greek unrelated word (e.g., *φυλακή-ΚΟΡΔΕΛΑ*), iii) their English non-cognate translation (e.g., *ribbon-ΚΟΡΔΕΛΑ*), or iv) an English unrelated word (e.g., *desire-ΚΟΡΔΕΛΑ*; see Table 12). 232 pronounceable nonwords were created by replacing two of the targets' letters (e.g., *ΚΙΡΔΗΛΑ*). These nonwords were primed by the same Greek and English words that preceded the nonword targets in Experiments 4a-6a (see Altarriba & Basnight-Brown, 2007).

For each sub-experiment four lists of materials were created so that each target appeared only once in each list and each time in a different priming condition. In each of the lists there were 58 experimental items per condition. List assignment was counterbalanced across participants.

Table 12
Examples and characteristics of the word materials used in experiments 4-6. Standard deviations are given within parentheses.

	Priming condition				Targets	
	English (L2)		Greek (L1)		English (L2)	Greek (L1)
	Repetition	Unrelated	Repetition	Unrelated		
	ribbon	desire	κορδέλα (ribbon)	φυλακή (prison)	RIBBON	ΚΟΡΔΕΛΑ (ribbon)
Frequency	86 (105)	83 (104)	75 (141)	77 (124)	86 (105)	75 (141)
Length	5.9 (1.6)	5.8 (1.6)	6.1 (1.7)	5.8 (1.5)	5.9 (1.6)	6.1 (1.7)
N	3.3 (4.4)	3.2 (4.4)	1.4 (1.9)	1.5 (1.9)	3.3 (4.4)	1.4 (1.9)

Note: *N*: Number of orthographic neighbors (Coltheart et al., 1977). The English *N* values were taken from N-Watch (Davis, 2005).

7.3.3. Procedure

All the participants completed the task in English (Experiments 4a-6a) and in Greek (Experiments 4b-6b) in two experimental sessions. The sessions took place in two different days with at least a three-day lag between them and their order was counterbalanced across the participants. The timing and sequence of masked priming events as well as the rest of the experimental procedure was identical to the one followed in Experiment 1 (a & b). Each experimental session lasted approximately 20 minutes.

7.3.4. Data analyses

In order to identify the effects produced by each of the three bilingual groups across each translation direction and following previous masked translation priming studies that have used the same design (e.g., Gollan et al., 1997; present dissertation: Experiments 1 and 3), ANOVAs based on participant and item response latencies and error percentages were conducted for each group and for each target language. These ANOVAs were based on a 2(Prime language: English, Greek) x 2(Relatedness: Repetition, Unrelated) x 4(List: List 1, 2, 3, 4) design. The factor List was included as a dummy variable (Pollatsek & Well, 1995). This design led to twelve separate sets of ANOVAs for the reaction times and for the error rates too: one for each of the three bilingual groups (low, medium, high proficiency; Experiments 4-6), one for each of the two translation directions (L1→L2 and L2→L1) and one for participant and item analyses. See Tables 13-15 for mean reaction times, error rates and priming effects obtained in the different priming conditions throughout Experiments 4 to 6.

7.4. Experiment 4 (a & b): Evidence from low proficient bilinguals

7.4.1. Participants

36 native Greeks, students of the British Council who were in the process of undertaking the Cambridge exam of the First Certificate in English completed this experiment. According to the University of Cambridge standards, English learners in preparation for this examination should be able to understand relatively complex pieces of writing and conversations on a variety of topics and to express their opinion. Based on their performance on the spoken part of the British Council entry tests, participants were able to produce longer sentences using simple grammatical structures in English but their communication was slow and occasionally hesitant and they were not yet able to spontaneously initiate a conversation. In overall, participants rated their English proficiency with a 5.8 on a 1-to-10 scale (10 representing the highest level of proficiency; see Table 10 for further information). Note that in the previous masked translation priming experiments testing low proficient bilinguals of the present dissertation (Experiments 1 and 2) as well as in the Duyck and Warlop (2009) study also testing low proficient bilinguals, participants' ratings of their overall proficiency were also in the same range. Each participant completed the task with both English and Greek targets (sub-experiments 4a and 4b).

7.4.2. Results and Discussion

4a: English (L2) targets

ANOVAs on the reaction times showed a significant main effect of Prime language: participants responded faster (18ms) to targets preceded by English repetition and unrelated primes compared to targets preceded by Greek repetition and unrelated primes [a code-switching cost: $F1(1,32)=26.79$, $MSE=434$, $p<.001$; $F2(1,227)=11.56$, $MSE=7818$, $p<.01$]. Moreover, the main effect of Relatedness was also significant: participants responded faster (48ms) to targets preceded by repetition primes (English and Greek) than to targets preceded by English and Greek unrelated primes [$F1(1,32)=166.58$, $MSE=489$, $p<.001$; $F2(1,227)=126.28$, $MSE=4835$, $p<.001$]. Importantly, the interaction between the two factors was also significant, indicating that the Identity priming effect was significantly larger than the Translation priming effect [a 34ms difference; $F1(1,32)=23.45$, $MSE=450$, $p<.001$; $F2(1,227)=13.05$, $MSE=4003$, $p<.001$]. The pairwise comparisons showed that responses to targets preceded by their exact English repetition were faster (65ms faster) than responses to targets preceded by unrelated English words [Identity priming effect: $F1(1,32)=177.86$, $MSE=436$, $p<.001$; $F2(1,227)=127.70$, $MSE=3993$, $p<.001$]. Similarly, responses to targets preceded by their Greek non-cognate translations were faster (31ms faster) than responses to targets preceded by unrelated Greek words [Translation priming effect: $F1(1,32)=33.15$, $MSE=503$, $p<.001$; $F2(1,227)=8.81$, $MSE=3601$, $p<.01$].

ANOVAs on the error rates showed a main effect of Relatedness: targets were responded to more accurately (3.3% less errors) when they were primed by repetition primes (English and Greek) as compared to when they were primed by unrelated English and Greek primes [$F1(1,32)=37.82$, $MSE=10$, $p<.001$; $F2(1,228)=31.04$, $MSE=86$, $p<.001$]. The rest of the effects did not reach significance (all $ps>.15$).

4b: Greek (L1) targets

ANOVAs on the reaction times showed a main effect of Prime Language, reflecting a 15ms cost in the trials involving a prime-target language change [F1(1,32)=20.11, MSE=396, p<.001; F2(1,228)=10.51, MSE=5702, p<.01]. There was also a main effect of Relatedness, with repetition primes (Greek and English) leading to faster lexical decision times (36ms faster) than unrelated primes (of both languages) [F1(1,32)=129.53, MSE=453, p<.001; F2(1,228)=13.49, p<.001]. Critically, the interaction between the two factors was also significant showing that the Identity and the Translation priming effects differed in magnitude [F1(1,32)=27.63, MSE=412, p<.001; F2(1,228)=36,48, MSE=2883, p<.001]. The pairwise comparisons revealed that, despite their numerical difference (43ms), both the Identity and the Translation priming effects were significant [Identity priming effect: 57ms, F1(1,32)=153.27, MSE=376, p<.001; F2(1,228)=115.07, MSE=3263, p<.001; Translation priming effect: 14ms, F1(1,32)=20.40, MSE=189, p<.001; F2(1,228)=8.81, MSE=3601, p<.01].

The error rate analysis revealed a significant main effect of Prime Language: targets were responded to 1.2% more accurately when preceded by Greek primes than by English primes [F1(1,32)=7.29, MSE=7, p<.05; F2(1,228)=3.97, MSE=86, p<.05]. Furthermore, there was a main effect of Relatedness: participants made 1.5% less errors to targets preceded by their repetitions (either Greek or English) compared to targets preceded by unrelated primes [F1(1,32)=7.23, MSE=12, p<.05; F2(1,228)=7.58, MSE=81, p<.01]. The rest of the effects were not significant (all ps>.55; see Table 13).

Table 13
Mean lexical decision times (in ms, RT) and error rates (%E) for word targets in sub-experiments 4a and 4b and net Identity priming, Translation priming and Switch cost effects.

	English targets (L2)				Greek targets (L1)			
	English primes		Greek primes		Greek primes		English primes	
	Rep.	Unrel.	Rep.	Unrel.	Rep.	Unrel.	Rep.	Unrel.
RT	657	722	692	723	664	678	627	684
%E	7.0	11.2	8.0	10.4	4.7	6.0	3.3	5.1

	Priming effects			Priming effects		
	Identity	Translation	Switch cost	Identity	Translation	Switch cost
RT	65	31	18	57	14	15
%E	4.2	2.4	0.1	1.8	1.3	1.2

Note: Rep.: Repetition; *Unrel.:* Unrelated

The main finding of Experiment 4 was an asymmetric pattern of non-cognate masked translation priming effects obtained with relatively low proficient Greek-English bilinguals: significant masked translation priming effects were found in both translation directions with a larger effect emerging in the forward translation (31ms vs. 14ms in the backward translation). This asymmetry is in line with the vast majority of previous studies testing unbalanced bilinguals (see Table 2). In contrast to this pattern of translation effects, the code-switching costs observed were unaffected by the prime-target language (i.e., L1→L2 and L2→L1 switches lead to symmetric significant costs of 18 and 14ms, respectively). Similarly, the masked identity priming effects found with Greek (57ms) and English targets (65ms) were also comparable in magnitude.

The overall pattern of the different masked priming effects was further confirmed by a set of post-hoc combined analyses of the lexical decision latencies of Experiments 4a and 4b in which Target language was included as a factor. With regard to the two translation priming effects these analyses confirmed that the 31ms forward masked translation priming effect was significantly larger than the 14ms backward translation as indicated by the significant interaction of Target language and Relatedness found for the between language priming conditions (translation and unrelated) Target language and Relatedness interacted with each other, [F1(1,32)=6.27, MSE=359, p<.05; F2(1,228)=5.73, MSE=3997, p<.05]. In contrast, this interaction was not significant when analysing conjointly the within-language conditions (repetition and unrelated) across Experiments 1a-b (both ps>.19) indicating that the 8ms difference in the within-language repetition priming effects was negligible. Finally, the lack of a directional asymmetry for the two code-switching effects found was confirmed by the absence of an interaction between Target language and Prime language (target, non-target; both ps>.55).

7.5. Experiment 5 (a & b): Evidence from medium proficient bilinguals

7.5.1. Participants

36 native Greek students of the British Council who were in the process of undertaking the exam of the Certificate in Advanced English completed this experiment. According to the standards of the University of Cambridge, English learners at this level should be able to follow an English academic course and to communicate effectively in English. Based on the spoken entry test measures, which were collected by the British Council, participants were able to spontaneously initiate a conversation in English and maintain interactions at a relatively normal speed on a wide range of topics. They had still some difficulties in pronunciation and in producing complex grammatical constructions and needed occasional assistance from the interlocutor. Participants rated their overall English proficiency with a mean of 6.8 (out of 10; see Table 11).

7.5.2. Results and Discussion

5a: English (L2) targets

ANOVAs on the target word latencies revealed a significant main effect of Prime language, with English targets preceded by same language repetition or unrelated primes being responded to 20ms faster than when preceded by repetition on unrelated Greek primes [F1(1,32)=27.79, MSE=535, p<.001; F2(1,227)=8.67, MSE=9327, p<.001]. The main effect of Relatedness was also significant. Targets were responded to 45ms faster when primed by their repetitions (both identity and translation) than when they were preceded by unrelated English or Greek words [F1(1,32)=87.24, MSE=847, p<.001; F2(1,227)=114.17, MSE=4585, p<.001]. Furthermore, these two factors significantly interacted with each other [F1(1,32)=19.53, MSE=539, p<.001; F2(1,227)=21.66, MSE=4119, p<.001]. Planned pairwise comparisons revealed a 63ms identity priming effect [F1(1,32)=204.40, MSE=343, p<.001; F2(1,227)=126.94, MSE=4116, p<.001] as well as a 28ms translation priming effect [F1(1,32)=13.73, MSE=1043, p<.001; F2(1,228)=18.40, MSE=4644, p<.001]. However, the translation priming effect was significantly smaller than the identity priming effect, as indicated by the significant Prime language by Relatedness interaction previously described.

ANOVAs on the error rates on the word targets showed a significant main effect of Relatedness. Participants made 2.7% less errors to targets preceded by their repetitions (identity and translation) compared to when they were preceded by unrelated English or Greek primes [F1(1,32)=18.78, MSE=14, p<.001; F2(1,228)=23.50, MSE=67, p<.001]. The rest of the effects did not reach significance (all ps>.25).

5b: Greek (L1) targets

ANOVAs on the reaction times showed a main effect of Prime language. Greek targets preceded by Greek primes were responded to faster (20ms faster) than targets preceded by English primes [$F1(1,32)=41.67$, $MSE=346$, $p<.001$; $F2(1,228)=23.53$, $MSE=3215$, $p<.001$]. The main effect of Relatedness was also significant, with targets preceded by their within and cross-language repetitions being responded to 39ms faster than when preceded by unrelated Greek and English primes [$F1=190.56$, $MSE=293$, $p<.001$; $F2(1,228)=164.85$, $MSE=2268$, $p<.001$]. Finally, there was a significant interaction between Prime language and Relatedness suggesting that the magnitude of the identity priming effect exceeded that of the translation priming effect [66 and 14ms, respectively; $F1(1,32)=122.84$, $MSE=201$, $p<.001$; $F2(1,228)=91.97$, $MSE=2121$, $p<.001$]. The subsequent pairwise comparisons confirmed that both effects were highly significant [identity priming: $F1(1,32)=252.22$, $MSE=307$, $p<.001$; $F2(1,228)=220.00$, $MSE=2524$, $p<.001$; translation priming: $F1(1,32)=16.64$, $MSE=187$, $p<.001$; $F2(1,228)=7.73$, $MSE=1864$, $p<.01$; see Table 14].

ANOVAs on the error rates of the word trials revealed a main effect of Relatedness with Greek and English repetition primes leading to 1.9% more accurate responses to the targets compared to the unrelated primes [$F1(1,32)=20.65$, $MSE=6$, $p<.001$; $F2(1,228)=17.09$, $MSE=52$, $p<.001$]. The main effect of Prime Language was not significant (both $ps>.20$). However, the interaction between the two factors was significant [$F1(1,32)=14.67$, $MSE=7$, $p<.001$; $F2(1,228)=11.42$, $MSE=64$, $p<.001$]. The subsequent pairwise comparisons showed that participants made 3.5% less errors when responding to targets preceded by their exact repetition as compared to when they were preceded by unrelated Greek primes [identity priming effect: $F1(1,32)=29.57$, $MSE=8$, $p<.001$; $F2(1,228)=36.43$, $MSE=44$, $p<.001$]. In contrast, the translation priming effect was not significant (both $ps>.70$; see Table 14).

Table 14
Mean lexical decision times (in ms, RT) and error rates (%E) for word targets in sub-experiments 5a and 5b as well as net Identity, Translation priming and Switch cost effects.

	English targets (L2)				Greek targets (L1)			
	English primes		Greek primes		Greek primes		English primes	
	Rep.	Unrel.	Rep.	Unrel.	Rep.	Unrel.	Rep.	Unrel.
RT	673	736	711	739	596	662	642	656
%E	5.7	9.0	6.4	8.6	2.3	5.8	4.5	4.7

	Priming effects			Priming effects		
	Identity	Translation	Switch cost	Identity	Translation	Switch cost
RT	63	28	20	66	14	20
%E	3.3	2.2	0.2	3.5	0.2	0.6

Note: Rep.: Repetition; *Unrel.:* Unrelated.

Experiment 5 revealed the exact same asymmetric pattern of non-cognate masked translation priming effects found in Experiment 4 with the same test materials but this time with a more proficient group of Greek-English bilinguals. More precisely, we obtained significant but asymmetric masked translation priming effects across the translation directions with Greek-English bilinguals of a medium level of L2 proficiency which were larger with L1 primes and L2 targets (28ms), than vice versa (14ms). Again, the significant identity priming and switching cost effects were unaffected by the target language, being highly comparable in Experiments 5a and 5b.

Just as in Experiment 4, the masked translation priming asymmetry observed numerically was further corroborated by the significant interaction between Target Language (English, Greek) and Relatedness obtained in a post-hoc analysis of the between-language priming conditions (translation and unrelated) of sub-experiments 5a and 5b [$F1(1,32)=3.90$, $MSE=524$, $p=0.5$; $F2(1,228)=5.08$, MSE=2920, $p<.05$]. These results, with the exception of the significant L2→L1 masked translation effect, offer yet another replication of the masked translation priming asymmetry reported with unbalanced bilinguals. Once more, as shown by the non-significant interaction between Target language and Relatedness for the combined analysis of the within-language priming conditions in the two experiments the masked identity priming effects found for L2 and L1 targets were symmetrical (63 and 66ms, respectively; ps>.61), and the same was the case for the code-switching effects across the two language-switching directions (i.e., non significant interaction between Target language and Prime language in the combined analysis, both ps>.90).

7.6. Experiment 6 (a & b): Evidence from high proficient bilinguals

7.6.1. Participants

36 native Greek British Council students who were in the process of undertaking the Certificate of Proficiency in English (CPE) participated in this experiment. At this level of English competence English learners should be able to understand easily virtually all the types of written and spoken English input and to express themselves with precision on all kinds of complex topics. According to the British Council entry test, this group of bilinguals was able to communicate in English effectively and fluently on almost every topic of conversation, using appropriate grammatical and syntactic structures. Participants rated their overall English proficiency with a mean of 7.7 (out of 10; see Table 11).

7.6.2. Results and Discussion

6a: English (L2) targets

ANOVAs on the word latencies showed a main effect of Prime Language, reflecting a 20ms benefit for targets preceded by primes of the same language as compare to when preceded by Greek primes [F1(1,32)=45.62, MSE=304, p<.001; F2=(1,228)=13.49, MSE=6186, p<.001]. The main effect of Relatedness was also significant: reaction times were 45ms shorter when targets were preceded by English or Greek repetition primes as compared to when the primes were English or Greek unrelated words [F1(1,32)=177.62, MSE=403, p<.001; F2(1,228)=176.78, MSE=2942, p<.001]. Moreover, the interaction between the two factors was significant too, indicating that the Identity and the Translation priming effects differed in magnitude [62 and 28ms, respectively; F1(1,32)=42.86, MSE=257, p<.001; F2(1,228)=36.48, MSE=2883, p<.001]. Pairwise comparisons revealed that both the Identity and the Translation priming effects were significant [Identity effect: F1(1,32)=181.79, MSE=382, p<.001; F2(1,228)=183.18, MSE=2818, p<.001; Translation effect: F1(1,32)=47.49, MSE=279, p<.001; F2(1,228)=36.24, MSE=2507, p<.001].

ANOVAs on the error rates revealed a main effect of Relatedness: participants responded more accurately (2.3% less errors) to the targets when they were preceded by repetition English and Greek primes as compared to when they were preceded by unrelated English and Greek primes [F1(1,32)=26.54, MSE=7, p<.001; F2(1,228)=21.80, MSE=61, p<.001]. The rest of the effects were not significant (all ps>.12).

6b: Greek (L1) targets

ANOVAs on the word latencies revealed a main effect of Prime language. Participants responded 14ms faster to targets preceded by Greek primes (repetition and unrelated) as compared to when the targets were preceded by English primes [F1(1,32)=25.26, MSE=295, p<.001; F2(1,228)=20.17, MSE=2613, p<.001]. Moreover, there was a significant main effect of Relatedness. Responses were 34ms faster when targets were primed by their repetition (Greek and English) as compared to when they were primed by unrelated Greek or English words [F1(1,32)=124.41, MSE=331, p<.001; F2(1,32)=157,32, MSE=1803, p<.001].

Finally, the interaction between the two factors was also significant [$F1(1,32)=87.74$, $MSE=222$, $p<.001$; $F2(1,228)=71.93$, $MSE=1803$, $p<.001$]. The following pairwise comparisons revealed significant Identity and Translation priming effects [Identity effect: $F1(1,32)=187.15$, $MSE=313$, $p<.001$; $F2(1,228)=206.59$, $MSE=1949$, $p<.001$; Translation effect: $F1(1,32)=8.37$, $MSE=239$, $p<.01$; $F2(1,228)=8.27$, $MSE=1709$, $p<.01$] although the Identity priming effect was significantly larger than the Translation effect (57 and 11ms, respectively), as indicated by the above-described significant interaction.

ANOVAs on the error rates showed a main effect of Relatedness, with targets primed by their Greek or English repetitions being responded to more accurately (1.8% less errors) than when primed by unrelated Greek and English primes [$F1(1,32)=22.82$, $MSE=5$, $p<.001$; $F2(1,228)=15.07$, $MSE=49$, $p<.001$]. The rest of the effects were not significant (all ps>.18; see Table 15).

Table 15
Mean lexical decision times (in ms, RT) and error rates (%E) for word targets in Experiments 6a and 6b as well as Identity, Translation priming and Switch cost effects.

	English targets (L2)				Greek targets (L1)			
	English primes		Greek primes		Greek primes		English primes	
	Rep.	Unrel.	Rep.	Unrel.	Rep.	Unrel.	Rep.	Unrel.
RT	630	692	667	695	594	651	632	643
%E	3.2	4.8	2.3	5.2	1.9	3.7	2.1	3.8

	Priming effects			Priming effects		
	Identity	Translation	Switch cost	Identity	Translation	Switch cost
RT	62	28	20	57	11	14
%E	1.6	2.9	-0.2	1.8	1.7	0.1

Note: Rep.: Repetition; *Unrel.:* Unrelated.

The results of Experiment 6 (6a and 6b) obtained with highly proficient (yet unbalanced) Greek-English bilinguals exactly replicated those reported with the low and the medium proficiency bilingual groups. Just as in Experiments 4 and 5, we obtained significant identity, code-switching and translation priming effects with both English (Experiment 6a) and Greek (Experiment 6b) targets. Critically, the translation priming effect obtained in the L1→L2 translation (28ms) was larger than the one obtained in the L2→L1 direction (11ms), while this was not the case with the identity priming effects and the code-switching effects which were of similar magnitude across languages (identity priming: 62 and 57ms, in L2 and L1, respectively; switch cost: 20 and 14ms, with L1→L2 and L2→L1 code switching, respectively).

The asymmetric pattern of the translation priming effects was further corroborated by the significant interaction between Target Language and Relatedness obtained in a post hoc combined analysis of the reaction times including only the between language priming conditions of Experiments 6a and 6b (Repetition and Unrelated) [$F1(1,32)=10.60$, $MSE=233$, $p<.001$; $F2(1,228)=9.42$, $MSE=1773$, $p<.01$]. On the contrary, this interaction did not reach significance in the within language priming conditions, indicating that the identity priming effects obtained in L1 and L2 were indeed comparable in magnitude (both $ps>.19$). Likewise, the general combined analyses did not reveal a significant Target language by Prime language interaction, confirming the symmetric pattern of the L1→L2 and L2→L1 code switching masked priming effects ($ps>.15$).

Hence, Experiment 6 replicated the non-cognate masked translation priming asymmetry obtained in Experiments 4 and 5 as well as in Experiments 1 and 2 (Chapter 6) and in most of the previous lexical decision studies examining non-cognate masked translation priming effects with unbalanced bilinguals (see Table 2).

7.7. Combined analyses of Experiments 4-6

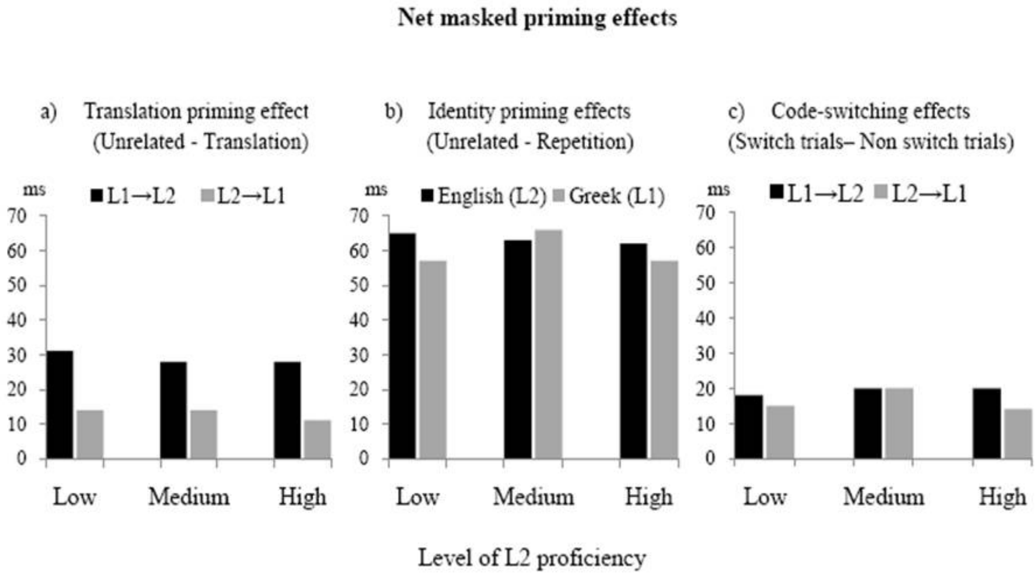
To further compare the apparently identical pattern of the critical masked translation priming effects found across the three levels of L2 proficiency we calculated the net masked translation priming effects in the cross-language priming conditions (Unrelated-Translation) obtained by each group in each translation direction in both the reaction times and the error rates. We conducted ANOVAs including the Level of L2 proficiency as a between subject factor with three levels (low, medium, high) and Translation direction as a within subject factor with two levels (forward, backward). As expected, the only significant effect obtained in both the reaction times and error rates was the main effect of Translation direction ($Fs>3$, $ps \leq .05$), further corroborating the overall asymmetric pattern of effects. The main effect of Level of L2 proficiency and more importantly, the interaction between the two factors were non-significant (all $ps>.22$).

Despite the seemingly indistinguishable performance of the three groups of bilinguals, post hoc analyses on the reaction times and error rates including the Level of L2 proficiency as a factor revealed that the three groups differed in their overall performance on L2 targets (sub-experiments 4a, 5a and 6a). These analyses showed a significant main effect of L2 proficiency obtained in both the lexical decision latencies and error rates on the English targets [reaction times: $F1(2,64)=3.71$, $MSE=18848$, $p<.05$; $F2(2,452)=150.01$, $MSE=3543$, $p<.001$; error rates: $F1(2,64)=21.34$, $MSE=.49$, $p<.001$; $F2(2,456)=76.14$, $MSE=92$, $p<.001$]. Pairwise comparisons revealed that the highly proficient group was faster and more accurate in performing lexical decisions on the English targets as compared to each of the two groups of less proficient bilinguals ($Fs>8$, $ps<.01$, with the exception of the high vs. low proficiency reaction times in the F1 analysis: $p=.09$). The pattern of the error rates on the English (L2) targets reflected even closer the L2 proficiency level of each bilingual group, since there were fewer errors the more proficient the bilinguals were, namely a progressive improvement of their performance as a matter of increased proficiency (Fs>3, ps<.001, with the exception of the low vs. medium proficiency difference which was marginally significant in the F1 analysis: p=.07).

7.8. Experiments 4-6: Discussion of the findings

Aiming at empirically examining whether automatic cross-language lexico-semantic activation is modulated by the level of L2 competence in unbalanced bilingualism, three non-cognate masked translation priming lexical decision experiments (Experiments 4-6) were conducted. We tested the pattern of effects obtained in the forward and the backward translation direction with three groups of Greek-English late and unbalanced bilinguals who differed only in their level of English proficiency (relatively low, medium and high). Results were straight-forward: although the overall performance in the non-dominant language improved as a matter of increased L2 proficiency, the masked translation priming effects obtained were completely unaffected by the proficiency manipulation. In further detail, the word latencies collected revealed that participants were in all cases significantly faster in performing lexical decisions when the targets were preceded by their non-cognate translation as compared to when they were primed by unrelated words of the non-target language. However, and in line with most of the previous evidence obtained with unbalanced bilinguals, this processing benefit was asymmetric depending on the translation direction: it was larger when the primes were the L1 non-cognate translation of the L2 targets, than vice versa. Crucially, the overall pattern of masked translation priming effects resulting from a thoroughly carried out proficiency manipulation, confirms that when the bilinguals tested are clearly unbalanced, L2 proficiency does not modulate the non-cognate masked translation priming effects. Finally, significant masked identity effects and code-switching costs of comparable magnitude were obtained throughout the different levels of L2 proficiency tested, and with both English and Greek targets (see Figure 8, for an overview of the effects).

Figure 8. Summary of the net masked priming effects (in ms) obtained across Experiments 4a-6b: a) masked translation priming effects b) masked identity priming effects and c) code-switching effects.



7.8.1. Masked identity priming effects

Contrasting with the asymmetric pattern of masked translation priming effects, the English (L2) and Greek (L1) within-language repetition priming effects observed in the three experiments were of comparable magnitude. This is in line with what has been reported in previous studies testing non-cognates with both balanced and unbalanced bilinguals (e.g., Duñabeitia, Dimitropoulou et al., 2010; Gollan et al., 1997; Experiments 1 & 2 of this dissertation). This set of findings shows that masked identity priming effects are unaffected by the difference in the relative exposure to L1 and to L2, even when this difference is rather marked (i.e., low proficient bilinguals). Thus, the symmetric pattern of effects reported so far could be suggesting that identity priming effects in bilingual readers emerge in a functionally language-specific manner, independent from the relative frequency of use of L1 and L2 items. Given the complete prime-target sub-lexical overlap, the observed effects would not be sensitive to the number of times that particular word has been previously encountered. The results from previous bilingual studies examining effects of formal overlap (masked phonological, orthographic or morphological priming) with native and non-native speakers further support the idea of the independence of these effects by the nativeness of the participants (Diependaele et al., 2011; Frost, Kugler, Deutsch, & Forster, 2005). In fact, given the cross-script nature of our study it could be the case that the script-specific letters of the prime could be boosting the effective activation of the critical words, overwriting any lexical level influence. In line with such a frequency independent account of masked identity priming effects when a different script is involved, Perea, Abu Mallouh, García-Orza and Carreiras (2011) recently found the same amount of masked identity priming for native Arabic speakers and for low proficiency Arabic learners thus suggesting that the relative frequency of use of the test items defined by the amount of exposure to this language, did not affect the results.

7.8.2. Masked code-switching costs

Just like the masked identity priming effects obtained across the three bilingual groups and with both Greek (L1) and English (L2) targets, we also observed remarkably consistent costs associated with a prime-target language switch. Reaction times were slower when the target was preceded by a prime belonging to the non-target language[7], and this was so, irrespectively of prime-target language direction, fully replicating the pattern of code-switching costs obtained with the two low proficient Greek-Spanish bilingual groups of Experiments 1 and 2. However, contrary to our behavioural results, in the ERP masked priming studies testing unbalanced bilinguals switch cost effects exhibited a directional asymmetry which was eliminated only with simultaneous and balanced bilinguals (Chauncey et al., 2008; 2011; Duñabeitia, Dimitropoulou et al., 2010; see also Perea, et al.,

[7] A code-switching cost was also observed in the error rate analysis of Experiment 4. The low proficient Greek-English bilinguals who completed this experiment were less accurate in their lexical decisions to the Greek targets when they were preceded by English primes as compared to the Greek priming conditions.

2008). It should be mentioned though, that unlike in these ERP studies, the present code-switching effects could have been greatly affected by the strong visual cue of language membership provided by the script-change involved in the prime-target language switch. For bi-scriptal unbalanced bilinguals the influence of script alternation between prime and target could be overwriting any processing asymmetries between their dominant and the non-native language since the script-related information is processed very early in the visual word recognition process (see Hoshino et al., 2010, for cross-script masked translation priming ERP effects).

The present code-switching costs emerging under masked priming conditions provide support to the BIA and BIA-d's postulation that language membership is computed in a fast and automatic way. However, both the BIA and BIA-d models would predict an increase in the top-down inhibition from the L2 language node to the L1 word forms as a matter of increased L2 proficiency (Grainger et al., 2010), which was not reflected in the code-switching costs obtained across the three different levels of English proficiency of our participants.

7.8.3. Non-cognate masked translation priming effects

The asymmetric pattern of masked translation priming effects we obtained across the two translation directions with three groups of unbalanced Greek-English bilinguals is clearly in line with the existing masked translation priming evidence reported in the lexical decision task with unbalanced bilinguals. As previously described, with the exception of one report of symmetric effects with relatively low proficient bilinguals (Duyck & Warlop, 2009), every single study examining forward and backward non-cognate masked translation priming effects with bilinguals with a marked L1 preference has obtained larger effects in the L1→L2 translation direction (see Table 4). Hence, our results further confirm the existence of the non-cognate masked translation priming asymmetry with unbalanced bilinguals. With regard to the influence of the level of L2 proficiency on the masked translation priming, the virtually identical priming effects obtained across the three proficiency levels (L1→L2: 31, 28 and 28ms, in Experiments 4a, 5a and 6a; L2→L1: 14, 14 and 11ms, in Experiments 4b, 5b and 6b) clearly show that when there is a unequivocal language dominance the pattern of masked translation priming effects is completely unaffected by the level of L2 proficiency. More importantly, and in combination with the findings reported with native-like and simultaneous balanced bilinguals (Basnight-Brown & Altarriba, 2007; Duñabeitia, Perea et al., 2010), our results complete the picture of how non-cognate masked translation priming effects are manifested across the different stages of bilingualism: only native-like bilinguals without a clear language dominance show symmetric non-cognate masked translation priming effects across the two translation directions.

Interestingly, the otherwise expected asymmetric pattern of masked translation priming effects was manifested in the presence of significant effects in the backward translation direction. This effect was surprisingly present across all groups (even in the least proficient group), thus partially replicating Duyck and Warlop's (2009) findings of significant bi-directional (though symmetric) effects with a group of a comparable L2 proficiency level. Reports of significant L2→L1 non-cognate masked translation priming effects have been so far scarce. Only 8 out of 19 lexical decision experiments testing this translation direction (see Table 4) have reported significant effects, while only two out of them have applied a SOA as short as the one used in our study (i.e., 50ms). Nevertheless, numerically the backward masked translation priming effects we obtained were close to the average 9ms benefit reported so far in this translation direction and were in all cases much smaller than those obtained in the forward translation. It could be initially argued that the prime-target script change could have provided a visual cue strong enough to facilitate the processing of the L2 primes even for the less proficient bilinguals. However, significant backward masked translation priming effects previously obtained in the lexical decision task with mono-scriptal unbalanced bilinguals of both high and low L2 proficiency (e.g., Duyck & Warlop, 2009; Schoonbaert et al., 2009; Schoonbaert et al., 2011) as well as null backward effects reported under cross-script conditions even with highly proficient bilinguals (Gollan et al., 1997; Jiang, 1999), weaken the validity of this claim. We believe that what led our L2→L1 effects to be highly significant was a combination of the large statistical power we had (36 participants/group and 58 items/condition) and of the lexical characteristics of the test items. Within the literature, the studies that have found null backward masked translation priming effects have in all cases had narrower sets of data points. Moreover, the fact that the critical non-cognate English translations used were mostly concrete nouns and adjectives of high frequency (a mean word frequency of 86 appearances/million) could have boosted the appearance of the significant L2→L1 translation effects obtained in the present study (see Duyck, Vanderelst, Desmet, Hartsuiker, 2008; Gollan et al., 2011; Kroll & Stewart, 1994, for frequency effects in L2 processing). Still, with a closer look at the data gathered in this translation direction it becomes evident that this effect is not the mere result of the ease of lexical access of these familiar L2 words in combination with a powerful design. If that were the case, one would expect it to be less consistent than the highly significant 15, 14 and 11ms found across the three groups of bilinguals, or to be mainly driven by the "deviant" performance of a subgroup of participants. However, the individual data collected revealed that 75% of the participants responded faster in this translation direction as compared to its corresponding control and that this was consistent within each of the three groups (67-80% of the participants). Despite the unexpected consistency of the L2→L1 effect, we consider that the most critical observation regarding these backward non-cognate masked translation priming effects was that they were in all cases significantly smaller than the L1→L2 effects. This was so across all groups, irrespectively of the gradual improvement of their overall L2 performance as a matter of increased L2 exposure (reaction times and error rates), thus confirming the persistence of the masked translation priming asymmetry with unbalanced bilinguals of different levels of L2 proficiency.

What do our findings show regarding the way the bilingual lexico-semantic system is organized? First, the significant backward translation priming effects emerging even with the less proficient group, add up to the increasing amount of evidence showing that starting from early in the L2 acquisition process L2 words can directly activate their conceptual representations (e.g., Duyck & Brysbaert, 2004). The fact that this effective L2 lexico-semantic activation was observed with the low proficiency group under conditions in which no strategic L2 processing was involved (i.e., masked priming), corroborates that from very early on the L2 lexico-semantic access is also highly internalized (see also Duyck and Warlop, 2009; for masked translation priming evidence with low proficient bilinguals in the same line). A similar conclusion is reached with respect to the masked priming code-switching costs obtained with this group: information regarding language membership is automatically computed irrespectively from the level of L2 proficiency. More importantly, the fact that despite the improvement of the participants' L2 performance, the pattern of the observed fast and automatic lexico-semantic effects (identity, switch cost and non-cognate translation) was practically identical throughout the different L2 proficiency levels shows that the early stages of processing of L2 words take place in an effective way, independently from the amount of exposure to the L2 or from the general performance in that language.

Despite the fact that the masked translation priming effects obtained with each of the different groups of Greek-English bilinguals tested were in line with the findings of the vast majority of the previous masked translation lexical decision studies testing unbalanced bilinguals, they only partly confirmed the predictions of the two dominant models of bilingual lexico-semantic organization. As said, the RHM (e.g., Kroll & Stewart, 1994) was the first model to offer an explanation of the asymmetries observed across the two translation directions with unbalanced bilinguals in a series of production studies. To the extent to which the unbalanced bilinguals who participated in our experiments showed in all cases larger forward than backward masked translation priming effects, our findings confirmed the RHM's predictions. However, the absence of any sign of a modulation of the effects by the level of English proficiency of our participants was in clear contrast with the RHM. This model predicted that as the level of L2 proficiency increases the two translation directions should become more comparable to each other, as a result of the increasing ease of direct semantic access for L2 words (see Kroll & de Groot, 1997; Kroll & Tokowicz, 2001; for an adaptation of this prediction on masked translation priming). Clearly our findings did not show any gradual approximation of the two translation directions as a matter of increased L2 proficiency, as the RHM proposed; the masked translation priming asymmetry persisted and the pattern of the effects was identical across the three groups. Additionally, one might have argued that the omnipresent significant L2→L1 effect would have also been unforeseen by the RHM, due to the fact that it reflects the existence of direct semantic access for L2 primes even for the less proficient bilinguals (see Duyck & Warlop, 2009, for discussion). Nevertheless, very recently Kroll and colleagues (Kroll et al., 2010) have explicitly stated that the RHM does accept the existence of direct L2 semantic access even at the early stages of L2 acquisition, but that it assumes that during L2 processing, less proficient bilinguals are more likely to engage the activation of the L1 translations (e.g., Sunderman & Kroll, 2006). Hence, and with these latest reformulations, the RHM would effectively account for the persistence of the masked translation priming asymmetry across the L2 proficiency continuum and the significant L2→L1 masked translation priming effects found with unbalanced bilinguals. Critically though, this model would still be unable to predict the absence of any attenuation of the asymmetry.

Analogous limitations are also found when trying to explain our findings within the theoretical framework provided by the computationally implemented BIA (+) models (e.g., Dijkstra & van Heuven, 2002). In unbalanced bilinguals L1 words would be recognized faster than L2 words because they have higher resting levels of activation since they are more frequently encountered. Under this assumption, it is of course expected that with unbalanced bilinguals, like the ones tested throughout our study, an L1 masked prime would pre-activate the shared conceptual node of its L2 translation more effectively than vice versa, thus explaining the directional asymmetry observed with this type of bilingual. Moreover, given that within the BIA framework the lexico-semantic processing differences across the two languages of a bilingual are quantified in a straightforward manner in terms of frequency of use, the BIA models can also account for the significant backward masked translation priming effects we obtained even with the less proficient group by considering the high lexical frequency of our test items (see above; e.g., Schoonbaert et al., 2011)[8]. However, the BIA models would furthermore predict, that as the level of L2 proficiency and the times a bilingual is faced with L2 words increase the resting levels of activation of L2 lexical items would correspondingly increase and the processing of these L2 items would gradually become more and more comparable to that of L1 words (i.e., they would be faster recognized). In fact, following the BIA premises Schoonbaert et al. directly compared the influence of increasing the prime-target SOA to that of increasing the L2 proficiency, since at higher levels of L2 proficiency more processing would be accomplished in a fixed amount of time. Our results did not confirm this prediction, since there was no difference in the pattern of masked translation priming effects obtained across the different levels of L2 proficiency. Even though at the theoretical level the BIA models would have not predicted this pattern of effects, future simulations of these or similar data obtained with bilinguals of different degrees of L2 proficiency would provide a direct test of the validity of the models' predictions (see also Dijkstra & van Heuven, 1998).

The recently proposed developmental version of the BIA models, the BIA-d model, would again fail to predict the exact pattern of our findings (Grainger et al., 2010). This model identifies a "*magic moment*" in L2 acquisition at which the lexico-semantic system of a late bilingual is shifted from an "*RHM-like structure*" to a "*BIA-like structure*". Even though we would be unable to identify if the bilinguals composing our three groups had undergone this shift or not, in either its initial

[8] In light of the significant backward masked translation priming effects obtained in their study when presenting the prime for 100ms as well as in previous studies using a SOA longer than the common 50 ms (Duyck & Warlop, 2009; Schoonbaert, Duyck et al., 2009), Schoonbaert, and colleagues (2010) argued that providing more time to process the prime by increasing the SOA leads to consistent non-cognate masked translation priming effects in the L2→L1 translation direction. However, this proposal is not supported by reports of null backward masked translation priming effects in lexical decision studies applying SOAs as long or even longer (100-250ms) than the 120ms one used by Schoonbaert, Holcomb et al. (see Table 4).

"*RHM-like*" structure or its later reached "*BIA-like*" structure the BIA-d model would have predicted that the masked translation priming effects is modulated as a matter of increased L2 proficiency, reflecting either increased ease of semantic access of L2 words (RHM stages of L2 acquisition) or increased resting levels of activation of L2 words (BIA stages of L2 acquisition) across the three groups. In fact, the authors of the BIA-d also acknowledge that backward non-cognate masked translation priming effects are only expected at the highest levels of L2 proficiency, with balanced bilinguals, thus failing to account for the significant L2→L1 masked translation priming effects we obtained even with the least proficient group. Nevertheless, in all fairness with the model, it should be noted that the BIA-d was explicitly proposed to describe the development of the lexico-semantic organization of mono-scriptal bilinguals and that its computational implementation, the critical test of the model's validity, has not been yet completed.

The only way a theoretical account could predict the absence of a modulation of the non-cognate masked translation priming effects across the three levels of unbalanced bilinguals we tested in the presence of a significant improvement of the overall L2 performance, would be by assuming that for unbalanced bilinguals there is a fundamental L1-L2 processing difference which is unaffected by the level of L2 proficiency. This prediction has been so far put forward by the DevLex II model (Zhao & Li, 2010). Within DevLex II the bilingual characteristic defining cross-linguistic interactions is the L2 age of acquisition and not the L2 proficiency. Accordingly, the model would predict comparable non-cognate masked translation priming effects for all groups of unbalanced and late bilinguals. Furthermore, for late L2 learners the model would predict asymmetric masked translation priming effects across the two translation directions. Still, it is not clear whether DevLex II would predict significant effects in the backward translation priming direction, since the nodes corresponding to the briefly presented L2 primes will not be activated strongly enough to cause the activation of their L1 translations, leading to less pronounced masked translation priming effects (Li & Farkaš, 2002).

Once the pattern of masked translation priming effects obtained with unbalanced bilinguals of different levels of L2 proficiency with cognate translations is established in the following Chapter, the potential influence of the L2 AoA on masked translation priming effects would be discussed in detail over the complete set of findings on both non-cognates and cognates (Part 3: Final Remarks).

CHAPTER 8

Does L2 proficiency modulate cognate masked translation priming effects?

8.1. Summary of the experiments

The cognate status of words (i.e., whether or not they are formally similar to their translation equivalent) is one of the properties most strongly influencing cross-language interactions observed in bilingual word production and comprehension (e.g., Costa, 2005; Lemhöfer et al., 2008). Despite the well-established processing benefit found for cognates over non-cognates, the question of whether or not the effects of their automatic co-activation are modulated by the level of L2 proficiency holds a considerable amount of interest for the bilingual research community. As seen in the General Introduction (Part 1), the pattern of the effects of automatic activation of cognate translations as well as the cognate processing benefits obtained at different moments of the L2 acquisition process have been relatively inconsistent. Moreover, the predictions put forward by the different bilingual models regarding whether the formal overlap across the two readings of cognates is processed differently and whether under masked priming conditions this additional formal overlap interacts in a different way with the semantic overlap across translations at different stages of L2 learning, are diverse.

Following the methodological principles used to address the experimental question of whether L2 proficiency affects non-cognate masked translation priming effects (Chapter 7), another set of lexical decision experiments (Experiments 7-9) was performed to examine whether L2 proficiency would modulate the pattern of masked translation priming effects obtained with cognate translations that shared a large amount of their orthographic and phonological representations. Critically, in the present set of experiments we opted for combining the study of cognate masked translation priming effects with an intra-script manipulation. Significant cognate masked translation priming effects have been also reported under cross-script conditions, where the overlap across the two reading of a cognate was limited to the phonological level (Gollan et al., 1997; Voga & Grainger, 2007). Nevertheless, cognate processing has been mainly studied with mono-scriptal bilinguals, since in their strict definition cognates are ortho-phonologically overlapping translation equivalents (see Dijkstra et al., 2010, for a review). In fact, previous studies examining cross-script cognate masked translation priming effects have pointed at the potential influence of the script change in the obtained effects (see Gollan et al., 1997, and Voga & Grainger, 2007, for a discussion). In a similar vein, Casaponsa, Carreiras and Duñabeitia (submitted), have recently provided evidence showing that under masked priming conditions cross-language differences at the bigram-level modulated the processing of language membership, while Hoshino (2006) found different patterns of cross-language semantic interference for mono-scriptal and bi-scriptal bilinguals. Finally, Bowers et al. (2000) obtained cognate priming only for mono-scriptal but not for bi-scriptal bilinguals, suggesting that the orthographic code is critically involved in cognate processing. Taking this into account, in the previous experiments of the dissertation testing non-cognates, a cross-script manipulation was used in order to restrict any formal overlap between the translations even at the level of the letter features and to ensure the pure semantic nature of the effects. Contrarily, in the present set of experiments, an intra-script manipulation was considered ideal in order to examine the processing of cognates to its full range. Accordingly, low *(Experiment 7)*, medium *(Experiment 8)* and relatively high *(Experiment 9)* proficient unbalanced Spanish-Basque bilinguals performed masked translation priming lexical decision experiments on both Basque (L2) and Spanish (L1) cognates.

8.2. Experiment rationale and design

In order to examine the pattern of cognate masked translation priming effects emerging with unbalanced bilinguals differing in their L2 proficiency, three groups of unbalanced Spanish-Basque bilinguals of different levels of Basque (L2) proficiency (relatively low, medium and relatively high) were tested on both forward (Spanish-Basque; Sub-experiments 7a, 8a and 9a) and backward (Basque-Spanish; Sub-experiments 7b, 8b and 9b) cognate masked translation priming directions. Through a thorough selection process (see Participant selection subsection) 96 Spanish dominant Spanish-Basque bilinguals were assigned to one of three proficiency groups, aiming to mimic as closely as possible the characteristics of the three groups of Greek-English bilinguals who completed Experiments 4-6. After establishing a clear L2 proficiency distinction across the three groups and ensuring that the L2 history of the three groups was otherwise comparable, each bilingual group was tested in two separate experimental sessions across both translation directions, in order to eliminate any between-subject variability. The critical translation pairs used to test both translation directions were frequent one-to-one Spanish-Basque cognate translations (e.g., the Basque *marinel* [sailor] and its Spanish translation, *marinero*), thus ensuring that the Basque materials would be familiar even for the less proficient bilinguals. Furthermore, several different measures were used to establish the cognate status of the words (see Materials subsection). Finally, just as in the previous experiments, a within-language repetition priming condition along with its corresponding control was included in order to compare the processing of formal and semantic overlap within and across-languages.

We expected to observe an overall improved performance in Spanish (L1; sub-experiments 7b, 8b and 9b) as compared to Basque (L2; sub-experiments 7a, 8a, and 9a) for the three groups. Moreover, a gradually improved performance in Basque (L2) as a matter of increased proficiency was expected, with progressively shorter latencies and fewer errors from low to medium and to high proficient bilinguals (see de Groot & Poot, 1997; Experiments 4-6 of the present dissertation).

Regarding the *masked identity priming effects*, significant effects were predicted for both L1 and L2 targets for the three groups of bilinguals. Considering the findings of Experiments 1-6 of the present dissertation, the magnitude of these effects would be initially predicted to be unaffected by the target language. Accordingly, these masked identity priming effects should be larger in magnitude than the masked translation priming ones, since they do not involve a language crossing. It should be noted however, that first, unlike what was the case in the previous experiments, in the present set of experiments the cross-language priming conditions included in the experimental list involved an intra-script manipulation, and second, the translation primes held a considerable amount of formal overlap to the targets, due to their cognate status. Hence, it could be feasible to assume that for this set of experiments, the difference between the identity and translation priming effects could be less pronounced, or even absent, since both the within and cross-language repetition primes were formally and semantically related to the targets. Within the existing masked translation priming literature, the only experiments examining masked identity priming effects in combination to cognate masked translation priming effects were reported by Gollan et al. (1997) and by Davis et al. (2010). Critically, in comparison to the cognate masked translation priming effects Gollan et al. reported larger masked identity priming effects with L1 targets, but smaller ones with L2 targets. Nevertheless, it should be noted that in this case the formal overlap across cognate translations was limited to the phonological level since this study involved a cross-script manipulation (Hebrew-English). However, in the study by Davis and colleagues, where different groups of monoscriptal Spanish-English[9] bilinguals were tested, Spanish and English masked identity priming effects were comparable in magnitude and did not differ to the cognate masked translation priming effects obtained across the two translation directions.

Just as in the previous experiments, the balanced experimental design in terms of prime language (i.e., half of the primes in the target and half in the non-target language) provided the chance to examine *masked code-switching costs*. The previous sets of experiments testing non-cognate translations (Experiments 1-6) revealed the absence of an influence of either the code-switch direction (L1→L2 or L2→L1) or the level of L2 proficiency of unbalanced bilinguals on these effects. Still, it remains to be seen whether the presence of prime-target formal overlap in the cognate translation priming conditions as well as the intra-script language combination would alter the previously obtained pattern. As argued, the near complete absence of any cross-language formal overlap in the non-cognate masked translation priming experiments could have boosted the appearance of the consistent and comparable automatic L1-to-L2 and L2-to-L1 code-switching costs obtained. If this were so, the present set of cognate test items could be expected to lead to more elusive code-switching effects, since in the cross-language as well as in the within-language priming conditions half of the primes were extensively overlapping to the targets at the formal level (cognate translations and identity primes, respectively). Moreover, given that the experimental lists were exclusively composed of cognate primes and targets, it could be thought that the language membership of these words could be more vaguely represented. On the other hand, if as suggested the visual cue of language membership provided by the script

[9] In the study by Davis et al. (2010), while both English and Spanish dominant bilinguals were tested, the performance of each group with either Spanish or English targets was not analyzed based on both their language dominance and level of proficiency in their non-dominant language. This critical point, in combination to the use of uncommon control priming conditions and to the inconsistency reported between the overall performance of each group in each target language and their grouping based on their L2 proficiency competence, prevents the drawing of any clear conclusions regarding the overall pattern of effects.

alternation in the previous experiments (i.e., Greek and Roman) was strong enough to overwrite any L1-L2 processing differences, then it could be expected that the asymmetric pattern of code-switching effects across the two switching directions reported in previous studies with unbalanced bilinguals could emerge (e.g., Chauncey et al., 2008; 2011; Costa et al., 2006). If this were so, further differences in the code-switching effects as a result of the L2 proficiency manipulation or the switch direction could be also expected.

The predicted pattern of the effects of major interest of the present Chapter, the *cognate masked translation priming effects*, should be similar to the one obtained with non-cognate translations in the previous experiments. First, and for the three groups tested, significant masked translation priming effects should emerge in both translation directions. As seen such bi-directional masked translation priming effects already appeared, even for low proficient bilinguals and even in the complete absence of any prime-target formal overlap (Experiments 4-6; but see Gollan et al., 1997, for non-significant cognate masked translation priming effects in the backward translation direction). Considering that the most influential models of bilingual lexico-semantic organization do not propose any representational differences between cognates and non-cognates, the pattern of the effects should replicate the asymmetry obtained with non-cognates (i.e., larger effects in the L1→L2 direction), in line with the language imbalance of the bilinguals. With regard to whether a potential modulation of the effects is expected as a result of the level of L2 proficiency of the bilinguals, if indeed the processing of cognates is not qualitatively different to that of non-cognates, and considering the invariant non-cognate masked translation priming asymmetry obtained for the three groups of different L2 competence of Experiments 4-6, then the effects should not be affected by the level of L2 proficiency. However, in the only study testing the influence of L2 proficiency on cognate masked translation priming effects a different pattern was obtained (Davis et al., 2010). The authors reported symmetric masked translation priming effects across the two translation directions with both balanced and unbalanced bilinguals, while beginning bilinguals only showed significant effects in the forward translation direction. Still, the previously enumerated methodological differences between this study and the present one preclude the drawing of straightforward comparisons (see Footnote 9).

8.3. Method

8.3.1. Participant selection

All the participants were selected from the BCBL participant database and were assigned to each of the three groups (low, medium and high proficiency group) upon the basic criterion of matching as closely as possible their personal and linguistic background to that of the Greek-English bilinguals of the corresponding proficiency level who completed Experiments 4 to 6. Just like the previously described groups of Greek-English bilinguals, the Spanish-Basque bilinguals tested in the present set of experiments were unbalanced with a clear Spanish (L1) language dominance. Moreover, according to their responses to an adapted Spanish version of the LEAP-Q questionnaire (Marian et al., 2007), the bilinguals assigned to each of the three groups had reported having an overall level of Basque (L2) proficiency comparable to that of the English (L2) proficiency of the Greek-English bilinguals of the corresponding group. All the participants were native speakers of Spanish and had acquired Basque later on as their second language (4-7 years; see Table 16 for further details). The three groups were matched in their age and educational level. However, unlike the participants of Experiments 4-6, and due to peculiarities inherent to the Basque society, the three groups were not matched in the age of Basque (L2) acquisition, with the High proficiency group having started acquiring the Basque language earlier than the groups of Low and Medium proficiency. Finally, given that Spanish and Basque are both official languages of the Basque country, the Basque language was present in the everyday life of the participants, while its acquisition took place within the context of their formal education. Each participant completed the Experiment in exchange to 12 euros.

Table 16
Characteristics and mean level of Basque (L2) proficiency of the three groups who participated in Experiments 7-9 as calculated by their self-ratings*.

	Low (Exp. 7)	Medium (Exp. 8)	High (Exp. 9)
Age	27	26	25
Years of formal education	15	15	15
L2 speaking **	5.6	6.8	8.0
L2 reading **	6.7	7.9	8.9
L2 understanding **	6.9	8.0	8.9
L2 writing **	5.7	6.8	8.3
Overall L2 proficiency **	5.7	7.2	8.4
% L2 speaking **	7%	17%	29%
% L2 reading **	10%	17%	29%
% L2 writing **	7%	17%	32%
% L2 exposure **	12%	21%	27%

*0= low proficiency, 10=high proficiency;** ps<.05.

8.3.2. Materials

Participants in the three experiments (7-9) were presented with exactly the same materials. 136 Basque nouns and adjectives taken from the E-Hitz database (Perea et al., 2006) with a cognate Spanish translation were used as word targets in sub-experiments 7a, 8a and 9a (e.g., *MARINEL,* [sailor]). All the targets were preceded by primes that were i) their exact repetition in Basque (e.g., *marinel-MARINEL*), ii) a formally and semantically unrelated Basque cognate word (e.g., *printzesa* [princess]-*MARINEL*), iii) their Spanish cognate translation (e.g., *marinero-MARINEL*) or iv) a formally and semantically unrelated cognate Spanish word (e.g., *secreto* [secret]-*MARINEL*). The words used as unrelated Basque and Spanish primes were the same related primes (identity and translation), rearranged in such a way that they did not share orthographic or semantic relationship with the targets, and that the same prime did not appear more than once in each experimental list. All the Spanish words used were taken from the LEXESP database (Sebastián-Gallés et al., 2000). The prime and target conditions were matched in mean word frequency per million, word length, number of orthographic neighbours (*N*), age of acquisition (AoA) and concreteness (see Table 17, for a full description of the word materials).

The translation pairs were taken from the BaSP database of Basque-Spanish translation equivalents (Duñabeitia, Casaponsa, Dimitropoulou, Martí, Larraza, & Carreiras, in preparation). This database contains a total of 2149 Basque-Spanish noun and adjective one-to-one translation pairs taken form a Basque-Spanish dictionary and cross validated by Basque-Spanish balanced native-like bilinguals. These bilinguals rated the quality of the translations in terms of how accurate they thought these were on a 1-to-7 Likert scale [1 corresponded to inaccurate translations and 7 to perfect translations]. Only those translation pairs rated with a quality higher than 6 were selected. Furthermore, for each entry of the database a large number of lexical and semantic variables are also available, thus providing the chance to further match the experimental materials along different dimensions. Critically, for the purposes of our study, the cognate status of these translations was defined following both objective and subjective measures. On the one hand, cognate pairs were differentiated from non-cognates in terms of their formal similarity based on their Orthographic and Phonological Levenshtein Distance to their translation pair (OLD and PLD, respectively; Yarkoni, Balota, & Yap, 2009)[10], as well as based on an adapted version of the Levenshtein distance's algorithm, which has been recently used in studies on bilingualism (see Schepens et al., 2012; see also Schepens, 2008). As shown by Schepens and colleagues, the normalized OLD/PLD measures (NOLD and NPLD, hereafter) are equally accurate as the bilinguals' subjective classification in drawing the cognate/non-cognate distinction (see also Duñabeitia et al., 2012). To calculate the NOLD and NPLD values of the translation pairs, the orthographic similarity scores based on the Levenshtein distance were adjusted for word length using the following formula: *score = (length – Levenshtein distance) / length*. The *length* corresponded to the

[10] The Levenshtein Distance between two letter strings is defined as the minimum number of substitutions, insertions, or deletions of letters (OLD) or phonemes (PLD) required to turn one letter string into the other (Levenshtein, 1966). Accordingly, a low OLD/PLD value indicates that two strings are highly overlapping while a high OLD/PLD value indicates that the two strings of interest do not overlap.

maximum length of the two strings to be compared. This way, perfect cognates would result in a score of 1, and completely different translation equivalents (namely, perfect non-cognates) would result in a score of 0. On the other hand, subjective measures of the cognate status of the translations were also collected. A group of 27 balanced Basque-Spanish bilinguals rated the translation pairs of the database in terms of their formal similarity on a 7-point Likert scale [1 corresponded to two dissimilar strings (non-cognate like) and 7 to two identical strings (cognate-like)]. Through these norming processes of the translation pairs of the BaSp database, the critical 136 cognate pairs that were finally used were selected. These items had been rated in terms of their quality as translation equivalents with a mean of 6.64 out of 7. Only cognates 1-2 letters/phonemes different to their translation equivalent were used since the use of perfect cognates would not be informative given that participants could process them always in the target language, thus preventing us from exploring cross-language priming. These translation pairs were classified as cognates with an overall score of 6.6 out of 7. This subjective rating of the cognate status of the critical test items was confirmed by their OLD and PLD values as well as by their NOLD and NPLD values, since they were found to yield mean OLD and PLD values of 1.7 (±0.5) and 1.4 (±0.6), respectively, and mean NOLD and NPLD values of 0.8 (±0.1) and 0.8 (±0.1), respectively

For the purposes of the lexical decision, an additional set of 136 pronounceable pseudowords were created by replacing 1-2 of the Basque targets' letters (e.g., *SUKABI*) using the Wuggy application (Keuleers & Brysbaert, 2010). Half of these nonwords were primed by formally unrelated cognate Spanish words, and the other half by formally unrelated cognate Basque words. The inclusion of both Spanish and Basque words preceding the nonwords aimed at maintaining an overall balanced list composition (i.e., half of the primes were Basque and the other half were Spanish words; see Altarriba & Basnight-Brown, 2007). These primes were matched in word frequency, length, phonological length and number of orthographic neighbours to the unrelated primes of the word targets.

In Experiments 7b, 8b and 9b, the critical cognate translation pairs were the same ones as in Experiments 7a-9a with the language order inversed: the Spanish primes of Experiments 7a-9a now served as targets and Basque targets now served as primes. Following the same design as in Experiments 7a-9a, the Spanish cognate targets were preceded by i) their exact repetition in Spanish (e.g., *marinero-MARINERO* [sailor]), ii) a formally and semantically unrelated Spanish cognate word (e.g., *secreto* [secret]-*MARINERO*), iii) their Basque translation (e.g., *marinel-MARINERO*) or iv) by a formally and unrelated Basque word (e.g., *printzesa* [princess]-*MARINERO*; see Table 17 for a full description of the materials). 136 pronounceable pseudowords were created using the Wuggy application by replacing 1-2 of the Spanish targets' letters (e.g., *ERCATO*). Just as in Experiments 7a-9a, these nonwords were primed by cognate Basque and Spanish words.

Table 17
Examples and characteristics of the word materials used in Experiments 7-9. Standard deviations are given within parentheses.

	Priming condition				Targets	
	Basque (L2)		Spanish (L1)			
	Repetition	Unrelated	Repetition	Unrelated	Basque (L2)	Spanish (L1)
	marinel (sailor)	printzesa (princess)	marinero (sailor)	secreto (secret)	MARINEL (sailor)	MARINERO (health)
Frequency	37 (67)	37 (67)	35 (55)	35 (55)	37 (67)	35 (55)
Length	7.2 (1.9)	7.2 (1.9)	7.1(1.9)	7.1(1.9)	7.2 (1.9)	7.1(1.9)
Phon. Length	7.0 (1.9)	7.0 (1.9)	7.0 (2.0)	7.0 (2.0)	7.0 (1.9)	7.0 (2.0)
N	1.4 (2.1)	1.4 (2.1)	1.7 (2.1)	1.7 (2.1)	1.4 (2.1)	1.7 (2.1)
AoA	3.4 (1.1)	3.4 (1.1)	3.3 (1.0)	3.3 (1.0)	3.4 (1.1)	3.3 (1.0)
Concreteness	4.2 (1.8)	4.2 (1.8)	4.1 (1.9)	4.1 (1.9)	4.2 (1.8)	4.1 (1.9)

Note: Frequency: Frequency per million appearances; *Length*: Number of letters; *Phon. Length*: Number of phonemes; *N*: Number of orthographic neighbours (Coltheart et al., 1977). The Spanish and Basque *N* values were taken from B-Pal (Davis & Perea, 2005) and E-Hitz (Perea et al., 2006), respectively. *AoA*: Age of Acquisition; AoA and Concreteness values for words of both languages were taken from the BaSP database (Duñabeitia et al., in preparation).

For each sub-experiment, four lists of materials were created so that each target appeared only once in each list and each time preceded by a prime of a different condition (translation or unrelated). In each of the lists there were 34 experimental items per condition. List assignment was counterbalanced across participants.

8.3.3. Procedure

All the participants completed the task in Basque (Experiments 7a-9a) and in Spanish (Experiments 7b-9b) in two experimental sessions. The sessions took place in two different days with at least a week lag between them in a between-subject counterbalanced order. The timing and sequence of masked priming events as well as the rest of the experimental procedure was identical to the one followed in Experiments 1, 4-6 (a & b). Prior to the 272 experimental trials each participant was presented with 6 word and 6 nonword practice trials. All the interactions with the participants and the experimental instructions were in the language each participant was performing the task in. Each experimental session lasted approximately 20 minutes.

8.3.4. Data analyses

In order to identify the effects produced by each of the three bilingual groups and following previous masked translation priming studies that have used similar designs (e.g., Gollan et al., 1997; Present dissertation: Experiments 1 and 4-6), ANOVAs based on participant and item response latencies and error percentages were conducted for each group and for each target language. Just as in Experiments 4-6, these ANOVAs were based on a 2(Prime language: Basque, Spanish) x 2(Relatedness: Repetition, Unrelated) x 4(List: List 1, 2, 3, 4) design. The factor List was included as a dummy variable (Pollatsek & Well, 1995). This design led to twelve separate sets of ANOVAs for the reaction times and for the error rates too: one for each of the three bilingual groups (low, medium, high proficiency;

Experiments 7-9), one for each of the two translation directions [L1→L2 (sub-experiments 7a, 8a and 9a) and L2→L1 (sub-experiments 7b, 8b and 9b] and one for participant and item analyses. See Tables 18-20 for mean reaction times, error rates and net priming effects obtained in the different priming conditions throughout Experiments 7 to 9.

8.4. Experiment 7 (a & b): Evidence from low proficient bilinguals

8.4.1. Participants

Thirty two native Spanish speakers who had started learning Basque around 6 years of age as part of their formal education completed this experiment. Overall, they rated their Basque level of proficiency with a of 5.7 on a 1-to-10 scale (see Table 16 for further information), a value similar to the ones obtained by the low proficient Greek-Spanish and Greek-English bilinguals of Experiments 1, 3 and 4 of the present dissertation. All the participants completed the Experiment with both Basque (L2) and Spanish (L1) targets (sub-experiments 7a and 7b).

8.4.2. Results and Discussion

7a: Basque (L2) targets

ANOVAs on the reaction times showed a significant main effect of Relatedness, with participants responding faster (47ms) to targets primed by their exact repetition or by their Spanish cognate translation, than to targets primed by unrelated Basque or Spanish primes[$F1(1,28)=82.48$, $MSE=843$, $p<.001$; $F2(1,132)=22.09$, $MSE=1351$, $p<.001$]. The main effect of Prime language was not significant (a negligible 2ms difference, both $ps>.65$). Importantly, the interaction between the two factors was significant, indicating that the cognate masked translation priming effect was significantly larger than the masked identity translation priming effect [a 25ms difference; F1(1,28)=7.71, MSE=639, p<.01; F2(1,132)=3.88, MSE=5159, p=.05]. The pairwise comparisons showed that responses to targets preceded by their Spanish cognate translation were faster (59ms) than responses to targets preceded by unrelated Spanish cognates [Cognate masked translation priming effect: F1(1,28)=64.54, MSE=863, p<.001; F2(1,132)=25.39, MSE=9316, p<.001]. The masked identity priming effect was also significant, with participants responding faster (34ms) to targets preceded by their exact repetition than to targets preceded by unrelated Basque primes [F1(1,28)=30.27, MSE=618, p<.001; F2(1,132)=8.76, MSE=9352, p<.01].

ANOVAs on the error rates only showed a main effect of Relatedness: targets were responded to more accurately (3.5% less errors) when primed by their repetition (identity and translation) than when primed by unrelated Basque and Spanish primes [F1(1,28)=23.46, MSE=17, p<.001; F2(1,132)=5.17, MSE=330, p<.05]. The rest of the effects were not significant; all ps>.80).

7b: Spanish (L1) targets

ANOVAs on the reaction times revealed a significant main effect of Relatedness: responses to targets primed by their Spanish repetition or their Basque cognate translation were 48ms faster than responses to targets primed by unrelated Spanish or Basque primes [F1(1,28)=83.42, MSE=892, p<.001; F2(1,132)=58.42, MSE=5708, p<.001]. The main effect of Prime Language was not significant (a 4ms difference, both ps>.25). Finally, the Prime language x Relatedness interaction was also significant, indicating that the masked identity priming effect was larger (33ms larger) than the cognate masked translation priming effect [F1(1,28)=17.52, MSE=502, p<.001; F2(1,132)=16.48, MSE=2727, p<.001]. This difference was confirmed by the subsequent pairwise comparisons, which revealed a significant 65ms masked identity priming effect [F1(1,28)=77.63, MSE=865, p<.001; F2(1,132)=81.16, MSE=3840, p<.001], as well as a significant 32ms cognate masked translation priming effect [F1(1,28)=30.28, MSE=529, p<.001; F2(1,132)=14.54, 4595, p<.001].

ANOVAs on the error rates only showed a significant main effect of Relatedness: 1.1% less errors on targets preceded by their Spanish or Basque repetition as compared to targets preceded by Spanish or Basque unrelated cognate primes [F1(1,28)=9.57, MSE=4, p<.01; F2(1,132)=7.89, MSE=23, p=.01]. The rest of the effect and interactions did not reach significance (all ps>.35).

Table 18
Mean lexical decision times (in ms, RT) and error rates (%E) for word targets in sub-experiments 7a and 7b as well as net Identity, Translation priming and Switch cost effects.

	Basque targets (L2)				Spanish targets (L1)			
	Basque primes		Spanish primes		Spanish primes		Basque primes	
	Rep.	Unrel.	Rep.	Unrel.	Rep.	Unrel.	Rep.	Unrel.
RT	786	820	776	835	637	702	658	690
%E	7.9	11.6	7.8	11.2	1.4	2.9	1.8	2.6

	Priming effects			Priming effects		
	Identity	Translation	Switch cost	Identity	Translation	Switch cost
RT	34	59	2	65	32	4
%E	3.7	3.4	-0.2	1.7	0.7	0.0

Note: Rep.: Repetition; *Unrel.:* Unrelated.

The main finding of Experiment 7 was an asymmetric pattern of cognate masked translation priming effects obtained with relatively low proficient Spanish-Basque bilinguals: significant cognate masked translation priming effects were found in both translation directions with a larger effect emerging in the forward translation (59ms vs. 32ms in the backward translation). Though there have been reports of bi-directional asymmetric cognate masked translation priming effect (Duñabeitia, Perea et al., 2010), this is the first time this pattern emerges with unbalanced and relatively low proficient bilinguals (see Table 3). Moreover, significant bi-directional but asymmetric masked identity priming effects were also obtained with L1 and L2 targets: larger effects with L1 than with L2 targets (65 vs. 34ms). In fact, this within language masked repetition priming effect was larger than the cognate translation priming effect only with L1 targets, while the inverse pattern was found with L2 targets (i.e., a larger benefit for translations than for identity primes). Finally, the code-switching costs found with non-cognate targets in the previous experiments were absent for both L1 and L2 cognate targets.

The overall pattern of the translation and the identity masked priming effects obtained was further confirmed by a set of post-hoc combined analyses of the lexical decision latencies of Experiments 7a and 7b in which Target language was included as a factor. As expected, responses to L1 targets were faster (132ms) and more accurate (7.4% less errors) than responses to L2 targets [RT: $F1(1,28)=34.66$, $MSE=32452$, $p<.001$; $F2(1,132)=652.80$, $MSE=7351$, $p<.001$; %E: $F1(1,28)=64.28$, $MSE=55$, $p<.001$; $F2(1,132)=87.97$, $MSE=171$, $p<.001$]. With regard to the two cognate translation priming effects, these analyses confirmed that the 59ms forward masked translation priming effect was significantly larger than the 32ms backward translation priming effect, as indicated by the significant interaction of Target language and Relatedness found for the between language priming conditions (translation and unrelated) [$F1(1,28)=9.35$, $MSE=641$, $p<.01$; $F2(1,132)=4.64$, $MSE=5602$, $p<.05$]. The Target language x Relatedness interaction was also significant when analyzing conjointly the within-language conditions (repetition and unrelated) across Experiments 7a-b, indicating that the 31ms difference in the within-language repetition priming effects was significant [$F1(1,28)=8.46$, $MSE=885$, $p<.01$; $F2(1,132)=6.75$, $MSE=5482$, $p<.05$].

8.5. Experiment 8 (a & b): Evidence from medium proficient bilinguals

8.5.1. Participants

Thirty two native Spanish speakers who had started learning Basque around 6 years of age as part of their formal education completed this experiment. Overall, they rated their Basque level of proficiency with an average of 7.2 on a 1-to-10 scale (see Table 16 for further information), a value similar to the one reported by the medium proficient Greek-English bilinguals of Experiment 5 of the present dissertation. All the participants completed the Experiment with both Basque (L2) and Spanish (L1) targets (sub-experiments 8a and 8b).

8.5.2. Results and Discussion

8a: Basque (L2) targets

ANOVAs on the reaction times showed a significant main effect of Relatedness, with participants responding faster (52ms) to targets primed by their exact repetition or by their Spanish cognate translation, than to targets primed by unrelated Basque or Spanish primes [$F1(1,28)=146.02$, $MSE=588$, $p<.001$; $F2(1,132)=36.45$, $MSE=11563$, $p<.001$]. The main effect of Prime language was not significant (both $ps>.45$). However, the interaction between the two factors was significant (marginally in the by items analysis), indicating that the cognate masked translation priming effect was significantly larger than the masked identity translation priming effect [a 18ms difference; $F1(1,28)=5.32$, $MSE=484$, $p<.05$; $F2(1,132)=2.63$, $MSE=4929$, $p=.11$]. The pairwise comparisons showed that responses to targets preceded by their Spanish cognate translation were faster (61ms) than responses to targets preceded by unrelated Spanish cognates [Cognate masked translation priming effect: $F1(1,28)=110.37$, $MSE=535$, $p<.001$; $F2(1,132)=37.06$, $MSE=7854$, $p<.001$]. The masked identity priming effect was also significant, with participants responding faster (43ms) to targets preceded by their exact repetition than to targets preceded by unrelated Basque primes [F1(1,28)=54.70, MSE=537, p<.001; F2(1,132)=16.59, MSE=8638, p<.001].

ANOVAs on the error rates only showed a main effect of Prime language, significant only in the analysis by participants: targets were responded to more accurately (1.6% less errors) when primed by cognates of the non-target language (translation and Spanish unrelated) than when primed by Basque primes (repetition and unrelated) [F1(1,28)=2.10, MSE=37, p=.16; F2(1,132)=4.65, MSE=71, p<.05]. The main effect of Relatedness was also significant: targets were responded to more accurately (2.5% less errors) when primed by their repetitions (identity and translation) than by unrelated Basque and Spanish primes [F1(1,28)=8.66, MSE=23, p<.01; F2(1,132)=3.99, MSE=210, p<.05]. Finally, the interaction between the two factors was not significant (both ps>.40).

8b: Spanish (L1) targets

ANOVAs on the reaction times revealed a significant main effect of Prime language: responses to targets primed by Spanish primes (repetition and unrelated) were faster (10ms) than responses to target primed by Basque primes (translation and unrelated) [Code-switching cost: F1(1,28)=8.97, MSE=354, p<.01; F2(1,132)=4.97, MSE=2005, p<.05]. The main effect of Relatedness was also significant: responses to targets primed by either their Spanish repetition or their Basque cognate translation were 44ms faster than responses to targets primed by unrelated Spanish or Basque primes [F1(1,28)=212.89, MSE=284, p<.001; F2(1,132)=51.81, MSE=4821, p<.001]. Finally, the Prime language x Relatedness interaction was also significant, indicating that the masked identity priming effect was larger (19ms) than the cognate masked translation priming effect [F1(1,28)=18.44, MSE=165, p<.001; F2(1,132)=6.47, MSE=2450, p<.05]. This was confirmed by the subsequent pairwise comparisons, which showed a significant 53ms masked identity priming effect [F1(1,28)=168.26, MSE=269, p<.001; F2(1,132)=59.22, MSE=3305, p<.001], as well as a significant but smaller 32ms cognate masked translation priming effect [F1(1,28)=101.36, MSE=269, p<.001; F2(1,132)=17.63, MSE=3966, p<.001].

ANOVAs on the error rates only showed a significant main effect of Relatedness: participants made 1.5% less errors on targets preceded by their Spanish or Basque repetition as compared to targets preceded by Spanish or Basque unrelated cognate primes [F1(1,28)=14.14, MSE=5, p<.01; F2(1,132)=7.98, MSE=39, p=.01]. The rest of the effect and interactions did not reach significance (all ps>.45).

Table 19
Mean lexical decision times (in ms, RT) and error rates (%E) for word targets in sub-experiments 8a and 8b as well as net Identity, Translation priming and Switch cost effects.

	Basque targets (L2)				Spanish targets (L1)			
	Basque primes		Spanish primes		Spanish primes		Basque primes	
	Rep.	Unrel.	Rep.	Unrel.	Rep.	Unrel.	Rep.	Unrel.
RT	719	762	709	769	586	640	606	640
%E	7.3	9.1	5.1	8.2	2.2	3.4	1.6	3.4

	Priming effects			Priming effects		
	Identity	Translation	Switch cost	Identity	Translation	Switch cost
RT	43	61	-1	53	34	10
%E	1.8	3.1	-1.6	1.2	1.8	-0.3

Note: Rep.: Repetition; *Unrel.:* Unrelated.

Experiment 8 revealed the exact same asymmetric pattern of cognate masked translation priming effects, found in Experiment 7 with the same test materials but with a less proficient group of Spanish-Basque bilinguals. More precisely, we obtained significant but asymmetric masked translation priming effects across the two translation directions (i.e., a 27ms larger forward than backward cognate masked translation priming effect) with Spanish-Basque bilinguals of a medium level of L2 proficiency. This asymmetric pattern is in the same line as the one obtained in Experiment 5 with Greek-English bilinguals of a comparable level of L2 proficiency but with non-cognate translations. Our findings also revealed significant bi-directional masked identity priming effects (53 and 43ms with L1 and L2 targets, respectively) as well as a significant 10ms code switching cost for L1 targets preceded by L2 primes.

Just as in Experiment 7, the cognate masked translation priming asymmetry observed numerically, was further corroborated by the significant interaction between Target Language (Basque, Spanish) and Relatedness obtained in a post-hoc analysis of the lexical decision latencies of the between-language priming conditions (translation and unrelated) of sub-experiments 8a and 8b [$F1(1,28)=15.30$, $MSE=383$, $p<.01$; $F2(1,132)=9.56$, $MSE=3961$, $p<.01$]. However, unlike what was the case in Experiment 7, when examining the masked identity priming effects with a combined analysis of the within-language priming conditions (repetition and unrelated) of sub-experiments 8a and b, there was not such an asymmetric pattern, though the interaction between Target language and Relatedness approached significance in the F1 analysis [$F1(1,28)=2.84$, $MSE=304$, $p=.10$; F2, $p<.50$]. Finally, in line with the fact that bilinguals had a clear L1 dominance, participants were faster (112ms faster) and more accurate (4.8% less errors) when responding to L1 targets than to L2 targets [RT: $F1(1,28)=40.43$, $MSE=23497$, $p<.001$; $F2(1,132)=483.47$, $MSE=6303$, $p<.001$; %E: $F1(1,28)=66.17$, $MSE=22$, $p<.001$; $F2(1,132)=87.19$, $MSE=71$, $p<.001$].

8.6. Experiment 9 (a & b): Evidence from high proficient bilinguals

8.6.1. Participants

Thirty two native Spanish speakers who had started learning Basque around 4 years of age as part of their formal education completed this experiment. Overall, they rated their Basque level of proficiency with a average of 8.4 on a 1-to-10 scale (see Table 16 for further information), a value similar to the one reported by the relatively high proficient Greek-English bilinguals of Experiment 6 of the present dissertation. All the participants completed the Experiment with both Basque (L2) and Spanish (L1) targets (sub-experiments 9a and 9b).

8.6.2. Results and Discussion

9a: Basque (L2) targets

ANOVAs on the word latencies showed a main effect of Prime Language, significant only in the by items analysis, reflecting a 6ms benefit for targets preceded by Basque primes as compare to when preceded by Spanish primes [$F1(1,28)=1.41$, $MSE=746$, $p=.25$; $F2=(1,132)=3.79$, $MSE=2142$, $p=.05$]. The main effect of Relatedness was also significant: reaction times were 52ms shorter when targets were preceded by Basque or Spanish repetition primes as compared to when the primes were English or Greek unrelated cognate words [$F1(1,28)=208.91$, $MSE=409$, $p<.001$; $F2(1,132)=47.80$, $MSE=8879$, $p<.001$]. Moreover, the interaction between the two factors was significant too, indicating that the cognate masked translation priming effect was significantly larger (17ms larger) than the masked identity priming effect [$F1(1,28)=10.74$, $MSE=224$, $p<.01$; $F2(1,132)=6.22$, $MSE=2868$, $p<.05$]. Pairwise comparisons revealed that both the identity and the translation priming effects were significant [43ms masked identity priming effect: $F1(1,28)=89.90$, $MSE=329$, $p<.001$; $F2(1,132)=25.87$, $MSE=5185$, $p<.001$; 60ms cognate masked translation effect: F1(1,28)=192.05, MSE=303, p<.001; F2(1,132)=46.95, MSE=6562, p<.001].

ANOVAs on the error rates only revealed a main effect of Relatedness: participants responded more accurately (2.2% less errors) to the targets when they were preceded by repetition Basque and Spanish primes as compared to when they were preceded by unrelated Basque and Spanish cognate primes [F1(1,28)=7.27, MSE=21, p<.5; F2(1,132)=3.64, MSE=182, p=.06]. The rest of the effects were not significant (all ps>.20).

9b: Spanish (L1) targets

ANOVAs on the word latencies revealed a main effect of Prime language. Participants responded 11ms faster to targets preceded by Spanish primes (repetition and unrelated) as compared to targets preceded by Basque primes [F1(1,28)=11.70, MSE=304, p<.01; F2(1,132)=9.41, MSE=2096, p<.01]. Moreover, there was a significant main effect of Relatedness. Responses were 52ms faster when targets were primed by their repetition (Spanish and Basque) as compared to when they were primed by unrelated Spanish or Basque words [F1(1,28)=181.65, MSE=469, p<.001; F2(1,132)=106.01, MSE=3900, p<.001]. Finally, the interaction between the two factors was also significant, indicating that the masked identity priming effect was significantly larger than the translation priming effect (22ms larger) [F1(1,28)=10.96, MSE=346, p<.01; F2(1,132)=6.65, MSE=2328, p<.05]. The following pairwise comparisons revealed significant identity and translation priming effects [62ms masked identity priming effect: F1(1,28)=181.02, MSE=345, p<.001; F2(1,132)=94.23, MSE=3214, p<.001; 41ms cognate masked translation priming effect: F1(1,28)=56.41, MSE=470, p<.001; F2(1,132)=43.33, MSE=3104, p<.001].

ANOVAs on the error rates only showed a main effect of Relatedness, with targets primed by their Spanish or Basque repetitions being responded to more accurately (1.9% less errors) than when primed by unrelated Spanish and Basque primes [$F1(1,28)=13.15$, $MSE=9$, $p<.01$; $F2(1,132)=8.51$, $MSE=57$, $p<.01$]. The rest of the effects were not significant (all $ps>.10$; see Table 20).

Table 20
Mean lexical decision times (in ms, RT) and error rates (%E) for word targets in sub-experiments 9a and 9b as well as net Identity, Translation priming and Switch cost effects.

	Basque targets (L2)				Spanish targets (L1)			
	Basque primes		Spanish primes		Spanish primes		Basque primes	
	Rep.	Unrel.	Rep.	Unrel.	Rep.	Unrel.	Rep.	Unrel.
RT	678	721	675	735	591	654	612	653
%E	5.9	7.3	4.9	7.9	3.2	4.7	1.9	4.2

	Priming effects			Priming effects		
	Identity	Translation	Switch cost	Identity	Translation	Switch cost
RT	43	60	6	62	41	11
%E	1.4	3.0	-0.2	1.5	2.3	-0.9

Note: Rep.: Repetition; *Unrel.:* Unrelated.

The results of Experiment 9 (9a and 9b) obtained with relatively high proficient but unbalanced Spanish-Basque bilinguals replicated those reported with the low and the medium proficiency bilingual groups. Just as in Experiments 7 and 8. We obtained significant identity and cognate translation priming effects with both Basque (Experiment 9a) and Spanish (Experiment 9b) targets. Critically, the cognate translation priming effect obtained in the L1→L2 translation direction was 19ms larger than the one obtained in the L2→L1 direction, while this was not the case with the identity priming effects, where a 19ms larger effect was obtained with L1 targets than with L2 targets. Finally, a significant 11ms code-switching cost was obtained with L1 targets, while, when testing L2 targets, this effect (6ms) was only significant in the analysis by items.

The asymmetric pattern of both the cognate masked translation priming effects and the masked identity priming effects was further corroborated by the significant interaction between Target Language and Relatedness obtained in a post hoc combined analysis of the reaction times including either only the between language priming conditions of sub-experiments 9a and 9b (translation and unrelated) to compare the effects obtained across the two translation priming directions, or only the within-language priming conditions (repetition and unrelated) to compare the two identity priming effects [cognate masked translation priming asymmetry: $F1(1,28)=9.69$, $MSE=318$, $p<.01$; $F2(1,132)=4.40$, $MSE=4036$, $p<.05$; masked identity priming asymmetry: $F1(1,28)=7.55$, $MSE=401$, $p<.05$; $F2(1,132)=5.15$, $MSE=3023$, $p<.05$]. Moreover, the absence of an interaction between Target language and Prime language in the overall combined analysis of the word latencies, showed that the code-switching costs obtained with L1 and L2 targets, were comparable in magnitude (both $ps>34$). Finally, though relatively highly proficient in Basque (L2), participants were still more proficient in Spanish, as confirmed by their overall performance. Their responses to L1 targets were faster (74ms) and more accurate (3% less errors) than their responses to L2 targets [RT: $F1(1,28)=31.09$, $MSE=11406$, $p<.001$; $F2(1,132)=177.26$, $MSE=4643$, $p<.001$; %E: $F1(1,28)=15.55$, $MSE=36$, $p<.001$; $F2(1,132)=24.23$, $MSE=99$, $p<.001$].

Hence, Experiment 9 replicated the asymmetric pattern of masked translation priming effects (larger L1$\rightarrow$L2 than L2$\rightarrow$L1) previously found with two groups of less proficient Spanish-Basque bilinguals in Experiments 7 and 8 presented with the same cognate materials, as well as with a group of unbalanced Greek-English bilinguals with a comparable level of L2 proficiency (Experiment 6) but tested on non-cognate masked translation priming. With regard to the masked identity priming effects, the pattern obtained with the more proficient Spanish-

Basque bilinguals was once more comparable to the one obtained with the less proficient bilinguals tested with the same experimental materials: larger L1→L1 than L2→L2 effect.

8.7. Combined analysis of Experiments 7-9

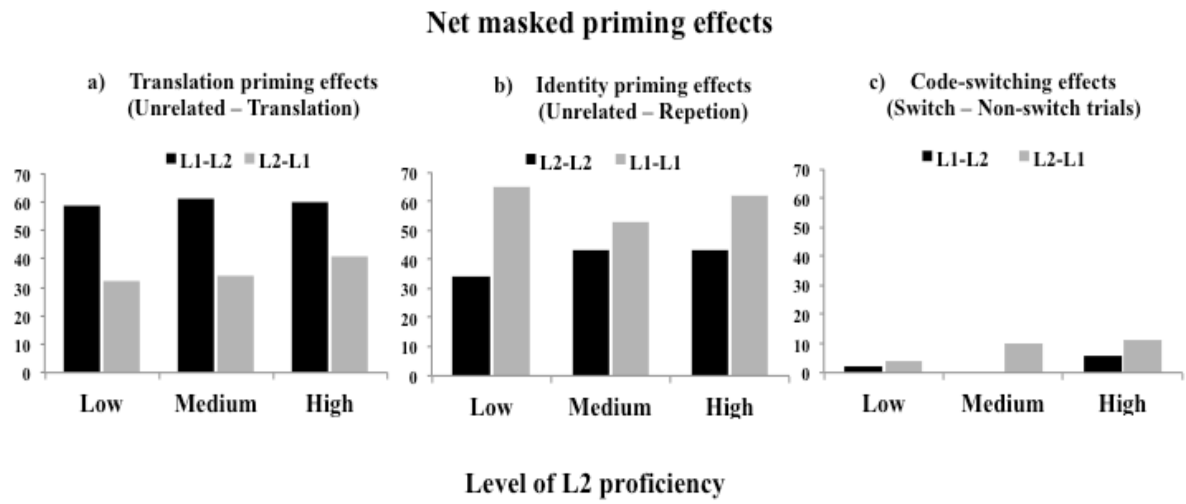
Post hoc analyses were performed on the reaction times and error rates collected with the three groups of bilinguals tested, including the Level of L2 proficiency as a between subject factor with three levels (low, medium, high). These analyses showed a modulation of the overall performance in the non-dominant language (Basque, sub-experiments 7a, 8a, 9a) by the level of L2 proficiency, as indicated by the significant main effect of L2 proficiency obtained in both the lexical decision latencies and error rates on the Basque targets [reaction times: $F1(2,84)=9.96$, $MSE=3452$, $p<.001$; $F2(2,396)=107.71$, $MSE=12786$, $p<.001$; error rates: $F1(2,84)=5.48$, $MSE=61$, $p<.01$; $F2(2,396)=6.74$, $MSE=212$, $p<.01$]. Pairwise comparisons on the error rates showed that both the highly proficient and medium proficient groups were more accurate than the low proficient one when responding to L2 targets (all $ps<.05$). The same pairwise comparisons performed on the L2 word latencies, revealed a progressive pattern of responses, with faster responses being obtained as a matter of increased L2 proficiency (all $ps<.05$).

Though the overall pattern of the identity and cognate translation priming effects obtained was seemingly comparable across the three levels of L2 proficiency, further analyses were performed on the word latencies after calculating the net priming effects (unrelated-repetition) obtained by each group in each target language. To directly examine the influence of L2 proficiency on the cognate masked translation priming effects, ANOVAs were conducted on the net priming effects obtained across the two cross-language priming conditions (unrelated-translation), following a 3(Level of L2 proficiency: low, medium, high) x 2(Translation direction: L1→L2, L2→L1), design. The only significant effect obtained in both the reaction times and error rates was the main effect of Translation direction (all $ps \leq .05$), further corroborating the overall asymmetric pattern of effects, while the main effect of Level of L2 proficiency or the interaction between the two factors were non-significant (all $ps > .22$). Accordingly, to test whether the level of L2 proficiency modulated the masked identity priming effects we conducted ANOVAs on the net priming effects obtained across the within-language priming conditions (unrelated-identity), including the Level of L2 proficiency and the Target Language as between and within subject factors, respectively. Once more, the main effect of the Level of L2 proficiency was not significant (all $ps > .60$). Finally, the ANOVAs conducted on the overall latency and error rate analyses of the L2 responses (Level of L2 proficiency x Prime language x Relatedness), revealed the absence of a modulation of the code-switching costs across the three bilingual groups, since the Level of L2 proficiency did not significantly interact with prime language (all $ps > .20$). Hence, although significant code-switching costs were obtained only in the responses of medium and high bilinguals to L1 targets (sub-experiments 8b and 9b), this combined analysis indicated that the overall pattern of responses as a matter of prime language did not significantly differ across the three groups tested.

8.8. Experiments 7-9: Discussion of the findings

After clearly establishing an asymmetric pattern of non-cognate masked translation priming effects for low proficient bilinguals (Experiments 1 and 2; Chapter 6) and showing that the level of L2 proficiency of unbalanced bilinguals does not affect the pattern of non-cognate masked translation priming effects repeatedly obtained with unbalanced bilinguals across the two translation directions (Experiments 4-6; Chapter 7), another set of lexical decision masked translation priming experiments was conducted in order to investigate whether the effects of automatic cross-language lexico-semantic activation would remain unaffected by the level of L2 proficiency in the presence of formal overlap across the critical translation equivalents. By mimicking the procedure followed in Experiments 4-6 of the present dissertation, three groups of non-simultaneous unbalanced Spanish-Basque bilinguals of different levels of Basque proficiency were selected and tested on both L1 and L2 cognate masked translation priming (Experiments 7-9). As seen, the overall performance on the L2 targets improved as a matter of increased L2 proficiency, validating the grouping of the participants based on their L2 competence. Just as in as in Experiments 4-6 with non-cognates, the general pattern of the critical cognate masked translation priming effects obtained was straightforward. These effects, though significant in both translation directions, were asymmetric, with larger forward than backward cognate masked translation priming effects for the three different groups tested. Furthermore, the effects were not modulated by the level of L2 proficiency of the bilinguals, fully replicating the pattern obtained with non-cognate translations with three groups of bilinguals of similar characteristics. In the same line, the overall pattern of masked identity priming effects, was also unaffected by the L2 proficiency of the participants. However, unlike what was the case with non-cognate masked identity priming effects (Experiments 1, 2 and 4-6), in the present set of experiments the masked identity priming effects obtained with cognates where asymmetric: larger L1→L1 than L2→L2 effects. In fact, though in the case of L1 targets, the masked identity priming effects were larger than the cognate masked translation priming L2→L1 effects, the opposite pattern was found with L2 targets for the three groups tested: larger translation than identity priming effects were obtained. This difference is relatively surprising, given that the within-language repetition primes completely overlapped with the targets both formally and semantically (*marinero* [sailor]-*MARINERO*), while the cognate translation primes apart from the semantic overlap, had 1 or 2 different ortho-phonological segments to the targets (e.g., *marinel-MARINERO*). At last, in line with the fact that the two languages tested in Experiments 7-9 shared their script (Roman script) and that the cross-language primes had an extensive amount of formal overlap with the targets (cognate translations), code-switching costs were smaller and less consistent than in the rest of the experiments of the thesis. Significant code-switching costs were only obtained for L1 targets for the medium and high proficient groups, while the more competent group also exhibited a marginally significant code-switching cost for L2 targets (see Figure 9, for an overview of the masked priming effects obtained in Experiments 7-9).

Figure 9. Summary of the net masked translation priming effects (in ms) obtained across Experiments 7a-9b: a) Cognate masked translation priming effects, b) Masked identity priming effects, and c) Masked code-switching costs.



8.8.1. Masked identity priming effects

The pattern of masked identity priming effects obtained with L2 and L1 targets in Experiments 7-9 contrasted to that obtained in all the previous experiments of the dissertation. Despite the fact that magnitude of the masked translation priming effects was not modulated as a matter of L2 proficiency, for the three groups masked identity priming effects were larger with L1 targets (sub-experiments 7b, 8b and 9b) than with L2 targets (sub-experiments 7a, 8a and 9a; i.e., an asymmetric pattern[11]). The larger L1-L1 than L2-L2 masked identity

[11] Though in the case of the medium proficient group the difference between the two identity priming effects was only marginally significant in the F1 analysis of the reaction times, the

priming effects could be initially thought to reflect a frequency-dependent effect predicted by the BIA theoretical framework (e.g., Dijkstra et al., 1999; Dijkstra & Van Heuven, 2002). According to this account, given that for unbalanced bilinguals L2 words are encountered less frequently than L1 words, they would require more time to be activated and hence they would lead to smaller priming effects. However, if the difference in the magnitude of the L1 and L2 masked identity priming effects would result from the relative frequency of use of L1 and L2 items, then the pattern of the effects should be also modulated by the level of L2 proficiency of the participants, since the more proficient bilinguals become in their L2, the more familiar they would be with the L2 items. This was not the case: the identity priming effects were virtually undistinguishable across the three different groups tested.

Moreover, while for L1 targets, masked identity priming effects were in all cases larger than the cognate masked translation priming effects (L2-to-L1), in line with the pattern obtained with non-cognates (Experiments 1, 2 and 4-6), in the case of the L2 targets, masked identity priming effects were found to be smaller than the L1-to-L2 masked translation priming effects. Given the consistency of this pattern across the three groups, it would be reasonable to assume that this could be either related to the intra-script manipulation used, or to the cognate status of the test items, since these were the two core differences to our Experiments 1, 2 and 4-6.

In an effort to understand the underlying mechanisms of this pattern of masked identity priming effects, the existing literature was reviewed. From the only two studies testing L1 and L2 masked identity priming effects with cognate words in combination to cognate masked translation priming effects only one used an intra-script manipulation. In this study, Davis and colleagues (2010) tested Spanish-English bilinguals of different levels of L2 proficiency and compared masked

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numerical difference between the L1 and L2 masked identity priming effects was in the same direction as the differences observed with the low and high proficient groups (i.e., an L1 identity priming effect 10ms larger than the L2 effect). This was further confirmed by the lack of an interaction between L2 proficiency and Target language in the post-hoc combined analysis of the net masked identity priming effects obtained throughout Experiments 7-9 (see subsection 8.7).

identity priming effects to cognate masked translation priming effects. Their results differed to ours in that translation and identity priming effects were of comparable magnitude and this symmetry was also found when comparing the L1 and L2 identity priming effects. Critically though, a number of marked methodological differences between the study by Davis and colleagues and our study, precluded a direct comparison of their results to ours. First, apart from the fact that unlike Experiments 7-9 of this dissertation, the experimental lists in the Davis et al. study included both cognates and non-cognates, the control condition against which identity and cognate translation priming conditions were compared was composed by nonwords with extensive orthographical overlap to the targets and not by the commonly used formally and semantically unrelated primes. Furthermore, each of the groups tested was composed of a relatively small number of participants, while the analyses of their responses were performed without taking into account their language dominance (i.e., responses of Spanish and English dominant bilinguals were analyzed conjointly). In fact, the authors found that L2 targets generated faster responses but more errors than L1 targets (speed/accuracy trade-off), suggesting that the language dominance of the bilinguals tested was not clearly identified.

In the other study exploring masked translation and identity priming effects with cognates within a single experiment, Gollan et al. (1997) reported a pattern of effects more akin to ours. These authors found larger identity than cognate masked translation priming effects with L1 targets and on the other hand, larger translation than identity priming effects with L2 targets. Although, the methodology followed throughout Experiments 7-9 of this thesis was clearly more comparable to the one followed by Gollan and colleagues (1997) than the one followed by Davis et al. (2010) there were still considerable methodological differences. First, both cognates and non-cognates were included in the experimental lists. Second, the experimental blocks were mixed in terms of target language, including both L1 and L2 targets. Third, the lists were not balanced either in terms of the number of test items belonging to each target language, nor in terms of the number of identity and translation primes included and, fourth, and possibly more critically, the study included a cross-script manipulation using a combination of Hebrew and English.

Hence, the overall pattern of identity priming effects as well as their relative magnitude in relation to the cognate masked translation priming effects cannot be directly related to the existing literature. Crucially, this pattern cannot be either explained by the bilingual models described in the General Introduction, since in all cases the models would predict larger identity than translation priming effects, as a result of the complete formal and semantic overlap of the identity primes to the targets (e.g., BIA, RHM). The only way a theoretical proposal could account for this set of findings would be by assuming a special pattern of activation of the L2 reading of intra-script cognates. Within the priming paradigm, this activation pattern would proceed in such a way that the L2-L2 cognate identity priming condition would involve a processing costlier than the one involved in performing the L1-to-L2 translation. In the last part of the dissertation (Part 3: Final Remarks), such an account will be described in detail and will be related to the existing evidence on cognate processing.

8.8.2. Masked code-switching effects

The code-switching effects obtained across Experiments 7-9 only reached significance when the two more proficient bilingual groups where presented with L1 (Spanish) targets. Still, the overall pattern of code-switching effects was consistent across all three groups in that the effects were remarkably elusive numerically small (i.e., ranged from -1 to 11ms) and elusive. The small and non-significant code-switching costs could be directly related to the fact that the prime-target language change present in the cross-language priming (switch) conditions only involved a small change in the visual input, as compared to the within-language conditions (non-switch). Considering that the cross-language primes were all cognates of the same script as the targets and that half of these primes were the cognate translations of the targets, differing only in one or two letters/phonemes, the visual or sub-lexical cues introducing the language change between primes and targets were limited. Given that under masked priming conditions code-switching effects seem to arise at early and pre-lexical levels of processing (around 250ms for intra-script manipulations, e.g., Chauncey et al., 2008; Duñabeitia, Dimitropoulou et al., 2010), it could be the case that the extensive ortho-phonological prime-target overlap at this sub-lexical level present in the switch trials, largely precluded the fast and automatic computation of the language membership of the primes. In line with the proposal that under masked priming conditions code-switching costs are more prominent when the prime-target language switch involves a clear orthographic cue of language membership, Casaponsa and colleagues (submitted) found that masked priming ERP code-switching costs in Spanish were only obtained when the Basque masked primes of the switch trials included language-specific bigrams and not when the Basque primes included bigrams also existing in the Spanish language.

However, small but significant effects emerged with L1 targets with the medium and the high proficient groups, possibly suggesting that once bilinguals reach a certain level of L2 competence, the language membership of the L2 masked primes is computed in a more effective way. This asymmetric pattern of code-switching costs is in line to the existing code-switching evidence obtained with unbalanced bilinguals where more marked costs have been obtained when switching from the non-dominant to the dominant language, than vice versa (e.g., Costa & Santesteban, 2004; Meuter & Allport, 1999; Von Studnitz & Green, 2002). The presence of these uni-directional and numerically small code-switching costs could be suggesting that despite the fact that on the whole, in the case of the intra-script cognate prime-target pairs our participants were presented with, the available sub-lexical cues of language membership were limited, some of the Basque (L2) primes could have been composed by language-specific bigrams, giving rise to the code-switching costs.

8.8.3. Cognate masked translation priming effects

Similar to the overall pattern of masked translation priming effects obtained with non-cognates across unbalanced bilinguals with different degrees of L2 competence (Experiments 4-6), the cognate masked translation priming effects obtained in the present set of experiments were remarkably consistent, though not completely in line to the predictions put forward by the different bilingual models. First, low, medium and relatively proficient but unbalanced Spanish-Basque bilinguals yielded significant cognate masked translation priming effects in both translation directions. Second, for the three groups these effects were larger in the L1-to-L2 translation direction (sub-experiments 7a, 8a and 9a) than in the L2-to-L1 translation direction (sub-experiments 7b, 8b and 9b). Third, the cognate masked translation priming effects were in all cases larger than the corresponding ones obtained with non-cognates with bilinguals of comparable levels of L2 competence (i.e., across the three groups and across the two translation directions). This far the results fit nicely with the existing empirical evidence as well as with the predictions put forward by the most influential bilingual models. As previously reviewed, cognate masked translation priming effects with unbalanced bilinguals have been found to be numerically larger than the effects obtained with non-cognates (e.g., De Groot & Nas, 1991; Gollan et al., 1997) as well as more consistent in the backward translation direction than the backward non-cognate masked translation priming effects, at least in languages sharing their script (e.g., Davis et al., 2010; De Groot & Nas, 1991). These larger benefits obtained for cognates vs. non-cognates could be reflecting an increased ease of activation of the cognate targets due to their large formal overlap to the preceding cognate translation primes, absent in the case of non-cognate translation pairs. Importantly, the reliable asymmetry obtained between the forward and backward cognate masked translation priming effects is also in line with previous findings, since, with the exception of the Davis' et al. study, this asymmetric pattern has been reported in all the studies testing cognate masked translation priming effects with unbalanced bilinguals across the two translation directions (De Groot & Nas, 1991; Gollan et al., 1997). Following the same rationale initially proposed to account for the non-cognate masked translation priming asymmetry, the models of bilingual lexico-semantic organization of reference in the bilingual literature (RHM, BIA (+, -d) and DevLex II) would in all cases predict such an asymmetric pattern of effects for cognate translations too. According to their proposals, this asymmetry would result from the imbalance in the activation status of L1 and L2 lexical items or from their relative ease of activation of the shared semantic node, present in bilinguals with a clearly identified L1 dominance (see Chapter 4 as well as subsections 6.5.3 and 7.8.3, for a detailed interpretation of the masked translation priming asymmetry by each model).

Still, just as with non-cognate translations, the lack of an influence of the level of L2 proficiency on the pattern of cognate masked translation priming effects in the presence of an improved overall L2 performance as a matter of increased L2 competence, does not fit with the predictions of either the RHM nor the BIA models (e.g., Dijkstra & Van Heuven, 2002; Grainger et al., 2010; Kroll et al., 2010). Through the application of different sets of working principles, these models would predict an attenuation of the masked translation priming asymmetry as the competence of the bilinguals in the non-dominant language increases, by assuming that as the L2 proficiency increases, the activation of the lexico-semantic links involved in the processing of the non-dominant language will become gradually more comparable to that involved in L1 processing. Once more, out of the models reviewed in the General Introduction (Chapter 4), only the DevLex II model (e.g., Zhao & Li, 2010) could account for the invariant pattern of cognate masked translation priming effects found across the three groups of bilinguals tested, since within this theoretical framework it is the age of L2 acquisition and not the level of L2 proficiency, the variable most drastically influencing the pattern of L1-L2 interactions. According to DevLex II, the “parasitic” and poorly defined representational status of L2 words in relation to L1 words giving rise to the L1-L2 processing asymmetries would only be eliminated with bilinguals who have started acquiring their second language simultaneously to the acquisition of their native language. Since, even the more proficient Spanish-Basque bilinguals tested in the present set of experiments (Experiment 9), had started acquiring Basque (L2) several years after fully developing their L1, the asymmetric pattern of effects should persist, in line what our findings revealed. In the final part of the dissertation (Part 3: Final Remarks) a detailed proposal on how the age of L2 acquisition could be critically involved in automatic cross-language interactions will be introduced.

PART 3

Final Remarks

CHAPTER 9

Summary of the findings and Conclusions

The main motivation for the present PhD project lies in the increasing amount of scientific interest on how the bilingual lexicon is organized and how interlingual connections operate through the process of acquisition of a second language. Within this framework, we focused on the early and automatic lexico-semantic processing taking place during single word comprehension in bilinguals with a clearly established L1 dominance. We furthermore focused on studying unbalanced bilinguals who had started learning a second language in late childhood or early adulthood, in a formal educational context, since this type of bilinguals comprise the vast majority of the existing bilingual population. During the L2 acquisition process the first connections between the native and the non-native language are established across translation equivalents. These word-pairs represent the most directly semantically related lexical items across languages, thus translation equivalents were selected as the ideal experimental materials to study cross language interactions, even at the early stages of L2 learning. Besides, though depending on the language combination under study, in a considerable amount of translation pairs the semantic relationship coexists with a formal relationship at the orthographic and/or phonological level of representation (i.e., cognates), thus providing the possibility of expanding the research scope on how this additional formal overlap modulates automatic cross-language lexico-semantic interactions at different moments of the L2 acquisition.

At the empirical level, in order to gain direct insights on the underlying structure of the bilingual lexicon, nine experiments were reported, in which the study of both non-cognate and cognate translation equivalents was combined with the masked priming paradigm (Forster & Davis, 1984), known to tap onto early strategy-free processing. Importantly, a number of studies had been already directed at examining masked priming effects with translation equivalents (see Tables 1 and 2). This existing literature had brought to light a relatively consistent asymmetric pattern of non-cognate masked translation priming effects depending on the prime-target language (i.e., the non-cognate masked translation priming asymmetry) along with several inconsistencies regarding how this pattern of effects is expressed throughout the L2 proficiency continuum with both cognate and non-cognate translations. Thus, all together the results reported so far, provided a further motivation at the empirical level to perform a set of nine experiments (Part II of the present Dissertation) *to explore the pattern of cognate and non-cognate masked translation priming effects obtained with unbalanced bilinguals differing in their level of L2 proficiency*.

The abundant cognate and non-cognate masked translation priming literature also provided a rich methodological framework, which was taken into account when designing the experiments to be performed (see Altarriba & Basnight-Brown, 2007, for a review of methodological issues to take under consideration when designing studies on cross-language semantic interactions). Accordingly, the methodological variations across the different experiments reported were kept to a minimum. As mentioned earlier, we first opted for using a brief SOA and masking the primes to ensure a non-strategic processing of the prime-target manipulation. Then, the task performed on the targets was consistently the widely used lexical decision task, while both translation directions were always tested with the same bilinguals, to eliminate further variance due to individual differences. The participants and materials selection was always performed based on several criteria, which minimally varied across experiments. Furthermore, the experimental lists were always balanced in terms of the prime-language, with half of the primes belonging to the target language and half to the non-target language, to avoid providing any processing benefit for any of the two languages involved. This balance in terms of prime language within each of the experiments also held the advantage of *examining whether switching languages, or not, between masked primes and targets affects L1 and L2 target processing across the different levels of L2 proficiency examined* (i.e., masked code-switching costs; e.g., Chauncey et al., 2011).

Additionally, apart from the cross-language priming manipulation, giving rise to the critical masked translation priming effects (cross-language unrelated vs. translation) in all the experiments, the primes belonging to the target language were also manipulated. Half were identical repetitions of the targets and the other half unrelated words, providing a masked identity full priming condition and its corresponding control (within-language unrelated vs. identity). This way, as has been already the case in some of the previous masked translation priming studies (e.g., Gollan et al., 1997; Jiang, 1999), a within-language priming effect to which the cross-language translation priming effect could be directly compared was included in the design. Still, given the importance of the L2 proficiency manipulation for the purposes of the present Thesis, the relevance of this masked identity priming effects is increased, especially since in the case of bilinguals with a low level of L2 proficiency the L2 masked identity priming effects could reflect the ease of processing of L2 words. Similarly, it is of great interest to examine the pattern of these *within-language repetition effects obtained across-different levels of L2 proficiency and to compare them against translation priming effects obtained with cognate and with non-cognate translations*.

9.1. Summary of the findings

9.1.1. Non-cognate masked translation priming effects with low proficient bilinguals

The first set of experiments of the present thesis (Experiments 1-3; Chapter 6), aimed at clearly establishing the pattern of non-cognate masked translation priming effects obtained across the two translation directions (L1→L2 and L2→L1) with relatively low proficient bilinguals who had started acquiring their second language late in life. Apart from the fact that this type of bilinguals are less commonly tested, this issue gained further importance in the light of a study (Duyck & Warlop, 2009) which tested low proficient bilinguals and reported a pattern of non-cognate masked translation priming effects different to the repeatedly reported non-cognate masked translation priming asymmetry (i.e., significant L1→L2 effects and smaller or null L2→L1 effects; e.g., Gollan et al., 1997). In this study, Duyck and Warlop (2009) reported significant and comparable non-cognate masked translation priming effects across the two translation directions with a group of late and low proficient Dutch-French bilinguals.

In two lexical decision experiments in which we used the same experimental materials and tested two groups of late and low proficient Greek-Spanish bilinguals across the two translation directions (Experiments 1 & 2), we obtained a pattern of non-cognate masked translation priming effects opposite to the one reported by Duyck and Warlop (2009). Critically, this was so even when adding a post-mask in the masked priming sequence (Experiment 2) to mimic the procedure followed by these authors. Non-cognate masked translation priming effects were only obtained in the forward translation direction and not in the backward translation direction, fully replicating the expected non-cognate masked translation priming asymmetry. This asymmetric pattern, in full alignment with the pattern found in the vast majority of the previous studies with more proficient but still unbalanced bilinguals, indicates that the L1 to L2 lexico-semantic links are active and functional even at low levels of L2 proficiency.

Moreover, in both experiments, and with both L2 and L1 targets, significant and symmetrical masked identity priming effects were found, which were larger than the non-cognate masked translation priming effects. Lastly, the same symmetric pattern of code-switching costs was obtained: with both groups of low proficient bilinguals, performance was negatively affected by prime-target language switches. These findings indicate that low proficient bilinguals effectively process L2 masked primes and that they also automatically process the language membership of L2 words.

Finally, Experiment 3 tested a monolingual Spanish control group with the materials used to test the forward translation direction in Experiments 1 and 2, obtaining only a code-switching cost for Spanish targets preceded by Greek targets, possibly boosted by the script change between Greek primes and Spanish targets.

9.1.2. Non-cognate masked translation priming effects at different levels of L2 proficiency

In Experiments 4-6 (Chapter 7), the question of whether the level of L2 proficiency of unbalanced bilinguals modulates non-cognate masked translation priming effects was addressed. Three groups of Greek-English unbalanced bilinguals differing only in their L2 competence (low, medium and relatively high proficient) performed lexical decisions on English (L2; sub-experiments 4a, 5a and 6a) and Greek targets (L1; sub-experiments 4b, 5b and 6b). Taking into account previous evidence of symmetric non-cognate masked translation priming effects with balanced bilinguals, a progressive attenuation of the masked translation priming asymmetry could be expected as a matter of increased L2 proficiency. Our findings across the three experiments were clear-cut: all groups showed significant bi-directional non-cognate masked translation priming effects which were larger in the L1→L2 translation direction. Crucially, though more proficient bilinguals showed an overall improved performance in L2, the asymmetric pattern of non-cognate masked translation priming effects was unaffected by the level of L2 proficiency of the bilinguals tested. The significant L2→L1 effects further confirmed that from early on in the L2 acquisition process, bilinguals automatically activate the semantic representations of L2 words, while the absence of a modulation of the effects as a result of the L2 proficiency manipulation showed that, the L1 dominance of unbalanced bilinguals is reflected in the pattern of automatic cross-language lexico-semantic activation irrespectively of the relative level of L2 proficiency.

In line with the findings of Experiments 1 and 2, masked identity priming effects were in all cases larger than the non-cognate masked translation priming ones and of comparable magnitude in the dominant and non-dominant languages (L2→L2=L1→L1). Moreover, these effects were unaffected by the L2 proficiency level of the bilinguals. Code-switching costs exhibited a similar pattern. The performance of the low, medium and high proficient bilinguals was affected to the same extent by prime-target language changes (L1→L2=L2→L1), suggesting that, under masked priming conditions and at least when the prime-target language switch entails a script switch, the resulting processing cost is unaffected by the level of L2 proficiency or the relative L1 language dominance.

9.1.3. Cognate masked translation priming effects at different levels of L2 proficiency

In the last set of lexical decision masked translation priming experiments (Experiments 7-9; Chapter 8) reported in the present Dissertation, the same procedure, experimental design and inter-group L2 proficiency manipulation as in Experiments 4-6 were applied, this time to the study of cognate masked translation priming effects. With these experiments we attempted to examine the influence of the variable found so far to be the one most notably defining translation processing: the cognate status (e.g., Lemhöfer et al., 2008). It should be noted that throughout the masked translation priming literature cognates have received a considerably smaller amount of interest and that the pattern of the expected effects across the two translation directions is far less straightforward than the established non-cognate masked translation priming asymmetry.

Once the lack of an impact of the relative L2 proficiency level of unbalanced bilinguals on the non-cognate masked translation priming asymmetry was established, we proceeded on testing whether this would also be the case when translations shared to a large degree their ortho-phonological representations. To this end, three groups of unbalanced (low, medium and high proficient) mono-scriptal Spanish-Basque bilinguals were tested. The results regarding the critical cognate masked translation priming effects were straightforward: the three groups exhibited significant bi-directional but asymmetric effects (i.e., larger forward than backward cognate masked translation priming effects) which did not differ as a matter of L2 proficiency. The asymmetric pattern of effects fully replicates the asymmetries reported with non-cognate translations throughout the first six experiments of the present thesis as well as in previous studies with unbalanced bilinguals (see Tables 2 & 4), and it clearly establishes the same asymmetric pattern for cognate translations in unbalanced bilingualism as well (see Tables 1 & 3).

However, the pattern of the masked translation priming effects in relation to the masked identity priming effects was found to differ for cognates as compared to non-cognates (Experiments 1-6). The masked identity priming effects were larger than the cognate masked translation priming ones only with L1 targets, while the reverse pattern was observed with L2 targets (i.e., larger translation than identity effects). As will be discussed, this pattern could be related to a closer interconnection of L2 cognates to their L1 translation equivalent, at least for languages sharing their script.

Lastly, the masked code-switching costs found in Experiments 7-9 were relatively elusive, only reaching significance with the two more proficient groups of bilinguals and only with L1 targets preceded by L2 primes. This pattern is in in line with the fact that the critical language combination in this experimental set involved an intra-script manipulation as well as the fact that the cross-language repetition (translation) involved cognate words largely overlapping at the formal level with the targets,.

9.2. General Conclusions

In an effort to summarize the main conclusions drawn from the results of the current research project, a grouping can be made based on whether they support already established findings or whether they illustrate future research directions. Following this grouping, moving from the broadest to the narrowest in terms of how bilingual process words and concepts, and from the most to the least well-established results, we ought to first point to the fact that the consistent effects of cross-language interactions taking place unintentionally provide further support to a *functionally language non-selective account of bilingual reading* (e.g., Thierry & Wu, 2007). Our findings of significant masked priming effects with primes belonging to the non-dominant language even for late and relatively low proficient bilinguals furthermore, support the proposal of *direct conceptual access of L2 words from the initial stages of L2 acquisition* (e.g., McLaughlin et al., 2004). The reliable asymmetric pattern of automatic co-activation of translation equivalents found for all groups of unbalanced bilinguals also confirms the fact that *as long as there is a clear L1 dominance, this is reflected in the pattern of activation of interlingual lexico-semantic links* (see French & Jacquet, 2004; Kroll & Tokowicz, 2005; Kroll et al., 2010, for reviews).

The present subsection of the last chapter of the present Dissertation aims at describing the main conclusions that can be drawn from the findings reported throughout Experiments 1-9, focusing on how the level of L2 proficiency affects first, the automatic processing of translation equivalents and then, the automatic within-language repetitions as well as the automatic computation of language membership.

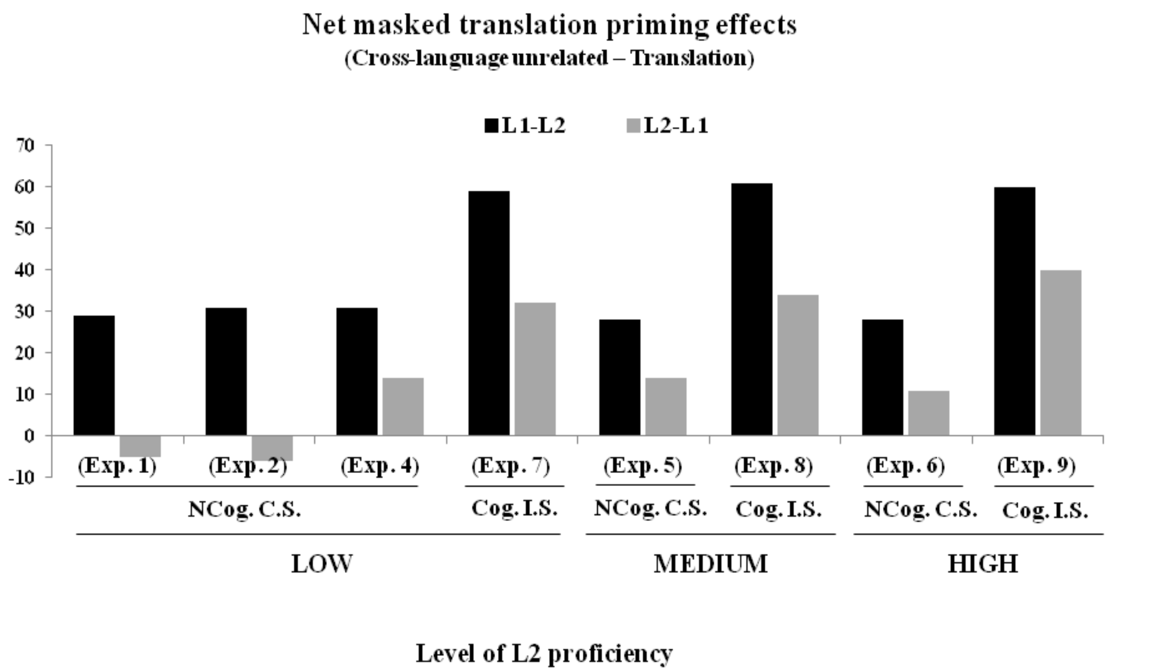
The implications of the entire set of results regarding the functional structure of the bilingual lexicon during the process of acquiring a second language and the factors found to affect it is discussed.

9.2.1. Automatic cross-language lexico-semantic interactions

The central experimental question tested in the present Dissertation addressed the way in which automatic cross-language lexico-semantic interactions take place in unbalanced bilinguals with different levels of L2 proficiency. Accordingly, the experiments were centered on the processing of translation equivalents under strategy-free conditions, since the processing of translation pairs taps both on the lexical as well as the semantic level of representation. Furthermore, the comparison of the processing of cognate vs. non-cognate translations provides an ideal setting to manipulate the cross-language overlap at the word-form level while maintaining constant the degree of semantic overlap across the test items. This way, the present research project offers a thorough investigation of how the level of L2 competence affects different levels of automatic cross-language interactions during visual word recognition.

The more straightforward conclusion drawn from the nine experiments presented in Part 2 is that as long as bilinguals have a clear L1 dominance, automatic cross-language lexico-semantic interactions show an asymmetric pattern This was reflected in our experiments as larger forward than backward masked translation priming effects. Critically, this pattern is unaffected by the degree of L2 competence of the bilinguals, by the cross-script or intra-script nature of the experiments, or the cognate status of the translations (see Figure 10). The cognate and non-cognate masked translation priming asymmetry completely fits the pattern reported in the previous lexical decision masked translation priming studies testing unbalanced bilinguals (see Tables 1-4) as well as the predictions of the most influential models of bilingual lexico-semantic organization (see Chapter 4). Nevertheless, the total absence of an influence of the level of L2 proficiency on masked translation priming effects is in contrast to the progressive attenuation of the asymmetry predicted by the RHM (e.g., Kroll & Stewart, 1994) and the BIA models (e.g., Dijkstra & Van Heuven, 2002; Grainger et al., 2010).

Figure 10. Summary of the net masked translation priming effects obtained throughout the present Dissertation with bilingual populations as a function of their L2 proficiency levels. In order to facilitate the reading of the figure, information on the cognate status (*Cog.*: Cognates; *NCog.*: Non-cognates) of the test items and the script combination (*I.S.*: Intra Script; *C.S.*: Cross Script) involved in each experiment is also provided.



Our findings are also in line with the increasing amount of evidence showing that L2 words (cognates and non-cognates) are effectively processed up to the semantic level, even at relatively low levels of L2 proficiency (e.g., Dufour & Kroll, 1995; Duyck & Brysbaert, 2004; 2008; Van Hell & De Groot, 1998). This conclusion is supported by the significant L2-to-L1 masked translation priming effects obtained with both cognates and non-cognates even with the less proficient bilinguals tested, as well as by the L2 within-language masked identity priming effects (Experiments 4-

9). Depending on the theoretical view taken, the significant effects obtained with L2 masked primes would indicate either that L2 masked primes have developed direct links to their corresponding semantic representations (RHM and BIA-d) or that their activation takes place fast enough to reach the higher semantic level of representation (BIA and BIA+). Finally, from the DevLex II (e.g., Zhao & Li, 2010) perspective, these effects would indicate that the L2 word nodes are relatively densely represented within the bilingual lexicon.

With regard to how the cross-linguistic similarity at the orthographic and phonological level across translations (i.e., cognates) affected the pattern of masked translation priming effects, our findings from Experiments 7-9 showed that the ortho-phonological overlap between intra-script cognates boosted the magnitude of the masked translation priming effects in both translation directions, since these effects were consistently larger than the ones obtained with non-cognates throughout Experiments 1, 2 and 4-6. In further detail, the forward cognate masked translation priming effects were on average 31ms larger than the forward non-cognate masked translation priming effects, while the same difference was found in the backward translation direction too (30ms). So far, the larger masked translation priming effects found for cognates fit nicely within the existing lexical decision masked translation priming literature (e.g., De Groot & Nas, 1991; Duñabeitia, Perea et al., 2010; Gollan et al., 1997). From a theoretical point of view, this pattern would be also in line with the RHM's proposal that cognate translations will have stronger lexical links to each other (e.g., Kroll & Stewart, 1994), as well as to the BIA models' proposal that cognates activate their translation equivalent faster than non-cognates do, as a result of their additional orthographic/phonological overlap across the two readings of a cognate (e.g., Dijkstra et al., 1999; Dijkstra & Van Heuven, 2002). However, the larger overall effects obtained with cognates as compared to non-cognates, when testing L1 targets, would have not be predicted by the DevLex II model, since simulations with translation equivalents have shown that effects of cross-language formal overlap are elusive during L1 processing. Finally, our findings showed that the presence of formal overlap for cognate translations did not alter the asymmetric pattern of the translation priming effects across the two translation directions, nor did it lead to differences across the groups with different L2 proficiency. This suggests that the asymmetric pattern of cross-language lexico-semantic interactions persists for cognate translations when non-simultaneous unbalanced bilinguals recognize words.

Hence, the persistence of the masked translation priming asymmetry irrespectively of the degree of exposure to the non-dominant language and of the cognate status of the translation pairs, found in the presence of significant effects in both translation directions suggests i) that active and functional bidirectional cross-language lexico-semantic links are established from relatively early during the L2 acquisition process, and ii) that the automatic activation of these links does not depend on the amount of exposure to the L2.

It should be noted though, that this does not mean that the early and automatic stages of L2 processing would be identical across the different types of bilinguals, since our findings can only be generalized to unbalanced bilinguals. In fact, an overview of the masked priming literature strongly suggests that there is indeed a critical distinction to be made across bilinguals with respect to the pattern of early and automatic cross-language effects: balanced vs. unbalanced bilingualism. The existence of a clear difference between balanced and unbalanced bilingualism can be deduced considering two critical findings. First, the asymmetric pattern of translation and cross-language associative/semantic masked priming effects emerging with unbalanced bilinguals is eliminated with balanced bilinguals (Duñabeitia, Perea et al., 2010; Duyck, 2005; Perea et al., 2008; Schoonbaert et al., 2009). Second, for unbalanced bilinguals cross-language lexico-semantic effects are consistently smaller than within-language ones, while for balanced bilinguals these effects are not affected by whether the manipulations involve both languages or just one, (i.e., comparable masked translation and identity priming N400 effects, as well as associative/semantic effects across-languages and within the same language, e.g., Dimitropoulou et al., 2012; Duñabeitia, Dimitropoulou et al., 2010; Perea et al., 2008). In light of the present findings it could be concluded that L2 proficiency, strictly defined as the amount of exposure to L2, is not the critical factor influencing these early effects. Hence, in combination with the previous masked priming evidence, the general pattern of our findings supports as more critical the balanced-unbalanced distinction rather than the high-low proficiency distinction.

If the critical distinction in the pattern of non-cognate masked translation priming effects reported throughout the lexical decision studies across the multiple groups tested is found between balanced and unbalanced bilinguals and if this distinction is not grounded on L2 proficiency differences, then which is the variable triggering the shift from the asymmetric to the symmetric pattern? According to some of the latest theoretical proposals as well as recent empirical evidence this critical factor could be the *age of L2 acquisition* (L2 AoA henceforth), based on which bilinguals would be grouped into early (or simultaneous) and late bilinguals. Due to maturational reasons, the acquisition of the dominant and the non-dominant languages in late L2 learners might rely on different mechanisms (potentially the lexical and the episodic memory systems), thus leading to asymmetric effects. In contrast, early learners acquiring their L1 and L2 in a relatively parallel way may have established lexical representations for both languages, in which case no asymmetry is expected in the pattern of masked translation priming effects obtained in the lexical decision task. Likewise, L2 AoA is also assigned such a fundamental part in the way L2 items are represented by DevLex-II (Zhao & Li, 2006; 2010). DevLex-II is an unsupervised connectionist network that does bilingual lexicon learning based on Hebbian Learning principles. Although the model does predict the expansion of the L2 lexicon with extensive training (i.e., increased proficiency), it proposes that it is the L2 AoA that mainly defines the functional properties of the L2 lexicon. As opposed to the well-defined lexica of simultaneous or early L2 bilinguals, the L2 lexicon of late bilinguals would be poorly-defined and "parasitically" related to L1 representations (Zhao & Li, 2010). In fact, even the BIA-d model (Grainger et al., 2010) emphasizes the importance of L2 AoA in shaping the bilingual lexicon by stating that their developmental hypothesis would exclusively hold for late L2 learners. Likewise, several studies point to a critical involvement of L2 AoA in the representational L1-L2 balance and its impact on semantic processing. Grossi, Savill, Thomas and Thierry (2010) found that only in late bilinguals performing a semantic categorization task in their L2, the hemispheric lateralization of the N1 ERP component - the earliest component thought to reflect linguistic processing - was highly correlated to the L1 pattern of N1 lateralization. This pattern suggests that for late and not for early bilinguals the L2 lexical organization is delimited by the existing L1 organization. Furthermore, in an fMRI translation priming study, Isel, Baumgaertner, Thrän, Meisel and Büchel (2010) found different neural patterns of cross-language repetition enhancement for early and late bilinguals performing a semantic categorization task. Moreover, some earlier comprehension studies have also shown that the pattern of L2 lexico-semantic activation of highly proficient bilinguals is closely related to the age at which exposure to the second language began (e.g., Kotz & Elston-Güttler, 2004; Silverberg & Samuel, 2004). Hence, from both a theoretical and an empirical perspective, it could be inferred that L2 AoA could be critically involved in the pattern of cross-language lexico-semantic activation. If L2 words are acquired simultaneously or in close temporal proximity to the acquisition of the L1 items they will develop stronger semantic connections with them and will be represented in a way similar to that of L1 items. This would in turn, be manifested as an attenuation of the L1-L2 processing asymmetries.

What is even more noteworthy is that when grouping the bilinguals who have participated in the existing masked translation priming lexical decision studies in early and late L2 learners the picture obtained is remarkably consistent with the proposal that L2 AoA could be indeed driving the overall pattern of masked translation priming effects. On the one hand, studies reporting the typical asymmetric masked translation priming pattern have tested late bilinguals who had started acquiring their L2 after early childhood (see Tables 3 and 4). On the other hand, studies presenting symmetric bi-directional effects have tested either simultaneous or early bilinguals (Basnight-Brown & Altarriba, 2007; Duñabeitia, Perea et al., 2010;

Duñabeitia, Dimitropoulou et al., 2010)[12]. Similar to what was the case with L2 proficiency, the potential influence of the L2 AoA on masked translation priming has not been investigated in isolation from other confounded variables. The most important limitation in this respect lays in the fact that all the studies examining masked translation priming effects have tested either late unbalanced or simultaneous/early native-like bilinguals. The present study is the first masked translation priming study to intentionally tease these two factors apart by examining bilinguals with different levels of L2 proficiency who had all started acquiring their second language later than their native language.

In more general terms, how would a simultaneous/early vs. late L2 AoA distinction affect the bilingual lexico-semantic organization? In our view this distinction would first affect the process followed to acquire the L2, and consequently the way L1 and L2 words become activated with respect to one another. Considering that the masked priming paradigm taps on non-strategic early processing, we will develop our rationale mostly based on evidence gathered using this paradigm while taking into account previous benchmark effects of the bilingual literature. In line with what has been already established, any theoretical proposal on bilingual lexico-semantic processing would have to assume i) that performance in each language would improve as a matter of increased exposure[13], ii) that starting from the sub-lexical level, activation would proceed in a parallel way across the two languages, with fast and automatic cross-language interactions taking place, and iii) that L2 direct lexico-semantic access would be achieved even by late and low proficient bilinguals. Critically, in this framework L2 AoA would not affect the ease of access of each specific lexical item but the *functional segregation* of the two languages. As previously mentioned, late bilinguals acquire their second language after both the

[12] The only studies whose results do not agree with this age of acquisition distinction are the studies by Duyck and Warlop (2009) and Davis et al. (2010), reporting symmetric effects with late bilinguals. However, as mentioned earlier this pattern could have been due to a lack of statistical power and to several methodological issues regarding the experimental procedures followed in these studies.

[13] The way in which increased exposure would affect the overall processing of each language would depend on the ortho-phonological relationship of the words of the two languages (e.g., script, proportion of cognates, interlingual homographs, etc.) and on the relative frequency of each specific lexical item (e.g., Gollan et al., 2011).

semantic system and the L1 lexico-semantic mappings have been established. The temporal separation of the L1 and the L2 systems would be reflected as a functional segregation of L1 and L2 words in a way that language-specific lexico-semantic activation would be more effective as compared to cross-language activation. Evidence in support of this proposal comes from studies showing comparable within-language masked priming lexico-semantic effects in native speakers and in less proficient late bilinguals when performing a pure L2 task (e.g., form, morphological or identity priming; Diependaele et al., 2011; Frost et al., 2005), and also from the fact that with late bilinguals masked translation priming effects have been found to be significantly smaller than masked identity priming effects (e.g., Midgley et al., 2009; Experiments 1,2, 4-6, 7b 8b, 9b of the present Dissertation). Moreover, in most cases, late bilinguals rely more on the already existing L1 translations to acquire the new L2 words. This would be reflected as a larger initial reliance on the activation of the L1 translation when recognizing and especially when producing L2 items (e.g., Elston-Güttler et al., 2005; Guo, Misra, Tam, & Kroll, 2012; Sunderman & Kroll, 2006).

In contrast, for simultaneous or early bilinguals L2 words would be acquired while the organization of the semantic system and of the L1 lexicon is not yet completed and would thus be represented with a less marked language tag (i.e., they would be functionally indistinguishable from L1 items), leading to comparable cross-language and within-language effects. In support of this assumption, Perea and colleagues (2008) found comparable cross-language and within-language masked associative/semantic priming effects with early Basque-Spanish bilinguals, which were later replicated with electrophysiological measures (Dimitropoulou et al., 2012) while Duñabeitia, Dimitropoulou et al. (2010) found symmetric N400 masked identity and masked translation priming effects with a different group of simultaneous bilinguals. Furthermore, given that early bilinguals usually acquire the L2 in a natural context without making reference to the L1, the co-activation of translation equivalents would mostly result from top-down feedback caused by their semantic overlap and less by association between translation equivalents at the lexical level. This is reflected in the pattern of masked translation priming ERP effects reported so far. Critically, only the studies testing late bilinguals have found, in addition to the N400 effects, significant non-cognate masked translation priming effects in the N250 time-window (e.g., Midgley et al., 2009; Schoonbaert et al., 2011), while Duñabeitia, Dimitropoulou et al. testing simultaneous bilinguals have only reported N400 effects, suggesting that with these bilinguals the co-activation of non-cognate translations is initiated later and is mainly dependent on their semantic overlap. In the same line, Guo and colleagues (2012) have recently shown that even at high levels of L2 proficiency, late bilinguals do activate automatically the L1 translation of L2 words.

The only exception to the proposed functional language segregation in the way translation equivalents are processed by late unbalanced bilinguals would be located in the pattern of activation of cognate words of the non-dominant language, and exclusively for languages sharing their script (i.e., mono-scriptal bilinguals). The unexpected finding of smaller within-language identity than cross-language translation priming effects obtained with Basque (L2) cognate targets (Experiments 7a, 8a and 9a), pointed towards a potential "special" activation pattern of L2 intra-script cognates. As seen, when processing Spanish (L1) targets, masked identity priming effects were larger than the translation priming effects, replicating the pattern obtained for non-cognates (Experiments 1, 2 and 4-6). However, with Basque (L2) targets this difference was inversed, with larger translation than identity priming effects emerging across the three groups tested. In fact, these L2 within-language masked identity priming effects were also smaller than the ones obtained with L1 targets. This pattern is surprising given that masked identity primes have been always found to lead to the strongest facilitative effects resulting from their complete overlap to the targets at all the levels of representation (see Nievas, 2010, for review). Moreover, throughout the six experiments reported in the present Dissertation with non-cognates, but with the exact same design as the one used in Experiments 7-9, masked identity priming effects with L1 targets were comparable to the effects obtained with L2 targets (see also Davis et al., 2010; Duñabeitia, Dimitropoulou et al., 2010; Gollan et al., 1997; Midgley et al., 2009), and in all cases larger than the translation priming effects (see also Jiang, 1999)[14]. The consistency of this surprising pattern found for L2 cognate repetitions in relation to the L1-to-L2 cognate translation priming effects across the three groups tested as well as a thorough revision of the existing literature on cognate processing, led us to tentatively propose that the activation pattern underlying the recognition of L2 cognates in mono-scriptal bilinguals is different to that of cross-script cognate and intra-script and cross-script non-cognate L2 words.

Taking into account that when processing L2 words even highly proficient bilinguals have been found to automatically activate the L1 counterpart (e.g., Guo et al., 2012; Thierry & Wu, 2007) and that even less proficient bilinguals directly access the semantic representations (e.g., Duyck & Brysbaert, 2004; 2008), we propose that in the case of mono-scriptal bilinguals processing L2 cognates, the activation of the L1 cognate translation equivalent would precede the activation of the lexical-representation of the input L2 word and of its corresponding conceptual representation, due to the extensive visual/orthographic overlap of the input L2 word to the L1 translation. Hence, a further processing cost would be added to the activation of the L2 lexical-representation. In other words, and in line with the proposal of bilingual connectionist models (e.g., BIA, DevLex II), upon visual presentation of a given word, L1 and L2 words overlapping at the formal and/or semantic level will be also activated. For cognates largely sharing their orthographic representation with their translation equivalent, the word of the non-target language receiving the strongest activation will be their cognate counterpart. Exclusively in the case of presentation of an L2 intra-script cognate to an unbalanced bilingual, the L1 translation will be the strongest attractor, even stronger than the proper L2 input word, due to the larger familiarization in terms of frequency of use with the L1 reading of the cognate (see also Li & Farkaš, 2002; Thomas & Van Heuven, 2005, for a similar interpretation of the cognate benefit). Support for the proposal that L2

[14] Gollan et al. (1997) found larger masked translation than identity priming effects with L2 cross-script cognates, while Davis et al. (2010) found comparable cognate and identity priming effects with unbalanced bilinguals. Nevertheless, as previously discussed, considerable methodological differences preclude further comparisons of these findings to the set of data collected with cognate translations in the present dissertation.

cognate processing might engage L1 activation to a larger extent than L2 non-cognate processing comes from studies showing that the presentation of cognate items, leads to an increase appearance of language switches (e.g., Kootstra, Van Hell, & Dijkstra, 2011). In the masked L2 identity priming condition, upon the presentation of an L2 cognate masked prime, first the L1 translation will be activated, which in turn will send activation to the L2 lexical representation, and the same process will also take place for the L2 targets. However, in the L1-to-L2 cognate translation condition, this process will only take place for the target, while the L1 prime will be more rapidly processed, thus giving rise to a more pronounced benefit than the one obtained for the L2-L2 repetition. Following this rationale, with regard to the effects obtained with L1 cognate targets (larger identity than translation priming effects), for identity primes the activation will proceed directly from the L1 visual input to the L1 lexical representation and will then match the L1 target's representation, while for L2 translation primes the effect would be smaller due to the processing cost added by the initial activation of the L1 translation equivalent of the prime. On the contrary, considering the lack of visual overlap between L2 cross-script cognates and L2 intra-script and cross-script non-cognates and their L1 translations, their processing will be directly initialized with the activation of the L2 lexical representation. It should be noted, that beyond this initial lexical activation, semantic activation as well as lexico-semantic interactions in the process of recognizing L2 intra-script cognates, would proceed in the same way as with non-cognates and cross-script cognates.

A similar account on how intra-script cognates could be processed has been put forward by Van Heuven and Thomas (2005; see also French & Jacquet, 2004). According to this view, the activation of the representations corresponding to the input stimulus proceeds within a multidimensional space composed by orthographic, phonological and semantic features, and is directed towards the representations of both L1 and L2 items that more closely match the input word. Representations corresponding to words overlapping on different dimensions will be more closely represented, thus functioning as attractors or competitors. In the case of the presentation of an L2 cognate word to an unbalanced bilingual, the extensive orthographic, phonological and semantic overlap with the L1 translation would direct the activation first towards the L1 reading of the cognate, as a result of the higher frequency of the L1 item. Hence, the recognition of this item would be considerably more effective than that of an L2 non-cognate word, since the L2 cognate will be initially identified as if it were an L1 word. In contrast, the processing advantage of an L1 cognate against an L1 non-cognate will be much more elusive, since in this case the L2 cognate translation will function as a less strong attractor, due to its less frequent use by the bilingual. Interestingly, the results of the simulations of the DevLex II model (Zhao & Li, 2010), are in the same line as this interpretation of the cognate benefit as well as with our pattern of findings with L2 cognates. In further detail, though DevLex II is so far only composed of semantic and phonological maps (not orthographic maps), when the researchers simulated the L2 learning of a non-simultaneous bilingual, as the ones we tested, by introducing in the model L2 inputs after introducing L1 inputs, the L2 words were broadly distributed across the maps and their location in the maps depended on the semantic and phonological similarity between the L2 and the L1 words: the more similar the newly introduced L2 items were to existing L1 items, the closer to them they would be located. Consequently, upon presentation of an L2 word, formally and semantically similar to an existing L1 word, as would be the case for L2 cognates, the closely represented L1 items would be strongly activated, thus functioning as attractors. For L2 cognates, the strongest attractor would be their L1 cognate translation, which could be activated before the target L2 reading of the cognate pair. Following this rationale, the DevLex II model would predict that the recognition of L2 cognates would involve the prior activation of the L1 version of the cognate, and would thus be costlier than that of L1 cognates, as the relative pattern of L2-L2 masked identity priming effects in comparison to the L1-L1 and to the L1-L2 masked translation priming effects suggested.

Considering the alignment of the overall pattern of effects obtained in the present experiments, with both cognates and non-cognates across the different L2 proficiency levels, with the predictions of the DevLex II model, we could conclude that, out of the bilingual models reviewed in the General Introduction (Chapter 4), DevLex II is the model most accurately accounting for our findings as a whole. Still, the validity of the proposed interpretation of the pattern of effects obtained with cognates in Experiments 7-9, as well as the proposal that the distinction between balanced and unbalanced bilingualism mainly reflects differences resulting from the relative AoA of the second language with respect to the first language, need to undergo further empirical testing as well as further simulations with the DevLex II model (see subsection 9.3).

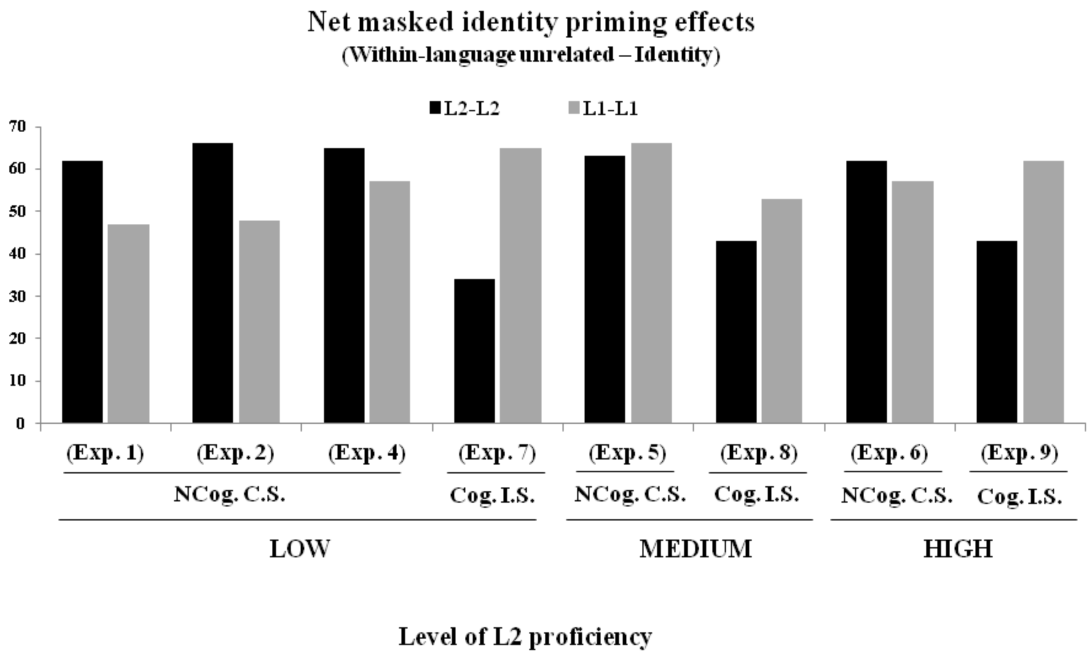
9.2.2. Automatic processing of within-language repetitions by bilinguals

In summary, throughout the present thesis significant masked identity priming effects were obtained with L1 and with L2 words, confirming previous findings of effective processing of L2 masked primes (e.g., Gollan et al., 1997; Jiang, 1999; see also Hoshino et al., 2010; Midgley et al., 2009; for ERP evidence). The overall pattern of these effects showed on the one hand, that L1 masked identity priming effects were unaffected by the L2 proficiency of the bilinguals or by the cognate status of the test items, and on the other hand, that L2 masked identity priming effects were influenced by the cognate status of the test items, but not by the degree of exposure to the non-dominant language. One straightforward conclusion of these findings is that L2 masked identity priming effects were not found to be sensitive to the relative frequency of use of the L2 words, since these effects were not modulated by the level of L2 competence of the bilinguals for neither non-cognates, (Experiments 4-6), nor for cognates (Experiments 7-9). In a similar vein, very recently, Duñabeitia and colleagues (2012) found masked morphological priming effects for derived L2 word pairs with unbalanced Spanish-English bilinguals, which were comparable to those obtained with balanced bilinguals (see also Perea et al., 2011). Altogether these results seem to suggest that at least under masked priming conditions, and in the presence of formally and semantically overlapping prime-target pairs, the effects are relatively blind to the frequency of use of the L2 words by the bilinguals[15].

The lack of an influence of the extent to which participants were familiarized with the test language was further extended to the symmetric pattern of L1 and L2 masked identity priming effects found irrespectively of the level of L2 proficiency of the bilinguals, though this was so only with non-cognate L1 and L2 words. Critically, this pattern has been previously obtained with L1 and L2 non-cognate words with both masked and visible primes (e.g., Geyer, Holcomb, Midgley, & Grainger, 2010; Hoshino et al., 2010; Midgley et al., 2009). As previously discussed (see Chapters 6 and 7), these findings could be indicating that at least when the test items do not have any formal similarity to their translations, within-language repetition priming effects could be taking place in a language-specific manner. In contrast, when participants were presented with cognate within-language repetitions, L1 words yielded larger effects than L2 words for the three bilingual groups tested (low, medium and high proficient; Experiments 7-9). In fact, when reviewing the masked identity priming effects obtained throughout the present experiments, in an effort to identify the origins of this asymmetric pattern, it is that this difference stems from the considerably smaller effects obtained for L2 cognates (see Figure 11). The potential processing cost causing these apparently smaller masked identity priming effects found for L2 cognates was discussed in the previous subsection (subsection 9.2.1).

[15] Within the masked priming literature, there is an ongoing debate regarding the appearance of lexical frequency differences on identity priming effects (e.g., Grainger, Lopez, Eddy, Dufau, & Holcomb, 2012; Ferrand, Grainger, & Segui, 1994; Nievas, 2010; Segui & Grainger, 1990; Sereno, 1991; but see Bodner & Masson, 1997).

Figure 11. Summary of the net masked identity priming effects obtained throughout the present Dissertation with bilingual populations as a function of their L2 proficiency levels. In order to facilitate the reading of the figure, information on the cognate status (*Cog.*: Cognates; *NCog.*: Non-cognates) of the test items and the script combination (*I.S.*: Intra Script; *C.S.*: Cross Script) involved in each experiment is also provided.



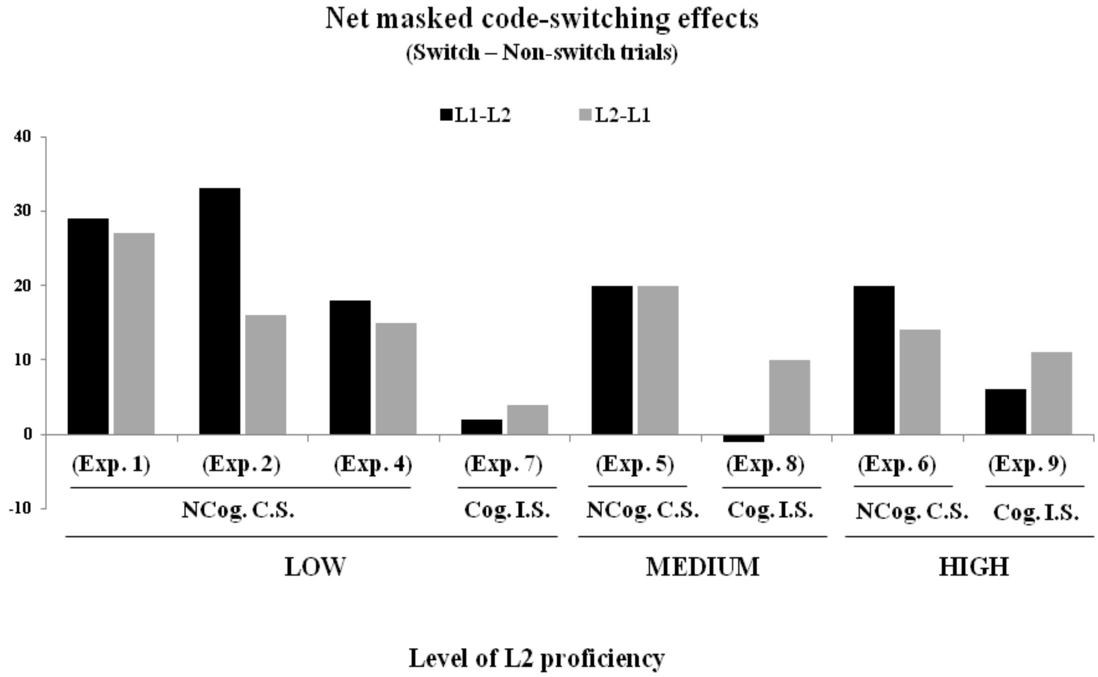
9.2.3. Automatic processing of language membership

The study of the automatic processing of language membership at different levels of L2 proficiency holds a substantial amount of interest at the empirical as well as at the theoretical level. The ability to identify language membership and to switch between languages has been related to a more effective use of attentional resources and to better cognitive control in bilinguals as compared to monolinguals (e.g., Bialystok, Craik, & Luk, 2012). Despite the fact that the study of code-switching costs emerging under masked priming conditions was not the main focus of the present work, the inclusion of an equal amount of target and non-target language primes in each of the nine masked priming experiments, allowed for a direct exploration of how unbalanced bilinguals process language membership from an early stage during the L2 acquisition process. Several production and comprehension studies have consistently found additional processing costs when bilinguals move from one language to the other (i.e., code-switching cost), whose magnitude differs for unbalanced and balanced bilinguals and for L1-to-L2 and L2-to-L1 language switches (e.g., Alvarez et al., 2003; Costa et al., 2006; Grainger & Beauvillain, 1987; see Kroll, Bobb, Misra, & Guo, 2008, for a review). Such code-switching effects have also been reported under masked priming conditions in the comprehension modality but mainly using electrophysiological measures (e.g., Casaponsa et al., submitted; Chauncey et al., 2008; 2011; Duñabeitia, Dimitropoulou et al., 2010). At the behavioural level however, the masked priming evidence on code-switching costs is still scarce (e.g., Perea et al., 2008).

Given that the present dissertation examined the processing of cognates and non-cognates and tested mono-scriptal and bi-scriptal bilinguals with different L2 proficiency levels, several conclusions can be drawn regarding whether the cross-language formal similarity, as well as the L2 competence of the bilinguals, affect the behavioral pattern of automatic code-switching costs (see Figure 12). At first, it is noteworthy that significant costs for the cross-language priming conditions, as compared to the within-language conditions, were obtained even when primes were only implicitly processed, and even when the bilinguals had a relatively low level of L2 competence. The fact that these effects emerged under masked priming conditions, suggests that their nature is mostly lexical, in line with the BIA and BIA-d models' account (e.g., Grainger & Dijkstra, 1992; Grainger et al., 2010; van Heuven, Dijkstra, & Grainger, 1998). This comes in contrast to the proposal of the Inhibitory Control (e.g., Abutalebi & Green, 2007) and BIA+ models (Dijkstra & Van Heuven, 2002) locating the effects of language membership outside the lexical processing system, on a task-dependent post-lexical level. The BIA and BIA-d models propose that for bilinguals, language identification takes place within the lexical system where the language nodes are found, and that it depends on the relative activation of the lexical representations belonging to each of the two languages. Accordingly, costs resulting from language switches emerge as a result of top-down inhibition from the non-target language node to the lexical representations of the target language. Furthermore, the fact that such effects were obtained even with low proficient bilinguals (with a cross-script manipulation; Experiments 1, 2 and 4), suggests that early on in the L2 acquisition process, language membership is rapidly computed, at least when considerable language-specific sub-lexical cues are available.

The overall pattern of effects suggested that indeed the presence of language-specific visual cues modulated the automatic code-switching costs. Specifically, all the experiments in which a cross-script manipulation was included showed significant and symmetric code-switching costs (i.e., comparable effects for L1-to-L2 and L2-to-L1 language switches; Experiments 1, 2 and 4-6), which were virtually identical across the different levels of L2 proficiency tested. Notably, though previous studies testing unbalanced bilinguals have revealed a modulation of the effects depending on the direction of the language switch, such an asymmetry was not found in our experiments with bi-scriptal bilinguals. In fact, a comparable code-switching cost was also found with a Spanish monolingual control group tested with the same materials as the Greek-Spanish bilinguals tested in Experiments 1 and 2. The absence of a modulation of these processing costs by the switch direction or by the level of L2 proficiency when a cross-script set of materials was used contrasts with the predictions of the BIA and BIA-d models which would predict an increase in the top-down inhibition from the L2 language node to the L1 word-forms as a matter of increased L2 proficiency, at least for intra-script language switches (Grainger et al., 2010). Therefore, our results could be indicating that the strong visual cues of language membership, available upon prime presentation, could be overwriting any differences related to the relative degree of activation of the L1 and L2 language nodes (see also Casaponsa et al., submitted; Vaid & Frenck-Mestre, 2002, for evidence of increased effectiveness in computing language membership in the presence of language-specific sub-lexical cues).

Figure 12. Summary of the net masked code-switching effects obtained throughout the present Dissertation with bilingual populations as a function of their L2 proficiency levels. In order to facilitate the reading of the figure, information on the cognate status (*Cog.*: Cognates; *NCog.*: Non-cognates) of the test items and the script combination (*I.S.*: Intra Script; *C.S.*: Cross Script) involved in each experiment is also provided.



In the absence of these sub-lexical cues, when testing code-switching costs with cognate words belonging to languages sharing their script (Spanish-Basque, Experiments 7-9), the pattern of effects was considerably altered. In this case code-switching costs were only found when the language switch was from the L2 to the L1, and were found only for the two more proficient groups. This pattern is in line with previous evidence gathered on intra-script language switching costs, showing more consistent effects when bilinguals were required to switch back to their dominant language (e.g., Costa et al., 2006). Furthermore, similar to our findings, code-switching studies with intra-script manipulations have also found a symmetric pattern of code-switching costs across the two switching directions only for bilinguals of the higher L2 proficiency level (e.g., Costa et al., 2006; Duñabeitia, Dimitropoulou et al., 2010; Koostra, van Hell, & Dijkstra, 2012). Considering the clear difference in the pattern of code-switching costs obtained with cross-script non-cognates and with intra-script cognates, it seems plausible to assume that bilinguals make use of the earliest available cues to identify the language membership of the input words. It is in the absence of such low-level cues that the relative activation of L1 and L2 language nodes comes into play and further processing differences related to the switching direction and to the level of L2 proficiency appear.

9.3. Future directions

As we approach to the end of the Dissertation, it can be concluded that apart from adding further evidence to some central but already answered questions on bilingual lexico-semantic processing, our findings also elucidated other issues regarding the variables influencing bilingual visual word recognition. In summary, the central findings of the present research project revealed that the interlingual lexico-semantic links involved in the automatic processing of translation equivalents are active and functional from relatively early on in the L2 acquisition process and across both language directions (i.e., L1-to-L2 and L2-to-L1). Moreover, our findings highlighted as defining the distinction between late and unbalanced bilinguals and early and balanced bilinguals, rather than the distinction between low and high proficient bilinguals. This could be deduced by the fact that the activation pattern of translation equivalents across the two translation directions was consistently asymmetric, throughout the different levels of unbalanced and late bilingualism and independently from the cognate status of the translation equivalents,. Furthermore, though not reflected in the masked translation priming asymmetry, the differences in the overall pattern of effects obtained with cognates as compared to non-cognates, indicated that the processing of intra-script cognates in their L2 version might involve a lexico-semantic activation pattern different to that of L1 cognates and to that of L1 and L2 cross-script non-cognates. Lastly, our findings underlined the importance of the presence of language-specific sublexical cues during the automatic processing of language membership.

As a final remark, the need of directing future research on specific aspects of bilingual language processing is also brought to light by our results. In this sense, how and when the processing asymmetries observed in unbalanced bilingualism are transformed into the symmetric pattern found for balanced bilinguals need to be established (e.g., Costa et al., 2006; Dimitropoulou et al., 2012; Duñabeitia, Dimitropoulou et al., 2010; Duñabeitia, Perea et al., 2010). As indicated by our findings, the distinction between balanced and unbalanced bilingualism goes beyond a grouping exclusively based on the level of L2 proficiency, measured as the amount of exposure to the second language. Hence, and taking from the BIA-d's (Grainger et al., 2010) proposal of the existence of a "magic moment" in L2 acquisition where the bilingual lexico-semantic system suffers a reorganization, it is of outstanding importance to identify not just when this "magic moment" takes place, but, and possibly even more critically, what variables trigger the appearance or not of this moment and how these interact with each other (i.e., how an unbalanced bilingual becomes balanced?). The finding that with non-simultaneous unbalanced bilinguals the L2 proficiency manipulation alone did not affect the masked translation priming asymmetry, could be pointing to the need to focus future research on L2 AoA as a potential factor driving the differences observed across balanced and early vs. unbalanced and late bilinguals in masked translation priming. This factor, typically neglected in word recognition studies (favoring proficiency manipulations) might significantly alter the L2 word processing mechanisms of bilingual readers. With regard to the masked translation priming effect, an essential test of this account would be to explore i) whether the symmetric masked translation priming pattern obtained with early balanced bilinguals would persist with late balanced bilinguals and ii) whether early but unbalanced bilinguals would exhibit the masked translation priming asymmetry consistently found with late unbalanced bilinguals.

Furthermore, with regard to whether for mono-scriptal bilinguals, the recognition of L2 cognate words proceeds in a unique way as compared to L2 non-cognate as well as to L2 cognate and non-cognate processing with bi-scriptal bilinguals, numerous predictions need to be put under test. First, if this is indeed the case, balanced bilinguals should show a symmetric pattern of cognate effects for their two languages (cognate vs. non-cognate), confirming that when the processing of the two languages is virtually undistinguishable, the non-target language reading of the cognate is no longer the stronger attractor upon the presentation of a cognate. Moreover, examining the overall pattern of responses to L1 and L2 cognates and non-cognates obtained with bilinguals with a progressively higher level of L2 proficiency or a progressively larger L2 AoA (up to balanced bilinguals), would be informative with respect to whether increased exposure to the non-dominant language or increased L2 AoA affect differently cognate and non-cognate processing. In fact, combining such a design with a script manipulation (cross-script vs. intra-script language combination) could clarify whether for bi-scriptal bilinguals the activation pattern of translation equivalents (non-cognates and phonologically overlapping cognates) is fundamentally different to that of mono-scriptal bilinguals.

In the same line, but focusing on masked translation priming effects, a replication of the L2 proficiency manipulation across unbalanced bilingualism, but this time testing the two script and cognate-status combinations unexplored in this Dissertation, would provide a strongest test to the two main conclusions of the present set of data: that the pattern of masked translation priming effects is unaffected by the level of L2 proficiency and that the recognition of L2 intra-script cognates proceeds in a different way. Such a replication would have to involve on the one hand, non-cognate translations belonging to languages that share their scripts and on the other hand, cross-script cognate pairs.

Finally, it should be kept in mind that the current research project has been exclusively focused on the pattern of effects of automatic co-activation of translation equivalents gathered with the lexical decision task. Taking into consideration the variant pattern of masked translation priming effects emerging with participants performing tasks other than the lexical decision (e.g., Finkbeiner et al., 2004; Jiang & Forster, 2001; Wang & Forster, 2010), as well as the evidence gathered outside the masked priming context revealing a task-dependency of bilingual lexico-semantic processing (e.g., Dijkstra et al., 2010; Francis, 1999), establishing an unequivocal pattern of automatic cross-language lexico-semantic interactions and fitting this pattern into a single theoretical framework of bilingual processing remains crucial.

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PART 4

Resumen en Español

Activación Automática de Traducciones durante el Reconocimiento Visual de Palabras en Bilingües

1. Introducción

En la actualidad, más de dos tercios de la población global es capaz de comunicarse en más de un idioma. Según los criterios establecidos por la comunidad científica, todos ellos son objeto de estudio de la investigación sobre el fenómeno del bilingüismo en sus diferentes vertientes (social, cultural, cognitiva, etc.), ya que, aunque con edades de adquisición distintas, dispares niveles y contextos de exposición a la lengua no dominante (L2), son considerados como bilingües. Este diverso grupo de bilingües, cuyo tamaño se encuentra en constante aumento, se compone en su mayoría de individuos denominados *bilingües tardíos y no-balanceados*, que tienen una clara dominancia de la lengua materna/nativa (L1) y que han comenzado a adquirir la L2 durante su infancia o principios de la edad adulta en un contexto educativo. En estos casos, el punto de partida para comenzar a adquirir la segunda lengua, parte a menudo por el establecimiento de lazos directos entre la nueva lengua y la lengua que los individuos ya dominan, y se realiza mediante la identificación de *pares de traducciones* entre las dos lenguas (p.ej., *casa* y *house* en castellano e inglés, respectivamente). La importancia del procesamiento de estos pares de traducciones en el proceso de aprender una segunda lengua se ha visto reflejada en algunas de las propuestas de organización léxico-semántica de la mente bilingüe, que plantean que para un bilingüe que se encuentra en los primeros estadios de aprendizaje de la L2, la asociación de las palabras en la L2 con sus equivalentes en la L1 es necesaria para poder procesarlas eficazmente. De manera correspondiente, para un bilingüe con un mayor nivel de exposición a la L2, esta mediación de la L1 durante el procesamiento de la L2, no sería obligatoria. Más allá de comprobar la validez de estas propuestas a nivel empírico, el uso de las traducciones en la investigación sobre la organización de la mente y el cerebro bilingüe, está muy extendido dado que estas ofrecen un marco idóneo para estudiar cómo interactúan las palabras de los dos idiomas entre sí y entre el nivel semántico, manteniendo constante la relación con el significado que comparten.

Gran cantidad de información sobre la organización léxico-semántica de los bilingües, tanto durante la producción oral como durante el reconocimiento visual de palabras (lectura) en L1 y en L2, ha sido hasta el momento recogida por investigaciones con manipulaciones relacionadas al procesamiento de las traducciones (véase p.ej., de Groot & Nas, 1991; Kroll & Stewart, 1994). Sin embargo, a menudo los resultados obtenidos se ven contaminados por procesos asociados a la resolución de la tarea que los participantes han de realizar, ya que sobre todo cuando las medidas de interés son conductuales (tiempos de respuesta y porcentajes de errores), el investigador no puede identificar qué parte del resultado obtenido es debida a la carga cognitiva que supone la tarea a realizar y qué parte se debe puramente al procesamiento de las traducciones. Para evitar este tipo de contaminación, más recientemente, los investigadores han optado por recoger datos en contextos experimentales en los cuales la manipulación experimental no pueda ser percibida conscientemente por los participantes (p.ej., Thierry & Wu, 2007). Un paradigma experimental ampliamente usado en investigaciones sobre el reconocimiento visual de palabras, tanto en monolingües como en bilingües, en el que los efectos observados están libres de este tipo de contaminación, es el paradigma de *priming enmascarado* (Forster & Davis, 1984). En este paradigma, se presentan sucesivamente dos palabras que guardan algún tipo de relación, mientras que el participante solo es consciente de la presentación de la segunda (target), ya que la primera (prime) es presentada muy brevemente (entre 30 y 60ms) y enmascarada entre una máscara (p.ej., #####) y el target. El participante ha de realizar sobre la palabra-target algún tipo de juicio no relacionado con la manipulación entre prime y target. Los efectos de priming enmascarado obtenidos resultan de la comparación entre la respuesta sobre el target, cuando este es precedido por un prime relacionado y la respuesta sobre el mismo target, cuando este es precedido por un prime que corresponde a una condición de control no relacionada con el target. Dado que en el priming enmascarado el participante no es consciente de la presencia del prime, y menos de la relación entre el prime y el target, se considera que los efectos observados reflejan estadios de procesamiento tempranos y automáticos, motivo por el que estos datos dan información sobre la estructura de las representaciones subyacentes.

Los estudios de priming enmascarado que en primer lugar han explorado el reconocimiento visual de palabras con monolingües, han mostrado efectos facilitadores de priming con pares de palabras-prime y target que comparten parcialmente o completamente sus representaciones ortográficas, fonológicas y/o semánticas (véase Lupker & Kinoshita, 2003, para una revisión de dichos efectos). Posteriormente, en la literatura sobre el procesamiento del lenguaje por bilingües, efectos similares han sido también obtenidos mediante la presentación de palabras-prime y palabras-target de la lengua no-dominante (p.ej., Diependaele et al., 2011), con el fin de investigar la medida en la que el procesamiento de la L1 es comparable al de la L2. Más recientemente, los efectos de priming enmascarado han sido investigados con primes y targets de diferentes lenguas (primes de la L1 y targets de la L2 y viceversa), con el fin de estudiar la existencia y la funcionalidad de conexiones entre las dos lenguas de un bilingüe en los diferentes niveles de procesamiento lingüístico (ortográfico, fonológico, léxico-semántico; p.ej., Altarriba & Basnight-Brown, 2007; Brysbaert et al., 1999; Dimitropoulou et al., 2011).

En la literatura existente sobre la lectura en bilingües, se han reportado numerosas instancias de investigaciones realizadas con el priming enmascarado en las que los pares críticos de primes y targets son pares de traducciones, *el priming enmascarado de traducciones*. Comparando los tiempos de reacción obtenidos sobre los targets precedidos por primes que son sus traducciones (p.ej., *casa-HOUSE*) a los tiempos obtenidos sobre los targets precedidos por primes de la lengua no-target que no mantienen ninguna relación formal o semántica con los targets (p.ej., *perro-HOUSE*), se obtiene el denominado *efecto de priming enmascarado de traducciones* (p.ej., de Groot & Nas, 1991). La mayoría de estas investigaciones ha examinado los efectos de priming enmascarado de traducciones usando la tarea de decisión léxica, en la que los participantes han de decidir si la palabra-target es una palabra real/existente o una palabra inventada. Además estos estudios se han centrado en bilingües que, si bien tenían una clara dominancia de su L1 (bilingües no-balanceados), tenían un nivel de competencia alto en su L2. Con este tipo de bilingües el resultado más frecuente ha sido un patrón asimétrico de efectos, donde efectos facilitadores de priming enmascarado de traducciones han aparecido principalmente con primes de la L1 y targets de la L2, y con menor frecuencia con primes de la L2 y targets de la L1. Además, mientras una pequeña parte de estos estudios ha examinado el procesamiento de traducciones que comparten en gran medida sus representaciones ortográficas y/o fonológicas (traducciones cognaticias, p.ej., *guitar* y *guitarra*, en inglés y castellano, respectivamente; véase por ejemplo, Duñabeitia, Perea et al., 2010), la mayoría ha usado exclusivamente traducciones que solo comparten su significado y no sus representaciones léxicas (traducciones no-cognaticias, p.ej., *house* y *casa;* Gollan et al., 1997; Grainger & Frenck-Mestre, 1998). De hecho, es con este último tipo de traducciones, donde la asimetría entre los efectos obtenidos en las dos direcciones de traducción ha sido más frecuentemente reportada (véase Tablas 1-4, de la tesis).

Aunque mayoritariamente los estudios de priming enmascarado de traducciones se han enfocado en el procesamiento de traducciones no-cognaticias por bilingües no balanceados pero altamente competentes, existe evidencia obtenida con bilingües que han adquirido las dos lenguas simultáneamente y no tienen una dominancia lingüística definida entre ellas (bilingües balanceados) que apunta a que el nivel de competencia entre las dos lenguas determina la efectividad de las conexiones inter-lingüísticas. Estos estudios han encontrado efectos simétricos de priming enmascarado de traducciones con efectos comparables con primes en L1 y targets en L2 y viceversa (véase Basnight-Brown & Altarriba, 2007; Duñabeitia, Perea et al., 2010; Duñabeitia, Dimitropoulou et al., 2010). Por otro lado, el único estudio que ha examinado estos efectos en bilingües tardíos de menor nivel de competencia en la L2 ha encontrado un patrón simétrico, similar al obtenido con bilingües balanceados (Duyck & Warlop, 2009). Sin embargo no existe un estudio que haya comprobado empíricamente si el nivel de competencia en la lengua no-dominante es lo que determina el patrón de los efectos de priming enmascarado de traducciones, manipulando directamente esta variable.

Esta tesis está dirigida a examinar empíricamente la siguiente pregunta experimental: *¿Cuál es el impacto del nivel de competencia en la lengua no-dominante de bilingües tardíos y no balanceados sobre los patrones de activación automática de las conexiones léxico-semánticas entre las dos lenguas?*

2. Los experimentos

Para obtener evidencia que nos permita contestar a la pregunta empírica planteada, hemos realizado una serie de nueve experimentos de priming enmascarado de traducciones, en los que los participantes realizaban decisiones léxicas sobre las palabras-target. Cada uno de los nueve experimentos examina los efectos de priming enmascarado de traducciones en ambas direcciones de traducción (de L1 a L2 y de L2 a L1) usando siempre el mismo diseño experimental. En este diseño además de las condiciones de priming de traducción (p.ej., *casa-HOUSE*) y su correspondiente control de prime no relacionado (p.ej., *perro-HOUSE*) se han incluido dos condiciones de priming en las que los primes son presentados en la misma lengua que los targets: una condición de primng de identidad (p.ej., *house-HOUSE*), que se considera el prime de mayor efectividad posible, y su correspondiente control (p.ej., *brain* [cerebro]-*HOUSE*). La inclusión de estas dos últimas condiciones de priming ha permitido comparar los efectos obtenidos entre lenguas con los obtenidos intra-lengua y comprobar la medida en la que los participantes serían capaces de procesar de forma efectiva los primes en su lengua no dominante (véase también Gollan et al., 1997; Jiang, 1999). Por último, el presente diseño experimental ha permitido también reunir información sobre los costes de cambio de lengua entre primes y targets que emergen de forma automática, dado que el cambio de lengua entre prime y target no es conscientemente procesado (véase Chauncey et al., 2008; 2011; Costa et al., 2006).

Los nueve experimentos realizados se presentan divididos en tres grupos, dependiendo de la pregunta experimental de interés. En el primer grupo, se investigaron *los efectos de priming enmascarado de traducciones no-cognaticias obtenidos en las dos direcciones de traducción con bilingües tardíos y de bajo nivel de competencia en la L2* (Capítulo 6). En el Experimento 1 se examinó a un grupo de bilingües griego (L1)-español (L2) de bajo nivel de competencia en español. En el Experimento 2 se examinó a otro grupo de bilingües griego (L1)-español (L2) de un nivel de competencia en español semejante al de los participantes del Experimento 1, y con los mismos materiales. Sin embargo, en este caso, en la secuencia de presentación de los estímulos se incluyó una máscara (50ms), entre el prime y el target, para replicar la metodología usada por Duyck y Warlop (2009) en el único estudio de priming enmascarado de traducciones con bilingües de bajo nivel de competencia en la L2. Finalmente, en el Experimento 3, un grupo de hablantes monolingües de español fue examinado, usando los mismos materiales que se usaron en los experimentos anteriores para explorar los efectos obtenidos con los targets en español.

El segundo conjunto de experimentos (Capítulo 7) fue orientado a investigar *la influencia del nivel de competencia en la lengua no-dominante de bilingües no-balanceados sobre los efectos de priming enmascarado de traducciones no-cognaticias obtenidos en las dos direcciones de traducción.* Este conjunto de experimentos estuvo compuesto por tres experimentos, en los cuales, los mismos materiales experimentales fueron presentados en tres grupos de bilingües tardíos y no balanceados griego (L1)-inglés (L2). En el Experimento 4, participaron bilingües con un bajo nivel de competencia en inglés, mientras que en los Experimentos 5 y 6, los participantes tenían respectivamente, un medio y un alto nivel de competencia en la L2.

En el tercer y último grupo de experimentos (Capítulo 8) se investigó *la influencia del nivel de competencia en la lengua no-dominante de bilingües no-balanceados sobre los efectos de priming enmascarado de traducciones cognaticias obtenidos en las dos direcciones de traducción.* En repetidas ocasiones, ha sido demostrado que las palabras cognaticias se procesan con mayor facilidad que las no-cognaticias, sobre todo en su versión en la lengua no-dominante (véase Dijkstra et al., 2012, para una revisión de la evidencia obtenida con palabras cognaticias durante la lectura). El uso de traducciones cognaticias nos permite examinar una posible modulación de los efectos por la presencia adicional de solapamiento formal entre las traducciones, así como su posible interacción con el nivel de competencia en la L2. Siguiendo la metodología del Capítulo 7, el mismo conjunto de materiales experimentales fue presentado en los tres experimentos. En esta ocasión, se investigaron los patrones de co-activación automática de pares de traducciones cognaticias con tres grupos de bilingües español (L1)- euskera (L2), no-simultáneos y no-balanceados con tres diferentes niveles de competencia en euskera: bajo (Experimento 7), medio (Experimento 8) y alto (Experimento 9).

3. Resumen de los resultados

En este apartado se presenta un resumen de los resultados obtenidos en cada uno de los tres conjuntos de experimentos descritos en los capítulos 6, 7 y 8 de la tesis. Dado que en todos los experimentos el diseño experimental era idéntico 2(Lengua target: L2, L1) x2 (Lengua prime: L2, L1) x2(Relación entre prime y target: Repetición, No-relacionado), para cada experimento se describirán los efectos obtenidos empezando por los *efectos de priming enmascarado de traducciones* (en cada una de las dos direcciones (L1-a-L2 y L2-a-L1), siguiendo con los efectos de *identidad intra-lengua* (L2-a-L2 y L1-a-L1), y terminando con los *costes de cambio de lengua entre primes y targets* (L1-a-L2 y L2-a-L1).

3.1 Experimentos 1-3 (Capítulo 6): Efectos de priming enmascarado de traducciones no-cognaticias con bilingües de bajo nivel de competencia en la L2

3.1.1. Experimento 1: Bilingües griego (L1)- español (l2) de bajo nivel de competencia en español.

- *Efectos de priming enmascarado de traducciones*: Se encontraron efectos significativos únicamente con los targets en español (L2) y los primes en griego (L1)- patrón asimétrico.
- *Efectos de identidad:* Se encontraron efectos significativos en ambas lenguas cuya magnitud fue comparable- patrón simétrico. Los efectos, tanto con los targets en L2 como con los targets en L1, fueron mayores que los obtenidos con los pares de traducciones.
- *Costes de cambio de lengua:* Se encontraron efectos significativos y comparables entre sí, en ambas direcciones de cambio de lengua-patrón simétrico.

3.1.2. Experimento 2: Bilingües griego (L1)- español (l2) de bajo nivel de competencia en español con adición de una máscara entre primes y targets.

La presencia de una máscara adicional entre primes y targets no modificó los resultados obtenidos, ya que los resultados replicaron los del Experimento 1.

- *Efectos de priming enmascarado de traducciones*: Se encontraron efectos significativos únicamente con los targets en español (L2) y los primes en griego (L1)- patrón asimétrico.
- *Efectos de identidad:* Se encontraron efectos significativos en ambas lenguas cuya magnitud fue comparable- patrón simétrico. Los efectos, tanto con los targets en L2 como con los targets en L1, fueron mayores que los obtenidos con los pares de traducciones.
- *Costes de cambio de lengua:* Se encontraron efectos significativos y comparables entre sí, en ambas direcciones de cambio de lengua- patrón simétrico.

3.1.3. Experimento 3: Hablantes de español monolingües, presentados únicamente con los materiales que contenían palabras–target en español.

- *Efecto de priming enmascarado de traducciones*: No se observó efecto significativo, confirmando que los participantes monolingües no tenían conocimiento del significado de los primes en griego.
- *Efecto de identidad:* Se encontró un efecto significativo.
- *Coste de cambio de lengua:* Se encontró un efecto significativo.

3.2 Experimentos 4-6 (Capítulo 7): Efectos de priming enmascarado de traducciones no-cognaticias con bilingües de diferentes niveles de competencia en la L2.

3.2.1. Experimento 4: Bilingües griego (L1)- inglés (L2) de bajo nivel de competencia en ingles.

- *Efectos de priming enmascarado de traducciones*: Se encontraron efectos significativos en ambas direcciones de traducción. El efecto obtenido con primes en L1 y targets en L2 fue mayor que el efecto obtenido con primes en L2 y targets en L1- patrón asimétrico.
- *Efectos de identidad:* Se encontraron efectos significativos en ambas lenguas cuya magnitud fue comparable- patrón simétrico. Los efectos, tanto con los targets en L2 como con los targets en L1, fueron mayores que los obtenidos con los pares de traducciones.
- *Costes de cambio de lengua:* Se encontraron efectos significativos y comparables entre sí, en ambas direcciones de cambio de lengua- patrón simétrico.

3.2.2. Experimento 5: Bilingües griego (L1)- inglés (L2) de medio nivel de competencia en ingles.

- *Efectos de priming enmascarado de traducciones*: Se encontraron efectos significativos en ambas direcciones de traducción. El efecto obtenido con primes en L1 y targets en L2 fue mayor que el efecto obtenido con primes en L2 y targets en L1- patrón asimétrico.
- *Efectos de identidad:* Se encontraron efectos significativos en ambas lenguas cuya magnitud fue comparable- patrón simétrico. Los efectos, tanto con los targets en L2 como con los targets en L1, fueron mayores que los obtenidos con los pares de traducciones.

- *Costes de cambio de lengua:* Se encontraron efectos significativos y comparables entre sí, en ambas direcciones de cambio de lengua- patrón simétrico.

3.2.3. Experimento 6: Bilingües griego (L1)- ingles (L2) de alto nivel de competencia en inglés.

- *Efectos de priming enmascarado de traducciones*: Se encontraron efectos significativos en ambas direcciones de traducción. El efecto obtenido con primes en L1 y targets en L2 fue mayor que el efecto obtenido con primes en L2 y targets en L1- patrón asimétrico.
- *Efectos de identidad:* Se encontraron efectos significativos en ambas lenguas cuya magnitud fue comparable- patrón simétrico. Los efectos, tanto con los targets en L2 como con los targets en L1, fueron mayores que los obtenidos con los pares de traducciones.
- *Costes de cambio de lengua:* Se encontraron efectos significativos y comparables entre sí, en ambas direcciones de cambio de lengua- patrón simétrico.

3.2.4. Análisis conjunto de los experimentos 4 a 6, incluyendo el Nivel de competencia en inglés (L2), como un factor entre participantes.

- *Respuestas sobre los targets en L2:* Las respuestas fueron mejorando progresivamente, a medida que iba aumentando el nivel de competencia de los participantes en la L2, de bajo, a medio y a alto.
- *Efectos de priming enmascarado de traducciones*: Los efectos no fueron afectados por la diferencia en el nivel de competencia en la L2. El patrón asimétrico obtenido entre las dos direcciones de traducción fue prácticamente idéntico en los tres grupos.
- *Efectos de identidad:* Los efectos no fueron afectados por la diferencia en el nivel de competencia en la L2. El patrón simétrico obtenido con targets en L2 y en L1 fue prácticamente idéntico en los tres grupos.

- *Costes de cambio de lengua:* Los costes de cambio de lengua entre primes y targets no fueron afectados por la diferencia en el nivel de competencia en la L2. El patrón simétrico obtenido en las dos direcciones de cambio de lengua fue prácticamente idéntico en los tres grupos.

3.3 Experimentos 7-9 (Capítulo 8): Efectos de priming enmascarado de traducciones cognaticias con bilingües de diferentes niveles de competencia en la L2

3.3.1. Experimento 7: Bilingües español (L1)- euskera (L2) de bajo nivel de competencia en euskera.

- *Efectos de priming enmascarado de traducciones*: Se encontraron efectos significativos en ambas direcciones de traducción. El efecto obtenido con primes en L1 y targets en L2 fue mayor que el efecto obtenido con primes en L2 y targets en L1-patrón asimétrico.
- *Efectos de identidad:* Se encontraron efectos significativos en ambas lenguas. El efecto obtenido en L1 fue mayor que el efecto obtenido en L1- patrón asimétrico.
- *Costes de cambio de lengua:* No se encontraron costes significativos en ninguna de las dos direcciones de cambio de lengua.

3.3.2. Experimento 8: Bilingües español (L1)- euskera (L2) de medio nivel de competencia en euskera.

- *Efectos de priming enmascarado de traducciones*: Se encontraron efectos significativos en ambas direcciones de traducción. El efecto obtenido con primes en L1 y targets en L2 fue mayor que el efecto obtenido con primes en L2 y targets en L1- patrón asimétrico.
- *Efectos de identidad:* Se encontraron efectos significativos en ambas lenguas. El efecto obtenido en L1 fue mayor que el efecto obtenido en L1- patrón asimétrico.

- *Costes de cambio de lengua:* Se encontró un coste significativo solo cuando el cambio de lengua entre prime y target era de L2 a L1.

3.3.3. Experimento 9: Bilingües español (L1)- euskera (L2) de alto nivel de competencia en euskera.

- *Efectos de priming enmascarado de traducciones*: Se encontraron efectos significativos en ambas direcciones de traducción. El efecto obtenido con primes en L1 y targets en L2 fue mayor que el efecto obtenido con primes en L2 y targets en L1- patrón asimétrico.
- *Efectos de identidad:* Se encontraron efectos significativos en ambas lenguas. El efecto obtenido en L1 fue mayor que el efecto obtenido en L1- patrón asimétrico.
- *Costes de cambio de lengua:* Se encontró un coste significativo cuando el cambio de lengua entre primes y targets era de L2 a L1, y un coste significativo solo en el análisis por ítems con primes en L1 y targets en L2- patrón simétrico.

3.3.4. Análisis conjunto de los experimentos 7 a 9, incluyendo el Nivel de competencia en euskera (L2) como un factor entre participantes.

- *Respuestas sobre los targets en L2:* Las respuestas fueron mejorando progresivamente, a medida que iba aumentando el nivel de competencia de los participantes en la L2, de bajo, a medio y a alto.
- *Efectos de priming enmascarado de traducciones*: Los efectos no fueron afectados por la diferencia en el nivel de competencia en la L2. El patrón asimétrico obtenido entre las dos direcciones de traducción fue prácticamente idéntico en los tres grupos.
- *Efectos de identidad:* Los efectos no fueron afectados por la diferencia en el nivel de competencia en la L2. El patrón asimétrico obtenido con targets en L2 y en L1 fue prácticamente idéntico en los tres grupos.

- *Costes de cambio de lengua:* Aunque los análisis separados de cada experimento mostraron diferentes costes de cambio de lengua para los tres grupos, en el análisis conjunto de los tres experimentos la interacción entre el Nivel de competencia en L2 y la Lengua del prime no fue significativa.

4. Conclusiones

Con respecto a los efectos de principal interés, los *efectos de priming enmascarado de traducciones*, los resultados obtenidos han reflejado la clara predominancia de la L1 de los bilingües sobre la L2, acorde con su estado de bilingües no-balanceados, ya que los efectos con primes de la L1 y targets de la L2 han sido en todos los casos superiores a los efectos obtenidos con primes de la L2 y targets de la L1 (efectos asimétricos).

A excepción de los experimentos realizados con bilingües griego (L1) – español (L2) de bajo nivel de competencia en español (Experimentos 1 y 2), este patrón asimétrico fue obtenido en presencia de efectos de priming enmascarado de traducciones significativos en ambas direcciones de traducción, mostrando que *incluso los bilingües que están iniciando la adquisición de la segunda lengua son capaces de activar las representaciones semánticas de las palabras de la L2* (véase Kroll et al., 2010; para una revisión del debate asociado al acceso semántico en la lengua no-dominante).

Es más, ni el patrón asimétrico ni la magnitud de los efectos obtenidos fueron afectados por la manipulación del nivel de competencia en la segunda lengua (Experimentos 4 a 9). Igualmente, aunque la presencia de solapamiento ortográfico y fonológico entre las traducciones (traducciones cognaticias) generó numéricamente mayores efectos en ambas direcciones de traducción, en comparación a los efectos obtenidos con traducciones que únicamente compartían su significado (traducciones no-cognaticias), el patrón asimétrico hallado, no varió entre los grupos de diferente competencia en su L2. Es importante señalar que la ausencia de la influencia del nivel de competencia en la L2 fue observado en presencia de una influencia significativa de este factor sobre el procesamiento de las palabras en L2, ya que, tanto con las palabras cognaticias como con las no-cognaticias, las respuestas (tiempos de reacción y porcentajes de errores) fueron mejorando a medida que iba aumentando el nivel de competencia en la L2. En otras palabras, la conclusión principal de nuestros resultados sería que *el patrón de activación léxico-semántica entre lenguas no depende del nivel de competencia en la L2* (medido según las valoraciones de los mismos bilingües y su nivel de exposición en la L2).

Este hallazgo señala la posibilidad de que sean otras las variables críticas que producen el cambio del patrón asimétrico de los efectos de priming enmascarado de traducciones obtenido con bilingües no-balanceados al patrón simétrico obtenido con bilingües balanceados (véase Basnight-Brown & Altarriba, 2007; Duñabeitia, Dimitropoulou et al., 2010; Duñabeitia, Perea et al., 2010). La revisión de la evidencia existente con el paradigma de priming enmascarado de traducciones revela que efectos simétricos entre las dos direcciones de traducción aparecen con bilingües que son caracterizados por un nivel de competencia comparable en las dos lenguas y que han adquirido las dos lenguas de forma simultánea durante la primera infancia (bilingües balanceados y simultáneos). En cambio, efectos asimétricos aparecen en bilingües con un nivel de competencia considerablemente mayor en la L1 que en la L2 y que han adquirido la segunda lengua después de establecer las representaciones léxico-semánticas de la L1 (bilingües no-balanceados y tardíos). Este patrón, así como la falta de modulación de la asimetría de los efectos priming enmascarado de traducciones por una manipulación exclusivamente enfocada al nivel de competencia en la L2 observada en nuestros resultados con bilingües tardíos, podría estar indicando que *la variable principalmente responsable del paso de la asimetría a la simetría en los efectos de priming enmascarado de traducciones es la edad de adquisición de la segunda lengua, y más concretamente, la medida en la que las dos lenguas han sido adquiridas de forma simultánea o no.*

Además, el hecho de que, a excepción de las palabras-target cognaticias en su versión en L2, los efectos de identidad obtenidos con nuestros bilingües no-balanceados y tardíos fueron en todos los casos mayores que los efectos de traducción, podría estar reflejando un coste adicional de procesamiento para los efectos cuya aparición depende de una activación entre lenguas en comparación a los efectos intra-lengua. Esta diferencia entre los efectos entre e intra-lenguas, no se ha encontrado con bilingües simultáneos y balanceados, donde los efectos léxico-semánticos entre e intra-lenguas son comparables (Dimitropoulou et al., 2012; Duñabeitia, Dimitropoulou et al., 2010; Duñabeitia, Perea et al., 2010). Por lo que, en su totalidad, este patrón estaría mostrando que *solo para los bilingües tempranos/simultáneos y balanceados, las representaciones correspondientes a cada lengua son, desde un punto de vista funcional, indistintas.*

Sin embargo, los experimentos realizados con palabras cognaticias pertenecientes a lenguas que comparten su alfabeto (español-euskera; Experimentos 7-9), revelaron que para las palabras cognaticias en su versión en L2 la diferencia en la magnitud de los efectos entre e intra-lenguas fue invertida. Es decir, en este caso, y para los tres grupos de participantes (sub-experimentos 7a, 8a y 9a), los efectos de identidad *fueron menores que* los efectos de priming enmascarado de traducciones y a su vez, menores que los efectos de identidad obtenidos para las palabras cognaticias en L1 (sub-experimentos 7b, 8b y 9b; patrón asimétrico de efectos de identidad). Este patrón indica que, a diferencia de lo observado con las palabras no-cognaticias de ambas lenguas (Experimentos 1-6) y con las palabras cognaticias en L1, en el caso de las palabras cognaticias en L2, y al menos en los casos en los que estas guardan gran parecido a sus traducciones en L1 tanto a nivel ortográfico como a nivel fonológico, el procesamiento de pares de primes y targets idénticos (p.ej., *marinel-MARINEL*, marinero en euskera) es más costoso que el procesamiento de pares de traducciones (p.ej., *marinero-MARINEL*). Una posible explicación de este patrón podría ser que, en un primer momento, las palabras cognaticias en L2 son procesadas como sus equivalentes en L1, y que posteriormente se activa la representación léxica en la L2.

Este paso inicial durante el reconocimiento de las palabras cognaticias en L2, se vería motivado, tanto por el gran parecido formal añadido que guardan las palabras cognaticias en L2 a sus equivalentes en L1, como por el mayor nivel de activación de las palabras en L1 en bilingües no-balanceados. En el caso de la condición de priming de identidad L2-L2, este paso añadido sería necesario para identificar tanto el prime, como el target. En cambio, en la condición de priming de traducciones L1-L2, este paso añadido estaría únicamente presente en el procesamiento del target, por lo que el coste sería menor que en la condición de identidad L2-L2.

Los modelos de organización léxico-semántica bilingüe más citados en la literatura bilingüe (Capítulo 4), el RHM (Kroll & Stewart, 1994) y el BIA en sus diferentes versiones (BIA, Grainger et al., 2008; BIA+, Dijkstra & Van Heuven, 2002; BIA-d, Grainger et al., 2010) podrían dar cuenta del patrón de efectos de priming enmascarado de traducciones, solo parcialmente. En detalle, en concordancia con nuestros resultados, estos modelos predecirían que con bilingües no-balanceados los efectos de priming enmascarado de traducciones mostrarían un patrón asimétrico entre las dos direcciones de traducción, siendo los efectos de L1-a-L2 mayores que los de L2-a-L1. Sin embargo, estos modelos no podrían dar cuenta de una parte central de nuestros resultados, en otros aspectos. En primer lugar, en contra de nuestros hallazgos, ambas propuestas teóricas predecirían una atenuación de la asimetría de los efectos de priming enmascarado de traducciones a medida que aumenta el nivel de competencia en la lengua no-dominante. En segundo lugar, tanto el RHM, como el BIA predecirían que, siempre y cuando los bilingües en cuestión fueran no-balanceados, los efectos de priming enmascarado de traducciones tanto cognaticias como no-cognaticias serían menores que los efectos de identidad. Pese a que con las palabras no-cognaticias así como con las palabras-target cognaticias en su versión en L1 se obtuvo de forma consistente este patrón, con las palabras-target cognaticias en L2 se encontraron efectos mayores para las traducciones que para la identidad.

No obstante, de los modelos descritos en la parte introductoria de la tesis (Capítulo 4), el DevLex II (p.ej., Zhao & Li, 2010) podría dar cuenta de la mayor parte de nuestros resultados. A diferencia del RHM y los modelos BIA, este modelo propone que el factor que más determina la estructura de las representaciones de las palabras en L1 y en L2 y los patrones de interacción entre ellas, es la edad de adquisición de la lengua no-dominante con respecto a la edad de adquisición de la lengua dominante, por encima del nivel de competencia. DevLex II propone que cuando los bilingües adquieren las dos lenguas de forma simultánea, las interacciones entre sí son simétricas; si la adquisición de la L2 ha sido posterior a la de la L1, las palabras de la L2 mantienen una relación "parasitaria" con aquellas palabras de la L1 con las que comparten, parcialmente o por completo, su significado o/y su forma, y por lo tanto, las interacciones léxico-semánticas entre lenguas son asimétricas. Teniendo en mente que los bilingües examinados en nuestros experimentos habían iniciado la adquisición de su L2 varios años más tarde que la de la L1 (bilingües tardíos), el DevLex II predeciría que los efectos de priming enmascarado de traducciones serían en todos los casos asimétricos, y que este patrón no se modificaría por el nivel de competencia en la L2 de los bilingües, tal y como nuestros datos mostraron.

Es importante destacar que aunque los autores del DevLex II no han realizado simulaciones con traducciones cognaticias, los resultados obtenidos en los Experimentos 7 a 9 con palabras cognaticias de la L2 encajarían con las predicciones del DevLex II sobre cómo se procesan las palabras de L2 que mantienen similitud formal y/o semántica con palabras de la L1 en bilingües no-simultáneos. En las simulaciones realizadas con el modelo, dirigidas a imitar la situación del bilingüismo no-simultáneo, se observó que la distribución y la localización de las palabras de L2 dependían del nivel de solapamiento semántico o fonológico[16] con las palabras de la L1. Cuanto mayor era este solapamiento, mayor era la proximidad de estas palabras en L2 a aquellas palabras de la L1 con las que guardaban similitud. Tomando en cuenta que las palabras cognaticias en su versión en L2 guardan gran similitud con sus equivalentes en la L1, estos pares de traducciones estarían localizados a gran proximidad entre sí, motivo por el que, los equivalentes cognaticios en L1

[16] El modelo aún tiene solo mapas de representaciones semánticas y fonológicas y no ortográficas.

funcionarían como competidores a la hora de reconocer las palabras cognaticias en la L2. Esto llevaría a que durante el reconocimiento de las palabras cognaticias en L2, su versión en L1 se activara primero. En el marco de nuestros resultados con los cognados en L2, esta activación inicial de la traducción cognaticia en L1 podría considerarse como responsable del mayor efecto de priming enmascarado de traducción en comparación con el efecto de identidad que obtuvimos, ya que en la condición de identidad de palabras cognaticias L2-L2 esta activación de la representación en la L1 sería necesaria para procesar tanto el prime como el target. En cambio, en la condición de traducción L1-L2, este paso añadido estaría únicamente presente en el procesamiento del target.

Por último, nuestros datos aportaron abundante información sobre el procesamiento automático de la identidad lingüística de las palabras. Esta información fue obtenida mediante los costes asociados a un cambio de lengua entre primes y targets, obtenidos en las condiciones de priming en las que los primes correspondían a otra lengua que los targets, en comparación con las condiciones de priming en las que no existía un cambio de lengua entre primes y targets. En resumen, estos costes fueron significativos, simétricos en las dos direcciones de cambio de lengua (primes en L1 y targets en L2, y viceversa) e invariantes en los diferentes niveles de competencia en la L2, solo cuando las listas experimentales estaban compuestas únicamente por palabras no-cognaticias y el cambio de lengua incluía también un cambio de alfabeto (Experimentos 1-3 con bilingües griego-español y Experimentos 4-6 con bilingües griego-inglés). En cambio, en los experimentos en los que los materiales estaban constituidos por palabras cognaticias y las lenguas de interés compartían su alfabeto, los costes asociados al cambio de lengua entre primes y targets fueron significativos únicamente en los dos grupos de mayor nivel de competencia en la L2 y cuando el cambio de lengua era de la L2 a la L1 (Experimentos 7-9). Este patrón asimétrico que obtuvimos con las palabras cognaticias que compartían el alfabeto, concuerda con el reportado en la literatura, con bilingües que tienen una clara dominancia de la L1 sobre la L2 (no-balanceados; véase Casaponsa et al., enviado, para una revisión reciente). Sin embargo, nuestros resultados con bilingües no-balanceados a los que presentamos palabras no-cognaticias que no compartían el alfabeto, fueron simétricos en las dos direcciones de cambio de lengua (Experimentos 1, 2 y 4-6). Teniendo en cuenta que los lectores bilingües disponen de mayor cantidad de información visual sub-léxica que indique la lengua a la que corresponde cada palabra en los casos en los que existe un cambio de alfabeto entre las dos lenguas, se puede concluir que, según nuestros resultados y dada la corta duración del prime en la pantalla, *en el priming enmascarado entre lenguas la información sub-léxica es crítica a la hora de identificar la lengua de los primes y es la que determina la aparición de costes simétricos de cambio de lengua entre las dos direcciones de cambio, por encima de lo mucho o poco familiarizados que los bilingües estén con las palabras en la L2.*