PROCESSING VERBAL INFLECTION IN NATIVE AND NON-NATIVE SPANISH

By

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ABSTRACT

The role of morphological complexity in visual word recognition has recently been studied in detail both with native speakers and second language (L2) learners. The present study investigates how morphologically complex words (such as *walk-walked*) are processed by native speakers of Spanish and English learners of Spanish as an L2. Moreover, the study examines factors such as proficiency and lexical decoding ability to see whether they can predict individual variability in the sensitivity that L2 learners show to morphological information. Subjects participated in two experiments, a lexical decision task (using a long-lag priming experiment), and a gating task, in order to assess their lexical decoding ability. Results show that native speakers of Spanish can decompose inflected verbs into their constituents, while L2 learners need to rely more on whole word storage in order to process the same forms. Furthermore, neither proficiency nor decoding ability were found to be related to individual differences in morphological processing in the learner group. These results suggest that native speakers and L2 learners rely on different mechanisms in order to process inflectional morphology.

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1. Introduction

Morphological complexity is argued to affect how words are processed. There is some debate about exactly what processes morphological complexity is affecting, however, and a number of studies have investigated its role in the processing and storage of complex lexical information. These studies aim to understand how inflected, derived, and compound words are processed and stored in the mental lexicon (e.g., Dominguez et al., 2000; Forster, 1988; McQueen, & Cutler, 1998; Seidenberg, & Gonnerman, 2000; Taft, 1991). The principal question in such studies revolves around whether morphemes, the elemental units of meaning in any language, are always the basic units used in lexical processing, or whether complex words are ever treated as a whole form (Hay & Baayen, 2005).

The current literature on this topic, which will be reviewed in the following sections, has investigated a variety of morphemes in many different languages. Inflectional morphemes (e.g., *walk-walked*), derivational morphemes (e.g., *view-viewer*), and compound words (e.g., *tea/cup-teacup*) have been studied in an attempt to understand how complex words are stored and accessed in the mental lexicon and then processed by native speakers. Importantly, the same techniques used with native speakers have also been used to investigate whether the mechanisms underlying the processing of complex words in a second language (L2) are the same or different from those underlying first language processing. The aim of the current study is to present evidence that sheds new light on the debate about morphological processing of an L2 by testing the processing of regular Spanish verbs by English learners of Spanish at different levels of proficiency.

More specifically, the two tasks designed in the current study have been created to investigate the two following questions on the processing of verbal inflection in Spanish:

1) Will native speakers of Spanish show decomposition effects when processing inflectional morphology in their native language? Will L2 learners show decomposition effects?

2) Can factors such as proficiency and decoding ability (defined in the next sections) explain individual variability in L2 learners' sensitivity to morphological information?

The Introduction is divided into three main subsections. The first part consists of an overview of the three models that have been proposed to explain how native speakers process morphologically complex words, outlining the predictions they make for verbal inflection, which is the main focus of the current study. The next subsection reviews the different theories proposed for how L2 learners process the same type of morphologically complex forms, emphasizing the predictions we can draw from each one of them. The Introduction concludes with an outline of the current study.

1.1 Native Speakers

Research on morphological complexity has investigated three theoretical models of lexical access that try to account for how complex words are stored and accessed in the mental lexicon by native speakers. The first model is the Full Storage Model, also known as the non-decompositional model. This model, represented in Figure 1, predicts no online role for morphological-level constituents. It proposes that any word (complex or simple) is stored and processed as a whole, without any advantage from the constituents that are combined to form the word. Using inflectional morphology as an example (as in the present/past tense pair *walk-walked*), this process of lexical access can be explained as follows: words in the past tense form are not broken up into their different constituents, but instead processed and accessed as a single unit. Thus, forms such as *walk* and *walked* are stored in the mental lexicon as individual, separate entries (e.g., Hay & Baayen, 2005; Seidenberg & Gonnerman, 2000). The same is true for irregular verbs such as *teach*/*taught*. This model argues that forms such as *walk* and *walked* are related to one another by orthographic/phonological form and by semantic similarity, rather than by the fact that they have a common root morpheme.

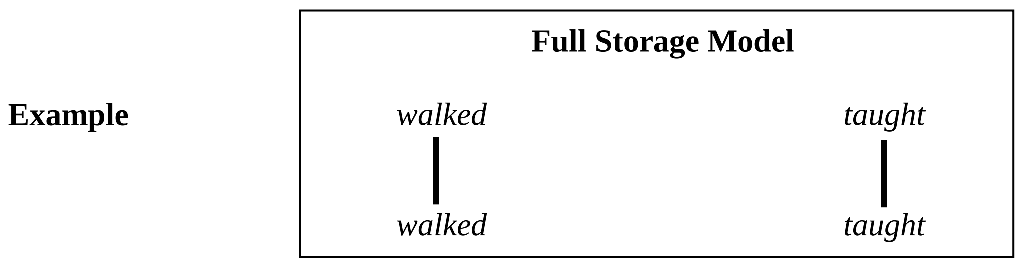

Figure 1. Past tense forms in the Full Storage Model.

The second model is the Full Decomposition Model. In this model, morphemes are predicted to play a critical role in lexical processing. This model states that complex words are not stored as a whole, but instead are accessed via their constituents (e.g., Fruchter, Stockall, & Marantz, in press; Stockall, & Marantz, 2006), as represented in Figure 2. Using the same example as before, this process can be explained as follows: a past-tense form like *walked* consists of two morphemes, *walk*– and –*ed*, which have independent entries in the mental lexicon. The same is true for irregular verbs; hence, a verb like *taught* is a combination of *teach*- and -*ed*. When reading a word, their brain decomposes the word into its morphemes, and then combines those two meaningful units in order to process the complete word (e.g., Duñabeitia, Laka, Perea, & Carreiras, 2008; Fiorentino & Poeppel, 2007; Marslen-Wilson, Bozic, & Randall, 2008; Solomyak & Marantz, 2008, 2010; Stockall, & Marantz, 2006).

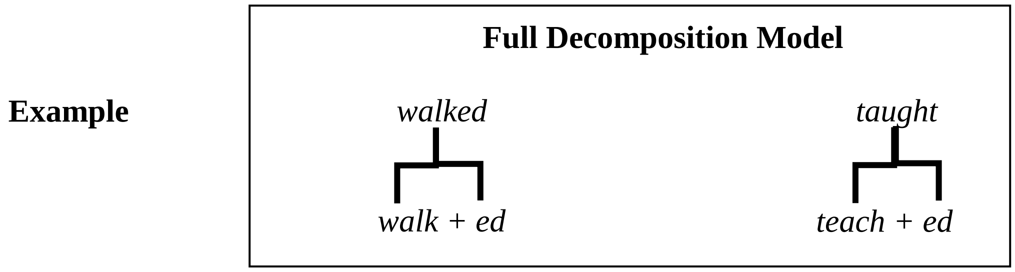

Figure 2. Past tense forms in the Full Decompositional Model.

The last model that has been proposed to explain lexical access is the Dual Route Model (e.g., Clahsen, Eisenbeiss, & Sonnenstuhl-Henning, 1997; Pinker, & Ullman, 2002). This model suggests that both decompositional and whole-word processing routes may be used at the same time, and that different factors such as transparency, lexicality, productivity, regularity, and frequency influence which one will be used for each form. Using the same examples as before, this model treats regular and irregular forms differently: regular forms are decomposed into their constituents, and irregular forms are processed as a whole. This is represented in Figure 3.

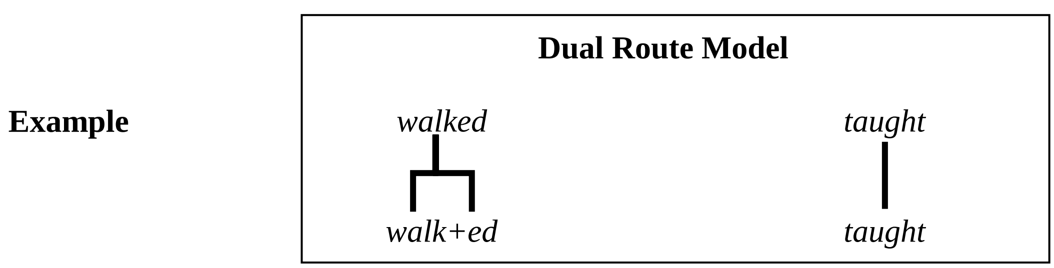

Figure 3. Past tense forms in the Dual Route Model.

Evidence in the literature on native speakers' processing of inflectional morphology, discussed in the next section, suggests that decomposition plays an important role in the processing of inflected forms (e.g., Marslen-Wilson, Bozic, & Randall, 2008; Solomyak & Marantz, 2008, 2010). Before discussing this literature, however, let us turn to a brief overview of the models that have been proposed for explaining L2 learners' use of inflectional morphology.

1.2 Second Language Learners

The results of investigations into L2 processing are quite heterogeneous: some show major differences between the processing of the native language and the L2 (e.g., Clahsen, & Neubauer, 2010; Murphy, & Hayes, 2010), while others find that L2 learners show patterns similar to those found in native speakers (e.g., Cheng, Wang, & Perfetti, 2010; Diependaele, Duñabeitia, Morris, & Keuleers, 2011).

Multiple theories have been proposed for the L2 processing of complex words. The first approach claims that the processing of a first and an L2 share the same cognitive system, but that processing of the L2 imposes higher cognitive demands. According to this approach, L2 processing may be slower and less automatic than processing of the native language, and is influenced by the shared properties of the first language (e.g., Hopp, 2010; McDonald, 2006; Perani & Abutalebi, 2005). Under this approach, the expectation is that morphologically complex words could be processed in the same way by both native speakers and L2 learners, but that L2 learners will be more easily/strongly affected by factors that contribute to increasing processing demands (e.g., propositional content of sentences, lexical frequency, long structural dependencies, etc.). If native speakers show evidence of decomposition, then, decomposition patterns are potentially possible in L2 processing as well, again depending on factors that may contribute to increasing processing demands. This first approach also has shown that factors that are predictive of individual differences, in addition to age of acquisition, may be used to explain a large extent of variability in the performance of L2 learners. The lexical decoding ability of the

L2 learners is one of these factors that have been found to be good predictor of L2 accuracy in a grammaticality judgment task (McDonald, 2006) and in the reading domain (e.g., Bruck, 1992; Kim & Davis, 2004; Kim, Davis, Burnham, & Luksaneeyanawin, 2004), and this study aims to understand how it may predict L2 learners' ability to process inflectional morphology. Lexical decoding is the ability to combine phonological information in order to access lexical information of orally presented words. It controls the phonemic awareness of individuals and provides us with a measurement of how much phonemic information they need in order to retrieve the correct word from among competitors. The results in the literature (McDonald, 2006) show that the learners who do not need a lot of information in order to correctly retrieve words process the L2 more similarly to native speakers. For this reason, this study aims to look at how lexical decoding may predict L2 processing of verbal inflection, that is, how native speakers of English process verbal inflection in their L2 (Spanish).

The second approach holds that the processing of a first and an L2 are different on a more fundamental level. Ullman (2005) proposed the Declarative/Procedural Model, a Dual Route Model according to which native speakers rely on two different memory systems in order to process regular and irregular verb forms. This model proposes the use of two different memory systems, the declarative and the procedural memory systems. Under this proposal, the declarative memory system is associated with the learning, representation, and use of knowledge about arbitrary relations, information which is usually available to conscious awareness. In the case of verbal inflection, for example, this memory system has been proposed to explain the learning of irregular forms and their tense marker (e.g., *went*). In contrast, the procedural memory is implicated in the learning of implicit, rule-based information, especially those types of information which imply sequences or systematicity. For this reason, the procedural memory system has been associated with the ability to construct regular, morphologically complex words formed predictably from a stem and an affix (e.g., *walk-* + *-ed*) (e.g., Alegre & Gordon, 1999; Münte, Say, Clahsen, Schiltz, & Kutas, 1999; Pinker & Ullman, 2002). In the literature with native speakers, we see evidence that females tend to rely more on declarative memory, even for functions normally associated with the procedural memory, such as decomposing regular inflection (Babcock et al., 2012). This model, therefore, can account for the fact that females tend to show an advantage over men at verbal memory tasks (e.g., Halpern, 2000; Babcock et al. 2012).

Ullman (2005) posited also that L2 learners primarily rely on declarative memory even for functions that are associated with the procedural system in native speakers. This difference between L2 and native speakers would explain why L2 learners usually need to rely more on lexical storage (Ullman, 2005). However, this model predicts that a shift from declarative to procedural processing is possible. This theory predicts that we will observe a qualitative shift in the processing of morphologically complex words, with learners being different from native speakers at lower but not at higher levels of proficiency.

Finally, Clahsen et al. (2010) claim that L2 learners are not as sensitive to morphological information as native speakers. Based on several studies of learners using an array of tasks and examining three domains (inflectional, derivational, and morphosyntactic phenomena), they argue for qualitative differences between native and L2 morphological processing, suggesting that learners are forced to rely more on lexical storage, independently of proficiency level. In fact, this theory predicts that native-like processing is not expected among L2 learners, even at high proficiency levels. The conclusions drawn in this review are consistent with Clahsen and Felser's Shallow Structure Hypothesis (2006), which claims that L2 learners' use of abstract grammar is restricted and the processing of the L2 contains less syntactic detail than that of native speakers.

The current study allows us to test the different predictions of these three theories. By testing the processing of regular Spanish verbs by English learners of Spanish at different levels of proficiency, we seek to determine whether learners decompose morphologically complex words in the same way native speakers do (as proposed by Diependaele, Duñabeitia, Morris, & Keuleers, 2011). Since learners have different levels of proficiency, we also seek to determine whether proficiency or lexical decoding ability may be good predictors to explain how these learners process regular inflection in their L2, or whether they will be showing reduced sensitivity to morphological structure regardless of proficiency (Clahsen et al., 2010).

1.3 Summary of the Current Project

The aim of the current study is to present evidence that will shed new light on the debate about the morphological processing of an L2 by testing regular verbal inflection in Spanish. There are still a lot of open questions in this subfield that need to be addressed. For example, there is no consensus regarding whether or not proficiency affects decomposition patterns. Additionally, this study will also analyze whether decomposition patterns are more robust by studying a morphologically rich language such as Spanish. Moreover, we need to investigate the possible causes of any differences found in the processing of morphologically complex forms by native speakers and L2 learners and to understand when these differences are most likely to arise (e.g., due to L2 learners' differing lexical decoding abilities, etc.).

The main purpose of the present study is, therefore, to explore some of these open questions. More specifically, the two tasks designed in the current study have been created to investigate the two following questions on the processing of verbal inflection in Spanish:

1) Will native speakers of Spanish show decomposition effects when processing inflectional morphology in their native language? Will L2 learners show decomposition effects?

2) Can factors such as proficiency and decoding ability (defined in the next sections) explain individual variability in L2 learners' sensitivity to morphological information?

The thesis is structured as follows. In Section 2, an overview of the Spanish morphological system is provided, including a detailed description of the verbal inflection system which is the focus of the present investigation. Sections 3 provide a review of the existing literature on native speakers and L2 learners, with a focus on studies related to Spanish and to inflectional morphology. Sections 4, 5 and 6 presents an overview of the current study, including detailed explanation of the methodology (participants, experiments, stimuli, tasks, and procedures), hypotheses, and predictions. Results appear in Section 7, and in Section 8, I discuss the main theoretical implications of our findings. Section 9 relates the results obtained with the previous literature, and presents overall conclusions.

2. Verbal Inflection in Spanish

Spanish, an Ibero-Romance language, can be classified as an inflecting language based on its rich verbal morphology (Mahlow & Piotrowski, 2009). Spanish verbal inflection consists of 17 possible combinations of mood and tense (Real Academia de la Lengua, 2009). Considering that verb forms are also marked for person and number in Spanish, there are a total of 111 conjugations for each verb. Spanish has three main conjugation classes, distinguished by the thematic vowel (*–a*, first, *–e*, second, and *–i*, third conjugation) in the infinitival form of the verb (e.g., *hablar* 'to talk,' *comer* 'to eat,' *mentir* 'to lie').

Traditionally, Spanish verbal forms have been analyzed into four parts: the stem, which is the unchanged part in irregular forms; the thematic vowel, referred to as the VT, which gives information about the conjugation of the verb; the time and mode markers (TM); and the person and number markers (PN) (e.g., Alcoba, 1999; Real Academia de la Lengua, 2009). These are represented in (1).

(1) a. cantabas
cant^{stem} – a^{vt} – ba^{tm} – s^{pn}
Sing – thematic vowel – past tense – second person singular
'You sang' (imperfective)

Another representation has also been proposed (Real Academia de la Lengua, 2009, p. 182), in which the stem and the thematic vowel are segmented together as part of the so called "theme" (see (2)). However, this segmentation does not exclude the previous one, because in most inflected forms the thematic vowel does not appear, so it has been argued to be considered part of the theme itself, not an independent morpheme (Real Academia de la Lengua, 2009, p. 182).

(2) a. $[\text{cant – a}]^{theme}$ – ba^{tm} – s^{pn}
Sing – thematic vowel – past tense – second person singular
'You sang' (imperfective)

In the present study, we examine the processing of morphologically complex forms using Spanish verbal morphology, focusing on the third person plural of the present tense of regular verbs. In Spanish, third person plural present tense, all regular verbs take a regular –*n* suffix (as represented in (3)). Furthermore, regular verbs do not evidence any changes in the stem, as happens with irregular verbal forms.

(3) a. $cant^{stem} – a^{vt} – ø^{tm} – n^{pn}$
b. $[cant – a]^{stem} – ø^{tm} – n^{pn}$
'They sing' (present, indicative)

One reason for using this verb tense is that review of a corpus shows that the present indicative tense is highly frequent, representing 50% of all attested verbal inflections (Román del Cerro, 1981). Moreover, the third person plural involves the same number of letters as the infinitival form of the verb (e.g., *cantar* 'to sing' and *cantan* 'they sang' both have 6 letters).

There is another motivation for examining third-person plural present tense Spanish inflection of regular verbs: the literature on storage and composition of these verbal forms by native speakers is remarkably consistent (e.g., Brovetto & Ullman, 2005; De Diego Balaguer, Sebastián-Gallés, Díaz, & Rodríguez-Fornells, 2005; Rodríguez-Fornells, Münte, & Clahsen, 2002). These studies, which overwhelmingly show evidence of decomposition by native speakers, are discussed next.

3. Literature Review on Morphological Processing

Having introduced the main concepts of verbal inflection in Spanish, a critical review of the most relevant literature on the processing of morphologically complex words by native speakers and L2 learners is now provided. Special focus has been given to the literature on inflectional morphology and the Spanish language.

3.1 Methods for Investigating the Processing of Morphology

A number of researchers have used data related to priming and frequency effects in an attempt to shed light on the mechanisms by which morphologically complex words are processed by native speakers. With regards to the three models outlined above, the evidence gained from these studies has been mixed, supporting both decompositional and non-decompositional accounts.

In most of the studies that we will review in the following sections, a masked-priming paradigm has been used. In masked-priming experiments, the primes are presented immediately before targets, between masks (e.g., hash signs) and the time between the onset of the prime and the onset of the target is generally less than 60 ms. This is sufficiently brief that participants are not aware of having seen the prime, as demonstrated by their inability to correctly recall the prime words when asked to try to do so (Forster & Davis, 1984). Participants are often asked to perform a lexical decision task[1], which means that they have to decide, as quickly and as accurately as possible, whether or not the target form is a real word. Both response times and accuracy are measured.

In the literature using masked-priming experiments, it is common to find different conditions tested. Masked-priming experiments usually include target words that are presented after an inflected prime (e.g., *walked*-*walk*), which is the critical condition, and different controls: identity control (e.g., *walk*-*walk*), an unrelated form (e.g., *sing*-*walk*), a semantic control (e.g., *march*-*walk*), and an orthographic control (e.g., *talk*-*walk*), in order to measure participant response times when recognizing the target form. The predictions that can be drawn

[1] There are other studies that use semantic categorization tasks, etc.

from the different conditions are the following: Response times are expected to be faster for the identity condition, than for the unrelated condition, because repeating the same word is going to prime the target form and so, facilitate its recognition. The morphology condition, in which the inflected prime appears before the infinitive, is expected to pattern as the identity condition if speakers decompose verbal inflection into its constituents, or more similarly to the unrelated condition if decomposition is not observed. The orthographic and semantic conditions are normally included as controls as well, in order to show that the facilitation obtained after an inflected prime is not solely due to the orthographic/semantic overlap between prime and target, but also to the fact that they share the root stem. The same holds true when derivation morphology or compound words are tested.

Using an example of the stimuli in Rastle et al. (2004), we can explain the rationale behind interpreting results when using this paradigm as follows. In this experiment, participants made lexical decisions to targets preceded by primes that shared (1) a transparent semantic-morphological relationship (*cleaner-CLEAN*), (2) an apparent morphological relationship but no semantic relationship (*corner-CORN*), or (3) a form relationship (not morphological) (*brothel-BROTH*) with the target. Different predictions could be drawn based on the different possibilities discussed for lexical access (decomposition vs. storage). If lexical access is mainly influenced by semantic relationship, only the transparent semantic-morphological condition (*cleaner-CLEAN*) should yield facilitation in response times. However, if representations are decomposed on the basis of the constituents forming the words, then the facilitation would be observed for the two conditions with a real morphological relationship (*cleaner-CLEAN*), and an apparent morphological relationship (*corner-CORN*), because all the elements are existing morphemes in English. Results in their study supported the second prediction, that is, that the response time facilitation (shorter response times in relation to a semantically and orthographically/phonologically unrelated control condition with the prime *cleaner-CLEAN*) was reported only for the first two conditions (the real and apparent morphological conditions), and the difference was significant when compared with the condition that only showed an orthographic form relationship (*brothel-BROTH*). In order to be able to process these forms faster, participants must be decomposing the morphologically derived forms into constituents when processing them.

Another method that has been used to investigate morphological processing is the effect of frequency on word recognition. The rationale for using frequency effects is based on the assumption that highly frequent lexical items may be processed faster than those with lower frequency of occurrence (e.g., Oldenfield & Wingfield, 1965). The reasoning is that if an inflected form is processed via its constituents, then two inflected verbs matched in terms of overall frequency but differing in terms of their morpheme frequencies should show differing response patterns; that is, an inflected form with a higher frequency morpheme should be processed faster than another inflected form with a lower frequency morpheme.

We now review the most relevant literature related to native speakers. These studies employ the basic methodologies outlined above in order to contribute to the debate about how morphologically complex words are processed and stored in the mental lexicon. We focus primarily on inflectional morphology in Spanish and other languages.

3.2 Native Speakers

The broadest field of study in the area of morphological processing, and the focus of the current study, revolves around an attempt to understand how inflected (mainly verbal inflection and agreement) words are processed and stored in the mental lexicon of native speakers of a given language. However, most studies of inflectional phenomena have been conducted in English and German. Other languages, particularly those with richer inflectional systems such as Spanish, are not well represented. For this reason, the distinction between storage and decomposition is less well-understood among these languages. The current study aims to contribute to the literature on these types of languages.

When investigating verbal inflection, much research presents evidence in favor of the Dual Route Model (e.g., Paradis, 2004, 2009; Pinker, 1999; Ullman, 2001a-b, 2004, 2005), in which regular verbs are generated from their stems by rules using the procedural memory and irregular verbs are memorized as whole forms and stored in the lexicon using the declarative memory system (e.g., Alegre & Gordon, 1999; Marslen-Wilson & Tyler, 1998; Münte, Say, Clahsen, Schiltz, & Kutas, 1999; Pinker & Ullman, 2002; Prado & Ullman, 2009). Pinker (1991) demonstrated that irregular verbs with higher whole-word frequency were generated more quickly than irregular forms with low whole-word frequency. He also found that regular verbs, which are predicted to be decomposed, showed an advantage for those forms with a highly frequent morpheme (the frequency of the whole word did not affect the response times). Pinker (1991) claimed that his results were consistent with the idea that the mental lexicon of a native speaker must be divided in two memory systems, each of which is specialized for storing irregular word forms or decomposing regular forms.

More support for the Dual Route Model was provided by Luck, Hahne, & Clahsen (2006). Using event related potentials, the authors found that auditory presentation of incorrect overregularizations (e.g., **Karussellen - Karussells* 'carousels') elicited LAN/P600[2] effects, while presentation of incorrect irregularizations (e.g., **Bienes - Bienen* 'bees') produced N400[3] effects. These results support a regular/irregular distinction, implicating the availability of both combinatorial and memory-based routes to lexical processing. The claim was that different effects emerged because the two types of inflected forms were processed by two different memory systems.

Bowden et al. (2010) found the same pattern (decomposition of regular verbs and storage of irregular forms) using a production task with native speakers of Spanish. Participants in this study were shown the infinitival forms of verbs from the three conjugations and were asked to produce either first-person singular present tense or imperfect forms, in different sessions. In the present tense, subjects responded faster to higher frequency forms (which is taken as evidence in favor of storage) for irregular verb forms. In contrast, regular verbs did not show whole-word frequency effects, taken as evidence in favor of the Full Decomposition Model. This pattern of results has been found consistently in the Spanish literature using different manipulations of the stimuli and different tasks (e.g., Brovetto, & Ullman, 2005; Clahsen, Aveledo, & Roca, 2002).

Using event related potential responses, Rodriguez-Fornells, Münte, and Clahsen, (2002) tested the processing of regular and irregular verbal inflection in Spanish (see Table 1 for examples of their stimuli). A delayed visual repetition priming paradigm, also known as long-lag priming paradigm, with a lexical decision task was used in this study. This type of priming differs from a masked-priming task in the fact that both primes and targets are visible to the

[2] In the literature using event related potentials, these two brain responses have been thought to reflect morphosyntactic processing (the LAN, or Left Anterior Negativity) and controlled processes like syntactic and morphosyntactic repair, including agreement mismatches (the P600 response) (Barber & Carreiras, 2005).

[3] On the other hand, N400 effects have been associated with the processing of lexical information. There is evidence in the literature, in which N400 effects were obtained when a target word was or was not somehow related to an immediately preceding word, suggesting that the amplitude of this response may be indexing the processing of meaning (Kutas & Federmeier, 2010).

participant, and the authors presented them (prime and target) with an inter-lag of 5 to 9 words. Participants were asked to make a lexical decision task for each one of the words, while event-related potentials were recorded. In the literature using event-related potentials, a bigger N400 is found for new words, and a reduced N400 is found for prime words, and thus a smaller N400 for a target following a morphologically related prime is evidence for decomposition as compared to a control condition, in which the prime had no relation (neither semantic, nor orthographic or morphological) with the target. In their data, authors reported a reduced N400 effect only for the regularly inflected forms in Spanish, but not for the irregulars. Their results support a regular/irregular distinction, consistent with Dual Route Model of morphological processing. A prime target pair such as *ando-andar* would be processed by accessing the same lexical entry (for the stem), but not in the case of an irregular form such as *duermo-dormir*.

Table 1. Example of the stimuli used in Rodriguez-Fornells et al. (2002).

	Prime	**Target**
Regular condition	*Ando* 'I walk'	*Andar* 'To walk'
Irregular condition	*Duermo* 'I sleep'	*Dormir* 'To sleep'

Arguments for alternative models of how inflected forms may be processed have also been proposed, however. One model that has received some support is the Full Decomposition Model, which proposes that regular and irregular inflections are processed by a single mechanism. Under one such theory, Stockall & Marantz (2006) argue that both regular and irregular verbs are composed as a combination of two or more morphemes. This differs from the dual mechanism account in which only regulars are composed by rule from their stems. Their evidence for this position comes from a magnetoencephalography (MEG) lexical decision study using unmasked and masked-priming evidence, in which they obtained priming effects for both regular and irregular verb-stem pairs (eliciting a similar M350 response[4]), but no priming effects for pairs such as *boil-broil*, which are phonologically and semantically similar but do not share a morphological relationship. This pattern is showing us that morphological relatedness is distinguishable from semantic and phonological relatedness; prime and target are processed as though they were identical, because they share the same root.

Fruchter, Stockall, & Marantz, (in press) also found evidence in support of the decomposition model by analyzing the processing of the English past tense, as they observed that even irregulars are decomposed into stems and affixes prior to lexical access. In order to make this claim, Fruchter, Stockall, & Marantz, (in press) asked participants to perform a visual masked-priming lexical decision task with regular and irregular inflected verbs in English, while measuring MEG responses. They found that activity in the brain was modulated by the masked-priming manipulation for both regular and irregular verbs (giving an M170 response[5]), which was taken as evidence that both forms are treated in the same way and so, priming effects were found as predicted by the Decomposition Model.

In terms of regular verbal inflection, two of the models of lexical access make the same predictions. Based on both the Decomposition and the Dual Route Model, it is to be expected that our control group of native speakers of Spanish would show decomposition effects. This pattern of results will show us that, at least with regular verbs, the relationship between two

[4] The M350 is a magnetoencephalography (MEG) index of lexical activation, which has been elicited using different experiments and which is sensitive to stimulus factors expected to affect lexical access, such as frequency, repetition, priming, etc. (Helenius *et al*., 1999)

[5] The M170 is an MEG response which has been shown to be sensitive to morphological properties such as affix frequency and the conditional probability of encountering each word given its stem. It has been reported that semantic or other true lexical properties of words do not affect activity at the M170 (Solomyak, & Marantz, (2010).

inflected forms is more than a simple semantic or phonological relatedness in Spanish. The Full Storage Model, on the other hand, would predict no effect of morphology that cannot be tied back to semantic or orthographic relatedness. The selected literature reviewed seems to support the prediction that decomposition plays an important role in native speakers' lexical access, at least for regularly inflected forms (e.g., Marslen-Wilson, Bozic, & Randall, 2008; Solomyak & Marantz, 2008, 2010).

3.3 Second Language Learners

As outlined before, most of the research about the representation of morphologically complex words has focused on monolingual native speakers. Less work has investigated how L2 learners process morphologically complex forms in their L2. The main goal of the present research is to study how L2 learners of Spanish who are native speakers of English process verbal inflection in Spanish, their L2. Before moving into a description of the current research, then, it is important to provide a review of some of the major findings in the literature on the representations and processing of inflected morphology in L2 learners.

In an early study, Beck (1997) examined how native speakers and L2 learners of English (with a variety of native languages) produced regular and irregular past-tense forms. The results of this study indicated that while native speakers showed faster naming latencies for highly frequent root forms, L2 learners did not show frequency effects for either verb type. These results were taken as evidence in favor of the Dual Route Model, given that a highly frequent shared root facilitates production times in natives, but not in L2 learners. However, using a selection task—in which participants were presented with an incomplete sentence and five different verbal forms and were asked to choose the form that best fits the sentence—Birdsong and Flege (2001) found whole form frequency effects for irregular but not for regular verb forms. Their participants were near-native learners of English with either Spanish or Korean as their native language. The fact that whole form frequency effects were found only for irregular verbs leads them to propose that highly proficient learners do have a morphological representation of words in the L2 and thus show decomposition effects. However, they could not compare the results of the L2 learners with those of native speakers, because they did not have a control group that they could use as baseline.

In a past-tense production task in English similar to the one used by Beck (1997), Brovetto and Ullman (2001) found frequency effects in the response times of native speakers for irregular forms, and in the response times of Spanish or Chinese L2 learners of English for both regular and irregular forms. These results were interpreted as suggesting that native speakers showed decomposition effects whereas L2 learners relied more on whole-word storage, as the frequency of the whole word, and not that of the morphemes, affected their response times. Again, these results were taken to be in line with the Dual Route Model.

Taking these findings into account, the evidence from previous studies on frequency effects and L2 processing of inflected forms seems somewhat inconsistent. Recall that under Declarative/Procedural Model, high proficiency L2 learners are predicted to show a shift towards decomposition of regularly inflected forms, whereas at lower levels of proficiency they are expected to rely more on whole-word storage for both regular and irregular forms (Ullman, 2005).

Beyond using evidence related to frequency effects to examine the distinction between storage and decomposition, previous research has also investigated priming effects in the attempt to elucidate this issue. To the best of my knowledge, four priming studies have investigated the processing of inflectional morphology by L2 learners. Only two have targeted highly inflected languages such as French or Spanish.

The first of these studies is Silva and Clahsen (2008). This study investigated the ways in which highly proficient Chinese and German learners of English as an L2 processed the past tense morpheme in English. Using a masked-priming paradigm (see Table 2 for some examples of the stimuli and the conditions tested), the authors found that native speakers showed full priming effects (faster response times) for the test and identity conditions than for the unrelated condition for regularly inflected verbs. This suggests that regular forms are decomposed. L2 learners, on the other hand, did not show the same pattern. They did not show priming effects for regular forms, indicating that they were accessing all forms as whole words. This was true for both the Chinese and German groups, meaning that the effect was independent of the similarities between the first and the L2. The authors argued that this set of results is in line with the Declarative/Procedural Model for native speakers, but not for second learners, who need to rely more on whole-form storage even at advanced levels of proficiency (the Declarative/Procedural Model would predict a shift towards decomposition of regularly inflected forms as proficiency increases).

Table 2. Examples of the stimuli used in Silva and Clahsen (2008).

	Prime	**Target**
Identity condition	*Pray*	*Pray*
Test condition	*Prayed*	*Pray*
Unrelated condition	*Bake*	*Pray*

It is worth pointing out that in this study, Silva and Clahsen also tested the processing of derivational morphology in English (specifically, derivation with the suffixes *–ity* and *–ness*). The authors found reduced priming effects for the morphologically derived condition as compared to the unrelated condition for L2 learners, and full priming for native speakers. This set of results seems to suggest that L2 learners can, in fact, employ morphological representations for derived forms during processing, albeit less effectively than native speakers. However, there must be something intrinsically different between inflectional and derivational morphology, given that it is only in the first domain that the two groups clearly differ. This is a clear example of why we still need more work to fully understand the abilities that L2 learners show when processing inflectional morphology, and how inflectional morphology may be processed differently from derivational morphology.

Similar results were found in a priming study that looked at processing of the German past participle by both native German speakers and native Polish learners of German (Neubauer & Clahsen, 2009). The authors manipulated the frequency of the whole word and the root in a lexical decision task (see Table 3 for some examples of the stimuli tested) to study the representation of past participles among highly proficient learners of German. The results were as predicted for native speakers—that is, whole-word frequency effects only for irregular participles. However, learners were equally slow at identifying the target when the prime was the inflected form of the verb as they were when the prime was an unrelated word, and they showed whole-form frequency effects for both regular and irregular forms. This set of results was taken as evidence that L2 learners do not decompose inflected forms into their constituents, but rather store forms as a whole.

Table 3. Examples of the stimuli used in Neubauer & Clahsen (2009).

	Prime Regular	Target Regular	Prime Irregular	Target Irregular
Identity condition	*Melde* 'I report'	*Melde* 'I report'	*Rufe* 'I call'	*Rufe* 'I call'
Test condition	*Gemelde* 'Reported'	*Melde* 'I report'	*Gerufen* 'Called'	*Rufe* 'I call'
Unrelated condition	*Wohne* 'I live'	*Melde* 'I report'	*Lüge* 'I lie'	*Rufe* 'I call'

After reviewing these and other studies on L2 morphological processing, Clahsen et al. (2010) concluded that the overall lesson to be gleaned from this body of research is that learners are less sensitive to morphological representations and have to rely more on whole-word storage than native speakers. These conclusions are consistent with Clahsen and Felser's Shallow Structure Hypothesis (2006), which claims that L2 learners are less sensitive to morphological information than native speakers, independently of their level of proficiency.

However, an alternative view is presented by Ullman and colleagues (e.g., Bowden et al., 2010; Ullman, 2001b). In contrast with Clahsen and colleagues, this group of researchers predicts that while low proficient L2 learners may rely primarily on declarative memory and favor the storage of complex forms, with higher levels of proficiency and more exposure to the L2, we can observe a shift to increasing reliance on procedural memory and thus find evidence of decompositional effects.

Bowden et al. (2010) tried to test these predictions with a production task in Spanish. They tested native speakers of Spanish and mid-to-advanced English L2 learners of Spanish. Participants were asked to conjugate a verb (the target) in either the present or the imperfect tense as quickly and as accurately as they could (see Table 4 for some examples of the stimuli used in this study). Their predictions were that seeing a regular infinitive would facilitate the conjugation of that target into the present or the imperfective, mainly when compared to irregular verb forms. Their results suggest that native speakers are able to decompose the regular forms of Class I verbs (the default conjugation in Spanish, given the number of verbs and their productivity), whereas the inflected forms of Class II and Class III verbs were stored, consistent with a dual-system view. However, the results indicate that L2 learners stored all inflected verbal forms. Bowden and colleagues argued that the differences between natives and learners were consistent with either the Declarative/Procedural Model or the Shallow Structure Hypothesis, depending on whether the differences observed arise from a basic difference in first and L2 learners or from the fact that the L2 groups had not yet attained a sufficiently high level of proficiency to transition to a more native-like processing pattern. The question of whether highly proficient and experienced L2 learners would show a native-like processing pattern in line with the Declarative/Procedural Model remains open.

Table 4. Examples of the stimuli used in Bowden et al. (2010). The target represents the forms expected to be produced by the participants.

	Prime Regular	**Target Regular**	**Prime Irregular**	**Target Irregular**
Class I (-*ar*)	*Pesco* 'I fish'	*Pescar* 'To fish'	*Pienso* 'I think'	*Pensar* 'To think'
Class II/III (-*er* and -*ir*)	*Vendo* 'I sell'	*Vender* 'To sell'	*Pierdo* 'I lose'	*Perder* 'To lose'

The results of Bowden et al. (2010) are interesting in that they are consistent with the predictions made by both the Declarative/Procedural Model and the Shallow Structure Hypothesis. There are a number of other findings in the literature, however, that neither hypothesis is able to explain. Coughlin (in press) used a masked-priming speeded word-naming task to study native and non-native processing of regularly inflected French verbs (see Table 5 for some examples of the stimuli used). Her results suggest that, like native speakers, native speakers of English learning French as an L2 decompose inflectional morphology.

Table 5. Examples of the stimuli used in Coughlin (in press).

Targets	**Primes**				
	Identity	Morphology	Unrelated	Orthographic	Semantic
DONNE 'Give'	*Donne* 'Give'	*Donnons* 'We give'	*Parle* 'Speak'	*Doute* 'Doubt'	*Sert* 'Serve'
DONNONS 'We give'	*Donnons* 'We give'	*Donne* 'Give'	*Parlons* 'We speak'	*Doutons* 'We doubt'	*Servons* 'We serve'

Coughlin (in press) found full priming effects for both groups, as evidenced by shorter production latencies in the morphology condition (e.g., when participants saw *parle*, saw *parlons*, and were asked to produce *parlons*), as compared to the unrelated condition (e.g., when they saw *parle*, saw *aimons*, and were asked to produce *aimons*). Importantly, no proficiency effects were reported, as even her lower-level learners showed decomposition effects. These results are inconsistent with the Declarative/Procedural Model, which would have predicted native-like results only for high-level learners.

Additional studies using tasks other than the masked-priming paradigm have also shown that L2 learners with a sufficiently advanced proficiency level can show decomposition effects. Recall that, as mentioned previously, Birdsong and Flege's (2001) results suggest that L2 learners may indeed be sensitive to the morphological structure of regularly inflected verbs. Similarly, in a nonce-word elicitation task using event-related potentials, Hahne, Müller, and Clahsen (2006) showed that high proficiency learners of German with Russian as their native language elicited an anterior negativity followed by a P600 in response to incorrectly inflected regular (e.g., **gelauft* - *gelaufen*, ‘laughed’) or irregular (e.g., **getanzen* - *getanzt*, ‘danced’) participles embedded in visually presented sentence contexts. These results in fact resemble previous findings with native speakers of German, and they were considered to provide evidence that advanced learners of German can decompose regularly inflected participles.

Taking all of these studies into consideration, it becomes clear that findings related to how L2 learners process verbal inflection in the L2 are far from conclusive. Furthermore, it is to be studied whether some of the results reported may be task-sensitive, given all the variability found in the literature (e.g., Birdsong & Flege, 2001; Hahne, Müller, & Clahsen, 2006; etc.). Additional studies of L2 processing of morphologically inflected forms are clearly needed, particularly in more inflection-heavy languages such as Spanish or French, in order to foster a more complete understanding of the processes learners go through when accessing and retrieving lexical information in the L2 and the ways in which their mental lexicon may be structured. Most of the research done on inflectional morphology has targeted language whose inflectional morphology exhibits little of the complexity seen in other inflectional systems. Whereas an approach based on rules (regulars) and exceptions (irregulars) may be almost enough to account for how verbal inflection is processed in, for example, English, a stronger test of the different models of lexical access would be provided by determining whether they apply as well in more complex inflectional systems, such as verbal inflection in Romance languages.

In the literature, results are mixed, possibly because some of what we see is task specific. Masked-priming paradigms have been commonly used in the literature with L2 learners. However, using a different paradigm, a long-lag priming paradigm, which has been found to show morphological priming, while reducing the effects of other types of priming in native speakers (Feldman, 2000; Kouider, & Dupoux, 2009), may help us understand the processing of complex words among L2 learners. In fact, there has been some controversy over the use of a masked-priming paradigm even with native speakers, because it has been claimed to reflect pure visual priming—that is, that the lexical decision made with a masked priming may be sensitive to the visual properties shared by prime and target even when the font or the size of the prime and target are different (e.g., Kouider & Dupoux, 2009).

In the literature with L2 learners we can observe that different experimental techniques have been used, that different language backgrounds have been tested, and that very different results have been reported. More studies are needed in order to better understand how L2 learners can process inflectional morphology, before any conclusion can be reached. Unlike much of the previous research on this topic, the present study uses a long-lag priming paradigm. In a long-lag priming paradigm (which will be explained in detail in Section 5.2.2.1), participants are always aware of all the words in the task, because stimuli prime and target forms are normally presented in an inter-item lag of five to nine items (Rodriguez-Fornells et al., 2002).

3.3.1 Individual differences

As discussed earlier in this thesis, the literature has shown that there are additional factors to the age of acquisition that can predict sensitivity to morphology. Among these factors, we could mention lexical decoding ability, which has been reported in the literature to be good predictors of L2 accuracy and response times (e.g., McDonald, 2006). However, studies have not (to the best of my knowledge) tried to correlate the ability to decompose morphologically complex words in an L2 with any measurement of such individual differences, other than proficiency. This is a particularly important point, because individual differences have been reported in the literature to affect morphological decomposition in native speakers.

Andrews and Lo (2013) pointed out that, when reviewing the literature on morphological decomposition among native speakers, it is quite common to find studies that test the same morphological constructions but report contradictory results. They argue that the different pattern of results found in the literature may be explained by individual differences in spelling abilities and vocabulary. The authors claim that, even when we focus only on studies that show decomposition patterns, we can observe that the facilitation effect obtained by the same items (e.g., for a transparent item such as *worker-work* and an opaque pair *corner-corn*) differs among studies.

In their study, participants' spelling abilities were measured with a spelling dictation and a spelling recognition task. For the first task, participants listened to 20 words in English with a sentence to clarify ambiguities and were then asked to spell the target words. Their score on the test was the number of correctly spelled words. For the second task, participants were presented with 88 words, half correctly spelled and half misspelled, and they had to correctly identify the misspelled forms; the score on the test was the number of correctly identified items. The vocabulary measure tried to index semantic knowledge, and consisted of 30 multiple-choice items. Participants were presented with a target word and five possible alternatives, and were asked to select which of these alternatives most nearly corresponded to the meaning of the target. Andrews and Lo found that participants with a higher score in the vocabulary than in the spelling measure showed more robust priming for transparent pairs (*worker-work*) than for opaque (*corner-corn*) or form (*turnip-turn*) pairs. However, individuals who scored better in the spelling than in the vocabulary tests showed sustained priming effects which were similar for both the opaque and the transparent conditions.

Given that individual differences have been found to play a role in the processing of morphologically complex words even for native speakers, and that in previous studies no correlation between proficiency and L2 processing of complex words was found (Coughlin, in press), this study aims to investigate the connection between the two by assessing the effect of individual differences on morphological processing by L2 learners. Accordingly, in the present work, factors that are predictive of individual differences in morphological processing will be measured to determine whether they can predict L2 learners' ability to decompose complex words.

The gating task designed for use in the present study is described in detail in Section 5.3, but in general these tasks consist of breaking words up into short segments, playing them to participants and asking them to try to identify the word from this partial information. Gating tasks have been used as a measure of phonemic awareness, which is defined as the listener's sensitivity to individual phonemes and phoneme combinations. Phonemic awareness in children has been found to predict later reading and vocabulary acquisition: poor readers typically showing relatively poor phonemic awareness compared with normal/good readers (e.g., Bruck, 1992; Kim & Davis, 2004; Kim, Davis, Burnham, & Luksaneeyanawin, 2004). In this investigation, the results from a gating task are used to measure whether the participants' sensitivity to individual phonemes correlate with their ability to process complex words in an L2 acquired later in life. One explanation that we want to study is whether the ability to perceive subtle differences in sounds in the native language (linked with the ability to discriminate among competitors in the mental lexicon) may predict the ability to access partial information from the mental lexicon in the L2. The question addressed in this study is whether the participants who need less phonemic information to correctly identify words presented auditorily in their native language are also more aware of the different morphological components of words in their L2.

This methodology is adopted from McDonald (2006), who used a similar gating task and a variety of other measures of non-linguistic processing demands to assess learners' ability to process the L2. McDonald found a correlation between participants' lexical decoding ability and their scores on a grammaticality judgment task. This finding held true for both native speakers and L2 learners. The author argued that while L2 processing may be slower and less automatic than processing a native language, the same mechanisms are used for processing both. By extending McDonald's approach, the current work can both test the proposed theory of processing constraints in L2 acquisition and determine whether scores on this specific processing measure may accurately reflect the ability to decompose lexical information in the L2.

Learning more about the lexical decoding ability and phonemic awareness of our participants can potentially help us better understand the processing of complex words among L2 learners, as well as the possible influence of individual differences on this field of research.

The following sections introduce the present study, which investigates how native English speakers at different levels of proficiency in Spanish process verbal inflection in Spanish. Section 4 presents the specific research questions that this study aims to address and the different hypotheses and predictions that we can draw based on the previous literature. Sections 5 and 6 review the methodology used and the participants tested in the current study, emphasizing those aspects of the work that represent new contributions.

4. The Present Study: Hypotheses and Predictions

The present priming study has been created with the aim of investigating how native speakers and English learners of Spanish as an L2 process verbal inflection.

4.1 Native Speakers of Spanish

The basic research question related to the native speakers included in this study has to do with the online processing of verbal inflection, and can be stated as follows:

Research Question 1:

Do native speakers of Spanish show evidence of morphological decomposition?

Predictions:

Based upon the evidence discussed in the literature review with native speakers, we could predict two different patterns from the native speakers' results, in line with the three different models stated to explain how native speakers process inflectional morphology.

On the one hand, based upon the Dual Route and the Full Decomposition Models[6], native speakers of Spanish should process regularly inflected verbs by decomposing them into their constituents. For example, according to these models, a regularly inflected form such as *walked* should be processed as a combination of *walk* and *–ed*. On the other hand, the Full Storage Model would predict that these regularly inflected forms are stored in the mental lexicon as a whole unit (e.g., the mental representation of *walked* in the mental lexicon would be *walked* and not a combination of *walk* + *-ed*), and so, no decomposition effects should be expected in our native speakers' results.

[6] Let us recall that the difference between these two models of lexical access would be on their predictions on how irregularly inflected forms are processed by native speakers (by decomposing them into their constituents according to the Full Decomposition Model or stored as a whole in the mental lexicon according to the Dual Route Model).

4.2 Second Language Learners

The specific research questions relative to the online processing of verbal inflection in L2 learners of Spanish (native speakers of English) are presented next, together with our predictions:

Research Question 2:

Will L2 learners show evidence of morphological decomposition?

Predictions:

Based upon the evidence discussed in the literature review with L2 learners, we could predict three different patterns from the L2 learners' results, in line with the three different approaches stated to explain how learners can process inflectional morphology in an L2.

On the one hand, based upon Hopp (2010) and McDonald (2006)'s approach to L2 processing, we could predict that native speakers and L2 learners can process regular verbal inflection in the same way, but with slower response times, and that proficiency, the native language, and processing capacity may explain the individual variability observed in the results. Let us recall that this approach predicts that the processing of a first and an L2 share the same cognitive system, but that L2 learners will be more easily/strongly affected by factors that contribute to increasing processing demands (e.g., working memory, speed of processing, etc.) as well as by the shared properties of the first language (Hopp, 2010; McDonald, 2006; Perani & Abutalebi, 2005). Based on this approach, if native speakers show evidence of decomposition, then, decomposition effects are expected in L2 processing as well.

On the other hand, the Declarative/Procedural Model (Ullman, 2005) holds that the processing of a first and an L2 are different on a more fundamental level. The main difference between the two groups would rely on the fact that L2 learners primarily use declarative memory and so they process words more through lexical storage. However, this model predicts a shift in the processing of morphologically complex words, with learners being different from native speakers at lower but not at higher levels of proficiency. Based on this approach, if native speakers show evidence of decomposition, then, decomposition effects are expected in L2 learners at high but not at low levels of proficiency, and this low proficiency group will show evidence of lexical storage.

Finally, Clahsen et al. (2010) and the Shallow Structure Hypothesis (Clahsen and Felser, 2006) claim that learners are not as sensitive to morphological information as native speakers. They argued for qualitative differences between native and L2 morphological processing, suggesting that learners are forced to rely more on lexical storage. Based on this approach, independently of whether native speakers show evidence of decomposition, L2 learners will always rely on lexical storage, independently of their proficiency level.

Research Question 3:

Can factors such as proficiency and decoding ability (defined in the next sections) explain individual variability in L2 learners' sensitivity to morphological information?

Predictions:

Based on the literature, we know that individual differences play an important role in how native speakers process morphologically complex forms in their native language (Andrews and Lo, 2013), so we may predict that individual differences may also help us better understand the processes that L2 learners go through in order to process regular verbal inflection in their L2. Among many of the factors that could help us understand these processes, we have focused in this study in proficiency and lexical decoding ability. In the literature with L2 learners, these two factors have been found to correlate with grammaticality judgment accuracies and response times (e.g., McDonald, 2006). Based upon the evidence discussed in the literature review with L2 learners, our predictions may be outlined according to two different patterns from the L2 learners' results.

On the one hand, in line with Hopp (2010) and McDonald (2006)'s approach and with the Declarative/Procedural Model (Ullman, 2005), we could find that differences in proficiency and/or lexical decoding ability may help us understand the L2 learners' results. Let us recall that, according to the approach taken by Hopp (2010) and McDonald (2006), individual differences such as proficiency and decoding ability may explain variability in the performance of the L2 learners, among other factors such as the properties of the native language and the complexity of the phenomenon in the L2. The Declarative/Procedural Model (Ullman, 2005) holds that proficiency will be the best predictor of native-like processing of regularly inflected forms in the L2. Let us recall that this model predicts a shift toward more use of the procedural system, and so more decomposition effects are expected.

On the other hand, Clahsen et al. (2010) and the Shallow Structure Hypothesis (Clahsen and Felser, 2006) would predict no effect of proficiency or lexical decoding in the results. Independently of proficiency or lexical decoding ability, this approach would predict that L2 learners are not as sensitive to morphological information as native speakers, and so they need to rely more on lexical storage.

5. Materials and Methods

In this section, we will review in detail the two experiments conducted in this study in order to develop a better understanding of how native speakers and L2 learners process verbal inflection in Spanish.

5.1 Participants

Participants included 50 native speakers of Spanish (32 females) and 51 English-speaking learners of Spanish (29 females). All participants completed a signed consent form before beginning the study.[7] The two groups had similar age ranges (native speakers: 18 to 49; L2 learners: 18 to 47). All participants had normal or corrected to normal vision and hearing, and reported no history of linguistic disabilities. Participants were recruited through fliers and by word of mouth at the University of Castellón and at the University of Alicante in Spain, as well as at the University of Kansas in the United States. They were paid either €5 or $10 for their participation in the study. The native speakers group only participated in the long-lag priming task (explained in Section 5.2).

5.1.1 Native speakers

This group included 49 native speakers of Castilian Spanish and one native speaker of Peruvian Spanish. No differences based on dialectal variation are expected, because all varieties of Spanish conjugate the third person plural of the present tense—which is the critical condition in this experiment—in the same way. All participants were raised in a Spanish-speaking country until at least the age of 17 and received all their education mainly in Spanish.

Forty nine out of the fifty participants reported being bilingual speakers of Spanish and another of the official languages of Spain (48 participants were Spanish-Catalan bilinguals, and the last bilingual participant was a Spanish-Galician bilingual). All of the participants reported

[7] Data from six additional participants was collected but discarded prior to analysis: six learners were excluded from the study, five because they started learning Spanish before the age of 10 and so did not meet the requirements of the study, and one due to poor performance on the proficiency test (a score of 1 out of 50 points).

having acquired both of their languages from birth and they rated themselves as being equally fluent in both or considered Spanish to be their dominant language.[8] Note that the verbal inflection system of the three languages is comparable: Catalan and Galician inflect verbs for person, number, tense, and mode in the same way as described for Spanish in Section 2.

In addition, all of the participants in this group were adult L2 learners of English (ranging from low to advanced levels of proficiency), and eight of them reported having studied other foreign languages (French, Chinese, Portuguese, or Russian). None claimed an advanced proficiency level in these languages, however.

5.1.2 L2 Learners

All of the adult L2 learners who participated in this study were native speakers of English with no significant exposure to Spanish or other languages before the age of 10 (age of acquisition ranged from 10 to 46).

The proficiency of the participants was assessed with a combination of the MLA Cooperative Language Text (Spanish Embassy, Washington, DC, USA) and the Diploma de Español como Lengua Extranjera (Educational Testing Service, Princeton, NJ, USA). This is a 50-item test which has been commonly used in previous studies targeting English-speaking learners of Spanish (e.g., White et al., 2004; Montrul et al., 2008; McCarthy, 2008; Foote, 2011).[9] Participants were not grouped based on proficiency, because their score on the test was included in the statistical models as a continuous variable. However, the test itself revealed that the distribution of participants in this study were twenty low (range: 10-29), thirteen intermediate

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[8] All bilingual participants attended elementary school and high school in their two languages, but they reported that their college education was exclusively in Spanish.

[9] An example of the proficiency test is provided in Appendix A.

(range: 30-39), and twelve advanced (range: 40-47) learners of Spanish (mean score: 29.31; range: 10-47).

As summarized in Table 6, participants reported having studied Spanish formally (at the University level or in language courses abroad) for approximately six years, and they reported having lived in a Spanish-speaking country for an average of nine months. Moreover, they reported using Spanish on a daily basis, either during their Spanish lectures or by means of watching Spanish TV shows or listening to music in Spanish. In addition, seven of the participants in this group reported having studied other foreign languages (Japanese, Portuguese, French, Turkish, or Cebuano), but stated that they did not reach a high level of proficiency in any of them.

Table 6. Language background and cloze test scores for L2 learners.

	Proficiency test (/50)	Age of acquisition	Years of instruction	Length of residence in a Spanish-speaking country (months)
Mean	29.31	15.36	6.5	9.18
SD	11.12	5.82	3.5	21.49
Range	10-47	10-46	1-15	0-96

5.2 Task 1: Priming Task

In the first part of this section, we discuss and explain in detail the task created to test how native speakers and L2 learners process verbal inflection in Spanish. As a reminder, priming is a phenomenon that has been shown to facility individual's ability to process repeated stimuli. Basically, when a person sees a word (prime), and later on this same form is repeated (target), response times are faster for the second item. We compare the response times of the target verb both when it is preceded with the same word or a completely unrelated form, in order to have a fair comparison of the facilitation obtained. In this study, we are including as primes both the same and an inflected form of the target verb, to see whether the morphemic elements play a role in the processing of a verbal inflection, both with native speakers and L2 learners. Other conditions, explained next, were included as well in the study to be able to distinguish between possible confounding factors in the results.

5.2.1 Materials

In this study, we used a long-lag priming paradigm because, as discussed in the literature review, this paradigm would allow us to test whether task-related effects can help explain the results obtained when targeting L2 learners. Moreover, it has been found that, when items intervene between prime and target, only morphological effects are present, while semantic or orthographic effects disappear (Feldman, 2000; Kouider, & Dupoux, 2009). This paradigm avoids any possibility of obtaining results based on pure visual priming (Feldman, 2000; Kouider, & Dupoux, 2009), and it is to be tested whether it will be sensitive enough to capture L2 morphological processing. Moreover, this is the first time, as far as we know, that this methodology is employed when targeting L2 processing of morphologically complex words.

The stimuli used in this study included sixty regular Spanish verbs, presented in five prime conditions. These conditions, which include identity, morphology, orthographic, semantic, and unrelated, are explained more fully below. The verbs selected and the conditions used were created following the stimuli used in Rodriguez-Fornells et al. (2002). Five different lists were used so that no participant saw any experimental item in more than one condition. Each list contained twelve different verbs per condition. The three conjugations in Spanish were represented among the experimental items. Of the 60 verbs used in this experiment, 52 are from the first conjugation (verbs which end in -*ar*), five are from the second conjugation (verbs which end in -*er*), and three are from the third conjugation (verbs which end in -*ir*). This split, although uneven, is appropriate given the make-up of the Spanish lexicon. The first conjugation is by far the most productive one in Spanish.

Recall that in a priming experiment, participants see a prime and are then presented with a target word. In our experiment, participants are asked to perform a lexical decision task, meaning they must decide whether the target is a real word or a nonsense word. With this in mind, we turn now to a more thorough discussion of the five prime conditions used in this study.

In the **identity condition**, the target word and the prime are the exact same verb (*girar-girar*). For the **morphology condition**, the prime and the target are the same verb but the prime is inflected in the third person plural of the present tense. This inflected form was selected because it is the most frequent form once we control items in terms of the number of letters between prime and target (*giran-girar*). Controlling for orthographic word length in the stimuli allows us to ensure that any observed response time differences between conditions using the infinitive vs. the third person plural form cannot be due to word length. In the **orthographic condition**, the two verbs are very similar, but differ by one (or two, in the case of verbs of the third conjugation) [10] letter (*girar-mirar*), and the differences were manipulated to appear in different positions of the word. The **semantic condition** consisted of two words that are related to one another semantically—in this case we used synonyms matched orthographically for number of letters (*girar-rotar*). Finally, in the **unrelated condition**, the prime and target were two phonologically and semantically unrelated verbs (*girar-venir*). A verb pair exemplifying

[10] The third person plural of the present tense of verbs of the third conjugation (ending in –ir) change the thematic vowel as well as the persona and number marker (for example, *dimitir-dimiten*).

each of the five conditions is shown in Table 7, and a complete list of the verbs used in each condition is provided in Appendix B.

Table 7. Example stimuli in the five experimental conditions for the three Spanish conjugations.

Target	**Primes**				
	Identity condition	Morphology condition	Orthographic condition	Semantic condition	Unrelated Condition
Girar **'to turn'**	*Girar* 'to turn'	*Giran* 'they turn'	*Mirar* 'to look at'	*Rotar* 'to rotate'	*Venir* 'to come'
Poner **'to put'**	*Poner* 'to put'	*Ponen* 'they put'	*Poder* 'to be able to'	*Dejar* 'to put'	*Saber* 'to know'
Dirimir **'to resolve'**	*Dirimir* 'to resolve'	*Dirimen* 'they resolve'	*Dimitir* 'to resign'	*Disipar* 'to dispel'	*Sonreír* 'to smile'

The LEXESP database was used to control for the frequency of the experimental items and to compute their mean log frequency (via BuscaPalabras; Davis & Perea, 2005). Table 8 includes the mean log frequency and mean length of the verbs in all five conditions. The experimental items in the infinitive form were matched in terms of frequency and length ($F(3, 236)=1.55$, $p = 0.20$). However, when the morphology condition is included in the ANOVA, we see that the inflected forms are in fact statistically less frequent than the verbs in the other conditions ($F(4, 295)=3.83$, $p = 0.005$). This difference in frequency will be considered in the analysis of the results.

Table 8. Mean log frequency and length of the experimental items tested.

	Mean Log Frequency	Mean Length
Identity condition	1.47	6.2
Morphology condition	1.004	6.2
Orthographic condition	1.2	6.2
Semantic condition	1.304	6.2
Unrelated condition	1.4	6.2

The materials also included 60 nonce verbs, presented in four prime conditions (identity, morphology, orthographic, and unrelated), to mirror the real test items. The same nonce verbs were again divided among five lists, as described above for the real words, so that no participant saw any experimental item in more than one condition. Each list contained 15 different nonce verbs per condition.

The nonce verbs conform with the phonotactics of the Spanish language, and were created by changing or adding one letter in a real Spanish verb (for example, *acabar*-**acrabar*). For the most part, the nonce verbs were created to imitate the conditions discussed above for the real testing items: it was impossible to create two nonce words with a semantic relationship, however, so this condition was not included among the nonce verbs. An example for each of the four conditions is shown in Table 9, and a complete list of the nonce verbs used in each condition is provided in Appendix C.

Table 9. Example of a nonce verb in the four experimental conditions.

Target	Primes				
	Identity condition	Morphology condition	Orthographic Condition	Semantic condition	Unrelated condition
Arrabar	*Arrabar*	*Arraban*	*Acrabar*	-	*Paninar*

Twelve more words were included in the experiment as fillers. Half of them were real Spanish verbs, and the other half were nonce verbs. They were created so that they did not share a prime-target relationship. They did not have to meet any other requirement. These verbs were included in order to achieve the five to nine word lag spacing, and they were created so that half of them were real and half of them nonce to keep balanced the number of real and nonce verbs in the study (ratio: 1/1). This was important in order to avoid creating a ‘no’ response bias in the lexical decision task. An example of a real and of a nonce verb filler is shown in Table 10, and a complete list of the fillers used is provided in Appendix D.

Table 10. Example of a verb and a nonce filler.

Verb Type	Verb
Real	*Apostar*
Nonce	**Conpretar*

5.2.2 Procedure

The testing was conducted in one-hour long sessions at the University of Castellón (Spain), the University of Alicante (Spain), and the University of Kansas L2 Acquisition Lab. All but two of the native speakers of Spanish and 11 of the L2 learners were tested individually in Spain, in a comfortable, isolated office where they sat facing a computer monitor. Native speakers took about thirty minutes to finish the complete session; L2 learners took about an hour to complete all the requirements. However, all participants were asked to plan for a one-hour experiment.

During the session, participants started by reading and signing the consent form. After giving their informed consent to participate in the study, they were asked to fill out a background questionnaire. Immediately after finishing the paperwork, native speakers completed the priming experiment (explained in detail in Section 5.2.2.1). L2 learners completed both the priming experiment and the gating task (explained in Section 5.3), and the order in which the two tasks were administered was counterbalanced. Participants concluded the experiment by taking the Spanish proficiency test described in Section 5.1.2 (e.g., White et al., 2004; Montrul et al., 2008; McCarthy, 2008; Foote, 2011).

5.2.2.1 Long-Lag Priming Paradigm

Participants were comfortably seated in an isolated room facing a computer screen. They were instructed to silently read a series of Spanish strings of letters and judge whether they considered them to be real words in Spanish or not. One of the reasons for using a lexical decision task was to be able to compare our results with those in the literature. More importantly, a lexical decision task gives us a measure of response times that we will use to probe for priming effects – i.e., the lexical decision response time is our main dependent variable. Moreover, the results we obtained from this task will gave us a direct measure of the L2 learners' familiarity with the words used for the experiment. Their lexical decision accuracy provides us with some information on how they processed the words and whether they could identify them correctly as real verbs in Spanish or not, and the analyses of the data is conducted only with those items correctly identified.

Each session began with six practice trials, none of which has any relation with verbal inflection in Spanish. No feedback was provided during the practice session. However, the main researcher stayed in the room during this part of the experiment to make sure that the equipment was working properly and that they did not have any question after the practice. This short practice allowed participants to become familiar with the responding paradigm and helped them understand what 'nonce words' would look like during the real experiment. The real experiment began right after the practice session.

Each experimental session included four blocks of sixty-four words, with the corresponding three breaks in between for participants to rest. Words appeared in black text (Courier New font) on a mauve background. All real verbs exhibited the appropriate diacritics and, in fact, nonce words were created using them as well to avoid providing the participants with some cues from the spelling of the words. The stimuli were presented using Paradigm by Perception Research Systems, Inc. (Tagliaferri, 2005).

Within each of the blocks, real, nonce, and filler words were intermixed following a specific order: Using a long-lag priming paradigm. In this paradigm, prime and target forms are normally presented in an inter-item lag of five to nine items (Rodriguez-Fornells et al., 2002). See Figure 4 for a detailed representation.

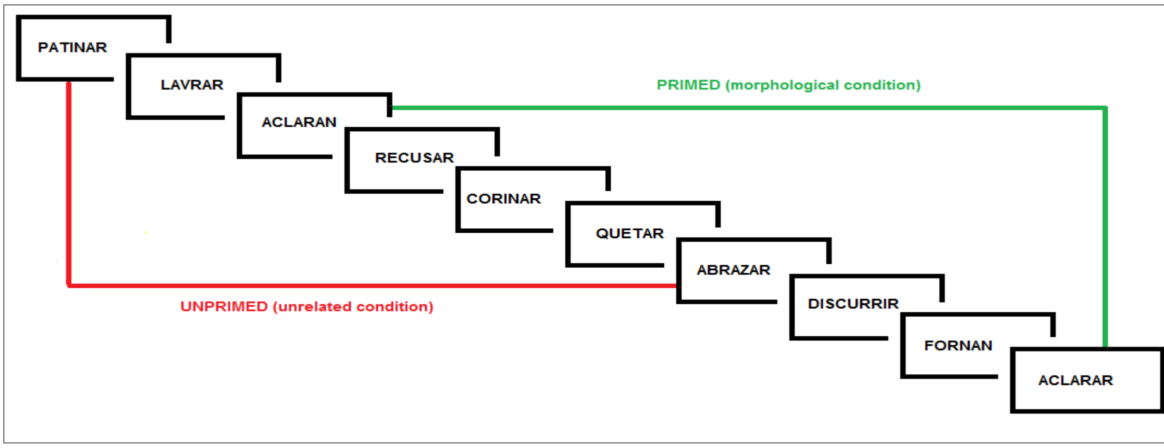


Figure 4. Example of part of one of the lists to be used in the long-lag priming paradigm.

Each trial was structured as follows: Each word was presented in the middle of the screen until the participant made a decision. Responses to the lexical decision task were made with the middle and index fingers of the right hand, respectively, using a Razer DeathAdder mouse, with the words 'SI' (on the left button) and 'NO' (on the right button) marked. Participants were asked to favor speed over accuracy, and to guess if they were not familiar with the word presented on the screen. Following the lexical decision response, there was an interval between trials ranging from 500 to 910 ms, pseudorandomly varied at 10 ms increments, in order to avoid strategic processes (Perea & Carreiras, 2003). After this interval, the next word appeared on the screen. Both accuracy and response time of the lexical decision task were measured.

5.3 Task 2: Gating Task

Lexical decoding and phonemic access ability was measured in a gating task. A gating task is a measure of phonemic awareness, of listener's sensitivity to individual phonemes and phoneme combinations. Phonemic awareness, for children, has been found to predict later reading and vocabulary acquisition, with poor readers typically showing relatively poor phonemic awareness compared with normal/good readers (e.g., Bruck, 1992; Kim & Davis, 2004; Kim, Davis, Burnham, & Luksaneeyanawin, 2004). In this investigation, it will be studied whether participants' sensitivity to individual phonemes correlates with their ability to process complex words in an L2 acquired later in life.

In this section, we discuss and explain in detail the task created to elicit L2 learners' ability to decode lexical information (linked to their phonemic awareness).

5.3.1 Stimuli

A gating task consists in breaking a word up into short segments, or gates, starting from the beginning of the word. Then, these fragments are played and participants attempt to identify the word from this partial information. Increasingly longer gates are played to the participants until they are able to correctly guess the word. In the gating task used here, we adopted the gating task used in McDonald (2006), with minor modifications.

The experimental items were twelve multisyllabic words[11] in English (see Table 11 for a complete list), the same words used by McDonald (2006) in her study on the processing of an L2.

[11] We did include all the nouns that McDonald (2006) planned in using for her study. However, she did have some problems with the recording of *helicopter*, so that word was not included in the final task.

Table 11. List of words used in the gating task.

Nouns used in the gating task	
1. *Literature* (used as the practice item)	*7. Caterpillar*
2. *Refrigerator*	*8. Carbohydrate*
3. *Television*	*9. Cauliflower*
4. *Cafeteria*	*10. Kaleidoscope*
5. *Thermometer*	*11. Encyclopedia*
6. *Vegetable*	*12. Helicopter*

Words were recorded by a female native speaker of English. The recordings were made onto a flash disc using a Marantz Portable Solid State Recorder at sampling rate of 22 kHz in the anechoic chamber at the University of Kansas campus. The digitized recordings were then processed using PRAAT (Boersma, & Weenink, 2010). Using this program, each word was broken into eight to ten[12] segments of 100 ms each. The first gate consisted of the first 100 ms of the word, and then segments of 100 ms were added until the whole word was represented.

5.3.2 Procedure

Participants were comfortably seated in an isolated room facing a computer screen and wearing headphones. They were instructed to quietly listen to different words in English presented in fragments. Their instructions were that they would be hearing the beginning fragment of a word, and had to guess the word, even if they did not have enough information to

[12] McDonald (2006) digitized the words on a computer in order to be able to break all the words into the same number of gates. We decided not to do it to present participants with natural, and not manipulated, stimuli.

make an accurate guess. Then, they would hear increasing longer fragments of each word. After each fragment was played, participants were prompted to guess the word, and this was true for all the fragments of all the words. Participants did not proceed to the next word until they heard all fragments of the previous word.

Each session began with a practice trial, which always was the word *literature*. No feedback was provided during the practice session. However, the main researcher stayed in the room during this part of the experiment to ensure that the equipment was working properly and that participants did not have any question after the practice. Items were presented in a randomized order, so that it was unlikely that two consecutive participants saw the same experimental items in the same order.[13]

The two tasks that L2 learners took were administered in counterbalanced order. The average number of gates needed to correctly identify the word was measured for each participant.

6. Data Analysis and Predictions

Response times were analyzed only on correct first responses (91.7% for native speakers, and 72.85% for L2 learners). Those items whose response times were faster than 300 ms or slower than 3000 ms were excluded from the analysis (0.3% of native speakers' data and 2.9% of L2 learners' data). Moreover, extreme outliers for each participant (response times 2.5 standard deviations above or below a given participant's mean) were also excluded from the analysis (this removed a total of 2.7% of the native speakers' data and 0.78% of the second learners' data).

[13] McDonald (2006) presented the experimental items in a fixed order.

Accuracy and correct response times for the target forms were analyzed using the linear mixed-effects model (cf. Baayen, Davidson, & Bates, 2008), as implemented in the *lme4* package (Bates & Maechler, 2009) in *R* (*R* Development Core Team, 2009). This statistical methodology has gained popularity in the language processing literature (e.g,. Baayen, Davidson, & Bates, 2008) because it allows to consider the effects of between and within subject in a single analysis, while also controlling for a number of sources of extraneous variability (Baayen, 2008). This is particularly suitable for this study because it allows us to control for residual effects of stimulus attributes, list construction, and trial sequence, even when stimuli were carefully matched and counterbalanced in the design of the experiment (Baayen, 2008).

The statistical analyses were conducted on the participants' response times and accuracy for the target verb, and comparisons were made among conditions. The models were performed separately for accuracy and response times. The effects of the different conditions (morphology, semantic, and orthographic) on each dependent variable (accuracy and response times) were analyzed with respect to two baselines (unrelated and identity) in separate models. Language group (native speakers vs. L2 learners) interacted with the response times, so subsequent models were conducted for response times and accuracy of the two groups separately. Significance of all effects was assessed using $\alpha = .05$. All our models included participant, test item, and trial order as crossed random effects.

In order to control for other sources of extraneous variability (Baayen, 2008), five potentially confounding item- and subject-level variables were examined for possible inclusion as predictors. These five variables (current age of the participants, log-transformed frequency of the target verbs, conjugation, distance between prime and target, and gender) were chosen among the variables described in the literature as having some potential explanatory effect on the dependent variables, both with native speakers and with L2 learners.

The Declarative/Procedural Model (Ullman, 2005), outlined in the Literature Review Sections of this study, predicts that females may rely more than males on declarative memory (the memory system which favors whole-storage access). Gender and age, then, were considered in the current study, not just as predictors but also as possible interactions with the conditions that could have a potential effect on the processing of lexical information. Frequency of the target word is considered as a potential predictor, as frequency effects have been discussed in the literature, affecting the processing of regular inflection (e.g, Sereno, & Jongman, 1997). Bowden et al. (2010) found that native speakers of Spanish decomposed only regular verbs of the first conjugation. Hence, conjugation was considered in the current analysis as well. Distance between prime and target was also explored, primarily to ensure that it did not affect in any way the results obtained, as larger distance is expected to be correlated with more decomposition effects by reducing the priming effects of the orthographic and semantic conditions (Kouider, & Dupoux, 2009). For the model with L2 learners' data, other variables (proficiency, score in the gating task, age of acquisition, length of residence, and years of instructions, variables that did not highly correlate among them, as we can see in Table 12) were studied as well.

Table 12. Correlation table with the variables studied among L2 learners.

	Age of acquisition	Length of residence	Years of instruction	Proficiency	Gating
Age of acquisition	1				
Length of residence	0.128673	1			
Years of instruction	-0.29413	0.134207	1		
Proficiency	-0.02663	0.455324	0.360916	1	
Gating	0.149317	-0.0566	-0.01801	-0.33711	1

We ran parallel models for the two dependent variables (accuracy and response times) that compared the different conditions with the baselines and that included the frequency of the target as a fixed variable, and gender as a correlation. We also tested models with the other variables reported before, but these additional variables did not improve or change the models, so we decided not to include them in the final model. Similarly, for our analyses of the L2 learners' data, we added proficiency (as a continuous variable) and years of instruction with the other fixed variables in the models. We also tried the other variables gathered for the L2 learners (score in the gating task, age of acquisition, and length of residence) but including them did not improve the models. For this reason, the final model included frequency of the target verb (and proficiency and years of instruction for the L2 models) as fixed variables and gender as an interaction.

The main idea behind any priming paradigm is that when a word is processed (prime) and afterwards that same form (target) is repeated, that target form is easier to re-activate, and so response times are expected to be faster (this is known as identity priming, as in *walk*-*walk*). We then compare this facilitation with a condition in which the prime is a completely unrelated word (known as unrelated priming, *read*-*walk*) and we observe that response times are faster for the identity than for the unrelated condition. The crucial point here is that, if the brain processes morphemes and not whole words, seeing an inflected form as the prime and later on the infinitive (*walked*-*walk*) should elicit this same facilitation as in the identity condition and response times are expected to be faster as well for the morphology condition. Orthographic and semantic conditions are normally included in priming studies (as it is the case in the current study) in order to show that the facilitation obtained for the morphology condition may not only by explained by means of orthographic and/or semantic overlap between prime and target. These two conditions should pattern similarly to the unrelated condition, and differ statistically from the identity condition.

If we do find in our data results that support this pattern (differences between the morphology/identity and unrelated/orthographic/semantic conditions), this would be taken as evidence that native speakers of Spanish decompose verbal inflection into its constituents, in line with the Decomposition Model or the Declarative/Procedural Model (recall that these two models make the same prediction for regularly inflected forms, but differ in their predictions for irregularly inflected verbs). On the other hand, if our results support the claim that the morphology condition patterns in the same way as the unrelated condition, it would imply that native speakers are not sensitive to morphological information and that they process inflection as whole words and not as a combination of stem and affixes, in line with the Full Storage Model. Exactly the same predictions can be outlined for the L2 learners' data.

7. Results

In Section 7.1, we report the accuracy results for both native and L2 learners, and in 7.2 the results of the response times for both groups. Section 7.2 is further subdivided into the results of the different conditions tested.

7.1 Accuracy

Native speakers of Spanish were equally accurate in all conditions (an average of 92%), as we observe in Figure 4.

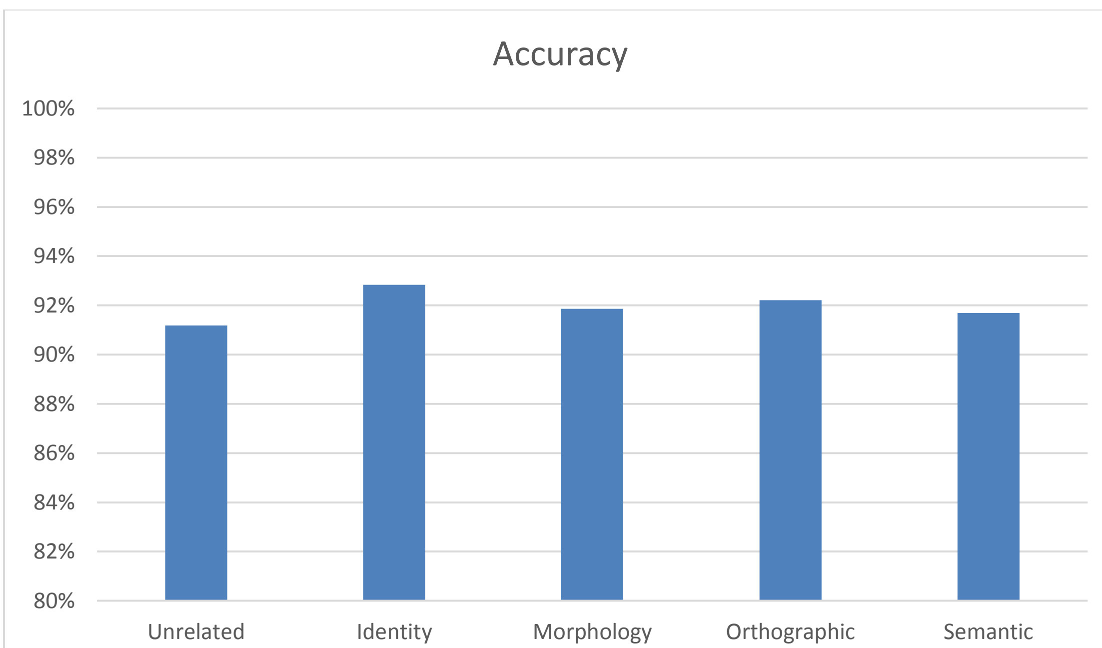


Figure 5. Percentage of correctly identified verbs for the five conditions tested.

The linear mixed model on accuracy results for native speakers' data revealed a marginal interaction with gender when the morphology condition was compared with the unrelated condition (see Table 13). The semantic condition also showed a marginal interaction with gender when compared with the identity condition (see Table 14).

Table 13. Linear Mixed-Effects Model for native speakers' accuracy on the morphology condition, with unrelated as the baseline.

Variable	**Estimate (SE)**	***t***	***p***
(intercept)	0.79 (0.03)	27.51	<.001
Morphology	-0.01 (0.02)	-.74	.46
Gender	-0.03 (0.03)	-1.28	.20
Log-transformed frequency	-0.09 (0.01)	5.85	<.001
Morphology x gender	0.06 (0.30)	1.83	.06

Note. *df* = 1766; α = .05

Table 14. Linear Mixed-Effects Model for native speakers' accuracy on the semantic condition, with identity as the baseline.

Variable	**Estimate (SE)**	***t***	***p***
(intercept)	0.79 (0.03)	25.65	<.001
Semantic	0.02 (0.02)	1	.32
Gender	0.06 (0.02)	2.48	.01
Log-transformed frequency	0.08 (0.01)	5.19	<.001
Semantic x gender	-0.06 (0.03)	-1.8	.07

Note. *df* = 1766; α = .05

Follow-up models were conducted separately for males and females. Results of these models reveal that these marginal results were driven by the accuracy rates of the male native speakers of Spanish (see Tables 15 and 16).

Table 15. Linear Mixed-Effects Model for native speakers' accuracy on the morphology condition for males and females, with unrelated as the baseline.

	Variable	**Estimate (SE)**	***t***	***p***
Males	(intercept)	0.77 (0.04)	20.54	<.001
	Morphology	0.05 (0.03)	0.09	.09
	Log-transformed frequency	0.08 (0.02)	4.07	<.001
Females	(intercept)	0.79 (0.03)	26.94	<.001
	Morphology	-0.01 (0.02)	-0.76	.45
	Log-transformed frequency	0.09 (0.02)	5.82	<.001

Note. Males: *df* = 638; females: *df* = 1128; α = .05

Table 16. Linear Mixed-Effects Model for native speakers' accuracy on the semantic condition for males and females, with identity as the baseline.

	Variable	**Estimate (SE)**	***t***	***p***
Males	(intercept)	0.78 (0.04)	20.64	<.001
	Semantic	0.03 (0.03)	0.92	.35
	Log-transformed frequency	0.08 (0.02)	3.80	<.001
Females	(intercept)	0.81 (0.03)	28.45	<.001
	Semantic	-0.01 (0.02)	-0.31	.76
	Log-transformed frequency	0.08 (0.02)	4.92	<.001

Note. Males: *df* = 639; females: *df* = 1127; α = .05

With respect to accuracy, L2 learners were not as accurate as native speakers (an average of 73%). However, neither significant differences nor interaction with gender were observed in the L2 learners' data. We can observe this pattern in Figure 6.

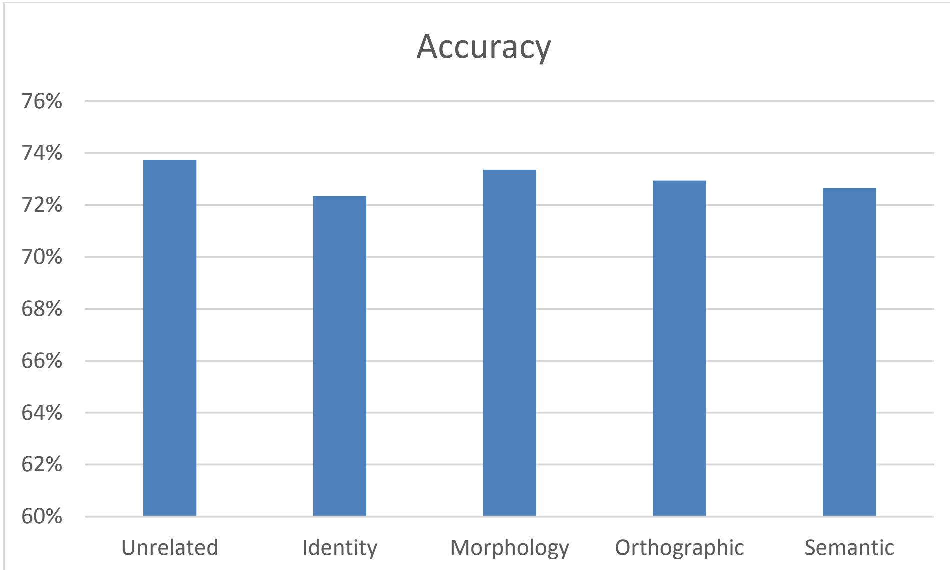


Figure 6. Percentage of correctly identified verbs for the five conditions tested.

7.2 Response Times

More variability was found with response times than with accuracy. Table 17 summarizes native speakers' average response times (in ms) per condition of the correctly identified target verbs.

Table 17. Native speakers' average response times (ms) and standard deviations.

	Condition				
	Identity Condition	Morphology condition	Orthographic Condition	Semantic condition	Unrelated Condition
Average	882	870	922	902	901
SD	328	316	341	324	318

Overall, the L2 learners' group was also just significantly slower than the native speakers' group, as can be observed in Table 18. The table summarizes the average response times (in ms) per condition of the correctly identified target verbs.

Table 18. Average response times (ms) and standard deviations.

	Condition				
	Identity condition	Morphology condition	Orthographic Condition	Semantic condition	Unrelated condition
Average	1074	1141	1190	1228	1174
SD	531	601	643	743	641

7.2.1 Identity Condition

A linear mixed-effects model using the unrelated condition as the baseline on all the participants' response times for correctly responded targets showed a significant interaction of the identity condition with language group and a marginal interaction of this condition with gender and group (Table 19).

Table 19. Linear Mixed-Effects Model for all participants' response times on the identity condition, with unrelated as the baseline.

Variable	**Estimate (SE)**	***t***	***p***
(intercept)	2.96 (0.05)	62.91	<.001
Identity	-0.04 (0.03)	-1.14	.26
Group	0.07 (0.03)	2.27	.02
Gender	-0.08 (0.06)	-1.41	.16
Log-transformed frequency	-0.06 (0.001)	-8.04	<.001
Identity x gender	0.003 (0.02)	0.15	.88
Identity x group	0.08 (0.04)	2.12	.03
Identity x gender x group	-0.05 (0.03)	-1.90	0.06

Note. $df = 2801$; $\alpha = .05$

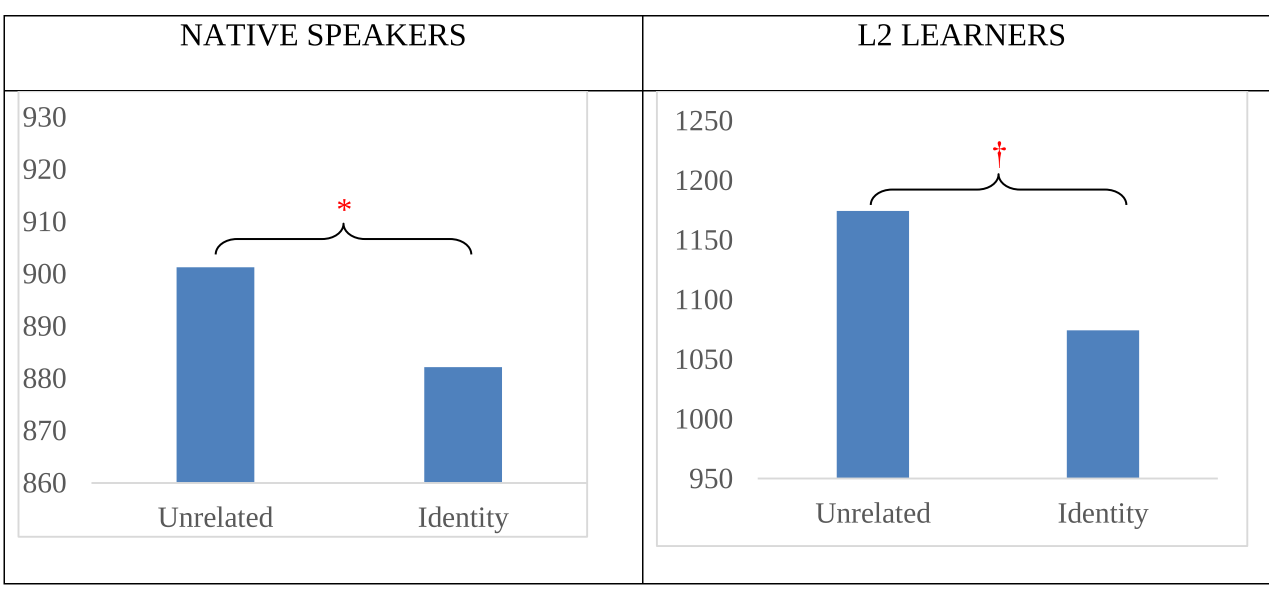
Subsequent linear mixed-effects models were performed separately on native speakers' and L2 learners' response times for the identity condition. For native speakers, a significant effect of identity condition and a significant interaction between the identity condition and gender were found. Subsequent models on the native speakers' data showed that the interaction with gender was mainly driven by the male group ($t(1047)= -2.68$), $p = 0.0075$) while for females the identity priming was not statistically significant ($t(1047)=0.29$, $p = 0.4791$). The model with the L2 learners' data showed a marginal effect of identity condition (see Table 20 and Figure 7). This set of results is in line with the literature and our predictions: the facilitation obtained after an identical prime is statistically different (faster) than the facilitation obtained after seeing an unrelated verb.

Table 20. Linear Mixed-Effects Model for all participants response times on the identity condition, with unrelated as the baseline.

	Variable	**Estimate (SE)**	***t***	***p***
Native speakers	(intercept)	3.01 (0.02)	128.93	<.001
	Identity	-0.03 (0.01)	-2.89	.004
	Gender	-0.02 (0.01)	-0.87	.39
	Log-transformed frequency	0.08 (0.02)	-6.14	<.001
	Identity x gender	0.03 (0.01)	2.41	.02
L2 Learners	(intercept)	3.14 (0.05)	67.27	<.001
	Identity	-0.03 (0.02)	-1.65	.09
	Gender	0.03 (0.03)	1.17	.24
	Years of instruction	0.007 (0.003)	2.23	.03
	Proficiency	-0.002 (0.001)	-1.62	.1
	Log-transformed frequency	0.07 (0.01)	-7.20	<.001
	Identity x gender	-0.01 (0.02)	-0.55	.58

Note. Native speakers: *df* = 1624; L2 learners: *df* = 1177; *α* = .05

Figure 7. Average response for native speakers and L2 learners for the identity condition with respect to the unrelated condition. The asterisk marks a significant difference, while the cross marks a marginal difference.



7.2.2 Morphology Condition

The morphology condition was compared to the unrelated and the identity conditions as baselines in two different models. Even though no interaction was found with group, as it happened in the identity condition, in order to have comparable results, two separate linear mixed-effects models were performed on native speakers' and L2 learners' data. For native speakers, a significant effect of condition was found when we compared the morphology condition with the unrelated condition; however, this effect was not found when the morphology condition was compared with the identity as the baseline (see Table 21).

Table 21. Linear Mixed-Effects Model for native speakers' response times on the morphology condition, using the unrelated and identity conditions as the baseline.

Baseline	**Variable**	**Estimate (SE)**	***t***	***p***
Unrelated	(intercept)	3.01 (0.02)	128.93	<.001
	Morphology	-0.03 (0.03)	-2.55	.01
	Gender	-0.02 (0.03)	-0.87	.39
	Log-transformed frequency	0.04 (0.01)	-6.14	<.001
	Morphology x gender	0.02 (0.01)	1.59	.11
Identity	(intercept)	2.98 (0.02)	127.47	<.001
	Morphology	0.004 (0.01)	0.39	.69
	Gender	0.01 (0.03)	0.41	.68
	Log-transformed frequency	-0.04 (0.01)	-6.14	<.001
	Morphology x gender	-0.01 (0.02)	-0.85	.39

Note. Unrelated as baseline: $df = 1624$; identity as baseline: $df = 1624$; $\alpha = .05$

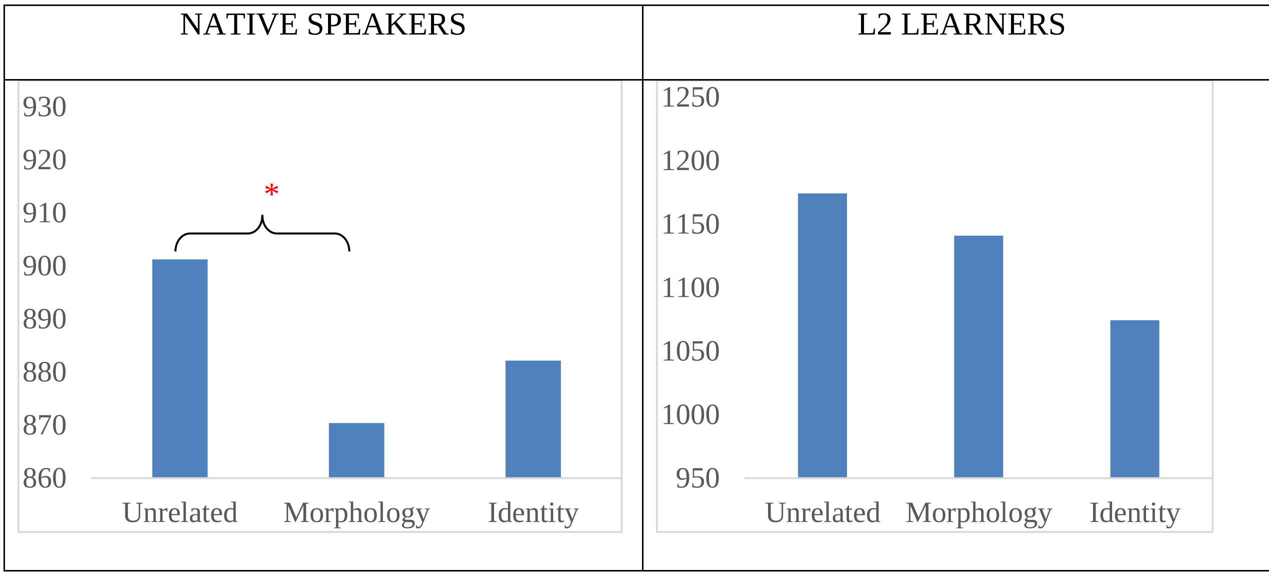
The model with the L2 learners' data did not show any statistical results, that is, the morphology condition could not be statistically distinguished from either the unrelated or the identity conditions (see Table 22). However, as it can be seen in Figure 8, numerically the facilitation obtained for the morphology condition is greater than that for the unrelated condition, but differences did not reach significance.

Table 22. Linear Mixed-Effects Model for L2 learners' response times on the morphology condition, with unrelated and identity as the baseline.

Baseline	**Variable**	**Estimate (SE)**	***t***	***p***
Unrelated	(intercept)	3.14 (0.05)	67.27	<.001
	Morphology	-0.004 (0.02)	-0.24	.81
	Gender	0.03 (0.03)	1.17	.24
	Years of instruction	0.007 (0.003)	2.23	.03
	Proficiency	-0.002 (0.001)	-1.62	.1
	Log-transformed frequency	0.07 (0.01)	-7.20	<.001
	Morphology x gender	-0.02 (0.02)	-0.71	.48
Identity	(intercept)	3.11 (0.05)	66.74	<.001
	Morphology	0.03 (0.02)	1.40	.16
	Gender	0.02 (0.03)	0.69	.49
	Years of instruction	0.007 (0.003)	2.23	.03
	Proficiency	-0.002 (0.001)	-1.62	.1
	Log-transformed frequency	-0.07 (0.01)	-7.20	<.001
	Morphology x gender	-0.004 (0.02)	-0.15	.88

Note. Unrelated as baseline: *df* = 1177; identity as baseline: *df* = 1177; α = .05

Figure 8. Average response for native speakers and L2 learners for the morphology condition with respect to the unrelated and the identity conditions. The asterisk marks a statistically significant difference.



In line with the predictions of the Declarative/Procedural Model and the Full Decomposition Model, native speakers of Spanish exhibited decomposition effects, by showing that response times for the identity and the morphology conditions were statistically significantly faster than those of the unrelated condition. However, L2 learners did not show this statistic pattern, suggesting that they cannot decompose verbal inflection.

However, native speakers' results could still be interpreted as showing orthographic or semantic facilitation between the prime and the target. Note that an inflected form shares an orthographic, semantic, and morphological relationship with the form from which it is inflected. Thus, ruling out the possibility that orthographic or semantic effects are the main cause of the effects observed would strengthen the interpretation that the observed facilitation is due to the morphological relationship and not to other confounding factors (orthographic or semantic facilitation).

7.2.3 Orthographic Condition

A linear mixed-effects model using the unrelated condition as the baseline on all the participants' response times for correctly responded targets showed a marginal interaction of the orthographic condition with gender and a marginal interaction of this condition with gender and group (see Table 23).

Table 23. Linear Mixed-Effects Model for all participants' response times on the orthographic condition, with unrelated as the baseline.

Variable	**Estimate (SE)**	***t***	***p***
(intercept)	2.97 (0.05)	61.65	<.001
Orthographic	-0.03 (0.03)	-0.95	.34
Group	0.07 (0.03)	2.28	.02
Gender	-0.08 (0.06)	-1.37	.17
Log-transformed frequency	-0.06 (0.006)	-9.38	<.001
Orthographic x gender	0.02 (0.02)	1.14	.25
Orthographic x group	0.07 (0.04)	1.73	.08
Orthographic x gender x group	-0.05 (0.03)	-1.88	0.06

Note. df = 2804; α = .05

Subsequent linear mixed-effects models were performed separately on native speakers' and L2 learners' response times for the orthographic condition using as the baseline both the unrelated and the identity conditions. For native speakers, a significant effect of condition was found when we compared the orthographic condition with the identity condition; however, this effect was not found when the orthographic condition was compared with the unrelated as the baseline (see Table 24).

Table 24. Linear Mixed-Effects Model for native speakers' response times on the orthographic condition, with unrelated and identity as the baseline.

Baseline	**Variable**	**Estimate (SE)**	***t***	***p***
Unrelated	(intercept)	3.01 (0.02)	128.58	<.001
	Orthographic	-0.005 (0.01)	-0.43	.67
	Gender	-0.02 (0.03)	-0.82	.41
	Log-transformed frequency	-0.04 (0.01)	-7.08	<.001
	Orthographic x gender	0.02 (0.01)	1.21	.22
Identity	(intercept)	2.98 (0.02)	127.16	<.001
	Orthographic	0.03 (0.01)	2.42	.02
	Gender	0.01 (0.03)	0.40	.68
	Log-transformed frequency	-0.04 (0.01)	-7.08	<.001
	Orthographic x gender	-0.02 (0.02)	-1.15	.25

Note. Unrelated as baseline: df = 1627; identity as baseline: df = 1627; α = .05

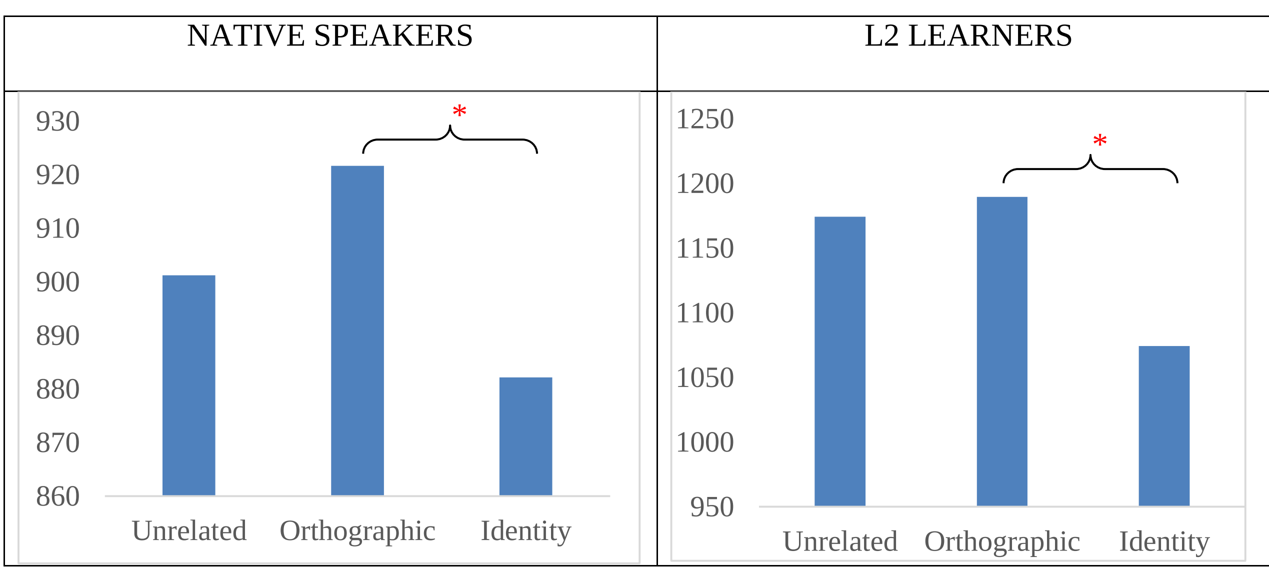
The model with the L2 learners' data showed a significant effect of condition when we compared the orthographic condition with the identity condition; however, this effect was not found when the orthographic condition was compared with the unrelated as the baseline (see Table 25). In Figure 9 we can see represented the orthographic condition, compared with the unrelated and identity as the baseline, for both native speakers and L2 learners.

Table 25. Linear Mixed-Effects Model for L2 learners' response times on the orthographic condition, with the unrelated and identity conditions as the baseline.

Baseline	**Variable**	**Estimate (SE)**	***t***	***p***
Unrelated	(intercept)	3.15 (0.05)	69.47	<.001
	Orthographic	0.02 (0.02)	0.87	.38
	Gender	0.03 (0.03)	1.27	.2
	Years of instruction	0.009 (0.003)	2.88	.004
	Proficiency	-0.002 (0.001)	-1.91	.06
	Log-transformed frequency	-0.09 (0.01)	-8.04	<.001
	Orthographic x gender	-0.03 (0.02)	-1.29	.2
Identity	(intercept)	3.12 (0.05)	68.73	<.001
	Orthographic	0.05 (0.02)	2.57	.01
	Gender	0.02 (0.03)	0.81	.42
	Years of instruction	0.009 (0.003)	2.88	.004
	Proficiency	-0.002 (0.001)	-1.91	.06
	Log-transformed frequency	-0.09 (0.01)	-8.04	<.001
	Orthographic x gender	-0.02 (0.02)	-0.76	.45

Note. Unrelated as baseline: *df* = 1177; identity as baseline: *df* = 1177; *α* = .05

Figure 9. Average response for native speakers and L2 learners for the orthographic condition with respect to the unrelated and the identity conditions.



These results rules out the possibility that the morphological facilitation obtained in natives speakers was due to orthographic overlap between the prime and the target, in line with the predictions of the Dual Route Model and the Full Decomposition Model.

7.2.4 Semantic Condition

The semantic condition was compared to the unrelated and the identity conditions as baselines in two different models. Even though no interaction was found with group, as it happened in the identity and orthographic conditions, in order to have comparable results, two separate linear mixed-effects models were performed on native speakers' and L2 learners' data. For native speakers, a marginally significant effect of condition was found when we compared the semantic condition with the identity condition; however, this effect was not found when the semantic condition was compared with the unrelated as the baseline (see Table 26).

Table 26. Linear Mixed-Effects Model for native speakers' response times on the semantic condition, with unrelated and identity as the baseline.

Baseline	**Variable**	**Estimate (SE)**	***t***	***p***
Unrelated	(intercept)	3.01 (0.02)	128.31	<.001
	Semantic	-0.01 (0.01)	-0.85	.4
	Gender	-0.02 (0.03)	-0.79	.43
	Log-transformed frequency	-0.04 (0.01)	-6.46	<.001
	Semantic x gender	0.01 (0.01)	0.97	.33
Identity	(intercept)	2.98 (0.02)	126.92	<.001
	Semantic	0.02 (0.01)	1.89	.06
	Gender	0.01 (0.03)	0.35	.73
	Log-transformed frequency	-0.04 (0.01)	-6.46	<.001
	Semantic x gender	-0.02 (0.01)	-1.26	.21

Note. Unrelated as baseline: df = 1623; identity as baseline: df = 1623; α = .05

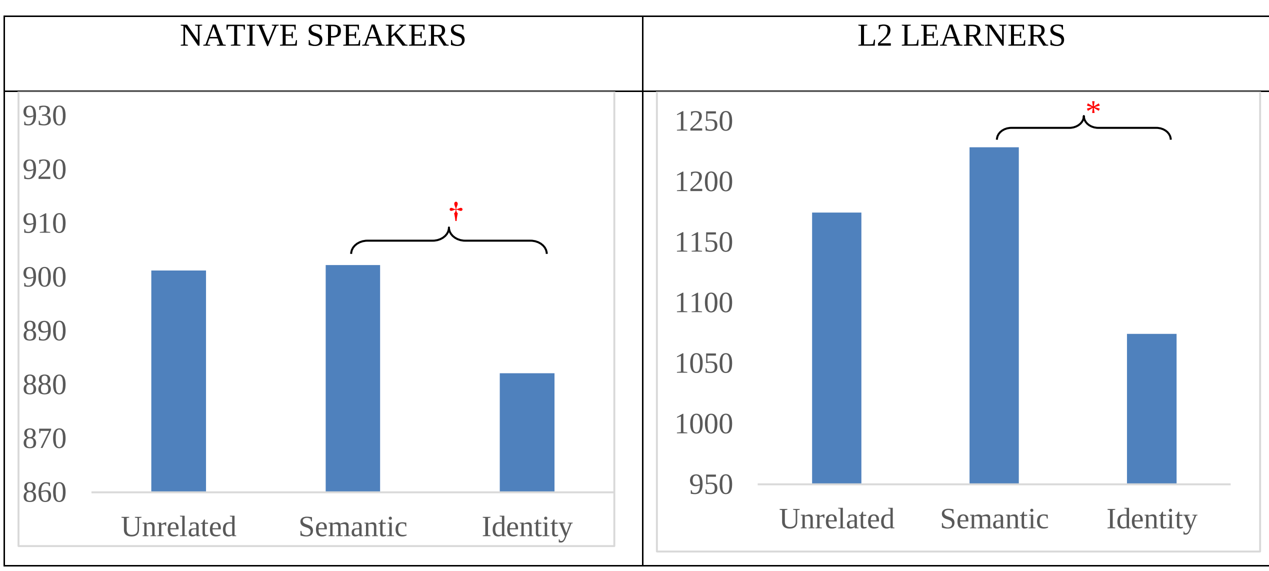
The model with the L2 learners' data showed the same pattern. There was a significant effect of condition when we compared the semantic and the identity conditions; however, the semantic and the unrelated conditions did now show any effect (see Table 27). This set of results is visually represented in Figure 10.

Table 27. Linear Mixed-Effects Model for the L2 learners' response times on the semantic condition, with unrelated and identity as the baseline.

Baseline	**Variable**	**Estimate (SE)**	***t***	***p***
Unrelated	(intercept)	3.14 (0.05)	61.75	<.001
	Semantic	-0.02 (0.02)	0.67	.5
	Gender	0.01 (0.02)	0.90	.37
	Years of instruction	0.03 (0.03)	2.31	.02
	Proficiency	0.009 (0.004)	-1.73	.08
	Log-transformed frequency	-0.072 (0.01)	-6.87	<.001
	Semantic x gender	-0.01 (0.02)	-0.57	.57
Identity	(intercept)	3.10 (0.05)	61.01	<.001
	Semantic	0.04 (0.02)	2.32	.02
	Gender	0.02 (0.03)	0.51	.61
	Years of instruction	0.009 (0.004)	2.31	.02
	Proficiency	-0.002 (0.001)	-1.73	.08
	Log-transformed frequency	-0.07 (0.01)	-6.87	<.001
	Semantic x gender	-0.002 (0.02)	-0.09	.93

Note. Unrelated as baseline: *df* = 1174; identity as baseline: *df* = 1174; *α* = .05

Figure 10. Average response for native speakers and L2 learners for the semantic condition with respect to the unrelated and the identity conditions.



These results rules out the possibility that the morphological facilitation obtained in natives speakers was due to semantic overlap between the prime and the target, in line with the predictions of the Dual Route Model and the Full Decomposition Model. This set of results, as well as the one described in Section 7.2.3 show that the long-lag priming worked by attenuating orthographic and semantic priming.

7.3 Gating task

Even though some variability was observed in the gating task (see Table 28), no interaction was found between the scores of the gating task and the results of the long-lag priming task.

Table 28. Average results of the gating task.

	Mean Average Number of Gates Used
Average	4.5
SD	5.7
Range	3.7 – 6.4

8 Discussion

This study examines the processing of Spanish verbal inflection, in native speakers and adult L2 learners of Spanish (native speakers of English). The study also investigated whether and how the processing of verbal inflection in an L2 may be influenced by some individual differences, in this case, the ability of combining phonemic information in order to retrieve lexical information among the phonetically similar competitors. Other variables such as age of acquisition, length of residence, years of instruction, and proficiency were also studied to understand their relationship with the ability of L2 learners to decompose verbal inflection into its morphemes.

The main purpose of the present study is, therefore, to explore the two following questions on the processing of verbal inflection in Spanish:

1) Will native speakers of Spanish show decomposition effects when processing inflectional morphology in their native language? Will L2 learners show decomposition effects?

2) Can factors such as proficiency and decoding ability explain individual variability in L2 learners' sensitivity to morphological information?

Using a long-lag priming task to try to capture decomposition effects among L2 learners, we found that native speakers of Spanish could decompose the third person plural of the present tense in their native language, but that L2 learners did not show this pattern. This pattern was interpreted based on the fact that response times were equally facilitated when presented after an identity priming (*andar-andar*) and an inflected form (*andan-andar*) for native speakers, but not for L2 learners. Interestingly, the pattern of decomposition found in native speakers to be statistically significant can be numerically observed as well in the learners' data, even though the results are not statistically significant. This opens the possibility that maybe the L2 learners recruited for this study were not advanced enough as to elicit decomposition effects. Further studies should try to recruit more advanced learners in order to study this possibility.

Gender differences were observed in native speakers' results, where female native speakers did not show any identity priming, but male native speakers did show a statistically significant pattern for this condition. In the L2 group, however, both gender groups patterned in the same way, only showing a statistically significant facilitation for the identity priming. Proficiency and years of instruction were found to improve the model of the L2 learners, but they did not interact with the priming effects. These two variables, then, predict faster response times and accuracy results for all conditions tested.

Results do not seem to be explained by means of confounding statistical or experimental factors (crossed random effects). The different conditions were matched on length, and frequency; however, the inflected primes in the morphological condition were, overall, statistically less frequent than the infinitival primes in the other conditions. In any case, this factor was introduced in the model in order to control for possible confounding factors when analyzing the data. Even though frequency was found to improve the model used to analyze the data, we find that frequency explains faster response times and more accurate results overall, irrespective of conditions. In other words, we did not find that frequency interacted with the priming effect. We do not find evidence, therefore, that decomposition would be found on low frequency forms. The above-described analysis helped ensure that the null result of morphological priming for the L2 learners' group was not due to a frequency confound.

The pattern of results found for native speakers is consistent with previous studies, which argue that regular inflected words are decomposed into their constituent morphemes (e.g., Alegre & Gordon, 1999; Marslen-Wilson & Tyler, 1998; Münte, Say, Clahsen, Schiltz, & Kutas, 1999; Pinker & Ullman, 2002; Prado & Ullman, 2009). This set of results is in line with both the Declarative/Procedural Model and the Full Decomposition Model. Let us recall that both models make the same predictions for regularly inflected forms, but differ in their predictions on how irregularly inflected forms are processed: they would be decomposed according to the Full

Decomposition Model, and stored as a whole according to the Declarative/Procedural Model. Some other differences are found between the two models with respect to predictions on females/males differences (predicted by the Declarative/Procedural Model but not by the Full Decomposition Model) and for how L2 learners are expected to pattern (described below). A more detailed study targeting both regular and irregular verbal inflection in Spanish would be needed in order to tease apart the predictions of these two models, in order to further our understanding of how native speakers process verbal inflection in Spanish.

Female/male differences were found to influence the processing of regular inflection in native speakers, but not in L2 learners. This set of results seems to support the view proposed by the Declarative/Procedural Model that female native speakers of a given language, but not males, rely more on declarative memory, and so they depend on whole word storage to process morphologically complex forms. We need to recall that the identity condition tested in the current study was an infinitive, and infinitives in Spanish are complex forms (e.g., *girar,* 'to rotate' is constructed with *gir–* the root shared by all the inflected forms, and *–ar,* the conjugation marker). For this reason, it is expected, based on the prediction of the Declarative/Procedural Model that women tend to rely more on whole word storage, on declarative memory, to process these infinitives. The pattern of results we find in this study is consistent with that interpretation of the Declarative/Procedural Model and has already been discussed in the literature to explain why females tend to show an advantage over men at verbal memory tasks (Halpern, 2000; Babcock et al., 2012). However, even when our evidence suggests that gender may have explanatory power to understand how inflectional morphology is processed, we need to be cautious when interpreting the implications of this result for the field as it could be accounted for by other as-of-yet unobserved factors.

On the one hand, a clear interpretation has not emerged because not many studies have looked at the effect of gender on the processing of morphologically complex words (Silva, 2009; Babcock et al., 2012), and because in these studies results are mixed, with some showing differences between the two genders (Babcock et al., 2012) but not others (Silva, 2009). Thus, drawing strong conclusions may be premature at this stage. On the other hand, the detractors in the literature point out simply that some of these results may not be completely related to gender differences, but to some unobservable variables, still to be fully identified, which might be conflated with gender effects (Ryan, Kreiner, & Tree, 2008).

One of these unobservable factors could be the different speed processing of the participants, not necessarily related to gender. In this study, we computed an ANOVA to compare the average response times of both gender of native speakers, and we found that females were marginally faster than the male group ($F(1,2708) = 3.51$, $p = 0.06$), pattern that was not observed in the L2 group ($F(1,2677) = 0.09$, $p = 0.76$). Even though these results are not robust, we can see that processing speed differences may be a contributing factor to explain why females do not show identity priming (as they respond faster overall for all conditions, it may be difficult to detect a difference for the identity and morphology conditions). Processing speed is a factor to take into account for the case of the L2 learners as well.

Something that it is also important to consider is that gender effects were not expected when we were creating the study. Hence, the two gender groups are not matched either in terms of participants or in terms of other variables. For example, the female group has an average age of 25.5 years (standard deviation of 9.5), while the male group, which only consisted of 18 participants, had an average age of 23.6 (standard deviation of 5.98). Given these differences in the groups themselves, we cannot rule out the possibility that the present results are due to other confounds, and not necessarily to gender effects. In any case, a more detailed study of gender effects, in which other variables such as age of the participants or number of participants per group are matched, would be interesting in order to fully understand the effects of gender in the processing of morphologically complex forms.

In line with the findings of Bowden et al. (2010), who reported in their study that native speakers of Spanish decomposed only regular verbs of the first conjugation, we included this variable in our model, both as an interaction with response times and as a predictor. However, none of the options improved the model, and so we concluded that conjugation was not an important predictor in order to explain how native speakers process verbal inflection in our study. In fact, our results are in line with the results reported by Rodriguez-Fornells et al. (2002), who did not find effects of conjugation. However, contrary to Bowden et al. (2010), we included five different conditions in our study, and in order to match them in terms of length and frequency, most of our verbs (fifty two out of sixty) corresponded to verbs of the first conjugation. We cannot rule out the possibility that there was not enough variation in the verb types to find the same effects reported in Bowden et al. (2010). In order to fully understand the effects of the conjugation in the processing of verbal inflection in Spanish, we would need to create a more balanced set of stimuli.

This study seems to strengthen the view that L2 learners, independently of their gender, behave differently from native speakers of Spanish, as proposed by the Shallow Structure Hypothesis and the Declarative/Procedural Model for learners at lower levels of proficiency. When controlling for other factors such as age of acquisition, length of residence, and proficiency, L2 learners in our study seem to depend more on storage to process regular inflected forms. However, the range of proficiency tested was not controlled, as it is very large and skewed towards low proficient learners. Partially in line with the Declarative/Procedural Model, we have seen that years of instruction and proficiency help improve the model with L2 learners' data. This finding suggests that, holding other factors constant, the amount of experience and proficiency in the L2 affect lexical processing by increasing accuracy and reducing response times in all conditions (although there is no evidence in our data that these variables would facilitate decomposition). No interactions were found in the study, which indicates that all participants, independently of their proficiency or how long they had been studying the language, process inflection in the same way. Our results seem to suggest that learners rely on whole-word storage.

Babcock et al. (2012) also tested native speakers of English and L2 learners of this language (native speakers of Chinese and Spanish) and found results similar to ours. They found gender differences among native speakers, and that proficiency and length of residence improved the lexical processing of L2 learners, but without reaching statistically significant decomposition patterns. They interpreted their results as being in line with the Declarative/Procedural Model. Let us recall that this model predicts that, with higher proficiency and more exposure to the L2, there will be a shift into using more procedural memory (and not relying as much on whole-word storage).

In our case, it was years of instruction, not length of residence, the factor that better explained the learners' data, together with proficiency. It is worth pointing out that only sixteen out of the forty-five participants tested in the learners group have lived in a Spanish-speaking country for more than one month. In our case, years of instruction was the best predictor of exposure to the language. However, by testing participants with longer exposures to the language, we may get results more similar to those reported by Babcock et al. (2012). More studies are needed in order to better understand the contribution of each one of these variables in the processing of verbal inflection in a L2.

It is important to realize that null results do not mean necessarily that L2 learners cannot process regular verbal inflection in the same way as native speakers. The fact that L2 learners are able to use the same mechanisms as native speakers in order to process morphologically complex words is not ruled out by the observed lack of statistical significance. The task and paradigm designed for this study were chosen to elicit decomposition effects even among L2 learners, given that they had been proved to be sensitive enough to enhance decomposition and reduce orthographic and semantic effects in the literature with native speakers (Feldman, 2000). However, it could be argued that something inherent to the task itself, or maybe to the paradigm, may not be the best option in order to elicit a response that is still developing. In fact, if we recall, the visual inspection of our data shows a pattern towards the decomposition of verbal inflection similar to the one observed with native speakers, even when the statistical results did not yield significance. The inclusion of more participants, or maybe more advanced participants, could improve the model and allow us to pick up statistically significant decomposition patterns in response times for the critical conditions tested.

Alternatively, behavioral data could be complemented by other means to try to understand a process that may be as subtle as difficult to assess solely with small variations in response times. It has been argued that the problem with a lexical decision task may be that it implies two processing steps: not only lexical access, but also post-lexical processing in deciding whether the target is a word. This second process (independent from decomposition) may well be obscuring potential evidence of decomposition (Coughlin, in press). L2 learners may decompose inflected forms into their constituents, but may be slower in order to perform the second process, and even more in studies like the current one in which both primes and targets are morphologically complex.

In order to fully understand this process of lexical access, using a methodology with a really good temporal resolution such as event related potentials could be a way forward that would complement the behavioral data and provide additional results for the analysis. If it were the case that the second step in a lexical decision task is the main problem for L2 learners, even when response times would not explain the processes learners go through in order to process inflectional morphology, we would still see the same brain response in native speakers and L2 learners when processing the complex form (Solomyak & Marantz, 2010).

The current study tried to expand the field to the investigation of the role of individual differences in the processing of inflectional morphology by L2 learners. As an exploratory question, we tried to see whether the ability to decompose verbal inflection in an L2 may be correlated with the ability to combine phonemic information in the native language to retrieve lexical information from among lexical competitors. Even when quite variability was observed in the results of the gating task, this variable was not useful in order to predict the ability of learners in the priming task. More studies are needed in order to understand how individual differences affect this type of second language processing, as for example, trying to correlate the ability to decompose in the two languages, the native and the second language. In fact, measures of spelling and vocabulary would be really suited to explain their possible interaction with morphological decomposition, as they have been found to affect decomposition in native speakers (Andrews and Lo, 2013).

Overall, these results, together with previous findings in the literature, strengthen our understanding of the mechanisms to process verbal inflection in a first and a L2 but also open up more questions for further research. In particular, the data seems to provide at least partial support for the predictions of the Declarative/Procedural Model (Ullman, 2005). The Full Storage Model does not seem to explain the pattern of results obtained in this study, because of the differences found between and within groups. Regularly inflected forms seem to be decomposed by native speakers, with males showing an advantage over females in the measured decomposition effect; however, these patterns are not statistically significant in second-language and could reflect that these forms depend more on storage and lexical memory for L2 learners. The response times among L2 learners seems to be affected by proficiency and length of exposure to the L2.

This study is part of a broad research agenda that may be continued in future research. First of all, the present study focused solely on regular verbal inflection. If we want to be able to tease apart the predictions made by the different models of lexical access (mainly the Declarative/Procedural Model and the Full Decomposition Model), we need to include irregular verbal forms to the study. Secondly, we did not manipulate some of the variables to see which one is the best predictor of native-like processing of verbal inflection in an L2. For example, Babcock et al. (2012) kept constant the age of acquisition of the participants, and tried to see how other variables (length of residence, among others) predicted the final results of a production task. However, they did not control for proficiency, and they claim that length of residence is the best predictor to explain how L2 learners process verbal inflection. However, proficiency and length of residence usually correlate in the literature, so it would be interesting to tease apart the effects of these two variables. Further research is needed to study whether the pattern of results reported here might generalize to other tasks, inflectional paradigms, languages, populations, and other aspects of language, including derivational morphology and syntax.

9 Conclusion

This study examined the processing of regular verbal inflection in Spanish by native speakers and adult L2 learners. The evidence suggests that regular forms are either decomposed or stored, depending on factors such as gender (among native speakers) or group (L2 (male) learners appear to rely more on whole storage than native (male) speakers). More years of instruction and higher levels of proficiency were found to affect the overall lexical processing by L2 learners, with those individuals who had studied the language during more time and had reached a higher level of proficiency responding faster and more accurately than their counterparts. These findings, together with previous evidence, seem to suggest that L2 processing may be different from native speakers' processing, and the degree to which they can pattern as native speakers is going to depend on a function of multiple factors that are still to be fully understood (Ullman, 2005). As the study progresses, we will further investigate the differences between our results and those of previous studies on the processing of verbal inflection in Spanish.

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APPENDIX A: Proficiency Test

<u>**Multiple Choice Test**</u>

Each of the following sentences contains a blank indicating that a word or phrase has been omitted. Select the choice that best completes the sentence.

1. Al oír del accidente de su buen amigo, Paco se puso __________.
a. alegre b. fatigado c. hambriento d. desconsolado

2. No puedo comprarlo porque me_______________.
a. falta b. dan c. presta d. regalan

3. Tuvo que guardar cama por estar ______________.
a. enfermo b. vestido c. ocupado d. parado

4. Aquí está tu café, Juanito. No te quemes, que está muy ______________.
a. dulce b. amargo c. agrio d. caliente

5. Al romper los anteojos, Juan se asustó porque no podía ________ sin ellos.
a. discurrir b. oír c. ver d. entender

6. ¡Pobrecita! Está resfriada y no puede ________________.
a. salir de casa b. recibir cartas c. respirar con pena d. leer las noticias

7. Era una noche oscura sin ________.
a. estrellas b. camas c. lágrimas d. nubes

8. Cuando don Carlos salió de su casa, saludó a un amigo suyo: -Buenos días,____.
a. ¿Qué va? b. ¿Cómo es? c. ¿Quién es? d. ¿Qué tal?

9. ¡Qué ruido había con los gritos de los niños y el _______ de los perros!
a. olor b. sueño c. hambre d. ladrar

10. Para saber la hora, don Juan miró el __________.
a. calendario b. bolsillo c. estante d. despertador

11. Yo, que comprendo poco de mecánica, sé que el auto no puede funcionar sin _.
a. permiso b. comer c. aceite d. bocina

12. Nos dijo mamá que era hora de comer y por eso _____________.
a. fuimos a nadar b. tomamos asiento c. comenzamos a fumar d. nos acostamos pronto

13. ¡Cuidado con ese cuchillo o vas a ____________ el dedo!
a. cortarte b. torcerte c. comerte d. quemarte

14. Tuvo tanto miedo de caerse que se negó a ___________ con nosotros.
a. almorzar b. charlar c. cantar d. patinar

15. Abrió la ventana y miró: en efecto, grandes lenguas de ______ salían llameando de las casas.
a. zorros b. serpientes c. cuero d. fuego

16. Compró ejemplares de todos los diarios pero en vano. No halló ____________.
a. los diez centavos b. el periódico perdido c. la noticia que deseaba d. los ejemplos

17. Por varias semanas acudieron colegas del difunto profesor a ________ el dolor de la viuda.
a. aliviar b. dulcificar c. embromar d. estorbar

18. Sus amigos pudieron haberlo salvado pero lo dejaron ______________.
a. ganar b. parecer c. perecer d. acabar

19. Al salir de la misa me sentía tan caritativo que no pude menos que _________ a un pobre mendigo que había allí sentado.
a. pegarle b. darle una limosna c. echar una mirada d. maldecir

20. Al lado de la Plaza de Armas había dos limosneros pidiendo ________.
a. pedazos b. paz c. monedas d. escopetas

21. Siempre maltratado por los niños, el perro no podía acostumbrarse a ________ de sus nuevos amos.
a. las caricias b. los engaños c. las locuras d. los golpes

22. ¿Dónde estará mi cartera? La dejé aquí mismo hace poco y parece que el necio de mi hermano ha vuelto a ___________.
a. dejármela b. deshacérmela c. escondérmela d. acabármela

23. Permaneció un gran rato abstraído, los ojos clavados en el fogón y el pensamiento _________.
a. en el bolsillo b. en el fuego c. lleno de alboroto d. Dios sabe dónde

24. En vez de dirigir el tráfico estabas charlando, así que tú mismo ____________ del choque.
a. sabes la gravedad b. eres testigo c. tuviste la culpa d. conociste a las víctimas

25. Posee esta tierra un clima tan propio para la agricultura como para _________.
a. la construcción de trampas b. el fomento de motines c. el costo de vida
d. la cría de reses

26. Aficionado leal de obras teatrales, Juan se entristeció al saber ______________ del gran actor.
a. del fallecimiento b. del éxito c. de la buena suerte d. de la alabanza

27. Se reunieron a menudo para efectuar un tratado pero no pudieron ___________.
a. desavenirse b. echarlo a un lado c. rechazarlo d. llevarlo a cabo

28. Se negaron a embarcarse porque tenían miedo de ____________.
a. los peces b. los naufragios c. los faros d. las playas

29. La mujer no aprobó el cambio de domicilio pues no le gustaba _____________.
a. el callejeo b. el puente c. esa estación d. aquel barrio

30. Era el único que tenía algo que comer pero se negó a _______________.
a. hojearlo b. ponérselo c. conservarlo d. repartirlo

In the following text, some of the words have been replaced by blanks numbered 1 through 20. First, read the complete text in order to understand it. Then reread it and choose the correct word to fill each blank from the answer sheet. Mark your answers by circling your choice on the answer sheet, not by filling in the blanks in the text.

El sueño de Joan Miró

Hoy se inaugura en Palma de Mallorca la Fundación y Joan Miró, en el mismo lugar en donde el artista vivió sus últimos treinta y cinco años. El sueño de Joan Miró se ha __________(1). Los fondos donados a la ciudad por el pintor y su esposa en 1981 permitieron que el sueño se ______________(2); más tarde, en 1986, el Ayuntamiento de Palma de Mallorca decidió _____________(3) al arquitecto Rafael Moneo un edificio que ___________(4) a la vez como sede de la entidad y como museo moderno. El proyecto ha tenido que _________(5) múltiples obstáculos de carácter administrativo. Miró, coincidiendo __ ____________(6) los deseos de toda su familia, quiso que su obra no quedara expuesta en ampulosos panteones de arte o en _______________(7) de coleccionistas acaudalados; por ello, en 1981, creó la fundación mallorquina. Y cuando estaba ______________(8) punto de morir, donó terrenos y edificios, así como las obras de arte que en ellos ______________(9).

El edificio que ha construido Rafael Moneo se enmarca en _____________(10) se denomina 'Territorio Miró', espacio en el que se han __________________(11) de situar los distintos edificios que constituyen la herencia del pintor.

El acceso a los mismos quedará ________________ (12) para evitar el deterioro de las obras. Por otra parte, se ________________(13), en los talleres de grabado y litografía, cursos __________________(14) las distintas técnicas de estampación. Estos talleres también se cederán periódicamente a distintos artistas contemporáneos, ______________________(15) se busca que el 'Territorio Miró' __________(16) un centro vivo de creación y difusión del arte a todos los _________________ (17).

La entrada costará 500 pesetas y las previsiones dadas a conocer ayer aspiran ________(18) que el centro acoja a unos 150.000 visitantes al año. Los responsables esperan que la institución funcione a _____________(19) rendimiento a principios de la ______________ (20) semana, si bien el catálogo completo de las obras de la Fundación Pilar y Joan Miró no estará listo hasta dentro de dos años.

Cloze Test Answer Sheet

1. a. cumplido	b. completado	c. terminado
2. a. inició	b. iniciara	c. iniciaba
3. a. encargar	b. pedir	c. mandar
4. a. hubiera servido	b. haya servido	c. sirviera
5. a. superar	b. enfrentarse	c. acabar
6. a. por	b. en	c. con
7. a. voluntad	b. poder	c. favor
8. a. al	b. en	c. a
9. a. habría	b. había	c. hubo
10. a. que	b. el que	c. lo que
11. a. pretendido	b. tratado	c. intentado
12. a. disminuido	b. escaso	c. restringido
13. a. darán	b. enseñarán	c. dirán
14. a. sobre	b. en	c. para
15. a. ya	b. así	c. para
16. a. será	b. sea	c. es
17. a. casos	b. aspectos	c. niveles
18. a. a	b. de	c. para
19. a. total	b. pleno	c. entero
20. a. siguiente	b. próxima	c. pasada

Answer Key: Multiple Choice Test

1. d	11. c	21. a
2. a	12. b	22. c
3. a	13. a	23. d
4. d	14. d	24. c
5. c	15. d	25. d
6. a	16. c	26. a
7. a	17. a	27. d
8. d	18. c	28. b
9. d	19. b	29. d
10. d	20. c	30. d

Answer Key: Cloze Test

1. a	8. c	15. b
2. b	9. b	16. b
3. a	10. c	17. c
4. c	11. b	18. a
5. a	12. c	19. b
6. c	13. b	20. b
7. b	14. a	

Total points possible: 50

Advanced	40 to 50
Intermediate	30 to 39
Low	0 to 29

APPENDIX B: Stimuli in Task 1 (real verbs in the five conditions tested)

Target		Prime				
		Morphology condition	Identity condition	Orthographic condition	Semantic condition	Unrelated condition
1	abrazar	Abrazan	abrazar	abrasar	abarcar	patinan
2	aclarar	Aclaran	aclarar	aclamar	enseñar	liberar
3	recusar	recusan	recusar	recular	denegar	abrumar
4	discutir	discuten	discutir	disentir	disputar	permitir
5	donar	donan	donar	dopar	legar	alzar
6	llevar	llevan	llevar	llegar	portar	bailar
7	meter	meten	meter	mecer	pasar	moler
8	pegar	pegan	pegar	pagar	fijar	pisar
9	rozar	rozan	rozar	rogar	tocar	jugar
10	temer	temen	temer	tejer	dudar	arder
11	vaciar	vacían	vaciar	variar	verter	crecer
12	contestar	contestan	contestar	contentar	responder	despuntar
13	revelar	revelan	revelar	rebelar	delatar	acercar
14	beber	beben	beber	deber	catar	parar
15	cazar	cazan	cazar	casar	lazar	negar
16	grabar	graban	grabar	gravar	tallar	bastar
17	vendar	vendan	vendar	vengar	cubrir	partir
18	rascar	rascan	rascar	raspar	arañar	captar
19	pesar	pesan	pesar	besar	doler	saber
20	arrojar	arrojan	arrojar	arropar	empujar	sosegar
21	regentar	regentan	regentar	reventar	presidir	perdonar
22	poner	ponen	poner	poder	dejar	cesar
23	tomar	toman	tomar	topar	coger	colar
24	marcar	marcan	marcar	mascar	firmar	juzgar
25	adorar	adoran	adorar	adobar	honrar	argüir
26	asomar	asoman	asomar	asolar	surgir	culpar
27	dirimir	dirimen	dirimir	dimitir	disipar	sonreír
28	talar	talan	talar	tapar	segar	domar
29	vender	venden	vender	vencer	saldar	luchar
30	acortar	acortan	acortar	acostar	encoger	bromear
31	timar	timan	timar	tirar	robar	sumar
32	sanar	sanan	sanar	sacar	curar	andar
33	abonar	abonan	abonar	abocar	avalar	holgar
34	votar	votan	votar	notar	optar	citar
35	menear	menean	menear	mentar	agitar	pelear
36	reportar	reportan	reportar	recortar	refrenar	concluir
37	tratar	tratan	tratar	trabar	cuidar	colgar
38	salvar	salvan	salvar	saltar	librar	fallar
39	rondar	rondan	rondar	mondar	pasear	ayunar

40	calar	calan	calar	cavar	mojar	manar
41	danzar	danzan	danzar	lanzar	bailar	copiar
42	ayudar	ayudan	ayudar	anudar	apoyar	llenar
43	comer	comen	comer	coser	cenar	vivir
44	girar	giran	girar	mirar	rotar	venir
45	abordar	abordan	abordar	abortar	asaltar	perecer
46	aceptar	aceptan	aceptar	acertar	admitir	suponer
47	achacar	achacan	achacar	achicar	imputar	merecer
48	afectar	afectan	afectar	afeitar	aquejar	cocinar
49	borrar	borran	borrar	bordar	anular	torcer
50	calmar	calman	calmar	callar	paliar	pastar
51	cebar	ceban	cebar	cegar	criar	morar
52	exigir	exigen	exigir	elegir	forzar	hojear
53	descargar	descargan	descargar	descartar	depositar	contactar
54	desnudar	desnudan	desnudar	desnucar	despojar	malvivir
55	empujar	empujan	empujar	empuñar	alentar	otorgar
56	entregar	entregan	entregar	entrenar	conceder	triunfar
57	formar	forman	formar	forzar	fundar	pintar
58	inventar	inventan	inventar	intentar	concebir	circular
59	ladrar	ladran	ladrar	labrar	aullar	palpar
60	quedar	quedan	quedar	quemar	pactar	vestir

APPENDIX C: Stimuli in Task 1 (nonce verbs in the four conditions tested)

	Target	**Prime**				
		Morphology condition	**Identity condition**	**Orthographic condition**	**Semantic condition**	**Unrelated condition**
1	arrabar	arraban	arrabar	abranar	-	Paninar
2	aclasar	aclasan	aclasar	aclanar	-	Liperar
3	remusar	remusan	remusar	recunar	-	Abrupar
4	discunir	discunen	discunir	discusir	-	permidir
5	doñar	doñan	doñar	dólar	-	alsar
6	llefar	llefan	llefar	llecar	-	Baimar
7	meder	meden	meder	meser	-	Momer
8	pebar	peban	pebar	pacar	-	pizar
9	bozar	bozan	bozar	logar	-	vugar
10	teber	teben	teber	tecer	-	arter
11	taciar	tacian	taciar	vasilar	-	creser
12	conteltar	conteltan	conteltar	contemtar	-	despumtar
13	regelar	regelan	regelar	redelar	-	Acelcar
14	bever	beven	bever	dever	-	pavar
15	cafar	cafan	cafar	canar	-	nevar
16	glabar	glaban	glabar	glavar	-	Basdar
17	verdar	verdan	verdar	vencar	-	pastir
18	rarcar	rarcan	rarcar	rasbar	-	cabtar
19	pezar	pezan	pezar	bezar	-	saver
20	arrogar	arrogan	arrogar	arrofar	-	Sosecar
21	rejentar	rejentan	rejentar	recentar	-	pertonar
22	pomer	pomen	pomer	poter	-	cecar
23	tolar	tolan	tolar	tobar	-	Comar
24	malcar	malcan	malcar	mazcar	-	jusgar
25	adozar	adozan	adozar	adopar	-	asgüir
26	azomar	azoman	azomar	asonar	-	Culbar
27	dilimir	dilimen	dilimir	dirinir	-	Sonleír
28	tacar	tacan	tacar	tabar	-	dozar
29	bender	benden	bender	bencer	-	Ruchar
30	asortar	asortan	asortar	asostar	-	Bronear
31	tilar	tilan	tilar	tiñar	-	sunar
32	samar	saman	samar	sazar	-	antar
33	agonar	agonan	agonar	azocar	-	Horgar
34	vodar	vodan	vodar	nodar	-	cidar
35	mengar	mengan	mengar	mendar	-	Pedear
36	rebortar	rebortan	rebortar	rezordar	-	condluir
37	tralar	tralan	tralar	tracar	-	coljar
38	salcar	salcan	salcar	salnar	-	fadlar
39	gondar	gondan	gondar	nondar	-	Oyunar

40	carar	caran	carar	cabar	-	malar
41	danlar	danlan	danlar	banzar	-	Cobiar
42	amudar	amudan	amudar	aludar	-	llonar
43	coper	copen	coper	cozer	-	vibir
44	lirar	liran	lirar	nirar	-	benir
45	apordar	apordan	apordar	avortar	-	Porecer
46	aceltar	aceltan	aceltar	acentar	-	Suboner
47	aclacar	aclacan	aclacar	aclicar	-	Melecer
48	afeltar	afeltan	afeltar	afertar	-	Cosinar
49	borcar	borcan	borcar	bortar	-	torper
50	calnar	calnan	calnar	cadlar	-	partar
51	cepar	cepan	cepar	cecar	-	Mogar
52	ixigir	ixigen	ixigir	iximir	-	Mojear
53	desmargar	desmargan	desmargar	descarvar	-	contartar
54	desnutar	desnutan	desnutar	desnugar	-	Malvibir
55	embujar	embujan	embujar	embuñar	-	Otargar
56	entlegar	entlegan	entlegar	entlenar	-	Tliunfar
57	fornar	fornan	fornar	forsar	-	Pindar
58	inlentar	inlentan	inlentar	indentar	-	Ciscular
59	latrar	latran	latrar	lavrar	-	Palbar
60	quetar	quetan	quetar	quenar	-	Verder

APPENDIX D: Stimuli in Task 1 (fillers)

	Real Verbs	Nonce Verbs
1	apostar	aizlar
2	carecer	conpretar
3	pretender	derucir
4	decidir	traspacar
5	iluminar	conprar
6	entrar	eslerar