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The role of form in morphological priming: Evidence from bilinguals

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Abstract

This article explores how bilinguals perform automatic morphological decomposition processes, focusing on within- and cross-language masked morphological priming effects. In Experiment 1, unbalanced Spanish (L1) – English (L2) bilingual participants completed a lexical decision task on English targets that could be preceded by morphologically related or unrelated derived masked English and Spanish prime words. The cognate status of the masked Spanish primes was manipulated, in order to explore to what extent form overlap mediates cross-language morphological priming. In Experiment 2, a group of balanced native Basque-Spanish speakers completed a lexical decision task on Spanish targets preceded by morphologically related or unrelated Basque or Spanish masked primes. In this experiment, a large number of items was tested and the cognate status was manipulated according to a continuous measure of orthographic overlap, allowing for a fine-grained analysis of the role of form overlap in cross-language morphological priming. Results demonstrated the existence of between-language masked morphological priming, which was exclusively found for cognate prime-target pairs. Furthermore, the results from balanced and unbalanced bilinguals were highly similar showing that proficiency in the two languages at test does not seem to modulate the pattern of data. These results are correctly accounted for by mechanisms of early morpho-orthographic decomposition that do not necessarily imply an automatic translation of the prime. In contrast, other competing accounts that are based on translation processes do not seem able to capture the present results.

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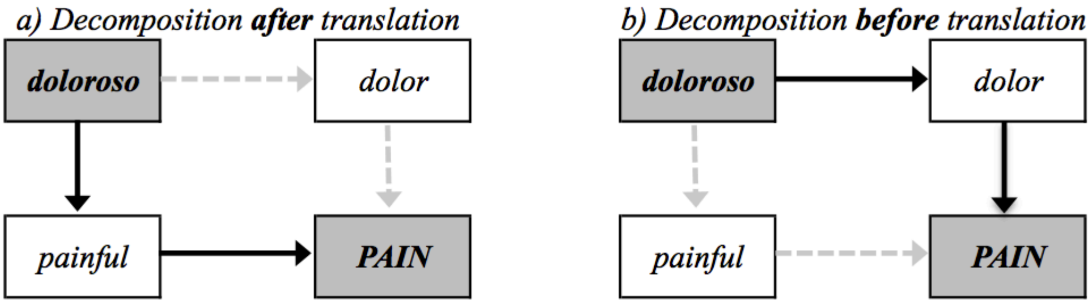
For many years visual word recognition research has been concerned with the question of whether and how morphologically complex words (e.g., *walker*), are decomposed into their constituent morphemes (e.g., *walk+er*) in native language processing (Bertram, Hyönä & Laine, 2011, for review). In this article, we focus on a line of research that is still in its infancy: how bilinguals access morphologically complex words.

Masked priming is one of the most widely used paradigms in monolingual research on polymorphemic word reading, because it focuses on automatic stages of word reading (Kinoshita & Lupker, 2003). Many masked priming studies have highlighted the capacity of the human visual word recognition system for identifying morphological relationships between briefly presented masked polymorphemic words and subsequently presented targets made of the primes' root lexemes (e.g., *painful-PAIN*; e.g., Rastle, Davis, Tyler & Marslen-Wilson, 2000), between derived primes and derived targets sharing the root (e.g., *painful-PAINLESS*; Pastizzo & Feldman, 2004), and even between derived prime and target words sharing the affix (e.g., *painful-WONDERFUL*; Duñabeitia, Perea & Carreiras, 2008). These studies, among others, support theoretical accounts that posit that access to the semantic representation of a polymorphemic word is mediated by decomposition processes in which the individual constituent morphemes are identified and used to guide lexical access (e.g., Rastle & Davis, 2008; Taft & Nguyen-Hoan, 2010). Current evidence also suggests that morpheme identification does not occur solely through the processing of low-level sub-lexical morpho-orthographic and morpho-phonological features, but that whole-word (lexical) morpho-semantic information does also play a key role in polymorphemic word processing, since priming effects have been shown to be larger for semantically transparent than for opaque derivations (i.e., the walker-WALK vs. corner-CORN debate; e.g., Diependaele, Sandra & Grainger, 2005, 2009; Morris, Frank, Grainger & Holcomb, 2007; see Feldman, O'Connor, & Moscoso del Prado Martin, 2009, and Davis & Rastle, 2010, for a complete summary).

A question that has recently arisen in polymorphemic word identification research is whether multilingual readers rely on the same processing mechanisms when reading complex words in a native versus a nonnative language. The use of native-like morphological decomposition strategies in L2 word recognition has been recently questioned and an increasing number of studies exploring inflectional and derivational morphology have tried to clarify this issue (see Silva & Clahsen, 2008). Some results on inflected (e.g., *walked*) word processing have suggested that morphological decomposition in a second language is not as automatic/mandatory as in a first language, at least at relatively low levels of proficiency. Indeed, a number of studies have shown no or only small facilitation effects for *walked-WALK*-like pairs in the L2 as compared to the L1 (Clahsen, Felser, Neubauer, Sato, & Silva, 2010; Feldman, Kostic, Basnight-Brown, Filipovic-Durdevic, & Pastizzo, 2009). In contrast, a recent study by Diependaele, Duñabeitia, Morris and Keuleers (2011) exploring morphological processing in a native and nonnative language using <u>derivational</u> relationships (e.g., *walker-WALK*) supports a radically different view. Diependaele et al. explored morphological priming in a masked priming lexical decision task with semantically transparent and opaque derivational relationships, as well as form-related items (e.g., *walker-WALK* vs. *corner-CORN* vs. *freeze-FREE*; see Rastle & Davis, 2008), with a group of native English speakers and two groups of bilinguals with varying levels of proficiency in their English (L2) levels. Interestingly, results showed similar priming patterns for the native participants and the two groups of bilinguals (i.e., no significant differences in the magnitude of the morphological priming effects), in line with recent studies on L1 masked morphological priming for derived words and their stems (Davis & Rastle, 2010; Feldman et al., 2009). Hence, according to the Diependaele et al. data, at medium and high levels of L2 proficiency, derived words from a nonnative language are decomposed early and accessed through the constituent morphemes in a fashion similar to that from a native language. In other words, expertise or proficiency in a given language does not seem to be a prerequisite for masked morphological priming effects to emerge, and morphological decomposition of polymorphemic words is an automatic process that does not depend on the proficiency of the reader in the language at stake.

Here we aimed to further explore morphological decomposition processes in bilinguals, extending the focus to cross-language morphological relationships. Most of the bilingual studies investigating the involvement of the mother tongue in visual L2 word processing have been mainly focused on basic orthographic or phonological levels (e.g., studies on cognates, homophones or homographs), on lexical competition between neighboring cross-languistic representations (e.g., studies on inter-lingual orthographic neighbors), or on associative/semantic relationships (e.g., studies on cross-language associations and translation equivalents). However, the number of studies exploring the involvement of L1 within-word morphological units in L2 processing is extremely reduced, and it is not clear to what extent L2 word reading is influenced (if it is at all) by the morphological characteristics of the corresponding L1 translations of those words. The present study will shed light on this issue by examining the relationship between the representation of L1 and L2 and its involvement in L2 processing, especially when it comes to morphological processing. Until now, the few studies that have examined morphological priming in bilinguals have only tested within-language relationships. A large body of research on bilingual word processing has repeatedly demonstrated that even at low proficiency levels, bilinguals show high sensitivity to the sequential presentation of translation equivalents under masked priming conditions (e.g., *doloroso-PAINFUL*, for Spanish-English bilinguals), especially when primes are in the L1 and targets in the L2 (Dimitropoulou, Duñabeitia & Carreiras, 2011a, for review), suggesting that bilinguals automatically activate the corresponding lexical representations in the non-target language. Considering that bilinguals exploit morphological derivational relationships in the same way as monolinguals (Diependaele et al., 2011), it seems reasonable to expect cross-language morphological priming as a consequence of the automatic activation of the translation equivalent of a masked polymorphemic prime (i.e., *doloroso* would prime *PAIN* via the automatic translation of the prime to *painful*). However, it's not entirely clear whether this automatic translation process would occur *before* or *after* morphological decomposition processes, as illustrated in Figure 1 where we schematically depicted the two hypothetical pathways for cross-language morphological priming through translation. According to one possible pathway, the polymorphemic prime (*doloroso*) would be first morphologically decomposed (*dolor* + *oso*) and the corresponding stem representation (*dolor*) would be subsequently mapped onto its translation (*pain;* i.e., decomposition *before* translation). In contrast, a second pathway would first involve the whole-word translation of the prime (translating *doloroso* into *painful*), and morphological decomposition processes would then occur for this translated representation (*pain* + *ful*) at an abstract level (possibly at a lemma level, as proposed by Taft & Nguyen-Hoan, 2010, or post-lexically, as suggested by Giraudo & Grainger, 2001), yielding to the masked morphological priming effects (i.e., decomposition *after* translation).

Figure 1. Possible mechanisms leading to cross-language masked morphological priming for the Spanish prime *doloroso* and the English target *pain*. The first mechanism (a) is based on an initial translation process of the prime that would activate the mental lexical representation of its translation equivalent, followed by the (presumably post-lexical) morphological decomposition of this word. The second mechanism (b) is based on an initial morpho-orthographic decomposition process, followed by the mental translation of the decomposed stem.



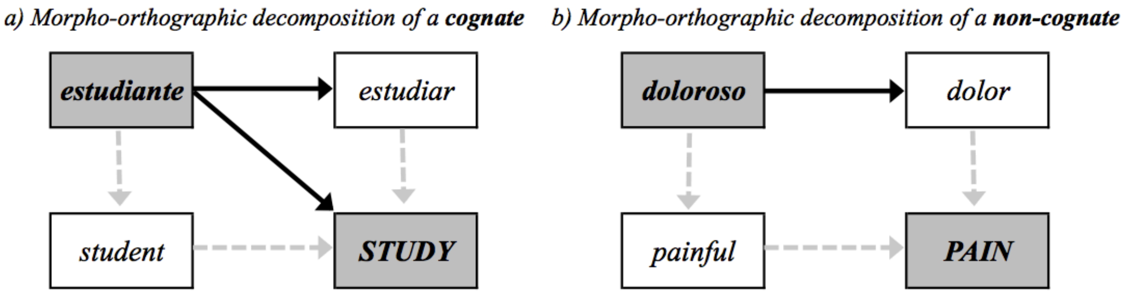
A priori, these two accounts would readily predict cross-language morphological priming effects. However, even though translation and morphological processes are highly automatic and take place even at unconscious levels of word processing as measured with the masked priming paradigm (see Duñabeitia, Dimitropoulou, Uribe-Etxebaria, Laka, & Carreiras, 2010; Lehtonen, Monahan, & Poeppel, 2011; Morris, Porter, Grainger, & Holcomb, 2011), these processes follow a different time course depending on the proficiency of the participants in their second language. On the one hand, electrophysiological recordings from unbalanced bilinguals have shown that the earliest neural signatures for automatic translation processes as measured by masked translation priming are found in the N250 time window (at around 200 ms after target presentation; e.g., Hoshino, Midgley, Holcomb, & Grainger, 2010; Midgley, Holcomb, & Grainger, 2009), and within-language masked morphological electrophysiological correlates have shown that morphological decomposition processes take place in this same epoch (e.g., Lavric, Clapp, & Rastle, 2007; Morris, Frank, Grainger, & Holcomb, 2007; Morris et al., 2011). Hence, according to the electrophysiological data from masked morphological and translation priming effects with non-balanced bilinguals, these two processes take place in a similar time window and it is not possible to *a priori* establish a temporal distinction between the two of them. On the other hand, it has been also found that masked translation priming effects in balanced bilinguals follow a different time course, which is critical for the current debate (see Duñabeitia, Dimitropoulou et al., 2010). The earliest electrophysiological signature for automatic translation processes in balanced bilinguals has been reported in the time window corresponding to the N400 component (starting at around 400 ms after target presentation). Hence, prior electrophysiological data have shown that translation processes take place in a time window in which morphological decomposition processes also occur, but that this only holds true in samples of unbalanced bilinguals. In contrast, automatic translation processes seem to take place in a later time window when the sample at test consists of balanced bilinguals. That is, for balanced bilinguals morphological priming effects would be expected to emerge before translation priming effects, while for unbalanced bilinguals the two effects would be expected to co-occur. For this reason, in the current cross-language masked morphological priming study we tested two different samples of bilinguals (unbalanced and balanced) in order to elucidate which of the two accounts explained above better captures the effects. If similar cross-language morphological priming effects are found for balanced and unbalanced bilinguals, this would be hardly reconcilable with the decomposition *after* translation view, given that in the former group the neural correlates of translation processes have been found to occur *after* those of morphological decomposition processes.

There appears to be at least some evidence in favor of such cross-language morphological priming. In a recent masked priming study, Zhang, van Heuven and Conklin (2011) presented Chinese-English (L1-L2) bilinguals with unrelated masked prime-target pairs in English such as *east-thing*. Critically, the Chinese translations of these pairs were morphologically related, since the entire translated prime appeared in the target as a constituent of an opaque compound (e.g., 东 - 东西, Experiment 1) or vice versa (东西 - 东, Experiment 2). Following previous work showing that compounds' constituent priming effects can be effectively found (e.g., Duñabeitia, Laka, Perea, & Carreiras, 2009; Duñabeitia, Marín, Avilés, Perea, & Carreiras, 2009; Shoolman & Andrews, 2003), Zhang et al. hypothesized that if automatic mental translation of both primes and targets takes place during reading in a nonnative language, word pairs that were morphologically related by translation could show priming effects. This was indeed the case, thus resulting in what the authors termed a "*hidden morphological repetition effect*" (namely, a masked constituent priming-by-translation effect; see also Thierry and Wu, 2007, for a similar "*hidden phonological repetition effect*" in a different paradigm). This study offered clear evidence in favor of fast automatic translation processes capable of producing masked morphological priming effects in the non-target language. In Zhang et al.'s words (p. 1241), these data showed that "*automatic translation and morphological decomposition occur very rapidly in (…) bilinguals, indicating that these two processes are highly automatic*".

Taken together, the findings reported by Zhang et al. (2011) and Diependaele et al. (2011) suggest that cross-language morphological priming could be effectively obtained. However, the current investigation differs from these studies in at least two important ways. First, we directly investigated cross-language priming (i.e., primes and targets were presented in different languages) and by comparison with within-language priming we explicitly investigated to what extent cross-language morphological relationships play a role in bilingual word recognition. Second, other than Zhang et al., the translation equivalents for the languages under study here potentially share extensive orthographic and/or phonological overlap. It is well established that compared to non-cognate pairs like *doloroso-painful*, cognates like *estudiante-student* show larger masked translation priming effects (Duñabeitia et al., 2010, for review). This can easily be explained by assuming that, apart from whole-word lexical-semantic links, translations for these words can also be activated through language-independent bottom-up orthographic/phonological activation. In the context of the two accounts presented above, it is feasible to expect that the magnitude of the cross-language morphological priming would be stronger for cognate pairs like *estudiante-STUDY* than for non-cognate pairs like *doloroso-PAIN* for the decomposition *after* translation view, while this would not be necessarily the case according to the decomposition *before* translation view. Within the former proposal, the activation of the translation of a cognate polymorphemic prime would be faster for a cognate than for a non-cognate, thus enabling a faster morphological decomposition of this translated form at an abstract level (either at the lemma level, or post-lexically). However, this cognate advantage would not predict any difference according to an account that contemplates morphological decomposition as the initial processing stage, since there are no reasons to expect that a cognate item would be morphologically decomposed faster than a non-cognate item. In other words, considering that a decomposition *before* translation account predicts first the morphological (presumably morpho-orthographic) analysis of the word that will lead to the mental activation of the stem representation, and then the translation of this stem at an abstract (presumably lemma-based) level, and given that the cognate effect is mainly driven by the orthographic/phonological overlap between the translation equivalents, there are no reasons to expect any cognate advantage at such an abstract level.

Thus far, we have focused on only two pathways for cross-language morphological priming that both involve translation. However, one of the major findings in morphological processing research of the last decade is that, at least within the first processing stages, morphological relationships are not only exploited on a semantic basis, but also on a purely orthographic one (see Rastle & Davis, 2008; see also Diependaele et al., 2011, for a demonstration of morpho-orthographic priming effects in a second language). Specifically, priming effects for semantically opaque or pseudo-complex items (e.g., *department-DEPART* or *corner-CORN*) are typically larger than for control items that do not share an apparent morphological relationship (e.g., *freeze-FREE*; Davis & Rastle, 2010; Feldman, O'Connor, & Moscoso del Prado Martín, 2009). There is broad agreement that such morpho-orthographic decomposition takes place at a sub-lexical ortho-phonological processing level. Hence, considering that the output of this early decomposition is used to activate lexical representations, this provides a third potential pathway for cross-language morphological priming, as illustrated in Figure 2: a decomposition *without* translation account. Given a cognate polymorphemic masked prime (e.g., *estudiante* [*student*]), this could be decomposed into its constituent morphemes, and then mapped onto the representations of the stems in the two languages (e.g., *estudiar* and *study*). The reason behind this dual mapping is that morpho-orthographic decomposition of polymorphemic items is preserved even in cases in which the stem of the complex prime and its corresponding base whole-word do not have completely overlapping orthographic forms (e.g., the stem *ador*- from *adorable* is mapped onto the lexical representation of the word *adore*; see McCormick, Rastle, & Davis, 2008). In other words, morphologically decomposed items are mapped onto the corresponding lexical representations tolerating to a certain extent orthographic changes between the decomposed stem and the mentally stored whole-word representation. In the case of cognate polymorphemic items, the decomposed stem could be mapped onto the whole-word representations in the two languages at stake, due to this tolerance to orthographic variation. In contrast, in the case of non-cognate items, the decomposed stem would only map onto a single (within-language) representation.

Figure 2. Predicted flow of activation based on a morpho-orthographic decomposition for the Spanish prime *estudiante* (cognate) and *doloroso* (non-cognate), and the English targets *study* and *pain,* respectively.



Interestingly, since this morpho-orthographic pathway strictly involves the activation of the orthographic and phonological codes, it will only be functional for cognate items. Non-cognate prime items would necessarily have to be translated into the target language in order to match the target (see the left vs. right panel in Figure 2). In line with this reasoning and based on a fast-acting orthographic analysis that detects affixes and permits a tentative stripping off of the morphological constituents (Rastle & Davis, 2008), cross-language morphological priming should be evident for cognate polymorphemic primes (e.g., *estudiante-STUDY*), while its magnitude should be significantly smaller (if any) for non-cognate primes (e.g., *doloroso-PAIN*). This same prediction would be derived from models that account for morphological priming effects in terms of lemma activation (Taft & Nguyen-Hoan, 2010; see also Baayen, Dijkstra, & Schreuder, 1997). According to these lemma-based models, it is suggested that after orthographic analysis, the individual lemmas of the decomposed polymorphemic word (i.e., the lemma of the stem and the lemma of the affix) are activated, leading to the indirect activation of the lemma of the combined representation (i.e., the whole polymorphemic word). Lemma-based accounts have traditionally accounted for the co-activation of translation equivalents in word production tasks (see Green, 1998, for review; see also Levelt, Roelofs, & Meyer, 1999, for the original proposal of linguistically tagged lemmas). Considering that lemma-based models predict initial morphological decomposition on the basis of a (morpho-) orthographic analysis of the input, these accounts would also predict a significantly greater cross-language morphological priming effects for cognate than for non-cognate items, given that the initially decomposed orthographic form of the cognate primes' stems (e.g., *estudiar* + *dad*) would activate the corresponding lemmas in the two languages (e.g., *estudiar* and *study*).

Partial support for this account was provided by Voga and Grainger (2007) in a study that compared cognate priming (e.g., *άτομο-ATOME*, meaning *atom*) to cross-language morphological priming with cognate Greek (L1) primes like *ατομικός* (meaning *atomic,* which translates into *atomique* in French), and French (L2) root morpheme targets like *ATOME*. Critically for the purposes of the present study, Voga and Grainger obtained significant cross-language masked morphological priming effect at a 66ms SOA. However, in this experiment the cross-language morphological priming effects were obtained compared to a cross-script phonologically related condition (e.g., *άτιμο-ATOME,* where *άτιμο* means *non-trustworthy*) and not compared to the most commonly used unrelated baseline condition. Also, it should be noted that in the same experiment but at 50ms SOA, the authors failed to find cross-language morphological priming effects. The authors accounted for this difference between 66ms and 50ms SOA by stating that these cross-language morphological priming effects "*are being driven by amodal, supralexical morphological representations, as has been proposed by Giraudo and Grainger (2001)*" (p. 941), suggesting that at the shortest SOA access to the supra-lexical representations cannot be completed. Critically, in this study the existence of a cross-language morphological effect in the absence of any formal overlap was not examined, since Voga and Grainger (2007) did not include non-cognate cross-language morphologically related word pairs in their design. Hence, it remains to be seen whether a "pure" cross-language morphological effect would emerge with non-cognates and with a more appropriate unrelated control condition. And, if such an effect exists, it is still unclear how it would compare to a cross-language morphological effect mediated by formal overlap (i.e., cognates). It will thus be critical to see whether non-cognate morphological priming occurs in the current context and how this compares to within-language morphological priming and to priming in a cognate condition. Hence, in the current study we included a cognate manipulation in order to explore to what extent cross-language masked morphological priming is modulated by the cognate status of polymorphemic items.

According to the three processing mechanisms sketched above, different outcomes are predicted regarding this cognate manipulation. While the decomposition *before* translation view does not predict a significant modulation of the magnitude of the cross-language morphological priming effects as a function of the cognate status of the primes (since there are no reasons to expect a faster morphological decomposition process for cognates than for non-cognates), the other two accounts do predict critical differences. The decomposition *after* translation view would predict a faster translation of the cognate primes (as shown, among many others, by Duñabeitia, Perea, & Carreiras, 2010), hence predicting larger morphological priming effects for cognates than for non-cognates. Similarly, the third account proposed (the decomposition *without* translation view) based on a mapping of the decomposed cognate stem onto the corresponding bilingual whole-word representations, would also predict clear-cut differences between cognates and non-cognates, since only cognates could lead to this bilingual mapping.

In Experiment 1 we explored for the first time within-L2 and between L1-L2 masked morphological priming with suffixed primes and stem targets. In line with Diependaele et al. (2011) we expected to find within-L2 facilitation relative to unrelated primes for both cognate and non-cognate items (i.e., *student-STUDY* and *painful-PAIN*). Based on the idea that cognates can be mapped more easily onto their translations and that morpho-orthographic decomposition leads to language-independent lexical activation, it can be predicted that cross-language morphological priming will be greater for *estudiante-STUDY* than for *doloroso-PAIN*. Priming in the latter condition is strictly dependent on the strength of cross-language morphological decomposition through translation. By further comparing the size of priming in these conditions to the within-language effects, we aim to evaluate the relative importance of cross-language morphological relationships in bilingual word recognition. In Experiment 2 we aimed for a more in depth investigation of the role of form overlap by turning to a design where cognate status was implemented as a continuum rather than as a categorical distinction. Form overlap for the cross-language morphological pairs was now operationalized by measuring string-edit or Levenshtein distance (see Schepens, Dijkstra, & Grootjen, 2012, for a similar approach). Other than in Experiment 1, participants came from a balanced bilingual population. As such, we aimed to evaluate the generality of the observed effects with respect to language proficiency and to test the appropriateness of the different accounts that have been proposed to explain cross-language morphological priming.

EXPERIMENT 1

Method

Participants. A group of 44 participants (32 female) with a mean age of 25.32 years (±4.73) and with normal or corrected-to-normal vision and no history of neurological insults were recruited from three English language schools. Participants were native Spanish speakers (mean age of acquisition, in years: 0.36 ±1.30), and had a relatively high level of English proficiency (mean age of acquisition: 8.11 ±2.80). In a language proficiency questionnaire that was administered participants had to subjectively rate their level in Spanish and English according to a 1-to-10 scale. As can be seen in Table 1, the scores confirmed that they had a perfect command of Spanish and were relatively fluent in English, i.e. that they were unbalanced bilinguals.

Table 1: Mean proficiency in Spanish and English according to self-ratings for the sample tested in Experiment 1.

	Spanish (L1)	English (L2)

AoA (in years)	0.36 (± 1.30)	8.11 (± 2.80)
General proficiency	9.36 (± 0.84)	7.02 (± 0.95)
Speaking proficiency	9.34 (± 0.91)	6.16 (± 1.31)
Reading proficiency	9.41 (± 0.90)	7.45 (± 1.11)
Comprehension skills	9.50 (± 0.85)	7.23 (± 1.18)

Materials. Two sets of 40 English monomorphemic targets matched for word frequency, length and number of orthographic neighbors (as taken from Davis, 2005) were selected (e.g., *pain, study*; see Table 2). Each target was then paired with a morphologically related derived word prime (i.e., related within-language primes), which were also matched across sets for the same metrics (e.g., *painful, student*). Critically, the Spanish translations of these English primes were non-cognate derived words in one set (e.g., *doloroso* [*painful*], derived from *dolor* [*pain*]), and cognate derived words in the other set (e.g., *estudiante* [*student*], derived from *estudiar* [*to study*]). These Spanish translations of the primes in the two sets were also carefully matched for the same indices (as taken from Davis & Perea, 2005; Table 2). These words were used as related cross-language primes. Furthermore, the graphemic positional overlap between primes and targets in the within-language priming conditions were matched (mean number of letters in common: 0.70 ±0.09 in the non-cognate set and 0.66 ±0.12 in the cognate set; e.g., *painful-PAIN* and *student-STUDY*, respectively). These scores were indistinguishable from the ones in the cross-language cognate set (0.70 ±0.24; e.g., *estudiante-STUDY*), but as expected, they were higher than for the cross-language non-cognate set (0.07 ±0.09; e.g., *doloroso-PAIN*). The cognate status of the cross-language set was confirmed by an analysis based on the Levenshtein distance between the English and the Spanish derived prime word sets: Cognate Spanish words had a low Levenshtein distance with regard to their English translations (mean: 2.67 ±1.27, range: 1-6), while non-cognate Spanish translations of the English derived words had a very high distance (mean: 7.45 ±1.80, range: 4-11). Unrelated word primes were then created by rearranging the related word primes 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. A set of 80 nonwords was also created for lexical decision purposes by changing some letters from the word targets. Half of these nonwords were presented preceded by English derived words, and half were presented preceded by Spanish derived words. Four lists were created, so that in each list every target and prime only appeared once, but in each list each of the targets was presented in a different priming condition (within- or cross-language related or unrelated). The same number of participants completed each list, and assignment was done at random. The full list of items used in this experiment (cognates and non-cognates) can be reached in the following URL: www.bcbl.eu/materials/jdunabeitia/Materials_D&D&M&D_2012.pdf

Table 2: Characteristics of the materials used in Experiment 1. Spanish indices are taken from Davis and Perea (2005) and English indices are extracted from Davis (2005). Standard deviation is reported within parentheses.

	English targets	Related English primes	Related Spanish primes
Non-cognate set			
Word frequency	84.71 (±45.30)	30.18 (±33.11)	26.42 (±38.75)
Number of letters	5.10(±1.03)	7.30 (±1.28)	8.82 (±1.84)
Number of neighbors	4.17 (±4.40)	1.02 (±1.42)	0.72 (±1.06)
Cognate set			
Word frequency	82.47 (±67.21)	30.78 (±52.10)	24.39 (±33.47)
Number of letters	5.17 (±1.06)	7.37 (±1.08)	8.22 (±1.29)
Number of neighbors	3.62 (±4.76)	0.95 (±2.02)	1.00 (±1.24)

Procedure. The experiment was controlled by the DMDX software package (Forster & Forster, 2003). All stimuli were centrally presented in Courier New font. A trial began with the presentation of a forward mask matched in length to the number of letters of the prime. After 500ms the mask disappeared and the prime was presented in lowercase for 50ms (3 refresh cycles of 16.66ms each in the CRT monitors). The prime was immediately followed by the uppercase target, which stayed on the screen until the participant responded or for a maximum of 2500ms. Reaction times were recorded using Empirisoft DirectIN High Speed button-boxes©. Participants were asked to decide as quickly and accurately as possible whether or not the target corresponded to an existing English word by pressing the corresponding button. Targets were presented in a different random order for each participant. The experiment started with eight practice trials.

Results

None of the participants reported that he/she noticed the presence of the prime display. We analyzed the correct RTs and accuracy for word targets with linear mixed-effects (*lme*) models, with participants and items as crossed random factors. For accuracy, we used a generalized *lme* with logistic link function and binomial variance. The models were fit using the *lme4* R library (Bates, Maechler & Bolker, 2011)[1]. There was no averaging of the data prior to the analyses. We inverse-transformed all RTs (i.e., -1000/RT) to reduce the positive skew in the distributions. Transformed RTs smaller than Q1-2.5*IQR or larger than Q3+2.5*IQR, by either participants or items (0.5%), were excluded from the analyses (with being Q1 the first quartile, Q3 the third quartile, and IQR the interquartile range). Condition means are presented in Table 3. For the RT data, significance values were obtained via Markov Chain Monte Carlo (MCMC) sampling of the posterior parameter distributions (sample size = 10,000)[2].

[1] R-scripts for the present analysis are available upon request.
[2] The observed densities can be inspected at http://users.ugent.be/~kdiepend/supp/morphCognMCMC.pdf

Table 3: Mean reaction times (in ms) and error rates (within parentheses) in Experiment 1. Priming effects are obtained by subtracting the RTs and error rates in the related conditions from those in the unrelated conditions.

	Related primes	Unrelated primes	Priming effects
Non-cognate set			
Within-language	643 (6%)	679 (6%)	36 (0%)
Between-language	686 (7%)	678 (6%)	-8 (-1%)
Cognate set			
Within-language	663 (6%)	706 (9%)	43 (3%)
Between-language	676 (8%)	701 (10%)	25 (2%)

We first investigated the presence of a significant 2x2x2 interaction between the design factors *Language* (within|between), *Cognate Status* (non-cognate|cognate) and *Relatedness* (related|unrelated). The interaction was significant for the RT data ($t(3231)=2.09$, $p_{MCMC}<.05$), but not for the accuracy data. We investigated the interaction in the RTs by inspecting the individual coefficients of the treatment coding, using different reference levels for our factors. The results are summarized in Table 4. For the accuracy rates we simplified the model in a backward stepwise fashion using $p_z \geq .05$ as the exclusion criterion. This resulted in a model with only a two-way interaction of *Cognate Status* and *Relatedness* ($z=2.16$, $p<.05$), showing significant priming for cognates only[3].

Table 4: Individual priming effects and comparisons in Experiment 1. *p*-values were adjusted following Benjamini and Hochberg (1995). Significant effects are presented in bold.

Effect 1	Effect 2	ΔRT (ms)	t	$p_{mcmc.BH}$
Non-cognate | Within-language		**36**	**5.19**	**0.0002**
Non-cognate | Between-language		-8	0.16	0.8890
Cognate | Within-language		**43**	**5.45**	**0.0002**
Cognate | Between-language		**25**	**4.29**	**0.0002**
Non-cognate | Within-language	Non-cognate | Between-language	**44**	**3.77**	**0.0002**

[3] Model summaries are available at http://users.ugent.be/~kdiepend/supp/morphCognlmer.pdf

Cognate | Within-language	Cognate | Between-language	18	0.79	0.5909
Non-cognate | Within-language	Cognate | Within-language	7	0.22	0.8890
Non-cognate | Between-language	Cognate | Between-language	**33**	**3.16**	**0.0045**

The results of Experiment 1 can be summarized as follows. We obtained significant within-language masked morphological priming effects in a second language, replicating recent results from Diependaele et al. (2011). Furthermore, we found little evidence for a different within-language morphological priming effect for cognate and non-cognate prime words (a 43 ms vs. a 36 ms priming effect). Importantly, results showed that cross-language masked morphological priming depends on the orthographic similarity between the L2 primes and their corresponding L1 translation equivalents. Cognate masked primes showed significant cross-language morphological priming effects (a 25 ms effect), whereas non-cognate masked primes produced negligible effects (a -8 ms effect).

According to these results, we can tentatively reject one of the three potential explanations for the cross-language masked morphological priming effects. Considering that clear-cut differences were observed in the magnitude of the cross-language masked morphological priming effects for cognate and non-cognate items, a possible account based on an initial morphological decomposition followed by an automatic translation of the decomposed stem (i.e., the decomposition *before* translation view) does not seem able to capture the present pattern of data, given that this view does not necessarily predict differences in the ease of morphological decomposition of cognate and non-cognate words. However, there are still two possible explanations that can readily account for these data.

On the one hand, these effects could be explained by a proposal based on initial translation mechanisms operating on the prime that would lead to the automatic activation of the translation equivalent of the polymorphemic word in the target language, which would then be morphologically decomposed (i.e., the decomposition *after* translation view). Given that cognates have been shown to be translated faster than non-cognates (e.g., Duñabeitia et al., 2010), this account can explain the present data by assuming that in the case of non-cognates, the mental processes leading to cross-language morphological priming cannot be successfully performed under masked priming conditions, while the ease of processing of cognates provides an advantage that ultimately leads to effective translation and decomposition effects.

On the other hand, these findings could be explained by an account that does not necessarily imply a translation process (i.e., the decomposition *without* translation view). On the basis of a morphological decomposition process operating very early during orthographic analysis of the masked polymorphemic prime, the stem would be stripped off and mapped onto its corresponding lexical (or lemma-based) representation. In the case of cognates, given the tolerance of morpho-orthographic decomposition processes to minimal mismatches between the decomposed form or the stem and its corresponding lexical representation (see McCormick, Rastle, & Davis, 2009, for review), it is expected that the cognate stems would map onto the whole-word representations in the two languages (e.g., *estudiar* and *study* for the stem *estudi*- from *estudiante*). Obviously, this would not be the case for non-cognate items, since the orthographic difference between the two lexical representations of the stem are clearly different.

However, as stated in the Introduction the decomposition *after* translation view predicts different outcomes depending on the relative balance of the bilinguals in the languages at test, given that electrophysiological data obtained from balanced bilinguals typically show that masked translation priming effects take place after morphological decomposition processes, while this is not the case for unbalanced bilinguals. Hence, if the same results as in Experiment 1 are found in a group of balanced bilinguals, the decomposition *after* translation view could hardly account for the general pattern of data, given that for this type of bilinguals translation processes take place *after*, not *before*, morphological decomposition processes. Oppositely, the account based on a pure morpho-orthographic decomposition (i.e., decomposition *without* translation) would not predict any difference between balanced and unbalanced bilinguals, while still predicting that cross-language morphological priming effects should increase as a function of the orthographic similarity between the masked polymorphemic primes and their translation equivalents, being completely absent for non-cognates and maximal for translation equivalent cognates with a high overlap.

In Experiment 2 we turned to a more fine-grained analysis of form overlap. Instead of making the usual crude categorical distinction between (a limited number of) cognates and non-cognates, we measured the form overlap between the primes and their translation equivalents continuously by means of a normalized Levenshtein distance metric. At the same time we selected a much larger number of items (N=200). A fine grained analysis of form-overlap effects should bring clarity about whether or not cross-language morphological priming occurs in the absence of such overlap and, thus, whether or not cross-language morphological relationships are also exploited via translation in bilingual word recognition (since translation is the only way to achieve priming in the absence of form overlap). Besides, in Experiment 2 we tested a sample of native balanced Basque-Spanish participants, in order to adjudicate between the competing accounts.

EXPERIMENT 2

Method

Participants. A group of 40 native Spanish-Basque balanced bilinguals with a mean age of 21.88 years (± 3.73) and with normal or corrected-to-normal vision and no history of neurological insults took part in this experiment. As presented in Table 5, participants acquired both languages very early in life (mean age of Spanish acquisition, in years: 0.63 ± 1.34; mean age of Basque acquisition: 1.22 ± 1.72). As in Experiment 1, participants completed a language proficiency questionnaire. Results of the self-ratings confirmed that these participants were perfectly proficient in Basque and Spanish (see Table 5).

Table 5: Mean proficiency in Spanish and Basque according to self-ratings of the sample tested in Experiment 2.

	Spanish	Basque
AoA (in years)	0.63 (± 1.34)	1.22 (± 1.72)
General proficiency	9.73 (± 0.50)	9.24 (± 0.86)
Speaking proficiency	9.68 (± 0.65)	8.73 (± 1.92)
Reading proficiency	9.63 (± 0.70)	9.49 (± 0.90)
Comprehension skills	9.71 (± 0.64)	9.66 (± 0.66)

Materials. A set of 200 common Spanish monomorphemic words was used as targets (e.g., *café* [*coffee*]; see Table 6 for item characteristics and Appendix). Each target was paired with a morphologically related derived Spanish word prime (i.e., related within-language primes; e.g., *cafetería* [*snack bar*]), and with the polymorphemic Basque translation of the Spanish prime (i.e., related cross-language primes; e.g., *kafetegi*). The words in the two related priming conditions were matched for word frequency, number of letters and number of orthographic neighbors (as taken from Davis & Perea, 2005, and from Perea et al., 2006). Critically, the Basque related primes had a varying degree of form overlap (i.e., a continuum of cognate status) with respect to their Spanish translation equivalents. In order to calculate the degree of overlap, we used 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 proposed by these authors, 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 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. The mean score for the 200 translation pairs was 0.36 (± 0.30), including pairs with varying overlap ranging from 0 (e.g., *blancura* and *zuritasun* [whiteness]) to 0.91 (e.g., *tradicional* and *tradizional* [*traditional*]). As in Experiment 1, we avoided the use of perfect cognates, since these items would not be informative given that participants could process them always in the target language, thus preventing us from exploring cross-language priming. Unrelated word primes were then created by rearranging the related word primes 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. A set of 200 nonwords was also created for lexical decision purposes by changing some letters from the word targets. Half of these nonwords were presented preceded by Spanish derived words, and half were presented preceded by Basque derived words. Four lists were created, so that in each list every target and prime only appeared once, but in each list each of the targets was presented in a different priming condition (within- or cross-language related or unrelated). Participant-to-list assignment was done at random. The full list of items used in this experiment (together with the orthographic overlap scores) can be reached in the following URL: www.bcbl.eu/materials/jdunabeitia/Materials_D&D&M&D_2012.pdf

Table 6: Characteristics of the materials used in Experiment 2. Spanish indices are taken from Davis and Perea (2005) and Basque indices are extracted from Perea et al. (2006). Standard deviation is reported within parentheses.

	Spanish targets	Related Spanish primes	Related Basque primes
Non-cognate set			
Word frequency	59.23 (± 90.43)	22.04 (± 25.66)	18.65 (± 49)
Number of letters	6.22 (± 1.40)	8.61 (± 1.54)	8.87 (± 1.65)
Number of neighbors	2.06 (± 3.15)	0.48 (± 0.72)	0.57 (± 1.03)

Procedure. The same procedure as in Experiment 1 was followed.

Results

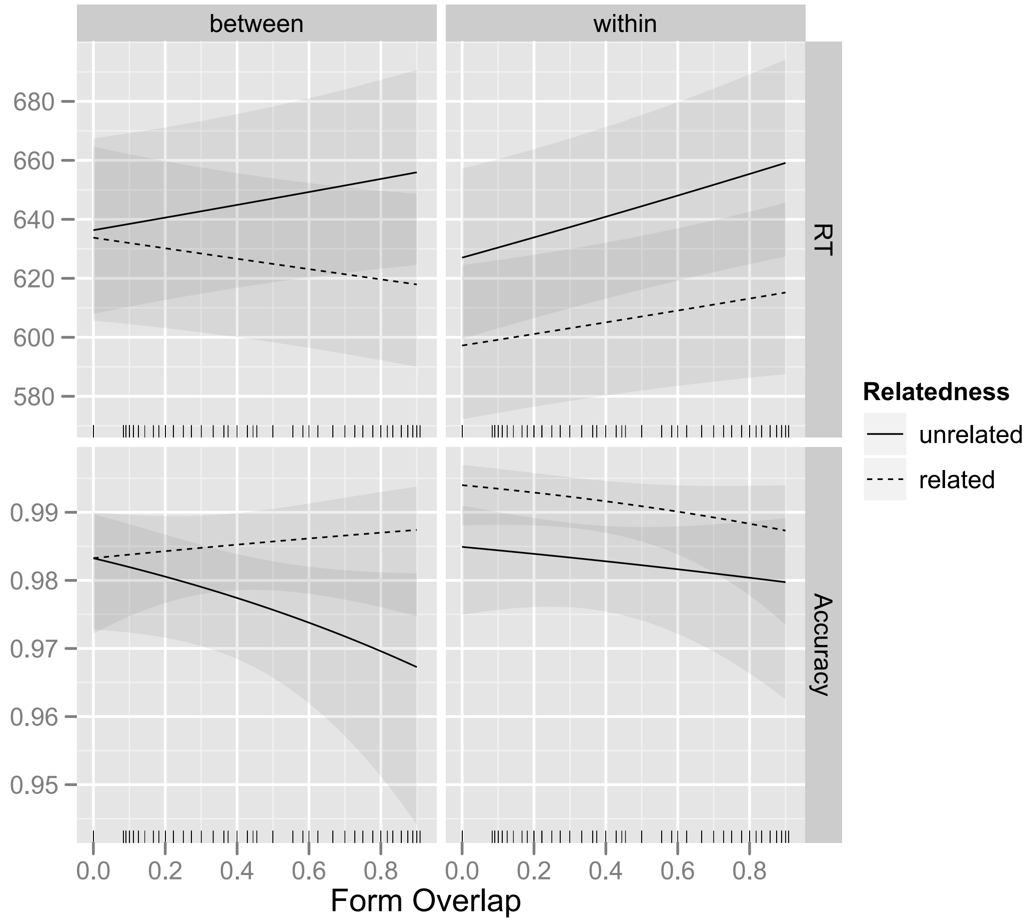
As in Experiment 1, none of the participants reported having noticed the presence of any prime. We analyzed the correct RTs and accuracy for word targets in the same way as in Experiment 1, except for the replacement of the factor *Cognate Status* with the *continuous* predictor *Form Overlap* (centered to its mean value)[4].

[4] Detailed information on the model estimates is available at https://docs.google.com/open?id=0B5cpY5t0Uu7GNlFUdEJGdGRSTi05Y2N3WkFRVmVKQQ and https://docs.google.com/open?id=0B5cpY5t0Uu7GU2twMVYtcVpRLTJMX0R5a0g4cWRSdw

As shown in the upper panels of Figure 3, for RTs there was significant priming in both the within- and cross-language conditions ($t(7906)=11.21$, $p_{MCMC} < .0001$ and $t(7906)=5.04$, $p_{MCMC} < .0001$, respectively), but priming was significantly smaller in the cross-language condition than in the within-language condition ($t(7906)=4.34$, $p_{MCMC} < .0001$). Importantly, the magnitude of the cross-language priming effect increased as a function of form overlap ($t(7906)=3.6$, $p_{MCMC} < .01$), showing that the priming magnitude was smallest with zero form-overlap (2ms[5]) and largest for the maximum overlap score (38ms). The lower panels of Figure 3 show a similar pattern for accuracy rates. Priming reached significance for both between- and within-language conditions ($z=2.08$, $p<.05$ and $z=3.25$, $p<.01$) and there was a marginally significant interaction between *Relatedness* and *Form Overlap* in the cross-language condition ($z=1.76$, $p=.08$), but not in the within-language condition ($z=-0.68$, $p>.49$), showing that the magnitude of the priming effect in the cross-language conditions in the accuracy rates was larger for primes with high orthographic overlap with respect to their translation equivalents (cognates) than for primes that shared minimal overlap with their counterparts (non-cognates).

Figure 3. Estimated RTs and accuracy rates along with 95% confidence bands in the analysis of Experiment 2. Form Overlap corresponds to the orthographic overlap between translation equivalents as measured by the Levenshtein distance metric.

[5] This value corresponds to the model estimation.



In Experiment 2 we replicated the results obtained in Experiment 1 with a sample consisting of balanced bilinguals and a continuous measure of orthographic similarity between translation equivalents. We showed that within-language masked morphological priming is consistently found in this population and that the magnitude of this effect does vary as a function of the cognate status of the prime. Importantly, we also showed that cross-language morphological priming can be obtained in this population, and that the magnitude of this priming effect is, in general terms, 1) smaller than the magnitude of the within-language morphological priming effects, and 2) different for cognates and non-cognates. Hence, these results converge with those gathered in Experiment 1 and demonstrate that proficiency in the two languages does not seem to radically alter the pattern of results.

General Discussion

The present study aimed to explore morphological decomposition processes in unbalanced (Experiment 1) and balanced bilinguals (Experiment 2), investigating whether or not between-language morphological relationships exist. To this end, participants were presented with simple target words, briefly preceded by either morphologically related or unrelated prime words in the same language, or in a different language. With regard to within-language masked morphological priming, in Experiment 1 we found significant priming effects for simple L2 targets preceded by related derived L2 primes that shared a root, relative to unrelated primes, generalizing previous evidence suggesting that nonnative polymorphemic derived words are decomposed and processed similarly to those from the native language (Diependaele et al., 2011). In Experiment 2, these effects were also replicated in a pool of balanced simultaneous bilinguals who rather than having an unambiguous L1 and L2, are better characterized as bilinguals with multiple L1s (see Perea et al., 2008), thus replicating preceding evidence on native language morphological priming (see Davis & Rastle, 2010, for review). However, the major finding of the present study corresponds to cross-language morphological priming, for which different cognitive accounts were initially proposed.

In the Introduction, three different cognitive accounts for the existence of cross-language morphological priming were discussed (see Figures 1 and 2). Such a priming effect could be predicted by a view of cross-language morphological priming based on an initial morphological decomposition process (e.g., *doloroso* = *dolor* + *oso*), followed by a mental translation process of the stem at an abstract level, which would match the target representation (e.g., *dolor* = *pain*). We initially suggested that this decomposition *before* translation account would be insensitive to the degree to which the polymorphemic prime overlapped with its translation equivalent in the target language (namely, the cognate status of the prime), since there are no reasons to expect that morphological decomposition (the first cognitive process in this account) would be faster accomplished for cognate words than for non-cognate words. However, we also discussed a different view of cross-language morphological priming, based on an initial translation process on the prime (e.g., *doloroso* = *painful*), followed by a morphological decomposition of the translated representation that would ultimately match the target (e.g., *painful* = *pain* + *ful*). In contrast to the previous account, this decomposition *after* translation account clearly predicted differences between masked cognate and non-cognate polymorphemic primes, given the large body of preceding evidence showing that cognate words are translated faster than non-cognates (see Duñabeitia, Perea, & Carreiras, 2010, for review). In this line, cognates should have led to significantly larger morphological priming effects than non-cognates. Lastly, we also discussed the possibility that cross-language morphological priming emerges as a result of a morpho-orthographic decomposition of the polymorphemic prime, in a language-independent manner (i.e., the decomposition *without* translation account). This account is grounded on two basic principles. On the one hand, previous evidence has shown that words with a real or apparent morphological structure are decomposed on the basis of an initial orthographic analysis (see Crepaldi, Rastle, & Davis, 2010; Davis & Rastle, 2010; Diependaele et al., 2011; Feldman et al., 2009; Rastle et al., 2004). On the other hand, research has demonstrated that this morpho-orthographic stem identification process survives to a certain degree orthographic variations between the decomposed form and its corresponding lexical representation (e.g., McCormick et al., 2008). Hence, a cognate polymorphemic prime in a given language (e.g., *estudiante*) would be initially decomposed into the corresponding stem and affix (e.g., *estudi|ante*), and the segmented representation of the stem would then be mapped onto the corresponding lexico-semantic representations in the two languages at test (e.g., *estudiar* and *study*), given their orthographic proximity. Importantly, this account exclusively predicts cross-language morphological priming effects for cognates.

In order to elucidate which of these three accounts was best suited to capture cross-language morphological priming effects, the cognate status of the primes was manipulated in a factorial design using cognates and non-cognates (Experiment 1) and in a continuous manner using a wide range of items varying in their orthographic similarity with respect to their translation equivalents (Experiment 2). Critically, in the two experiments here reported, we failed to find significant cross-language masked priming effects when primes and targets shared a morpho-semantic relationship but lacked formal overlap. However, when derived primes were related to targets in terms of form and meaning (i.e., cognate translations of derived words), significant cross-language morphological priming effects were observed. Indeed, as depicted in Figure 3, in Experiment 2 we further demonstrated that priming effects emerged as a function of increased orthographic similarity, showing the tight relationship between cognate status and cross-language morphological priming. Hence, according to these data we think that we can safely reject the decomposition *before* translation view, given that according to this view no differences are predicted in the morphological decomposition processes for cognates and non-cognates. (Note that the difference between cognates and non-cognates has been classically interpreted as a result of the orthographic and/or phonological overlap of cognates, and that this form-based advantage is not expected to occur at an abstract level once the polymorphemic words have been decomposed). Further support to this rejection is provided by the results observed in the within-language conditions in Experiments 1 and 2, where the magnitude of the morphological priming effects did not interact with the cognate status of the prime, showing the little effect played by cross-language orthographic similarity between translation equivalents when primes and targets correspond to the same language.

With one of the three accounts rejected, we still needed to adjudicate between the two other accounts (i.e., the decomposition *after* translation account and the decomposition *without* translation account). The two accounts correctly predicted significantly greater cross-language morphological priming effects for cognates than for non-cognates, but while the former account would still predict priming for non-cognates, the latter account would exclusively predict priming effects for cognates. In Experiment 1 no priming effects were found for non-cognates, and in Experiment 2 we further showed that the priming effects only emerged for words that shared with their translation equivalents a high number of orthographic units (70% overlap according to the Levenshtein distance metric adjusted for word length; see Figure 3). Hence, we believe that these data suggest that the decomposition *without* translation account is the proposal that correctly captures the observed pattern. Nonetheless, one could still argue that the lack of priming for the non-cognate sets simply reflects that the number of computations to be done by the visual word processing system in order to show cross-language priming effects precludes us from obtaining significant priming under masked priming conditions, and that only those items that can be more quickly translated (namely, cognates) are able to overcome the processing constraints imposed by the paradigm. Hence, the decomposition *after* translation view could still be taken as an acceptable account. For this reason, while in Experiment 1 participants corresponded to a pool of unbalanced bilinguals, in Experiment 2 we focused on balanced simultaneous bilinguals, considering preceding research showing a different time course of translation processes in balanced vs. unbalanced bilinguals.

Electrophysiological studies on the masked translation priming effect have shown that translation priming effects in unbalanced bilinguals can be found as early as 200 ms after target word presentation (see Hoshino et al., 2010; Midgley et al., 2009), coinciding with the earliest neural signatures for morphological priming effects (see Morris et al., 2011, for review). However, this is not the case for balanced bilinguals, who start showing electrophysiological markers of translation processes 400 ms after the target word has been presented (see Duñabeitia, Dimitropoulou, et al., 2010). Considering that masked morphological priming effects in bilinguals are highly similar to those found in monolinguals (see the within-language conditions in the current study; see also Diependaele et al., 2011), and that these effects occur earlier in time than translation processes in balanced simultaneous bilinguals (see Duñabeitia, Dimitropoulou, et al., and Morris et al.), it does not seem plausible to accept a view based on a morphological decomposition process that occurs *after* translation processes have been completed. This decomposition *after* translation proposal could correctly predict the pattern observed in Experiment 1, whereas it would not be suited to account for the pattern observed in Experiment 2. Moreover, considering that according to this account, morphological decomposition processes would take place at an abstract level (either lemma-level or post-lexically), and taking into account the bulk of evidence demonstrating the important role of form-based (orthographic) analysis in morphological decomposition (see Davis & Rastle, 2010, for review), this decomposition *after* translation account seems implausible. Nevertheless, the proposal based on a morpho-orthographic decomposition process *without* mediation of translation processes can perfectly account for the data gathered in the two experiments, since language proficiency (or balance) is not a factor that alters its basic principles.

If one takes the view that morphological decomposition is primarily morpho-orthographic in nature (e.g., Rastle et al., 2004), it could be straightforwardly explained why only cognates showed cross-language morphological priming. Taking the Spanish word *nacional* [*national*] as an example, if a sublexical decomposition process isolates the stem *nación* [*nation*] it is reasonable to assume that this will activate lexical representations in a language non-selective way such that both *nación* and *nation* become activated, thus explaining cross-language morphological priming. On the condition that such lexical activation develops in a language-independent fashion given the tolerance to slight orthographic changes between the decomposed stem and its associated lexical representations, a cognate polymorphemic word like *nacional* would map onto the lexical representations of *nación* and *nation*, similarly to how a polymorphemic word like *adorable* maps onto the lexical representation *adore* in spite of the differences between the orthographic representations of the decomposed and the lexically stored form (i.e., *ador*- vs. *adore*; see McCormick et al., 2008). Contrastingly, a non-cognate polymorphemic word like *doloroso* would only map onto its (language-dependent) stem *dolor*, given the huge orthographic difference with respect to *pain*. The absence of a cognate effect in within-language morphological priming conditions is a highly critical finding, since it further supports the view that morphological priming effects in a given language are relatively insensitive to the orthographic overlap between the prime words and their translation equivalents. This suggests that there is little involvement of mental translation processes in masked morphological priming.

So far we have discussed how morpho-orthographically decomposed cognate stems map onto language-independent lexical representations, but it should be noted that this same rationale applies to other accounts of morphological decomposition that propose that the decomposed forms map onto lemma representations, such as the one described by Taft and Nguyen-Hoan (2010; see also Baayen et al., 1997). Unfortunately, given that the underlying mechanisms in these lexical-based and lemma-based morpho-orthographic accounts are equally well suited for accounting for language-independent morphological priming for cognates, we cannot disambiguate between them on the basis of the current data.

Considering that the present study exclusively presents behavioral data from a series of masked priming experiments, we would want to acknowledge that these results do not unambiguously demonstrate a negligible role of mental translation processes in cross-language morphological relationships. Due to the prime words' processing limitations imposed by the immediate presentation of the target words in the masked priming paradigm, it remains to be determined whether or not between-language morphological relationships can be found as a consequence of automatic translation processes in the absence of bottom-up support via prime-target orthographic overlap (i.e., for non-cognates) when the word recognition system has a reasonable amount of time to process the primes and assess the existing relationship between primes and targets (e.g., in an unmasked conscious priming context). We are currently working on an explicit priming version of this study that combined with EEG recordings will help us to clarify the role of translation processes in between-language morphological priming with varying degrees of ortho-phonological overlap between the translation equivalents.

Finally, we wish to mention that at the experimental level, these data apparently contrast with those reported by Zhang et al. (2011). While Zhang et al. showed cross-language morphological priming effects in the absence of explicit form overlap, we show that only when a form overlap is explicitly present cross-language masked morphological priming effects emerge. Nonetheless, three critical issues should be kept in mind. First, as opposed to the Chinese-English language combination reported by Zhang et al., here we focused on alphabetic languages (English, Basque and Spanish). At least for alphabetic languages, it seems that morphological priming is mediated by form, and that in the absence of explicit form relationships (either orthographic or phonological as in the case of the cross-script masked morphological priming effect reported by Voga and Grainger, 2007), cross-language masked morphological priming effects are elusive. Second, it is worth mentioning that while the present study focused on derivational morphological priming, the study of Zhang et al. focused on constituent priming in compound words. It remains to be explored whether the type of morphological relationships at stake determines the influence of form as an access cue to morphology (see also Feldman & Moskovljevic, 1987). And third, it should be kept in mind that Zhang et al. did not explore cross-language morphological relationships *per se*, since they presented participants with word pairs in the same language (L2-L2 pairs). In contrast, we directly investigated cross-language priming by mixing the languages of the primes and the targets. Therefore, we believe that there are multiple reasons that preclude us from drawing strong theoretical conclusions regarding the discrepancies between the current study and that reported by Zhang and colleagues.

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