PREDICTING THE END: MONOLINGUALS, L2 LEARNERS AND INTERPRETERS' USE OF PROSODY TO PREDICT WORD ENDINGS

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ABSTRACT OF THE DISSERTATION

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Prediction is essential to human cognition and language is no exception. Native speakers anticipate upcoming linguistic information rapidly and easily, but some studies show that second language (L2) learners have difficulty making linguistic predictions, even at advanced proficiency levels. I investigate whether prior experience with linguistic anticipation acquired via simultaneous interpreting explains adult learners' trouble making L2 predictions. Simultaneous interpreting requires constant and quick predictions to ease the cognitive load of simultaneous interpreting. Also, I examine the role of working memory (WM) on the anticipation of morphology to shed light on how cognitive resources support prediction. To address the role of anticipatory experience and WM on L1 and L2 prediction, adult Spanish monolinguals and adult English learners of Spanish with and without interpreting experience completed a WM test and a visual world paradigm eye-tracking task asking them to predict word endings based on prosodic cues.

Study 1 examines the effects of prediction experience via simultaneous interpreting on L2 prediction. Spanish monolinguals, and advanced L2 learners of Spanish with and without interpreting experience performed an eye-tracking task in which they saw two verbs on the screen while hearing a sentence and could anticipate the target verb based on lexical stress (paroxytone, oxytone) and syllabic structure (CV, CVC). Data showed that native and non-native speakers use lexical stress and syllabic structure in the initial syllable of a verb to predict its suffix, although the learners did not predict suffixes preceded by CV stressed syllables, and interpreters predicted faster than non-interpreters and even monolinguals under some conditions. Hence, prosodic cues facilitate morphological prediction during oral word recognition, and anticipatory experience enhances L2 prediction.

Study 2 explores prediction of non-morphological word endings (e.g., *PApa* – *paPÁ*, ‘potato-dad’) to determine whether the findings in Study 1 are limited to words with inflectional morphology. Participants and tasks were identical to Study 1. Data revealed that monolinguals and interpreters also use lexical stress and syllabic structure to predict non-morphological word endings, but non-interpreters display more difficulties making predictions than monolinguals and interpreters, and can only anticipate word endings preceded by CVC unstressed syllables (which minimize lexical competitors). Therefore, prosody in the first syllable is key for lexical access and prediction, L2 prediction is more vulnerable to semantic interference, and anticipatory experience via interpreting enhances L2 prediction.

Finally, Study 3 investigates the effects of WM on morphological prediction during oral word recognition. Participants and tasks were identical to Study 1. In addition, participants completed a letter-number sequencing WM task. Data showed that, in the stressed condition, higher WM monolinguals predicted earlier and higher WM interpreters predicted faster; whereas, in the unstressed condition, lower WM non-interpreters predicted earlier. Importantly, interpreters' use of WM is closer to that of monolinguals.

Taken together, these studies inform prediction models, and support accessibility models and usage-based models. The findings from this dissertation advance our understanding of prediction by teasing apart L2 proficiency from prediction experience. Also, findings support accessibility accounts, by showing that L2 learners can process their L2 on par with native speakers, and usage-based models of adult L2 acquisition, indicating that repeated exposure to prediction is essential to the optimization of the cognitive resources to gain L2 fluency.

Keywords: prediction, lexical stress, syllabic structure, working memory, interpreting

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PREFACE

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Chapter 1: Introduction

A growing body of research indicates that anticipation is crucial in our lives. Humans anticipate what will come next when making a sandwich (Hayhoe, Shrivastava, Mruczek, & Pelz, 2003), driving (Van Der Hulst, Meijman, & Rothengatter, 1999), or reading music (Land & Furneaux, 1997). Similarly, humans do not wait until the end of an utterance to construct meaning. Instead, they incrementally process language by using all the available information (semantic, phonological, syntactic, or even properties like shape or color) and create predictions about new input (Ito, 2016). Bar (2007) proposes associations as one of the key components in the process of prediction generation. First, humans create associations by extracting repeating patterns from input. Second, analogies allow to establish correspondence between stored and novel input. Third, analogies trigger activation of associated representations that become predictions.

The study of anticipation is fundamental for the understanding of language processing. However, this idea was rejected by early syntactic parsing models. In early approaches, head-driven theories proposed that head-nodes triggered processing and that listeners could not project any phrase until the head appears (Pritchett, 1991). By contrast, most psycholinguistic theories have shown that language is processed incrementally by constantly mapping items onto mental representations (Kamide, 2008; Kamide & Mitchell, 1999). Anticipatory models radically extend these accounts by explaining the ways in which the parser not only processes information that has already appeared, but also prepares for upcoming information. This preparation liberates cognitive capacity when the prediction is correct and maximizes processing efficiency

(Kamide, 2008). Previous literature suggests that there are differences between prediction in L1 and L2 processing. Whereas native speakers seem to predict upcoming linguistic information easily, adults exhibit difficulties when making predictions in their L2 (Kaan, Kirkham, & Wijnen, 2014). In monolingual processing, maturational and experiential factors influence the ability to make predictions among native speakers. For instance, older monolingual adults are less successful than younger adults at exploiting contextual semantic information to predict an upcoming noun, showing that age modulates prediction (Federmeier & Kutas, 2005; Huang, Meyer, & Federmeier, 2012). Furthermore, literate adults and children show stronger prediction patterns than adults and children with low levels of literacy. These findings evidence that language experience, and in particular literacy, also modulates prediction, probably thanks to the additional orthographic representations that sharpen lexical representations and facilitate lexical retrieval (see Huettig & Pickering, 2019 for a review). Research to date has focused on comparing monolinguals and bilinguals in order to explore what type of cues are used for prediction and what type of information can be anticipated during L2 processing. However, little is known about the type of language exposure that could implicitly enhance L2 prediction.

The present project examines whether the use of prediction during simultaneous interpreting extrapolates to anticipatory strategies during language processing. Professional interpreters constantly switch between their working languages and, in the case of simultaneous interpreting, under high time and cognitive constraints. Moreover, prediction is an important strategy that releases cognitive load during simultaneous interpreting. Interpreters provide an interesting opportunity to study how "extreme bilingualism" and additional anticipatory experience affect predictive processing. These findings will contribute in several ways to prediction, phonological and second language acquisition models, providing evidence for the notion that language prediction is trainable.

This dissertation includes three studies. In Study 1, I investigate the role of additional prediction experience in facilitating L2 prediction. To do so, I compare the prediction of morphology based on prosodic cues in Spanish, non-interpreter and interpreter L2 learners. Study 2 assesses the relevance of prosody in prediction by examining whether lexical stress and syllabic structure also trigger prediction of non-morphological endings in monolinguals, interpreters and non-interpreters. Finally, Study 3 attempts to identify the cognitive mechanisms allowing prediction by investigating the role of WM in morphological prediction in monolinguals, interpreters and non-interpreters. The next section includes research on morphosyntactic prediction in monolingual speakers.

1.1 Prediction between words

1.1.1 L1 morphosyntactic prediction

Humans are not mere passive receptors of information. They actively engage in using available cues to generate expectations about upcoming information. The same applies to linguistic anticipation. Thus, morphological cues constrain sentence processing among monolingual speakers. Research shows that native speakers can use grammatical gender, case marking and number marking to predict an upcoming noun, even at a young age.

First, anticipation based on gender agreement has been reported in a variety of languages ranging from Dutch (Huettig & Janse, 2016), to Spanish (Lew-Williams & Fernald, 2007), German (Hopp, 2013), and French (Dahan et al., 2000). Huettig & Janse (2016) investigated, in an eye-tracking experiment, whether native speakers of Dutch could exploit gender in the article to predict an upcoming noun. Results showed participants could predict the target noun using article gender and that prediction ability was facilitated by enhanced WM and faster processing speed (see section 'WM and prediction' for further details on this study). Lew-Williams & Fernald (2007) found similar results with an eye-tracking experiment, showing that adult monolingual native speakers of Spanish can use the gender in the determiner to predict an upcoming noun (e.g., *Encuentra la$_{fem}$ galleta$_{fem}$,* "Find the cookie"). Moreover, they showed that this ability develops early in life and young children with a vocabulary of approximately 500 words can also make predictions based on the gender of the article. Dahan et al. (2000) examined whether gender-marked information constrains the set of activated lexical candidates. In their eye-tracking study, participants were presented with four objects: a target (*bouton*, 'button'), a phonological competitor (*bouteille*, 'bottle') and two distractors. In sentences where the article had a neutral gender (i.e. *les*, 'the' plural), both target and phonological competitor were activated. However, when the article was gender-marked (*le/la*, 'the' masculine/feminine), participants only directed looks towards the target noun. This processing pattern indicates that gender-marked information constrains the set of activated lexical candidates and that natives consistently integrate this cue to anticipate upcoming referents in the sentence.

Second, number marking is another morphological cue that allows us to generate expectations about upcoming information. Marull (2017) showed that Spanish natives can both integrate number-marking information and use it predictively. In a self-paced reading experiment, Spanish natives were sensitive to number-marking violations between the determiner and the noun as demonstrated by a reading slow-down in the critical noun, indicating integration. Moreover, in a picture-selection task, natives were significantly faster in selecting the correct picture in the informative condition (i.e., the sentence heard contained number-marking information associated with only one of the two pictures shown). This finding suggests that number marking is exploited predictively to narrow down a set of potential nouns.

Third, anticipation using case-marking information has been found in German (Hopp, 2015) and Japanese (Mitsugi & MacWhinney, 2016). Hopp (2015) examined whether German native speakers integrate case marking and verb semantics to generate predictions in sentence comprehension. In his eye-tracking study, participants listened to a sentence while seeing a picture displayed. Half of the sentences where SVO (nominative case article) and half were OVS (accusative case article). Results showed that German native speakers rapidly integrate case marking to make predictions about an upcoming referent. In another visual-world paradigm experiment, Nakamura & MacWhinney (2016) showed that Japanese native speakers also use case markers to predict syntactic structure. Taken together, results from these studies indicate that natives integrate thematic role information to prevent unlikely sentence interpretations and, thus, use this cue to rapidly predict the sentence structure.

Nevertheless, exposure to mismatched morphosyntactic cues can disrupt morphosyntactic prediction in native speakers. Hopp (2016) investigated the effects of exposure to non-target gender assignment in native speakers of German. One group received target-like gender assignment while another group received items with non-target gender assignment. The group that received non-target gender disrupted their ability to anticipate. These results show that variability in the assignment of lexical gender affects anticipation in native speakers, and that processing is subject to adaptation even after a short exposure to input.

Here we have reviewed how native speakers use morphology to generate expectations about upcoming information. Native speakers consistently use grammatical gender and number marking morphology to restrict the possible set of referents and predict a noun. Importantly, in the cases of gender marking, this ability seems to be modulated by WM and processing and is developed early in life. However, exposure to non-target-like relationships hinders prediction, showing that native speakers can adapt their prediction strategies. Case marking is another cue that allows prediction in native speakers by preactivating sentence structure. These studies show that natives use morphosyntactic relationships between words to facilitate processing. We continue by analyzing L2 morphosyntactic prediction in the following section.

1.1.2 L2 morphosyntactic prediction

Adult L2 learners do not anticipate to the same extent as L1 speakers. Anticipatory difficulties do not seem to stem from inherently different predictive mechanisms in the L1 and the L2, but from general distinctions between native speakers and language learners. Individual differences such as weaker lexical representations in bilinguals than in monolinguals might explain the differences between L1 and L2 prediction (Kaan, 2014). Thus, advanced L2 learners use grammatical gender and number marking to anticipate an upcoming noun (Dussias et al., 2013; Grüter & Rohde, 2013; Hopp, 2013; Marull, 2017), whereas intermediate learners show anticipation in some cases (Hopp, 2016; Lew-Williams & Fernald, 2010) but not always (Marull, 2017). Case marking appears to be more problematic for L2 learners considering that they are not able to use this type of information for prediction despite having advanced L2 (for intermediate and advanced German L2, see Hopp, 2015; for intermediate Japanese L2, see Mitsugi & MacWhinney, 2016).

We begin by summarizing findings related to the use of grammatical gender for L2 prediction. Results in this area have been mixed and one of the reasons that might explain why L2ers do not consistently use gender for prediction is the lack of target-like associations between a specific noun and its gender class features. Hopp (2013) investigated whether adult advanced learners of German used a determiner's gender to anticipate an upcoming noun. The eye-tracking data showed that only those L2 speakers that had target-like production of grammatical gender were able to use this cue for predictive anticipation. These results are in line with production-prediction accounts that propose that language production and comprehension interact (Pickering & Gambi, 2018): people engage in action representations during perception, and in perception representations during action. This dynamic relationship helps the prediction of what people are going to listen to or what they are going to produce (Pickering & Garrod, 2013). In another study, Grüter, Lew-Williams, & Fernald (2012) explored whether advanced and near-native L2 learners of Spanish (L1 English) could exploit the determiner's gender to generate expectations of an upcoming noun. Participants performed a visual world paradigm task in which they could anticipate a noun based on the gender of the article. The task included 8 familiar nouns and 4 novel nouns (pseudo-words that had been previously taught to them). Surprisingly, their data showed that L2 learners were able to predict novel (but not familiar) nouns, whereas the native speakers anticipated both word categories. The authors speculated that L2 learners relied on distributional cues of the more recently created lexical representation, whereas familiar words might have been learned through non-distributional cues. However, novel items were taught right before the eye-tracking experiment, whereas familiar items had not been presented to participants before the experiment. It is possible that recent presentation of novel items could also explain differences between novel and familiar items in the L2 group.

Nevertheless, difficulties in L2 morphosyntactic prediction can be overcome through explicit training. To further examine the role of training, Hopp (2016) investigated whether training of German grammatical gender in intermediate L2 learners (L1 English) could improve predictive processing of nouns. During the pre-test, participants performed an eye-tracking task in which they saw four images while listening to a sentence containing one of the objects. Over the course of a week following the pre-test, participants performed the training phase and returned to the lab to complete the post-test (identical to the pre-test). He found that the intermediate learners started using L2 gender agreement predictively and that there was a correlation between accuracy in gender production and the ability to anticipate. Similarly, Liburd (2014) examined whether beginning English L2 learners of Dutch could use determiners with a similar or different form between English and Dutch, or unique to Dutch, for predicting a noun. After two training sessions, participants completed an eye-tracking task in which they listened to truncated sentences (e.g. *Nicolaas kopt dit* ____, 'Nicholas buys this ____'). Results indicate that learners were more accurate, faster and fixated earlier when the determiner was similar between the two languages. Hence, beginner learners are able to use the morphosyntactic information present on determiners in order to anticipate an upcoming noun, and this ability is facilitated by cross-language similarity.

Importantly, L2 morphosyntactic prediction occurs both with cues that are shared between the L1 and L2, and with cues that are unique to the L2. For instance, Marull (2017) investigated whether intermediate and advanced learners of Spanish (L1 English) could use number marking – a cue shared by their L1 and L2 – from the demonstrative and the definite articles to predict an upcoming noun. Participants completed a picture selection task in which they had to select the picture on the screen that best matched the sentence they heard while their reaction time was recorded. Results indicated that only the advanced learners were able to use the number marking of the articles predictively, suggesting that intermediate learners have not developed the ability to use morphosyntactic cues to generate expectations.

Prediction also takes place with morphosyntactic cues absent in the L1. Trenkic, Mirkovic, & Altmann (2014) investigated how English natives and intermediate Mandarin L2 speakers of English use English definite and indefinite articles predictively, taking into account that Mandarin is an article-lacking language. Participants looked at an image with an agent (person) and four possible referents, and listened to sentences like '*The pirate will put the cube inside the/a can*' while their eye-movements were recorded. Their findings indicate that both natives and L2 speakers were faster deciding the upcoming reference when there was only one compatible referent in the scene for the definite article, and they were faster when there were two compatible referents for the indefinite article. This suggests that L2 speakers, similar to natives, can integrate morphosyntactic information unique to the L2 to make predictions.

In contrast to the research above, other studies have failed to find morphosyntactic anticipation. Case-marking seems to pose more difficulties for L2 speakers, who cannot exploit this morphosyntactic cue predictively. For example, Mitsugi & MacWhinney (2016) examined whether intermediate English L2 speakers of Japanese used case markers in order to anticipate linguistic information. In a visual world paradigm experiment, participants listened to sentences in canonical and scrambled orders in which the theme object could be anticipated based on the case marker. Results indicated that only native speakers of Japanese used case marking in a predictive manner during online processing. This is also the case for L2 learners of German. In a similar study, Hopp (2015) explored whether late L2 learners of German (L1 English) of different proficiency levels (i.e. low-intermediate, high-intermediate, and advanced) used German case marking and verb semantics to make predictions during L2 processing. In an eye-tracking experiment, participants listened to subject or object first sentences containing case marking information that could help them predict the upcoming referent. Findings show that whereas native German speakers integrated case marking to make predictions of object-first structures; L2 groups, regardless of their proficiency, always anticipated the second noun to be the patient (both in SVO and OVS sentence structures). Taken together, these studies show that L2 learners, contrary to natives, are not able to integrate the case marking, preferring the subject-first structure when parsing the sentences. Despite having knowledge of case morphology, the L2 learners were not able to use this information during online processing. Thus, knowledge of a specific grammatical construction is not enough to rapidly access it and generate expectations about upcoming linguistic items.

Other studies reveal L2 learners' inability to use grammatical gender to anticipate an upcoming noun. Lew-Williams & Fernald (2007) found that adult and children Spanish monolinguals use gender (instantiated in the definite articles *el/la*) to anticipate a noun before it has been pronounced. However in a replication study, adult intermediate L2 learners of Spanish (L1 English) anticipate to a lesser extent and only in cases of high frequency nouns that could be memorized as lexical units (Lew-Williams & Fernald, 2010). One possibility is that speakers did not have sufficient proficiency in the L2 (an average of 3.5 on a 5 point scale, self-rated proficiency) to rapidly and incrementally use grammatical information to predict a noun. However, in a similar eye-tracking study, Dussias et al. (2013) found that both Spanish monolinguals and English advanced learners of Spanish could anticipate upcoming nouns based on the article's gender information, being qualitatively the same (they anticipated to the same extent), although quantitatively different (L2 speakers were slower). Interestingly, Italian-Spanish bilinguals only anticipated in the feminine condition, probably because of their relatively low Spanish proficiency.

The studies reviewed above show that L2 learners, unlike natives, do not always rapidly integrate available morphological information (grammatical gender, case marking, and number marking) in order to make predictions. In general, higher L2 proficiency seems to correlate with ability to anticipate. However, this does not seem to apply to the use of case-marking, for which even advanced L2 learners didn't use this information to pre-activate the upcoming referent. Finally, beginner and intermediate learners seem to benefit from training and show improvement in the use of grammatical gender and number marking as cues for prediction. The following table summarizes the results of studies related to L2 prediction based on morphosyntax and we continue reviewing the literature on semantic prediction in native speakers.

Table 1. 1 Summary of studies on L2 morphosyntactic predictive processing

Study	**Cue**	**Info anticipated**	**L2 Proficiency**	**Anticipated: Yes**	**Anticipated: No**
Dussias et al., 2013	Gender	Noun	Advanced	✔	
Grüter et al., 2013	Gender	Noun	Advanced	✔ (only novel nouns)	
Hopp,	Gender	Noun	Advanced	✔	

2013				(only if target-like production)	
Hopp, 2015	Case	Sentence structure (word order)	Low-intermediate High-intermediate Advanced		✔ ✔ ✔
Hopp, 2016	Gender	Noun	Intermediate	✔ (only if target-like production)	
Lew-Williams & Fernald, 2010	Gender	Noun	Intermediate-high	✔ (only with high frequency nouns)	
Liburd, 2014	Determiner	Noun	Beginner	✔ (after training)	
Marull, 2017	Number	Noun	Intermediate Advanced	 ✔	✔
Mitsugi & Mac Whinney, 2016	Case	Sentence structure (word order)	Intermediate		✔
Trenkic et al., 2014	Article	Noun (Reference)	Intermediate	✔	

1.1.3 L1 semantic prediction

Native speakers use contextual information incrementally as soon as it is available to them in order to narrow down the possibilities of upcoming information. Multiple types of cues can consistently trigger semantic prediction among native speakers. Specifically, semantic features and tense in the verb (Altmann & Kamide, 1999, 2007), semantic information of the agent of a sentence (Kamide, Altmann, & Haywood, 2003), as well as contextual information in the sentence and discourse levels (Van Berkum, Brown, Zwitserlood, Kooijman, & Hagoort, 2005; Wicha, Moreno, & Kutas, 2014) can assist a listener in predicting an upcoming noun, and predicted nouns leave a memory trace even when the noun was not presented to the listener (Foucart et al., 2015). Nevertheless, prediction in the native language is subject to variability due to linguistic factors like variability of the article (e.g., an airplane / a big airplane) (Nieuwland et al., 2018) or individual factors like age (Federmeier, McLennan, De Ochoa, & Kutas, 2002).

For instance, Altmann & Kamide (1999) found that native speakers use the semantic features and tense information contained in a verb to predict incoming nouns. In their visual-world experiment, native English speakers listened to sentences like *The boy will move the cake* or *The boy will eat the cake.* They could anticipate the noun 'cake' only when hearing the informative verb 'eat'. In a similar eye-tracking study, native English speakers listened to sentences such as *The man will drink the beer* or *The man has drunk the wine* and directed their looks towards a full glass or an empty glass respectively upon hearing the verb (Altmann & Kamide, 2007). Moreover, native speakers use semantic information about the agent of the sentence in order to anticipate one of two nouns that satisfy the restrictions of verb. Using sentences like *The man will ride the motorbike* or *The girl will ride the carousel*, Kamide, Altmann, & Haywood (2003) found increased eye-movements towards the motorbike after hearing *The man will ride…,* and to the carousel after hearing *The girl will ride*… indicating that both the verb and the information provided by the preceding grammatical subject can guide anticipatory processes.

English speakers use phonological regularities and contextual information to predict upcoming words. DeLong, Urbach, & Kutas (2005) researched whether readers use the sentence context to pre-activate an upcoming noun. They used sentences like *The day was breezy so the boy went outside to fly...* with a highly probable ('a kite') or an unlikely ('an airplane') continuation presented visually one word at a time. The improbable determiner (in this case, 'an') elicited an N400 response and the authors concluded that readers integrated incoming words incrementally by using probabilistic prediction. Hence, readers integrate meaning from words to estimate the likelihood of upcoming words. Nevertheless, these findings have been recently challenged in a replication study with over 300 participants that failed to find an effect (Nieuwland et al., 2018). The lack of stability between the article and the noun ('an airplane' but 'a big airplane') could make prediction based on the indefinite article in English less robust.

Anticipation of upcoming nouns also takes place thanks to discourse cues. Van Berkum et al. (2005) investigated whether discourse context aids anticipation. Native Dutch speakers listened to (ERP tasks) and read (self-paced reading task) stories in Dutch that supported the prediction of a particular noun. Prediction effects were revealed by both ERP waveforms and slower reading times in the prediction-inconsistent trials, showing that native speakers can make predictions during fluent discourse and that predicted words are immediately used during incremental parsing operations. Similar results have also been found in Spanish within a sentence, where the mismatched grammatical gender instantiated in the determiner of an expected noun elicited a posterior late positivity (P600) (Wicha et al., 2014). These findings suggest that semantic context (both at the discourse and sentence levels) interacts with grammatical gender information to generate predictions about incoming words. This seems to be the case even when the expected word is muted. Foucart, Ruiz-Tada, & Costa (2015) conducted a similar ERP experiment with high-constrained Spanish sentences where the expected or unexpected noun was muted. They also provided a lexical recognition task where participants were asked whether a series of nouns had appeared in the listening ERP task. Results revealed that Spanish natives showed effects when the preceding article mismatched the gender of the expected item, indicating that they were predicting a specific noun. Also, expected words were falsely recognized more than unexpected words, suggesting that predictions created a memory trace of the noun prior to its presentation.

Finally, age seems to play a role in the use of contextual information predictively. Federmeier, McLennan, De Ochoa, & Kutas (2002) explored whether older adults could anticipate semantic information to the same extent as younger adults. While recording their brain activity, they exposed participants to sentences with an expected word from the same semantic category, or a semantically unrelated unexpected word. Their results show that older adults, similar to younger adults, are able to use context information to facilitate processing of upcoming information. Only younger adults seem to generate expectations, although older adults with higher verbal fluency and larger vocabularies pattern similarly to younger adults. Their results indicate that larger vocabularies and higher verbal fluency can help to offset aging effects.

The studies presented thus far provide evidence that semantic information from the context at the sentence and discourse levels, as well as semantic features from the verb are immediately used to make predictions about upcoming nouns. These predictions result from the integration of semantic and grammatical information and create a memory trace even if the prediction is never heard. Nonetheless, circumstances like variability of form in an article or individual differences like older age can hinder prediction among native speakers. In the next section, we will review research on semantic prediction among second language learners.

1.1.4 L2 semantic prediction

As in the case of L2 morphosyntactic anticipation, L2 semantic prediction has also yielded inconclusive results. First, Foucart, Martin, Moreno, & Costa (2014) investigated whether French-Spanish late bilinguals, Spanish-Catalan early bilinguals, and a Spanish monolingual group were sensitive to the appearance of an unexpected noun with different gender while reading a highly constrained sentence (e.g. *El pirata tenía el mapa secreto, pero nunca encontró* <u>el tesoro/la gruta</u> *que buscaba*, 'The pirate had the secret map, but he never found <u>the treasure/the cave</u> he was looking for'). The authors found an N400 effect at the determiner onset (e.g. *el* or *la*) in the three groups, which indicated that both early and late bilinguals use anticipation in their L2 in a similar way to monolinguals. They acknowledge that this finding could be due to languages being closely related. L2 learners also make predictions during oral speech recognition and predicted nouns seem to create a memory trace also for them. Foucart, Ruiz-Tada, & Costa (2016) investigated whether advanced French L2 learners of Spanish could predict a noun when listening to sentences, and whether this prediction would also have an impact on memory. Their results showed that prediction also takes place during L2 speech comprehension and support top-down accounts of L2 processing. By contrast, Martin et al. (2013) found that advanced (self-rated proficiency) late L2 learners of English (L1 Spanish) did not show an N400 effect in response to an unexpected article, although they did show an N400 effect on the unexpected noun. The authors argue that the lack of prediction effects in the L2 learner group could be due to L2ers being too slow or because L2 processing relies exclusively on integration mechanisms.

Inherent differences between monolinguals and bilinguals could also be the reason why L2 learners do not always exhibit predictive processing. Dijkgraaf, Hartsuiker, & Duyck (2016) explored this idea by focusing on whether prediction occurs to the same extent in bilinguals' L1 and L2, and whether bilinguals' use of prediction is equivalent to that of natives. Advanced adult learners of English (L1 Dutch) and English monolinguals saw a display with four possible stimuli (only one of them could be read) while listening to constraining (e.g. 'Mary reads a letter') or neutral (e.g. 'Mary steals a letter') sentences. Bilinguals were presented with one list in their L1 and another list in their L2, while monolinguals saw both of the English lists. The results revealed that bilinguals made predictions in their L1 and L2, but were slightly slower in both their L1 and L2 than the monolinguals. These findings support the weaker links hypothesis, which states that because bilinguals' time is divided between exposure to each of their languages, the links between lexical items and their phonological representations are weaker (Gollan, Montoya, Cera, & Sandoval, 2009).

The studies reviewed in this section show that L2 learners of closely related languages can use contextual meaning to make predictions of a noun both while reading and listening to sentences. As is the case with monolinguals, L2 predictions leave a memory imprint even when the prediction does not appear in the input. Semantic L2 prediction, similar to morphosyntactic L2 prediction, shows variability, and in some studies L2 learners cannot anticipate an upcoming noun. Finally, research comparing prediction in both the L1 and L2 of bilingual speakers suggests that bilinguals are slightly slower in both languages when making predictions, supporting the notion that phonological representation in the bilingual mind is weaker than among monolinguals. Findings reviewed thus far analyze how relationships between words trigger anticipation. The next section delves into the use of prosodic cues to make predictions within a word among monolingual speakers.

Table 1. 2 Summary of studies on L2 semantic predictive processing

Study	**Cue**	**Info anticipated**	**L2 Proficiency**	**Anticipated: Yes**	**Anticipated: No**
Dijkgraaf et al. 2016	Informative verb	Noun	Advanced	✔	
Foucart et al., 2014	Gender/context	Noun	Advanced	✔	
Foucart et al., 2016	Gender/context	Noun	Advanced	✔	
Martin et al., 2013	Context/article (a/an)	Noun	Advanced		✔

1.2 Prediction within words

1.2.1 L1 phonological prediction

We have so far provided a review on how morphological and semantic cues guide prediction during L1 and L2 processing. Besides these cues, phonology is also crucial for prediction during spoken word recognition. There are three prosodic cues that have been studied in L1 anticipatory processing: vowel duration, word tones, lexical stress, and syllabic structure. Previous research has established that vowel duration can help pre-activate verbal morphology in English, lexical stress and syllabic structure preactivate upcoming verbal suffixes in Spanish, and word tones predict tense and number morphology in Swedish verbs and nouns.

First, for vowel duration, Stromswold, Eisenband, Norland, & Ratzan, (2002) researched how native English speakers used vowel duration to disambiguate passive and active sentences. In their eye-tracking experiment, participants listened to a passive or active sentence while seeing two images on the screen and could use vowel duration on the verb to anticipate the agent of the sentence. The findings revealed that English natives used vowel duration to differentiate between active sentences (shorter vowel: e.g., shorter *u* in ‘pushing’ in ‘the girl was pushing the boy’) and passive sentences (longer vowel: e.g., longer *u* in ‘pushing’ in ‘the girl was pushed by the boy’).

Second, for word tones, Roll and colleagues have extensively examined how Central Swedish speakers use word-tones in the first syllable of nouns and verbs to predict the suffix. Roll, Horne, & Lindgren (2010) investigated whether Swedish word accents (low tone and high tone) could be used to anticipate suffixes (singular or plural) related to them. They found a P600 effect indicating that Swedish natives were sensitive to incorrect accent-suffix associations. Importantly, in a similar study Söderström, Horne, & Roll (2015) found that low tones generated stronger predictions because they are connected to a smaller pool of lexical items. These findings were replicated with the South Swedish variety, which has a mirror image of the word accents of Central Swedish, demonstrating that the electrophysiological response was not due to the difference in acoustic features, but due to the mental association between the accent and the suffix (Roll, 2015). Interestingly, the association between word tones and suffixes is independent of lexical content. Söderström, Horne, & Roll (2017) investigated whether grammatical suffixes could be activated on the bases of tone alone by using pseudowords. Their results show that both low and high tones preactivate grammatical suffixes and that suffixes linked to low tone are easier to predict.

Third, for lexical stress and syllabic structure, Sagarra & Casillas (2018) investigated whether Spanish monolinguals used stress and syllabic structure in verbs to predict their suffix. In their eye-tracking task, participants saw two words on the screen while listening to a sentence and could use the stress (stressed: *LAva*, '(s)he washes'; unstressed: *laVÓ*, '(s)he washed') and the syllabic structure (CV: *lava*; CVC: *firma* '(s)he signs') in the initial syllable to predict whether the verb was past or present tense. The results showed that Spanish monolinguals used both stress types to anticipate suffixes, and that they predicted better with initial CVC than with CV syllables because CVC syllables are associated with fewer lexical competitors.

The studies reviewed in this section furnish evidence that monolinguals rapidly integrate prosodic information to generate expectations about upcoming morphological and syntactic information. Specifically, word tones allow speakers to predict nominal and verbal morphology in Swedish, vowel duration to predict verbal morphology in English, and lexical stress and syllabic structure to predict verbal morphology in Spanish. The next section examines how prosodic cues aid prediction in L2 processing.

1.2.2 L2 phonological prediction

In contrast with the L1 findings discussed in the previous section, research on L2 learners are scant and inconclusive. Some studies show that advanced L2 learners have implicitly learned to use word tones for anticipation (Schremm, Söderström, Horne, & Roll, 2016) and that beginners can be explicitly trained to use this cue (Schremm, Hed, Horne, & Roll, 2017). Other studies show that L2 learners cannot exploit vowel duration predictively (Rehrig, 2017) and that beginner L2 learners cannot use word tones in a predictive manner as natives do (Gosselke Berthelsen, Horne, Brännström, Shtyrov, & Roll, 2018).

First, for vowel duration, Rehrig (2017) compared how Mandarin L2 learners of English used vowel duration to predict verbal suffixes related to voice (active/passive). In an eye-tracking experiment, participants listened to active or passive sentences that could be predicted before listening to the verbal morphology based on the duration of the stem vowel. Her results indicate that the advanced L2 learners could not anticipate the morphological ending based on the duration of the stem vowel of the verb and had to wait until hearing the suffix in order to decide whether the sentence was passive or active. The author hypothesizes that this is due to the absence of the cue (i.e., vowel duration) in their L1. However, previous studies show that L2 learners can acquire prosodic distinctions like vowel duration absent in their L1 (Chládková, Escudero, & Lipski, 2013). Insufficient L2 proficiency or L2 development (active sentences are acquired earlier than passives) could explain why these L2 learners of English could not make predictions. Researching L2 learners of English whose L1 includes vowel duration and could transfer the predictive use of this cue, would contribute to elucidating the reason why L2ers in Rehrig's experiment were unable to make predictions.

Second, for tones, Gosselke Berthelsen, Horne, Brännström, Shtyrov, & Roll (2018) investigated whether German L2 learners of Swedish and Swedish native speakers used word tones instantiated in the verb stem to predict suffixes. Participants' brain activity was recorded while listening to sentences in which a high tone in the target noun could be used to predict plural morphology and a low tone predicted singular morphology. Their findings revealed that the beginning learners did not use tones to predict word endings, but there was a mid-distributed negativity similar to that produced by pure pitch differences. The authors interpreted this negativity as a preliminary stage leading towards the use of tones for prediction. However, their data cannot specifically explain whether the L2 learners distinguish the Swedish intonation patterns as something different from their L1 intonation patterns, or whether they processed it as pure pitch tones without being linked to an intonation pattern. These results indicate that before using word tones in a predictive manner, L2 learners must dissociate the word tones from the default L1 tonal patterns (pitched accented dialects of German), as well as become sensitive to pitch height differences.

One way to explain why beginning L2 learners cannot use tones predictively is the lack of tone in their L1. To test the role of L1 transfer, Gosselke Berthelsen et al. (2020) examined the acquisition of novel words with grammatical tone. Participants with a tonal (L1 Swedish) and non-tonal (L1 German) background learned words of an artificial language in which a tone contour indicated grammatical meaning, specifically, number or gender. Results revealed that, while behaviorally both groups were alike, only the tonal L1 group showed effects signaling early (ELAN) as well as late neural processes (LAN, P600), while the non-tonal L1 group relied on the late processing components (LAN, P600) to access meaning. These findings suggest that L1 transfers plays an important role even during the initial states of second language acquisition.

Another way to explain why beginning L2ers cannot use tones predictively could be lack of L2 proficiency. Related to this possibility, Schremm, Söderström, Horne, & Roll (2016) investigated whether intermediate L2 learners of Swedish (with non-tonal L1 backgrounds) can use word tones predictively. In a response time experiment, participants listened to sentences containing a verb with a high or low tone initial syllable and had to predict the verb´s suffix (high tone is associated with past tense, low tone is associated with present tense). Results showed that invalidly cued suffixes, as opposed to validly cued suffixes, increased reaction time. This suggests that, despite the lack of explicit training on this tone-suffix association, the intermediate L2 learners used tones to predict verbal morphology and used them in a similar manner to native speakers.

Nevertheless, natives had a larger processing advantage relative to L2ers in target verbs with validly cued suffixes. Importantly, L2 learners with increased exposure to Swedish behaved more native-like. These findings contradict Rehrig's (2017) notion that the lack of a specific cue in the L1 is the reason why L2 learners cannot use the cue in their L2, and strongly suggest that the reason for the negative results could have been a lower English proficiency of the L2 learners.

Beginners' inability to use tones to predict word suffixes can be compensated through training. Schremm, Hed, Horne, & Roll (2017) researched whether strengthening the tone-suffix associations via a videogame would enhance prediction among beginning learners of non-tonal L1s. Results showed an improvement both in accuracy and reaction time when predicting the correct suffix. More time spent on the game yielded greater accuracy gains. Importantly, participants' production of the tones also improved after the two weeks of training.

Third, we discuss lexical stress as a predictive cue. Sagarra & Casillas (2018) investigated how intermediate and advanced English learners of Spanish used the stress (unstressed or stressed) of a verb's initial syllable to predict its suffix (see details about this study on section 'L1 prediction with prosodic cues'). Results showed that the beginning learners did not use stress to predict verb suffixes, but that the advanced learners used stress to predict verb suffixes similarly to Spanish monolinguals (with the exception of CV syllabic structure because of the increased number of lexical competitors). This study shows that adult learners can acquire predictive processing patterns in a qualitatively similar way to monolinguals, but quantitatively different, and that proficiency is a key factor modulating L2 prediction.

To sum up, adult L2 learners' use of prosodic cues to predict word endings depends on L1 transfer and L2 proficiency. In relation to L1 transfer, presence of a prosodic cue in the L1 facilitates the predictive use of such a cue in the L2, whereas its absence hinders prediction. As for L2 proficiency, beginners can only use L2 acoustic cues present in their L1 to predict L2 word endings, but advanced learners can use L2 acoustic cues absent in their L1 to predict word endings. A number of questions still remain unanswered. We have seen that proficiency and L1 transfer are important factors for L2 prediction, but other factors modulating L2 prediction are unclear. Also, evidence shows that L1 and L2 speakers use prosodic cues to predict word suffixes, but it is unclear whether the same applies to non-morphological word endings. To answer the first question, Study 1 investigates the role of increased anticipatory experience via interpreting on L2 prediction. In relation to the second question, Study 2 investigates whether monolinguals and L2 learners with and without interpreting experience use lexical stress to predict non-morphological word endings. The next section will discuss the relevance of prediction during simultaneous interpreting.

Table 1. 3 Summary of studies on L2 prosodic predictive processing

Study	**Cue**	**Info anticipated**	**L2 Proficiency**	**Anticipated: Yes**	**Anticipated: No**
Rehrig, 2017	Vowel duration	Verbal morphology	Intermediate-advanced		✔
Schremm et al. 2016	Word tones	Suffixes	Advanced	✔	
Gosselke	Word tones	Suffixes	Beginners		✔

Berthelsen et al. 2018					
Gosselke-Berthelsen et al. 2019	Word tones	Suffixes	Beginners	✔	
Sagarra & Casillas, 2018	Lexical stress	Verbal morphology	Beginners		✔
			Advanced	✔	
Schremm et al., 2017	Word tones	Suffixes	Beginners	✔ (improved with training)	

1.3 Prediction and processing in interpreters

Psychologists have shown special interest for simultaneous interpreting because of its complexity (Gile, 2015). Sustained interpreting experience drives neurocognitive changes that could inform models of bilingual processing and control (García, Muñoz, & Kogan, 2019a). According to the effort model, interpreting entails listening, analysis, production, and memory efforts (Gile, 2009). This complex task taps into different cognitive processes: retaining information from the source language in working memory, accessing meaning, connecting to previous information, translating into the target language, and eventually producing the message in the target language (Bajo, Padilla, & Padilla, 2000).

Numerous studies suggest that interpreters have superior linguistic and cognitive skills (for a review, see Dong & Cai, 2015). For example, Bajo et al. (2000) conducted a study in which they compare performance of tasks measuring semantic and lexical access, reading speed and comprehension of four different groups: professional interpreters, bilinguals without interpreting experience, interpreting students (at the beginning of their training) and students from other fields. The interpreter group had faster and more accurate reading abilities, faster access to lexical and semantic information, larger and more efficient WM, and more resistance to articulatory suppression. Moreover, student interpreters and the comparison group of students performed the tasks again at the end of the academic year. Only the interpreting students showed significant improvements, indicating that they were not due to practice effects, but to the interpreting training. These findings indicate that interpreting training and practice enhance cognitive skills involved in comprehension, namely faster and more accurate reading skills, faster access to lexical and semantic information, larger working memory capacity and more efficient use of this capacity (as shown in better performance under the articulatory suppression task).

In addition to enhanced cognitive skills, interpreters also show superior language processing and, in particular, they are better than non-interpreter bilinguals when disambiguating sentences and detecting errors. Togato, Paredes, Macizo, & Bajo (2015) investigated language activation during an interpreting task and a regular comprehension task. Participants read ambiguous sentences in Spanish and repeated them in Spanish or translated them into English. The results revealed that the interpreters used the parsing strategy preferred by Hispanophones when repeating the sentences in Spanish, and the parsing strategy preferred by Anglophones when translating them into English. Finally, Yudes, Macizo, Morales, & Bajo (2013) explored error detection in monolinguals and bilinguals (interpreters and non-interpreters) and concluded that interpreters were able to detect more syntactic and semantic errors in a text in their L2 than non-interpreter bilinguals and even than L1 speakers. This study supports the idea that interpreting skills generalize to simple comprehension tasks because they modify the way in which one analyzes a text (Padilla, Bajo, & Padilla, 1999). Taken together, interpreting practice enhances processing of syntactic structures according to context and increases error detection in the L2.

Prediction within the frame of simultaneous interpreting is the production of a speech segment by the interpreter before the speaker has uttered that specific segment and it is one of the strategies taught in simultaneous interpreting courses (Li, 2015; for a review Kurz & Färber, 2003). Performing simultaneous interpreting requires concurrent comprehension and production in two different languages. This complicated process can lead to cognitive overload and the longer the constituent that needs to be interpreted, the more demanding it becomes. One technique to ease the interpretation of more complex sections is predicting what the next segment will be, which allows the interpreter to release processing capacity (Kurz & Färber, 2003; Seeber & Kerzel, 2011).

Previous literature on prediction in interpreters has mainly focused on prediction between words and between language pairs with asymmetrical syntax (e.g., English and German), where the distinct syntactic structures (SVO/SOV) pose a difficulty for the interpreter. When exploring these language pairs, corpus studies show that anticipation is a common phenomenon occurring every 85 seconds (for German-French, Van Besien, 1999), used in 60% of the cases where there is syntactic asymmetry, and interpreters' predictions are successful in the vast majority of cases (for German-Greek, Liontou, 2012). Furthermore, anticipation correlates with interpreting quality. Kurz & Färber

(2003) investigated the relationship between anticipation and interpreting quality and they concluded that prediction correlates negatively with errors (the more an interpreter anticipates, the fewer errors they make), but correlates positively with completeness (the more anticipation, the more complete the interpretation). It is important to notice that these studies only measure prediction in the production of the interpretation when there is an asymmetry in syntactic structure between source and target languages, and not during perception (as it is the focus of the present dissertation).

Prior research on interpreting prediction demonstrates the existence and pervasiveness of this mechanism. Interpreting models claim that anticipation is possible due to contextual knowledge, both in terms of the speech being interpreted and general knowledge of the topic, as well as syntactic knowledge (Moser-Mercer, 1978). However, a number of questions remain unanswered, namely: what additional cues trigger prediction, which constituents can be anticipated (beside verbs), and how does interpreting boost the ability to anticipate. In order to answer these questions, the present dissertation investigates whether different groups of speakers (monolinguals, non-interpreter bilinguals and interpreters) can anticipate verbal morphology and noun-endings based on lexical stress in Spanish, and whether WM affects prediction. In the next section, we will review previous literature on the link between WM, prediction and interpreting.

1.4 Working memory

1.4.1 Working memory and linguistic prediction

We start by describing WM and continue summarizing studies on its role during prediction in monolingual processing. According to Baddeley (2007, 2003), WM is the executive function component dedicated to storing and processing information at the same time, it is limited, and it changes from person to person. Some models propose that WM is domain-specific and WM capacity constrains L2 learning. Within this category, single resource models theorize that processing and storage draw from the same resource pool and there is a trade-off between them (Just & Carpenter, 1992). Multiple-resource models defend that storage and processing function independently (Baddeley, 2003, 2007). By contrast, domain-general models do not differentiate between storage and processing, arguing that WM is the active part of long-term memory as opposed to a series of cognitive processes (Cowan, 1998). Focusing on the relationship of WM and language, WM is one of the factors modulating L2 processing. Both cross-sectional and longitudinal studies show that WM influences L2 grammar and reading abilities, and L2 processing of syntax and morphosyntax. Moreover, task demands and L2 proficiency interact with WM during L2 processing (see Sagarra, 2000; for a review).

Because of the relevance of WM during language processing, some research has focused on how WM also modulates L1 predictive processing. Huettig & Janse (2016) investigated how WM and processing speed influence language prediction. Dutch native speakers performed a battery of WM tests: non-word-repetition task, backward digit-span, spatial working memory, and processing speed with two different tasks: digit symbol substitution (timed paper and pencil test), and the letter comparison test. They also performed an eye-tracking study where they listened to sentences like '*Kijk naar de$_{COM}$ afgebeelde piano$_{COM}$*' ('Look at the displayed piano') while viewing four objects and predicted the noun based on the determiner's gender. Results showed that both WM (verbal and spatial) and processing speed mediated participants' ability to anticipate the noun. This supports the idea that WM is the link between long-term visual and linguistic representations and their specific locations.

In contrast, other studies have not found a connection between WM and ability to predict upcoming linguistic information. Otten and Van Berkum (2009) investigated whether prediction ability depends on WM. Dutch natives performed a reading-span task and a reading ERP experiment in which they could anticipate a noun based on the gender of the article. Results show that low and high WM groups were able to predict the noun, suggesting that prediction is not restricted to those with high WM. However, the low WM group showed an additional later signal, indicating differences in dealing with information inconsistent with their predictions is different from the high WM group. A noticeable difference between the sentences in this experiment and those of Huettig and Janse (2016), besides the technique (eye-tracking vs. EEG), resides in the amount of information and time elapsed between the determiner and the noun. Otten and Van Berkum (2009) used sentences like *Ze pakte **het** verfinjde maar toch opvallende **collier** dat haar stylist had uitgezocht* (She picked up the$_{neut}$ delicate yet striking collar$_{neut}$ that had been selected by her stylist), including more adjectives and, thus, allowing more time for participants to generate expectations. It could be possible that allowing less time between the cue and the information anticipated would translate into differences between low and high WM speakers.

Research on the role of WM during L2 prediction is also scant and inconclusive. Ito (2016) investigated whether L1 and L2 prediction was affected by an increased cognitive load. L1 and L2 speakers of English performed an eye-tracking task in which they listened to sentences while seeing four objects on the screen and could predict an upcoming object based on the semantic features of the verb. Participants were randomly assigned to load or no-load condition. In the load condition, participants were shown five words before hearing the predictive sentence and they were asked to list the initial words in any order. Results indicate that predictive looks towards the target were significantly reduced when listening under a higher cognitive load (asking participants to remember words while listening). The author suggested that when cognitive resources available are decreased, prediction of upcoming information is not possible, indicating that prediction and WM share cognitive resources. Nevertheless, this study does not include any tests measuring WM.

Other studies looking into the role of WM during L2 prediction have failed to find a correlation between WM and prediction. Sagarra & Casillas (2018) investigated whether WM influenced Spanish monolinguals and L2 learners of Spanish ability to exploit stress to predict verb suffixes. Participants performed both a visual-world eye-tracking task (online processing) and a gating task (offline processing), together with a WM task. They did not find any correlation between prediction in the eye-tracking task and WM and the gating task only yielded a marginal effect of WM, such that greater WM capacity was associated with higher accuracy scores. Similarly, Perdomo & Kaan (2019) used a visual world paradigm to investigate the use of contrastive intonational cues to restrict a set of upcoming referents in L1 and L2 speakers of English, and whether proficiency and WM affected anticipatory skills. Their results indicated that neither WM nor proficiency were correlated with prediction measures among L2 learners.

The few studies that have investigated WM during L2 prediction have yielded mixed results, with one study showing indirect evidence of WM mediating L2 prediction (Ito, 2016) and other studies not finding WM effects on prediction based on prosodic cues (Perdomo & Kaan, 2019; Sagarra & Casillas, 2018). The present dissertation continues exploring whether WM is a mediating factor in L1 and L2 prediction. Specifically, Study 3 investigates the role of WM during the use of prosodic cues to anticipate morphological information in monolinguals and different groups of L2 leaners, namely interpreters and non-interpreters. These findings inform cognitive models by revealing whether language prediction relies on domain general cognitive skills.

1.4.2 Working memory in interpreters

To our knowledge, there is no research on the role of WM and prediction in interpreters. However, many studies have focused on the impact of interpreting experience on WM capacity. Some scholars claim an ‘interpreter advantage’ reflected in superior cognitive skills during non-interpreting tasks (García, 2014). In particular, WM is thought to be one of the key cognitive processes allowing interpreting and a plethora of studies has explored the effects of interpreting experience and training on WM capacity. Results so far have been mixed, probably due to the differences across studies in interpreters' experience, age, L2 proficiency and WM tasks (for reviews, see Dong & Cai, 2015; Signorelli, Haarmann, & Obler, 2011). Some articles have found that the extended practice of interpreting enhances the phonological-loop function when compared to non-interpreters. Padilla, Bajo, Cañas, & Padilla (1995) showed that professional interpreters had higher WM (phrase span) than non-interpreters and student interpreters, signaling that extended interpreting practice can enhance WM. When looking at different WM measures, Christoffels, de Groot, & Kroll (2006) found that interpreters were significantly better than interpreter students in both the reading span, word span and speaking span. As far as the effects of age, Signorelli, Haarmann & Obler (2011) found that interpreters were significantly better than non-interpreters in a reading span test regardless of age (both younger and older groups). A longitudinal study examined whether these advantages were inherit characteristics of interpreting students, or whether they develop with interpreting training (Babcock, Capizzi, Arbula, & Vallesi, 2017). The authors concluded that interpreting, but not non-interpreting, students improved their verbal short-term memory, indicating that simultaneous interpreting training enhances cognitive measures.

Other studies have found parity between interpreters and non-interpreter groups in WM tasks, or benefits limited to certain components of WM. Stavrakaki, Megari, Kosmidis, Apostolidou, & Takou (2012) explored how professional interpreting experience impacts verbal WM and semantic and phonological processing. They concluded that, even though interpreting seems to enhance the phonological loop function, their central executive functioning is equal to a control group of foreign-language teachers. In another article focusing on interpreters' WM, Köpke & Nespoulous (2006) gave a series of tasks to interpreters, novice interpreters, non-interpreter bilinguals and monolinguals: free recall with and without articulatory suppression, a category and rhyme probe task, listening span, digit span, word span, and Stroop test in both the L1 and L2. The authors found that interpreters performed better under the articulatory suppression condition, indicating greater resistance to phonological interference. However, for most of the tasks, there were either no significant differences between groups, or the novice interpreters showed an advantage. The broad and diverse age ranges of each group is a clear limitation of this study (interpreters 29-61 years old, novice interpreters 23-38, bilingual controls 27-63, and monolinguals 18-26). These age differences could account for the better performance of the students. Remarkably, despite the older age of the interpreters and bilingual controls, they did not show impoverished performance in most of the tasks. Finally, Liu, Schallert, & Carroll (2004) also found that interpreters' listening-span was similar to advanced and beginning interpreting students. The age of the participants in this study was not reported, and the mix of late and early bilinguals introduced another confounded variable.

Collectively, cross-sectional and longitudinal studies show that interpreting experience increases WM capacity, and divergent findings are likely due to inadequate control of interpreters' professional experience, age, L2 proficiency and mixed WM tasks (Dong & Cai, 2015). The present study will make a contribution to this body of research by investigating whether differences in interpreters' WM also influence how WM interacts with prediction of verb suffixes based on prosodic cues. We continue by explaining how lexical stress and syllabic structure behave in both English and Spanish.

1.5 Linguistic phenomena

As mentioned earlier, research has shown that different prosodic cues can guide anticipation and the syntactic or morphosyntactic analysis of a sentence. This dissertation explores the role of lexical stress and syllabic structure in the preactivation of upcoming linguistic information. Specifically, Studies 1-3 focus on how paroxytone (*LAva*, '(s)he washes') and oxytone (*laVÓ,* '(s)he washed') words, as well as CV (*lava*) and CVC (*firma*, '(s)he signs') initial syllabic structure guide the prediction of verbal suffixes and noun word-endings in Spanish. The following sections discuss previous studies related to lexical stress and syllabic structure.

1.5.1 Lexical stress

Lexical stress refers to the relative prominence of a syllable in relation to the rest of the syllables in a word. The acoustic correlates associated with stress are tone (F0, Hz), duration (ms), and intensity (dB) (see Gordon & Roettger, 2017; for a review). Both English and Spanish use this prosodic cue in a phonologically contrastive way: changes in stress can result in different meanings (e.g. *PApa/paPÁ*, 'potato/dad'; 'CONtent/contENT') (Hualde, 2013). However, according to some, English is a stress-timed language (interval between two stressed syllables is the same), whereas Spanish is a syllable-timed language (duration of every syllable is the same). This means that while vowels in Spanish are affected by stress, English vowels undergo a greater reduction (usually to [ə]) when they are unstressed. Therefore, English speakers tend to rely on vowel reduction cues in order to identify stress (Cooper, Cutler, & Wales, 2002; Cutler, 1986) and Spanish speakers rely on F0, intensity and duration.

The aforementioned differences might be key in explaining why English natives have difficulties both perceiving (Face, 2006; Ortega-Llebaria, Gu, & Fan, 2013) and producing (Lord, 2007) lexical stress in Spanish. Besides differences in cue weighting between Spanish and English, other perceptive processing differences have been found and research shows that English and Spanish natives use lexical stress differently for lexical access. Soto-faraco, Sebastián-Gallés, & Cutler (2001) looked at the role of suprasegmental and segmental information in the activation of spoken words. Participants listened to sentences ending with a word fragment that could match two Spanish words, only differentiated by its lexical stress (e.g. *prinCI-*, for the target '*principio'*, 'beginning'; or *PRINci*-, for the target '*príncipe'*, 'prince'). After hearing the sentence, the target word appeared and participants had to decide whether it was a word or not. Results indicate that matching conditions (e.g. *PRINci*- for the target '*príncipe'*) facilitated lexical access to the word, whereas mismatching conditions (e.g. *prinCI*- for the target '*príncipe'*) inhibited their access by slowing down their reaction time. They conclude that in Spanish, both suprasegmental and segmental information contribute equally to the activation of word forms.

Similarly, Cooper et al. (2002) were interested in whether English native speakers underwent the same effects. They followed the same experimental design with English words (e.g. ADmi-, for the target word 'admiral; adMi-, for the target word 'administration'). The authors also found a facilitation effect for the matched conditions when comparing them to control conditions. However, the mismatched condition did not inhibit lexical access and participants did not show a slower reaction time. They conclude that even though English natives can use suprasegmental information for lexical access (as shown by smaller reaction times in the matched condition), segmental information plays a stronger role in lexical activation.

Thus far, we have explored the differences and similarities of lexical stress in English and Spanish. Both languages use stress in a phonologically contrastive manner, although the acoustic cues used to determine stress patterns and the importance of stress for lexical access varies between the two languages. The three studies contained in the present dissertation explored the role of lexical stress in the anticipation of morphological and semantic information in Spanish. Results will shed light on whether English proficient late L2 learners of Spanish can readjust the way in which they process lexical stress in a rapid manner that allows prediction at the word level.

1.5.2 Syllabic structure

The present dissertation includes syllabic structure as a variable relevant for prediction and, in particular, the presence or absence of a coda in the first syllable. English and Spanish allow syllables to remain codaless, with an open sequence of onset + vocoid (Hyman, 1975; Jakobson, 1968). This tendency seems to spread across all languages, such that even though some languages allow codas, codas are never required. Thus, English and Spanish have a general preference for CV syllables, making CVC syllables more salient. Perception studies have compared phonologically similar words with matching onsets or codas. Words with matching codas trigger stronger activation, confirming the notion that codas are more salient in English (Hahn & Bailey, 2005). Similarly, when investigating activation of competitors sharing an onset, a coda or phonologically unrelated lexical competitors, onset competitors reached the highest overall activation but faded quickly. However, coda competitors' activation was more lasting and exceeded that of onset competitors (Allopenna, Magnuson, & Tanenhaus, 1998). Similarly, syllable priming studies find longer priming effects with CVC-primes than with CV-primes (see Cholin, Levelt, & Schiller, 2006, for a review). Listeners use the information contained in the first syllable of a word to reduce the number of competitors. For this reason, adding information in the form of a coda reduces possible competitors for lexical activation (Cholin et al., 2006).

In line with the aforementioned priming studies, CVC syllables facilitate L1 and L2 predictive processing. Sagarra & Casillas (2018) found that L2 leaners of Spanish were able to anticipate verb suffixes when the initial syllable of the verb contained a coda (CVC). Hence, additional acoustic information accelerated processing. Similarly, Roll et al. (2017) found that brain activity denoting predictive processing (pre-activation negativity effect, PrAN) increases as the number of possible completions of word onsets decreases and lexical frequency of the completions increases. The evidence reviewed here suggests that CVC syllables are more salient and trigger more long-lasting activation, facilitating lexical activation and prediction. In this project, we investigate syllabic structure in the prediction of both morphological and non-morphological word endings.

1.6 The current dissertation

A much-debated question among scholars is whether L2 learners can acquire anticipatory processes in their L2. Most studies examine how learners use morphological and contextual cues to predict upcoming words. Studies investigating the association between prosodic cues and anticipation of a word's ending have arrived at different conclusions. Some studies suggest that L2 learners cannot make linguistic predictions. Rehrig (2017) found that advanced L2 learners cannot anticipate morphology based on English vowel duration presumably because this specific cue is absent in their L1 (Mandarin), although other factors like insufficient L2 proficiency and development could also explain L2ers' inability to predict. Along the same lines, Gosselke Berthelsen et al. (2018) found that beginner learners of Swedish did not pre-activate morphological suffixes based on the verb stem tones, but the reason precluding prediction remained unclear. Contrary to these findings, other studies defend that L2 prediction is possible. Schremm, Söderström, Horne, & Roll (2016) showed that intermediate L2 learners were able to use Swedish tones to anticipate morphology even when their L1s did not use tones. Similarly, Sagarra & Casillas (2018) found that advanced learners of Spanish, but not beginning, used lexical stress and syllabic structure to anticipate verbal morphology, except when lexical competitors were increased (CV condition). Collectively, these studies show that proficiency and L1 transfer are important factors determining ability to predict in the L2. However, it is still unclear how anticipatory experience impacts L2 prediction ability.

This dissertation furthers this line of research by investigating the role of additional anticipatory experience via interpreting on L2 prediction. I explore how intensive practice of interpreting, sometimes referred to as ‘extreme bilingualism’, impacts L2 anticipation. Considering all previous evidence, it is clear that anticipation is an important strategy used during simultaneous interpreting. Most research has focused on semantic prediction in structures with asymmetrical syntax in each language, although there is also evidence that anticipation is not restricted to certain language pairs (Zanetti, 1999). To date, little is known about what triggers anticipation during simultaneous interpreting and whether this practice results in enhanced prediction during non-interpreting tasks. Thus, I focus on the use of lexical stress and syllabic structure for prediction of morphological and non-morphological word endings. These findings will shed light on the mechanisms that train anticipatory abilities during L2 processing.

Prosodic cues can guide morphological and syntactic processing in both native speakers (Nakamura et al., 2012; Rehrig, 2017; Roll, Söderström, & Horne, 2013; Roncaglia-Denissen, Schmidt-Kassow, Heine, & Kotz, 2015) and L2 learners (Schremm et al., 2017, 2016); but see (Gosselke Berthelsen et al., 2018; Rehrig, 2017). In the case of semantics, research shows that context cues aid in the pre-activation of upcoming words in natives (DeLong et al., 2005; Martin et al., 2013; Van Berkum et al., 2005) and non-natives (Foucart et al., 2014; Foucart, Ruiz-Tada, & Costa, 2016). However, it remains unknown whether prosodic information can also guide the anticipation of semantic information. This project addresses this gap in the literature by comparing the use of the same prosodic cue (i.e., lexical stress) for the prediction of both morphology and semantics (non-morphological word-endings).

This project includes three studies: Study 1 investigates whether anticipatory experience gained through interpreting facilitates L2 prediction; Study 2 investigates the role of lexical stress and syllabic structure in the anticipation of semantic information (non-morphological word ending) and the role of additional anticipatory experience; Study 3 investigates the role of WM during prediction of morphological endings. Next, we detail research questions and hypotheses.

R.Q. 1 Do Spanish monolinguals, non-interpreter bilinguals and interpreters use lexical stress and syllabic structure to anticipate morphology? Does anticipatory experience facilitate this type of prediction?

Lexical stress is a suprasegmental cue present both in English and Spanish, even though it is processed differently in each language (Cooper, Cutler, & Wales, 2002; Soto-faraco, Sebastián-Gallés, & Cutler, 2001). Based on previous research showing that monolinguals use prosody to anticipate morphology (Nakamura et al., 2012; Rehrig, 2017; Sagarra & Casillas, 2018; Söderström et al., 2015), I hypothesize that monolinguals in Study 1 will use lexical stress to predict verbal morphology. Further, because advanced L2 learners also use prosody to predict morphological endings (Schremm et al., 2016), I expect that both learner groups (interpreters and non-interpreters) will be able to make predictions of verbal suffixes, although not to the same extent as monolinguals. This is because L2 prediction is constrained by other limitations such as slower lexical access (Kaan, 2014). Moreover, I anticipate finding differences between the non-interpreter and the interpreter groups, with the latter showing stronger anticipatory patterns. These findings would show that extensive practice making predictions under highly demanding circumstances and having to constantly monitor switching between both languages helps to overcome the constraints that usually apply to L2 speakers (e.g. slower lexical access). Finally, based on studies showing that cues associated with less words trigger stronger prediction (Roll et al., 2017; Sagarra & Casillas, 2018), I expect that the CVC condition will trigger stronger prediction for all groups.

R.Q. 2 Do Spanish monolinguals, non-interpreter bilinguals and interpreters use lexical stress and syllabic structure to anticipate non-morphological word endings? Does anticipatory experience facilitate this type of prediction?

Research shows that different prosodic cues (i.e., word tones, vowel duration and lexical stress) trigger prediction of morphological endings (Lozano-Argüelles, Sagarra, & Casillas (Study 1), 2019; Rehrig, 2017; Roll, 2015; Sagarra & Casillas, 2018). However, it is unclear whether prediction based on prosody also applies to prediction of non-morphological word endings or it is exclusive to morphological endings. I expect that monolinguals will show prediction of word endings based on lexical stress and syllabic structure, although at a lower rate than in previous studies (Sagarra & Casillas, 2018), due to semantic unrelatedness of word pairs displayed to the participants (e.g., *papa-papá*, ‘potato-dad’). Semantically unrelated words may activate a broader network of semantic neighbors than semantically related word pairs. Also, words that are related only at the phonological level (as opposed to both phonological and semantic levels) might be harder to process and yield weaker prediction. In particular, monolinguals will not make predictions under the CV paroxytone conditions because this condition is connected to a larger pool of lexical competitors, which has been shown to diminish prediction (Lozano-Argüelles et al, 2019; Roll et al., 2015; Sagarra & Casillas, 2018). In the case of interpreters and non-interpreters, I expect that they will have more difficulties making predictions partly because of the activation of an even broader set of words in their two languages. Thus, they will only be able to make predictions in the CVC-oxytone condition, linked to fewer possible competitors. Nonetheless, interpreters' greater experience making predictions will accelerate their prediction rate. Findings from this study will elucidate whether prediction is possible thanks to semantic and phonological connections or whether just phonological connections suffice for L1 and L2 prediction.

R.Q. 3 . Is working memory a mediating factor in the anticipation of semantic and morphological information based on prosodic cues in L1 and L2 prediction? Does anticipatory experience enhance the use of WM for L2 prediction?

Prior studies have noted the importance of WM as a mediating factor in anticipatory processes in native processing (Huettig & Janse, 2016). However, less is clear about the role of WM during L2 prediction, with some studies suggesting that WM support L2 prediction (Ito, 2016) and others finding no relationship between WM capacity and prediction abilities (Perdomo & Kaan, 2019; Sagarra & Casillas, 2018). Thus, I predict that monolinguals prediction of morphology will be correlated with WM capacity, and that WM will play a stronger role in conditions associated with more competitors (CV and paroxytones). This is because considering more options in memory is more cognitively demanding (Cowan, 1998). Based on studies showing no WM effect in L2 prediction (Perdomo & Kaan, 2019; Sagarra & Casillas, 2018), I expect that WM will not influence the ability to make predictions in non-interpreters. Finally, I predict that interpreters will behave similarly to monolinguals and WM will influence their predictive patterns. Perception becomes easier with experience and, hence, their interpreting experience will allow them to fine-tune the use of prosodic cues (Francis & Nusbaum, 2009).

1.7 Methods

1.7.1 Participants

Each experiment included Spanish monolinguals, non-interpreter bilinguals and interpreter bilinguals. Both non-interpreters and interpreters were adult learners of Spanish and started acquisition of their L2 after puberty. The Spanish monolinguals were born and raised in a monolingual region of Spain. Despite formal English instruction during school, their English L2 proficiency was low. None of them lived abroad for more than a month and all their education had been in Spanish.

The learner groups, interpreters and non-interpreters, were composed of English advanced late learners of Spanish. Both learner groups started studying Spanish after puberty in formal settings and scored above 39 points (out of 56) on a modified version of the DELE Spanish proficiency exam. Most of them had spent time in a Spanish speaking country. Their education was entirely in English up until college, where they started taking content classes in Spanish. Learner groups lived in an English-speaking country and reported using their L2 on a weekly basis. The non-interpreters did not speak other languages at a proficient level and did not have any formal training or professional experience translating or interpreting.

All interpreters had formal training in interpreting (master's programs, court and medical professional certificates), as well as at least two years of professional experience. The majority of the interpreters work in both simultaneous and consecutive interpreting modes (some worked exclusively in consecutive), and in both language directions (English into Spanish and vice versa, some worked exclusively from Spanish into English). Due to the difficulty of finding professional interpreters meeting all criteria to participate in the experiment, I included interpreters that also spoke other languages (French, German, and Dutch).

1.7.2 Materials and procedure

All tasks were collected in one session of about one hour. First, participants completed the proficiency test (20 min) on a computer, using the software Qualtrics. Next, they answered the questions of the background questionnaire orally (5 min), while the researcher took notes. Third, they continued with the eye-tracking task (20 minutes), programmed with Experiment Builder (SR-Research). Finally, they completed the phonological short-term memory task (10 min) and the WM task (10 min); both of them programmed using E-Prime 2.0 (Psychology Software Tools).

1.7.2.1 Language proficiency test

Participants completed an adapted version of the *Diploma de Español como Lengua Extrajera* (DELE) with a total of 56 multiple-choice questions (Sagarra & Herschensohn, 2010). The first 36 questions tested grammatical knowledge and the last

20 questions focused on reading comprehension. They received one point per correct answer and incorrect answers received 0 points. In order to qualify for this study, subjects scored a minimum of 39 points. Appendix II includes the L2 proficiency test.

1.7.2.2 Language background questionnaire

Participants orally provided information about their age, age of first exposure to Spanish, other languages spoken, time living in a Spanish speaking country, languages of education, languages at which they were exposed from 0 to 3 years old, 3 to 12 and 13 until now, and estimated percentage of use of Spanish and English per week. Besides these questions, the interpreters completed another set of questions about the interpreting modes used during work (consecutive interpreting, simultaneous interpreting or sight translation), whether they were freelance or staffed interpreters, their language combinations, degrees or certifications in interpreting, topics they usually work with (legal, medical, international affairs, etc.), and years of interpreting experience. Appendix I includes the questions on the background questionnaire that all participants completed.

1.7.2.3 Eye-tracking task

The three experiments of this dissertation utilize visual world paradigm eye-tracking methodology. The eye-tracking technique is based on the premise that humans move their eyes in order to bring attention to a specific area and, in particular, to focus on a small portion of the visual field where the pupil is looking at. This small portion of the visual field is related to where humans bring their attention. Hence, studying eye movements can provide us with insight into where and when a person’s attention is drawn (Duchowski, 2017). A very common experimental design in eye-tracking is the visual world paradigm, initiated by Cooper (1974). In his experiment, Cooper noticed that when presented simultaneously with a short narration and a visual image containing some of the objects mentioned in the narration, participants consistently looked at the objects mentioned in the narration or objects that were semantically related, even just by hearing the first phonemes designating a specific object. It was not until the nineties that this paradigm became popular, with another experiment showing that when listening to a complex set of instructions, people make eye-movements closely following the words in the instructions (Tanenhaus, Spivey-knowlton, Eberhard, & Sedivy, 1995). The authors demonstrated that humans tend to seek the relationship between the linguistic input they hear and their visual environment (referential nonlinguistic information). They concluded that this type of experiment allows the investigation of the conditions under which rapid mental processes trigger spoken language comprehension.

Previous research has also shown that people tend to launch saccades towards pictures containing shared initial or final phonemes (rhymes) with a target word, as opposed to objects without phonological relation (Allopenna et al., 1998). This is particularly useful when researching prediction of words that share initial phonological information but can be distinguished thanks to prosodic information.

The visual world paradigm has been used to investigate, among other phenomena, predictive processing, as well as the influence of prosody on the resolution of syntactic ambiguities (see Huettig, Rommers, & Meyer, 2011; for a review). One of the advantages of this technique is that tasks do not require metalinguistic interpretation, and it has been shown that even in the tasks where subjects are not required to perform a specific response (answer a question, press a button, etc.), eye-movements are still closely related to the audio they hear (Altmann & Kamide, 2007). Time accuracy is another advantage of this paradigm. Eye movements are almost time-locked to the audio, with an average reaction time of 200 ms between hearing the stimulus and launching a saccade (Salverda, Kleinschmidt, & Tanenhaus, 2014). This allows us to research anticipatory processes happening within a word and very rapidly.

However, the visual world paradigm has its limitations as well. Presenting visual content (images or words) to participants before they listen to the audio file already activates the content related to the images in one's mental lexicon (Ito, 2016). The preview time of the visual referents can determine whether participants will be able to anticipate or not (Huettig & Guerra, 2019). The authors measured whether Dutch natives could anticipate a target object based on the gendered marked article. In the first experiment, participants had four seconds of preview time before listening to a sentence that was presented either at a slow or a fast rate. Results indicated that participants were able to anticipate in both conditions. In the second experiment, they repeated the same procedure, but with a preview time of only one second. Subjects were able to anticipate only in the slow condition, indicating that prediction is dependent on the situation and when more time is allowed for activation, anticipation is more likely.

Besides using images, visual world paradigm experiments can also present written words. The main advantage of using written words is the possibility of including abstract objects or referents as target words (Huettig et al., 2011). Moreover, some studies indicate that written words present higher sensitivity to phonological manipulations than drawings or pictures (Huettig & McQueen, 2007). Nevertheless, they are less sensitive to semantic processing (Huettig & McQueen, 2008). Importantly, words activate a specific lexical item, whereas showing an image could trigger activation of different lexical items (e.g., a picture of a ‘shoe’ could trigger the word shoe or other synonyms like ‘loafer, sneaker, flats, heels’, etc.).

In my dissertation, the visual-world paradigm methodology was used to determine whether native and non-native speakers can use prosodic cues to predict morphological and non-morphological word endings. Data were collected with the EyeLink 1000 Plus desktop mount from SR Research (sampling rate: 1k Hz; spatial resolution: .32$_{o}$ horizontal, 25$_{o}$ vertical; averaged calibration error: . 25°-.5°). The task was presented to participants in a BenQ XL2420TE monitor at a resolution of 1920 x 1080 pixels. All sentences were recorded in a sound-attenuated booth with a Shure SM58 microphone and a Marantz Solid State Recorder PMD670 (sampling rate of 44.1 kHz and 16-bit quantization). Two female native Spanish speakers from Spain (one read sentences of Studies 1 and 3, a different female read sentences of Study 2) read each sentence three times (pseudo-randomized order) in a natural manner and the clearest repetition was selected. Sound files were manipulated using Praat (Boersma & Weenik, 2017). One sound file per sentence was created, removing all extraneous speech and standardizing volume to an average of -18dB (half of the volume range). Each file was padded with a 100ms leading a trailing silence.

In the eye-tracking task, first a fixation cross appeared on the screen for 250 ms. Second, the two visual stimuli, target and distractor (e.g. *firmá / firmó*, ‘he/she sings /

signed'), were shown on the screen for 1000 ms. Then, participants listened to a sentence (e.g. *El director firma la factura* 'The director signs the bill') containing one of the two words. Their task was to choose the word appearing in the sentence as soon as possible by pressing a right or left button (See appendix 1).

There were two versions of the test that started with a practice phase (these sentences had same characteristics as the experimental items), followed by the testing phase. Items were distributed in blocks with a Latin square design, each block containing only one sentence of a specific condition, and the blocks and the sentences within each block were randomized. Sentences were pseudo-randomized to avoid that two experimental sentences of the same condition being presented consecutively. The task used words instead of drawings or pictures because a pilot study with Spanish monolinguals showed that participants were not able to decipher the image fast enough. Previous studies show that printed words provide faster access to phonological knowledge than pictures, because the latter requires processing not only of semantic information, but also of visual features (Huettig & McQueen, 2007). Appendix III provides a sample trial of one of the eye-tracking tasks.

1.7.2.4 Working memory task

This non-linguistic letter-number test was adapted from the Wechsler Adult Intelligence Scale test (WAIS) (Wechsler, 1997). Participants listened to a set of numbers and letters (7-C-3-A) in their L1 and were asked to recall all the characters, organizing them first in numerical order and then in alphabetical order (37AC). There were 2 practice trials and 21 experimental trials from 2 to 9 letter-number combinations.

Participants received one point per correct trial (correct digits in the correct order). Appendix IV details all practice and experimental trials. The next section provides a summary of the three studies included in this dissertation.

1.8 Study 1: Lexical stress and syllabic structure to predict verb suffixes

Study 1 explored whether extensive anticipatory practice via interpreting is associated with the use of lexical stress (stressed or unstressed) and syllabic structure (CV or CVC) in the initial syllable of a verb to predict morphological information. Anticipation is essential for a wide range of cognitive activities, from the construction of emotions (Barrett, 2017) to the preparation of a sandwich (Hayhoe et al., 2003). Language processing is another area where anticipation is pervasive. Context (Martin et al., 2013), morphology (Dussias et al., 2013), prosody (Steinhauer, Alter, & Friederici, 1999) and meaning contained in the verb (Altmann & Kamide, 1999) serve as cues to predict upcoming linguistic information (e.g. lexical items, syntactic structures, or morphological endings) in monolingual speakers. However, it is unclear whether L2 learners are able to rapidly integrate different sorts of cues to predict linguistic information. Previous studies have shown that beginning and intermediate L2 learners cannot use prediction in their L2 (Hopp, 2015; Marull, 2017; Mitsugi & MacWhinney, 2016; Sagarra & Casillas, 2018). In the case of advanced L2 learners, some of them are able to predict linguistic information (Grüter & Rohde, 2013; Hopp, 2016; Lew-Williams & Fernald, 2010; Marull, 2017) and others not (Hopp, 2015; Martin et al., 2013).

To date, studies have not dealt with the role of language experience at advanced levels in relation to anticipatory abilities. This is an important issue to understand variation in L2 prediction. Professional interpreters are a special L2 population because interpreting involves processing under highly demanding cognitive circumstances that require, among other processes, simultaneous listening and production of two different languages. Previous studies revealed that extended interpreting practice results in the enhancement of general cognitive functions (Hervais-Adelman, Moser-Mercer, Murray, & Golestani, 2017). Relevant to the present study, anticipation is one of the strategies employed during simultaneous interpreting in order to relieve the processing load (Seeber & Kerzel, 2011). Investigating this particular population (i.e. professional interpreters) would point to whether prediction in the L2 can be enhanced through language experience.

Most prediction research has examined how semantic and morphosyntactic relationships between words trigger anticipation in monolinguals and L2 learners, but prediction also happens within words. Previous studies show that native speakers of Swedish use tonal information to predict morphological information (Roll, Horne, & Lindgren, 2010; Roll, Söderström, Frid, Mannfolk, & Horne, 2017) and advanced L2 learners as well (Schremm et al., 2016). Study 1 investigates whether a similar effect can be found in Spanish with a different prosodic cue. Lexical stress (or the relative prominence of one syllable in comparison with others in a word) exists both in English and Spanish although each language has a different way of realizing this prosodic cue. Whereas unstressed English vowels tend to be shorter with a centralization of format frequencies towards [ə], Spanish vowels remain relatively unchanged by lexical stress. Furthermore, Spanish natives use lexical stress to reduce the number of competitors for lexical access (Soto-Faraco, Sebastián-Gallés, & Cutler, 2001), whereas English natives do not (Cooper et al., 2002). In relation to the present study, lexical stress allows distinguishing between the present and past tenses in the third person singular in Spanish before the morphological ending is produced. Thus, this prosodic cue could be used to anticipate the verb ending and facilitate its processing. Sagarra & Casillas (2018) showed that Spanish monolinguals use lexical stress predictively, advanced L2ers only predict when more time and phonological information are available, and beginning L2ers cannot predict at all. This opens the question of whether L2 prediction can be comparable to monolingual prediction.

To understand the factors facilitating L2 prediction, Study 1 examines how simultaneous interpreting experience affects anticipatory abilities in the L2. Spanish monolinguals, advanced L2 learners of Spanish (L1 English) with and without interpreting experience participated in an eye-tracking study. Participants saw two words on the screen and listened to a sentence containing a verb in the present (paroxytone condition, e.g. *FIRma*) or in the past (oxytone condition, e.g. *firMÓ*). Half of the target verbs had a coda (CVC) in the first syllable and half did not (CV). Participants had to select the verb form they had heard in the sentence. Eye-fixations towards the target word before the suffix would indicate they were able to use lexical stress to predict the morphological suffix.

Results showed that monolinguals anticipated above chance in all conditions, while interpreters and non-interpreters anticipated morphology in all conditions except for CV-paroxytones (e.g., *LAva*, '(s)he washes). Moreover, monolinguals started to make predictions before both learner groups. Interestingly, interpreters showed faster anticipation rates than non-interpreters in all conditions except for CV-paroxytones, and faster than monolinguals in the CV-oxytones (e.g., *laVÓ*, ‘(s)he washed) and CVC-paroxytones (e.g., *FIRma*, ‘(s)he signs’). For all groups, less frequent conditions (oxytones, CVC) facilitated prediction.

Collectively, findings demonstrate that lexical stress syllabic structure modulate native and non-native processing. Also, fewer possible word endings facilitate prediction during spoken word recognition. These findings are consistent with research showing that suprasegmental and segmental information guides prediction of morphological information (Roll, 2015; Roll et al., 2017; Sagarra & Casillas, 2018). Also, native and non-native prediction follow the same patterns, although not to the same extent, with L2 learners predicting less than monolinguals. The reason for this difference between L1 and L2 prediction could be found in the learners’ native language interfering with their L2 perception of lexical stress, although further research is needed to confirm this hypothesis.

As expected, interpreting experience impacted L2 prediction, such that interpreters were faster than non-interpreters making predictions in all conditions but CV paroxytones, and faster than monolinguals in conditions with CV oxytones and CVC paroxytones. These findings indicate that extended practice with interpreting enhances processing in the L2, as demonstrated in the study by faster anticipation of morphology in the L2. Therefore, practice with interpreting not only benefits general cognitive functions but also linguistic processing. Specifically, it is possible to train anticipatory processing in the L2 via a cognitively complex task (i.e. interpreting) that involves anticipation. This is in line with research showing that interpreters are faster than non-interpreters coordinating simultaneous actions (García, Muñoz, & Kogan, 2019b) and dual tasks (Morales, Padilla, Gomez-Ariza, & Bajo, 2015). Increased speed during prediction is essential to facilitate recognition and interpreting information, releasing cognitive resources to prepare for future information. This an example of how top-down processes can guide attention to improve processing (Bubic, Von Cramon, & Schubotz, 2010). Despite clear indications that lexical stress and syllabic structure drive morphological processing, it is still unclear whether these cues guide prediction of non-morphological word endings. Study 2 tackles this question by exploring prediction of word endings in monolinguals, non-interpreter and interpreter L2 learners of Spanish.

1.9 Study 2: Lexical stress and syllabic structure to predict L2 word endings

Study 1 showed that lexical stress is key for predicting verbal morphology in Spanish among monolinguals and advanced L2 learners of Spanish, and that interpreting experience enhanced predictive processing in the L2. However, it remains unclear whether lexical stress is only relevant for the prediction of morphology, or whether it is a key prosodic cue to predict other types of word endings. We investigate this question in Study 2 by focusing on the role of lexical stress and syllabic structure in the prediction of noun non-morphological endings.

Research shows that speakers utilize constraining contexts to predict upcoming linguistic information. This strategy facilitates processing by reducing the number of possible continuations in a sentence. Specifically, native speakers use semantic context from the agent (Kamide, Altmann & Haywood, 2003), verb (Altmann & Kamide, 1999; Altmann & Kamide, 2007), sentence (Wicha et al., 2014) and discourse (Van Berkum, et al., 2005) to predict nouns. Interestingly, predictions leave a trace in memory even when they have not been mentioned in the discourse (Foucart et al., 2015). L2 learners follow similar prediction patterns as monolinguals based on semantic context. In particular, L2ers use contextual information in a sentence to predict nouns (Foucart et al., 2014) and predictions also leave a memory trace (Foucart et al., 2016). Nonetheless, some research shows that L2 learners are not always able to use sentence context predictively (Martin et al., 2013). As a whole, research on semantic prediction shows that different relationships between words trigger prediction of specific lexical items or their semantic features. Comparatively, little is known about whether prediction of meaning also happens within a word and whether cues different from contextual meaning trigger semantic prediction.

Prior research has clearly established a link between prosody and morphology, but it could be possible that prosody in the first syllable of a word is also key in anticipating other word endings. This is relevant to understanding the relationship between phonology in the first syllable and predictive lexical access. Also, comparing native and non-native speakers will clarify whether connections between phonology and meaning are similar in the L1 and L2. Findings from Study 1 indicated that additional experience making predictions via interpreting accelerated L2 prediction of morphology, although monolinguals were still superior at making predictions. It is possible that morphological endings involve a higher cognitive load and this partially explains why both L2 learner groups (interpreters and non-interpreters) could not predict under certain conditions.

Study 2 focused on the ability of Spanish monolinguals and L2 learners of Spanish with and without interpreting experience to use lexical stress and syllabic structure to predict non-morphological noun-endings. These findings provide insights into whether prosody also helps in predicting non-morphological word-endings and whether L2 difficulties in prediction are due to morphological processing. Lexical stress is contrastive both in English and Spanish, although research shows that Spanish natives rely more on lexical stress for lexical access than English natives (Cooper et al., 2002; Soto-Faraco et al., 2001). Also, syllabic structure in the first syllable plays an important role in reducing the number of possible lexical competitors (Cholin et al., 2006), such that CVC are easier to predict than CV, and L2 learners can only predict with CVC initial syllables (Sagarra & Casillas, 2018).

Spanish monolinguals and late advanced L2 learners of Spanish (L1 English) with and without interpreting experience performed an eye-tracking task in which they could use lexical stress and syllabic structure to predict word-endings (e.g., *PApa-paPÁ*, 'bullet-ball'*; CARne-carNÉ*, 'meat-ID card'). During the visual-world paradigm task, participants listened to a sentence while seeing two words on the screen. They were instructed to select the word contained in the sentence with a button press. Prediction was measured through eye-movements towards the target word before hearing the first syllable offset of the target word.

Results show that unstressed and CVC initial syllables facilitated prediction in monolinguals. Non-interpreters displayed a lower prediction rate than monolinguals and the benefits of adding a coda were more helpful for non-interpreters than for monolinguals. By contrast, interpreters showed comparable prediction rates to those of monolinguals for all conditions. As with non-interpreters, the addition of the coda was more beneficial for interpreters than for monolinguals. When comparing both learner groups, analyses show that non-interpreters start making predictions later than interpreters and that the coda conditions helped more prediction among non-interpreters.

Findings from this experiment make significant contributions to phonological, prediction and second language processing models. First, these results show that for monolingual processing, lexical stress triggers prediction regardless of whether the word-ending is morphological or non-morphological. In this sense, the syllable seems to emerge as a fundamental sub-lexical unit for prediction. Interpreting experience clearly impacts prediction of word-endings, such that interpreters', unlike non-interpreters', prediction was comparable to that of monolinguals. This could be explained because while in the present experiment target and distractor words were related phonologically, in Study 1 both words were related phonologically and semantically. Semantic unrelatedness in the present experiment does not affect monolingual processing. However, for L2 learners, the activation of more semantical neighbors hindered prediction. This explanation would imply that L2 prediction is more vulnerable to semantic interference.

Moreover, results show that the interplay of phonological and semantic connections is different during L1 and L2 predictive processing. Importantly, interpreters' data indicates that it is possible to readjust the use of stress to make predictions in the L2 through additional practice making predictions. This could be due to increased white matter in brain areas in charge of speech processing and, in particular, those involved in articulatory and lexical representations. Overall, interpreters' enhanced abilities suggest that language processing demands modify predictive processing. Despite showing that interpreting experience aids L2 predictions, the cognitive mechanisms underlying prediction based on prosodic cues remain unknown. Study 3 focuses on this issue by exploring how WM mediates L1 and L2 prediction within a word.

1.10 Study 3: The role of working memory in L1 and L2 prediction of morphological endings

Studies 1 and 2 indicated that lexical stress and syllabic structure guide predictive processing of morphological and non-morphological information in monolinguals and L2 learners. Nevertheless, the cognitive individual differences modulating predictive processing are still unknown. To shed light on this issue, Study 3 investigated the role of WM for prediction of morphological information based on prosodic cues. WM refers to the cognitive mechanism that allows the storage and processing of information concurrently (Baddeley, 1992). Importantly, WM is crucial for L2 morphosyntactic processing, predictive processing and interpreting performance.

Prior studies on the effects of WM on prediction are scant and contradictory. L1 studies show that WM is one of the factors, together with processing speed, mediating morphosyntactic prediction (Huettig & Janse, 2016). Other studies have not found such an association, although they revealed differences in the way native speakers resolved an unconfirmed prediction, such that lower WM participants showed an additional effort processing unexpected nouns (Otten & Van Berkum, 2009). L2 studies on WM and prediction also yield mixed findings. On the one hand, there is evidence that an additional cognitive load disrupts predictive processing, suggesting that sufficient cognitive resources and WM are necessary for prediction in the L2 (Ito, 2016). On the other hand, other studies do not report WM effects on L2 prediction (Perdomono & Kaan, 2019; Sagarra & Casillas, 2018). Taken together, we see that the relationship between WM and prediction is still unclear.

Study 3 investigated how WM mediates the prediction of morphological endings based on lexical stress and syllabic structure cues during monolingual and L2 processing. This question is crucial to informing prediction models by showing whether cognitive resources supporting prediction are shared with domain-general resources, and also to inform WM models by revealing whether higher demands on WM via interpreting can modify allocation of attentional resources in L2 processing.

The participants and tasks of Study 3 were identical to those of Study 1, with the addition of the letter-number sequencing WM task. For this task, participants heard a series of numbers and letters that they had to remember and organize with numbers first in ascending order, followed by letters in alphabetical order. There were two practice trials and 20 experimental trials. Correct trials received 1 point correct (digits and order) and incorrect ones received 0 points.

Results showed that higher WM monolinguals made predictions earlier in the paroxytone condition (stressed initial syllable) and in the CVC condition. Higher WM interpreters predicted later in the paroxytone condition but did so at a faster rate than monolinguals. Lower WM non-interpreters predicted earlier in the oxytone condition (unstressed initial syllable).

Collectively, WM results from this study show that processing of inflectional morphology is cognitively taxing both for natives and learners. Words with stressed initial syllables have more lexical competitors in Spanish than words with unstressed initial syllables. For monolinguals and interpreters, WM facilitates prediction in conditions with more lexical competitors. However, for non-interpreters, WM has an effect on prediction when fewer competitors are present, most likely because holding more alternatives in memory is too cognitively taxing. A crucial finding is that additional prediction experience through interpreting enhances efficiency of WM and L2 interpreters are able to handle more lexical possibilities in memory. Thus, predicting morphology relies on availability of cognitive resources and prediction experience during interpreting. Crucially, interpreting experience is key in optimizing the use of cognitive resources for more efficient L2 processing. These findings provide support for accessibility models of adult SLA, showing that adult L2 learners can acquire native-like proficiency in their L2.

1.11 Limitations and future directions

Finally, a number of limitations need to be considered. This section will detail issues related to why L1 and L2 prediction is different, why morphological and non-morphological prediction are different for learners but not for monolinguals, how results from GCA are interpreted, and why interpreters behave differently. Specifically, for interpreters, we will discuss differences in age and modes of interpreting (consecutive vs.

simultaneous interpreting), the possibility of self-selection, and reasons underlying why interpreters predict better than non-interpreters.

First, the reason why L2 prediction is more cumbersome than L1 prediction remains unclear. We have hypothesized that L2 learners display greater difficulty because morphosyntactic processing is more difficult for L2ers and because their phonological processing is more vulnerable to semantic interference. However, there could be other reasons behind differences in L1 and L2 prediction. One possibility is that age of acquisition hinders prediction in the L2 groups. To test this hypothesis, we have collected data with a group of heritage speakers of Spanish. Alternatively, differences in the use of lexical stress between English and Spanish could also be the reason why L2 groups predicted to a lesser extent than monolinguals. Our current design does not allow us to tease apart these possibilities. To address this limitation, I am currently investigating the role of lexical stress on morphological anticipation in verbs in Spanish monolinguals, Mandarin L2 learners of Spanish (Mandarin is a syllable-timed language) and English L2 learners of Spanish (English is a stress-timed language). Comparing these groups will elucidate the role of transfer during L2 prediction.

Second, results from this dissertation cannot explain why L2 learners show differences processing morphological and non-morphological word-endings. While Study 1 measured prediction of morphological endings in verbs, Study 2 focused on non-morphological endings in nouns, thus making a direct comparison between studies impossible. Previous research on the prediction of number marking in nouns (Roll, 2015) and tense suffixes in verbs (Söderström, Roll, & Horne, 2012) based on tonal information in Swedish shows that prediction patterns are shared in both nouns and verbs. Therefore, it seems unlikely that this could explain differences between Studies 1 and 2. To disentangle these variables, I am exploring prediction of word endings based on lexical stress between two semantically related nouns (e.g., *DEdo-deDAL*, 'finger-thimble').

Third, finding a homogeneous group of professional interpreters is a challenging task. Interpreter and non-interpreter L2 learners were raised in a monolingual environment by monolingual parents, their education up to university was in their L1, were advanced adult learners of Spanish with an advanced level in their L2. Nevertheless, we could not match both groups in terms of age and interpreters were older. This is because one of the requirements to be included in the interpreter group was to have at least two years of professional experience as an interpreter. Many interpreters arrive to the profession as a second career and, therefore, are older. We conducted an analysis in Study 1 to test the possibility of age affecting performance and we did not find any significant effects (older interpreters were not predicting less than younger interpreters). This interesting finding could imply that interpreting experience has protective effects against cognitive decline with aging, although further research would be necessary to test this hypothesis.

Fourth, interpreters worked in different modes of interpreting. Most of them worked in simultaneous interpreting, but some of them worked mainly with consecutive interpreting. Although both modes are cognitively challenging, the underlying cognitive mechanisms involved in each mode are different. While simultaneous interpreting requires great coordination efforts to allow concurrent perception, processing, translation and production, consecutive interpreting could exert higher demands on memory. It is possible that each task has a different impact on L2 predictive processing.

Fifth, self-selection among interpreters has been a long-standing question in interpreting studies. Are interpreters born or made? One could argue that interpreters are innately better at language and this is why they choose that career path. However, longitudinal studies with interpreting students have shown that: (1) before training, interpreting students do not differ from bilingual students of other subjects on cognitive measures such as working memory or short term memory, and (2) interpreting training results in improvement of brain function in areas involved during interpreting (Babcock et al., 2017; Dong, Liu, & Cai, 2018; Nour, Struys, & Stengers, 2020). Thus, we can safely assume that interpreting experience is responsible for the enhancement of L2 predictive processing in the current project. We have attributed interpreters' superior prediction skills during L2 processing to the additional practice interpreters have making predictions during interpreting. However, we cannot rule out the possibility of other factors influencing these results. For instance, even though both learner groups had comparable scores in the L2 proficiency test measuring grammatical knowledge, interpreters might have increased L2 proficiency in other linguistic areas or L2 weekly contact as compared to non-interpreters.

Furthermore, interpreting experience is linked to greater resistance to articulatory suppression (Yudes, Macizo, & Bajo, 2012), superior cognitive flexibility or enhanced lexico-semantic processing (García, 2014). Because the role of these cognitive mechanisms during prediction is still not clear, we cannot reject the possibility of other factors explaining why interpreters predict closer to monolinguals than non-interpreter bilinguals.

Moreover, we attributed interpreters' delayed prediction under more challenging conditions to one of their coping mechanisms during interpreting. Interpreters are trained to wait for enough semantic and syntactic cues before starting to interpret into the target language. Nonetheless, our data do not allow us to confirm whether interpreters are extrapolating their waiting tactic from interpreting to L2 processing in non-interpreting situations. Further research on this topic would contribute to understand how bilinguals' attention to specific cues in linguistic input can be shifted through training and experience.

Finally, the implications of different GCA findings are unclear. In particular, our results do not allow us to assess how time (how early) and speed (how fast) of prediction explain the effectiveness and accuracy of L1 and L2 prediction. Answering this question in future research would have important methodological implications for prediction research.

1.12 Conclusions

The present dissertation focused on predictive processing within a word in Spanish from three different perspectives. Study 1 investigated whether interpreting experience facilitated the use of prosodic cues to predict morphological information. Answering this question elucidates whether additional experience making predictions during interpreting results in better prediction skills in non-interpreting situations. Study 2 explored whether prediction based on lexical stress cues in Spanish applies to non-morphological word-endings as well. This a crucial issue to understanding the relevance of the prosodic features in the first syllable to access meaning. Finally, Study 3 delves into the role of WM during L1 and L2 prediction of verb suffixes based on lexical stress. This is relevant to identifying whether the cognitive mechanisms that allow prediction are shared with domain general resources.

Results from Study 1 indicate that prosodic information guides spoken word recognition both in native and non-native speakers. This finding is consistent with research revealing the relevance of prosody for predicting morphological endings within a word (Roll, 2015; Schremm et al., 2016). Additionally, less frequent suprasegmental and segmental cues, that is oxytonic stress and CVC syllables, yielded stronger prediction for all groups. When comparing natives with learners, we see that although the predictions were qualitatively similar (i.e., less frequent cues were linked to stronger prediction), they were quantitatively different, with L2 learners predicting to a lesser extent and not being able to make predictions under the CV-paroxytone condition. Finally, another significant finding from Study 1 is that interpreting experience drives adaptations of L2 predictive processing. Thus, interpreters started making predictions later than monolinguals and non-interpreter L2 learners but did so at a faster rate. This could be due to interpreting training, in which interpreter students are advised to wait until enough information has been received before they start producing the interpretation in the other language. This particular strategy could be applied to making predictions in the L2 and explain why the interpreter group waited to have enough cues before committing to a specific prediction. In relation to the speed of prediction, interpreters were faster than non-interpreters in all conditions except CV-paroxytones (the most common conditions for both variables), and faster than monolinguals in CV-oxytones and CVC-paroxytones. Again, we attribute this difference to the relevance of prediction during interpreting. Prediction allows the interpreter to release cognitive load in order to continue translating incoming input, and also has been linked to higher accuracy and completeness of speech (Kurz & Färber, 2003). Taken together, these findings make an important contribution to prediction models by showing how processing experience, listener's goals and expected utility of the prediction can modify the strategy adopted to make a prediction.

Study 2 indicated that lexical stress and syllabic structure are not only relevant for the prediction of morphology, but also for the prediction of non-morphological word-endings. This issue is important because it highlights the relevance of prosody for quick and efficient processing. Specifically, Spanish monolinguals and interpreters used lexical stress and syllabic structure to predict noun-endings under all conditions, while non-interpreters only anticipated when the initial syllable was CVC unstressed. Monolingual data indicated that prediction of non-morphological word-endings follows the same patterns as prediction of verbal morphology. However, L2 learner groups displayed different patterns. Non-interpreters only predicted under the CVC unstressed condition. Predicting non-morphological noun endings is more challenging for non-interpreter L2 learners. Semantic unrelatedness between the two words presented on the screen (target and distractor, e.g., *PApa-paPÁ*, 'potato-dad') might have triggered activation of a broader semantic network both in their L2 (Spanish) and L1 (English) than in prior studies where targets and distractors only differed in verbal tense (e.g., Sagarra & Casillas, 2018: *LAva-laVÓ*, '(s)he washes/washed'). Hence, an increased number of lexical competitors slows down prediction. L2 learners have difficulty inhibiting irrelevant competitors (Kaan et al., 2017), suggesting that phonological processing in the L2 is more vulnerable to semantic interference. Results from the interpreter group suggest that L2 prediction is subject to change. Interpreters predicted word-endings at a similar rate to monolinguals under all conditions. When comparing interpreters and non-interpreters, interpreting experience enhances predictive processing of noun-endings during non-interpreting situations. This could be due to interpreters' increased white matter in brain areas linked to articulatory and lexical representations, making phonological representations stronger and L2 predictive processing closer to monolingual prediction.

Finally, Study 3 showed that WM affects prediction of morphology but does so differently in monolinguals, non-interpreters and interpreters. Monolinguals and interpreters' WM effects appear in the stressed condition (linked to a higher cognitive load), whereas non-interpreters' WM effects are visible in the unstressed condition (related to lower cognitive load). Hence, processing of inflectional morphology is cognitively taxing, but more so for L2 learners, who are unable to hold an increased number of lexical competitors in memory, unless they have additional experience making predictions during interpreting. These findings go in line with processing studies indicating that morphological cues are cognitively more demanding than lexical cues, and that higher WM facilitates processing when the cognitive load is increased (Ellis &

Sagarra, 2011; Hartsuiker & Barkhuysen, 2006). Study 3 advances this line of research by showing that the prediction of morphology also depends on the cognitive resources available.

To sum up, findings from this dissertation contribute to understanding the role of prosodic information in guiding morphological and semantic prediction in L1 and L2 spoken word recognition. For monolinguals, lexical stress and syllabic structure are crucial for the prediction of both morphological verb suffixes and non-morphological noun-endings. Importantly, cues associated with a smaller group of words (i.e., less frequent in the input) trigger stronger prediction of morphology and semantics. Advanced late L2 learners of Spanish show a different picture. In the case of verb suffixes, L2ers (interpreters and non-interpreters) can make predictions in all conditions except when cues are associated with a large number of words (i.e., more frequent in the input) because of the increased number of lexical competitors. This difficulty might also be related to their reduced ability to generated expectations (Grüter & Rhode, 2013). As for non-morphological word endings, semantic interference poses great difficulty for non-interpreters and they only anticipated meaning in the unstressed coda condition. Interpreting experience is key in overcoming this difficulty and interpreters in this experiment show similar prediction patterns to those of monolinguals. Finally, WM results show that processing morphology is cognitively demanding and even more so for L2 learners than for monolinguals. Again, anticipatory experience during interpreting enhances efficiency processing under more demanding conditions. Overall, our findings are consistent with computational accessibility models of adult SLA, indicating that L2 native-like proficiency is attainable, and usage-based models, showing that language experience impacts the underlying cognitive organization of linguistic knowledge (Bybee, 2009).

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1.14 Appendix I: Oral background questionnaire

- Personal information: name, email, phone number, and age
- When were you first exposed to Spanish?
- Do you speak other languages fluently?
- Have you spent time living in a Spanish speaking country? How long?
- Was your education in English (except for language classes)? (elementary, middle, high school, university)
- Was your education in Spanish (not counting language courses)? (elementary, middle, high school, university)
- What languages were in your environment when growing up? (0-3 years old, 3-12, 13 to not)
- What is the approximate percentage of use of English per week?
- What is the approximate percentage of use of Spanish per week?

Extra set of questions for interpreters

- What modes of interpreting do you use in your work? (simultaneous, consecutive, sight-translation, whispering)
- Are you freelance or staff?
- What is your language combination?
- Do you have any degrees or certifications in interpreting?
- What are the topics you specialized in? (legal, medical, international relations, etc.)
- How many years of professional experience in interpreting do you have?

1.15 Appendix II: Language proficiency test

Write the correct letter (A, B, C or D) for each sentence. "Ø" *means nothing is necessary to complete the sentence.*

BLOQUE A

C___ 1. ___________ edificio alto es la Torre Sears.
A. Eso B. La C. Aquel D. Ø

B___ 2. Los autos que chocaron en el accidente iban ___________ el oeste.
A. dentro B. hacia C. fuera D. Ø

A___ 3. Los novios pasaron unas vacaciones fantásticas __________ fueron a Hawai.
A. cuando B. que C. donde D. Ø

C___ 4. –¿Van a invitar al profesor y a su esposa a la reunión? –Sí, vamos a invitar ___.
A. ellos B. sus C. los D. Ø

C___ 5. Si no puedes usar tu bicicleta usa ___________.
A. nuestra B. de él C. la mía D. Ø

A___ 6. A Juana no ________ gustan las películas de ciencia ficción.
A. le B. se C. la D. Ø

C___7. En nuestro barrio hay muchas casas bonitas, pero _____ Juan es la más bonita.
A. su B. de la C. la de D. Ø

B___8. –¿Conoces _______ hombre de la camisa verde? –¿Es muy guapo verdad?
A. un B. al C. esto D. Ø

A___9. Óscar no va a graduarse este semestre, ni yo ________.
A. tampoco B. ningún C. además D. Ø

C___10. –¿Con quién saliste al bar anoche? –No salí con ______; fui sola.
A. tú B. alguien C. nadie D. Ø

D___11. Estamos comprando _______ pan francés para la cena de mañana.
A. la B. hay C. algo D. Ø

C___12. La palabra 'venir' viene _________ latín.
A. por B. en C. del D. Ø

BLOQUE B

C___ 1. Por favor, __________ llegues a Madrid, me llamas.
A. desde que B. antes de C. cuando D. después de

D___ 2. –¿Hasta qué hora estuvo Lorenzo en la consulta?
–Pues no sé, no lo vi. Cuando yo llegué, a las 12, ya se __________.
A. iba B. ha ido C. fue D. había ido

C___ 3. Hoy invito yo __________ todos al café, que es mi cumpleaños.
A. para B. de C. a D. sobre

B___ 4. ¿__________ has pedido ya a tus padres?
A. Se te B. Se lo C. Se les D. Se le

A___ 5. Manuel, como no __________ más fruta, no tendremos suficiente.
A. compres B. compras C. compraras D. comprarás

D___ 6. ¿Que te vas a París? ¡Quién __________ tú!
A. es B. sea C. sería D. fuera

C___7. Sinceramente, yo que tú __________ un mapa antes de viajar.

A. compraré B. compro C. compraría D. comprara

B___8. La música de los vecinos está muy alta. Estoy _________ llamar a la policía.

A. a B. por C. entre D. tras

C___9. El médico me dijo que __________ que volver mañana.

A. había tenido B. tuve C. tenía D. he tenido

B___10. Por favor, en cuanto __________ a Lucía, dile que me llame.

A. verás B. veas C. ves D. vieras

D___11. El regalo que __________ he comprado a Andrés es muy bonito.

A. lo B. se C. la D. le

B___12. El profesor me pidió que _________ a sus horas de oficina.

A. iré B. vaya C. iría D. iba

BLOQUE C

D___ 1. Ellos estaban dispuestos a que ________ nosotros en el coche y ellos andando.

A. íbamos B. fuimos C. iríamos D. fuéramos

A___ 2. __________ como se enteraron de lo sucedido fueron a visitar a la familia.

A. Tan pronto B. No bien C. En cuanto D. Nada más

D___ 3. Elisa llegó a la estación cuando el tren __________ de salir, ¡qué rabia!

A. acabó B. acaba C. acabaría D. acababa

C___ 4. En cuanto deje la maleta en la habitación del hotel _____ meterme en la piscina, ¡qué calor!

A. creo B. debo C. pienso D. siento

D___ 5. Carolina y Luis se casaron muy jóvenes, __________ cumplieron los 20 años.

A. al B. apenas C. de D. pronto

D___ 6. El perrito de María es muy gracioso, tan pronto salta __________ se tumba.

A. que B. de C. y D. como

B___7. El jefe no se ha enfadado porque María __ llegado tarde, sino porque no se había preparado bien.

A. ha B. haya C. había D. hubiera

C___8. Al abuelo le encantaba que Juanito ___ a verle todos los días.

A. haya ido B. iba C. fuera D. iría

C___9. Pedro va a hablar con el director, pero no quiere que ___ vaya con él.

A. algún B. alguien C. nadie D. todo

A___10. Aunque ___ muy tarde, iré a verte al hospital, te lo prometo.

A. llegue B. llegara C. llegaría D. llegué

C___11. Le dieron todo lo que pidió, ____ estuviera feliz y se quedara allí.

A. a saber B. por eso C. de ahí que D. por consiguiente

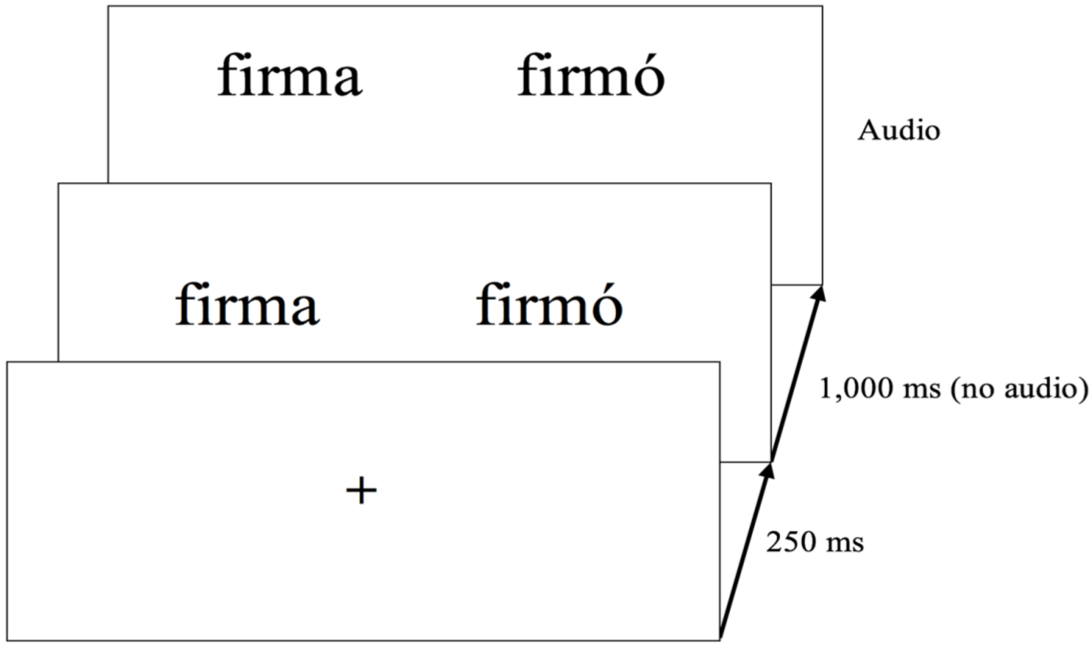
A___12. Está ___ nevar, así que abrígate bien.

A.por B. en C. si D. Entre

Write the correct letter (A, B, C or D) for each sentence.

Las bicicletas también son para el otoño
El ciclismo está considerado por los especialistas como uno de los deportes más completos. Fortalece el cuerpo y también la mente, y a él puede __1__ cualquier persona porque no tiene __2__ de edad. La bicicleta es uno de los mejores deportes, sobre todo para la gente __3__ no puede hacer ejercicios de contacto con el suelo, como correr. __4__ estemos ante un deporte muy beneficioso, ya que no solo mejora nuestra condición física, sino que nos hace más resistentes; __5__ tiene unos efectos anímicos extraordinarios. Elimina el estrés y hace que __6__ más eufóricos y enérgicos, __7__ supone encontrarnos mejor. Por último, la práctica de este deporte facilita el contacto con la naturaleza.
Para practicar este deporte, debemos __8__ en cuenta algunos aspectos. El tiempo es una de las dificultades con __9__ que se cuenta si se vive en la ciudad. Hay que intentar sacar tiempo de __10__ sea para poder practicar nuestro deporte preferido. En el caso de la bicicleta, lo ideal es salir todos los días aunque sólo __11__ un cuarto de hora, si bien se recomienda pedalear __12__ 40 y 45 minutos. También se pueden realizar tres sesiones a la semana __13__ a los 60 minutos, y los fines de semana __14__ de entrenar un poco más porque tenemos más tiempo libre. La distancia a recorrer dependerá __15__ la velocidad y el ritmo que __16__, aunque no hay que obsesionarse con los kilómetros. Otro elemento __17__ importante es la elección de la bicicleta que hagamos: de carretera para los más deportivos, de montaña para los __18__ de la naturaleza, y las híbridas, que valen para todo.
Con la bicicleta ya escogida, solo __19__ resta equiparnos adecuadamente. En el atuendo no debe __20__ un buen *culotte*, un *maillot*, un chubasquero por si llueve, y un casco.
A___ 1. A) acceder B) practicar C) ejecutar
A___ 2. A) límite B) término C) frontera
C___ 3. A) quien B) quienes C) que
B___ 4. A) De modo que B) De ahí que C) Así que
C___ 5. A) pero B) sino C) también
B___ 6. A) estamos B) estemos C) estaremos
A___ 7. A) lo que B) el cual C) cuyo
A___ 8. A) tener B) considerar C) darnos
B___ 9.A) lo B) las C) la
A___ 10. A) donde B) como C) cuando
C___ 11. A) sería B) es C) sea
A___ 12. A) entre B) hacia C) de
B___ 13. A) alrededor B) en torno C) cerca
A___ 14. A) tratar B) intentar C) esforzarse
B___ 15. A) en B) de C) a
C___ 16. A) corramos B) vayamos C) llevemos
C___ 17. A) más B) tan C) muy
A___ 18. A) amantes B) aficionados C) interesados
B___ 19. A) se B) nos C) le
A___ 20. A) faltar B) sobrar C) quedar

1.16 Appendix III: Eye-tracking experiment



1.17 Appendix IV: Series included in the letter-number sequencing task measuring WM

Practice trials:
24p
59ab

Experimental trials:
2j
6c
8f
14g
7jo
49s
35dj
18ac
28ez
46hkt
279bh
13imq
459nbr
168ctz
237dkx
258floz
3467dfn
1489rqm
2458kosx
1379jtuu
3569cnrx

Chapter 2: Slowly but Surely: Interpreting Facilitates L2 Morphological Anticipation Based on Suprasegmental and Segmental Information

2.1 Abstract

Native speakers use suprasegmental information to predict words, but less is known about segmental information. Moreover, anticipatory studies with non-native speakers are scarce and mix proficiency with anticipatory experience. To address these limitations, we investigated whether Spanish monolinguals and advanced English learners of Spanish use suprasegmentals (stress: oxytone, paroxytone) and segmentals (syllabic structure: CVC, CV) to predict word suffixes, and whether increased anticipatory experience acquired via interpreting facilitates anticipation in non-interpreting L2 situations. Eye-tracking data revealed that: (1) the three groups made use of the linguistic variables, L2 groups did not anticipate in CV paroxytones; (2) everybody anticipated better with the less frequent conditions (oxytones, CVC) having fewer lexical competitors; (3) monolinguals anticipated earlier than L2 learners; and (4) interpreters anticipated at a faster rate in some conditions. These findings indicate that less frequent suprasegmental and segmental information and anticipatory experience facilitate native and non-native spoken word prediction.

2.2 Introduction

Anticipation forms an integral part of our lives. Language is no exception. Linguistic anticipation consists of the pre-activation of linguistic information before it has been heard (Huettig, 2015). Monolinguals constantly predict morphological information of upcoming words (Kamide, 2008) and suffixes within a word (Roll, 2015), but the evidence is mixed regarding L2 learners (see Kaan, 2014, for a review). Relevant to our study, to predict a word's suffix, native speakers use both suprasegmental (e.g., tone, stress, vowel duration) and segmental (e.g., syllabic structure) information, high proficiency learners use suprasegmental and less frequent segmental (e.g., CVC but not CV syllabic structure) information, and low proficiency learners do not use suprasegmental or segmental information (see Sagarra & Casillas, 2018, for a review). However, it is unclear what makes proficient learners better anticipators than non-proficient ones: is it their higher L2 proficiency or their increased anticipatory experience?

This study investigates whether native speakers and advanced learners use suprasegmental and segmental information to predict a word's suffix, and whether anticipatory experience affects L2 predictions. To this end, advanced English learners of Spanish with and without professional interpreting experience and Spanish monolinguals looked at two Spanish verbs on a screen while hearing Spanish sentences containing one of the two verbs. Eye fixations to the target verb before hearing the suffix measured the use of suprasegmental (lexical stress) and segmental (syllabic structure) information in the verb stem to predict the verb suffix. Professional interpreters were included because they have extensive practice anticipating linguistic information (Liontou, 2012). Lexical stress was chosen because it is contrastive in English and Spanish, yet it is realized differently in each language, resulting in cross-linguistic interference in L2 learners (Face, 2005; Lord, 2007). Syllabic structure was selected because it can be used to reduce competition during lexical activation for speech production (Cholin, Levelt, & Schiller, 2006). Finally, the visual world paradigm methodology was employed because it measures attention to upcoming linguistic information prior to disclosure by time-locking listeners' eye-movements to a visual stimulus (e.g., a written word) in response to an oral stimulus (e.g., a sentence) (see Huettig, Rommers, & Meyer, 2011, for a review). Taken together, the findings of this study will advance our understanding of how humans gain anticipation expertise and will inform cognitive models and instructional practices.

2.3 Anticipation in Monolinguals

Native speakers use a myriad of information to make linguistic predictions, including semantics (Altmann & Kamide, 1999), morphology (Grüter, Williams, & Fernald, 2012; Lew-Williams & Fernald, 2010), and phonology (intonation: Nakamura, Arai, & Mazuka, 2012; Weber, Rice, & Matthew, 2006; tone: Roll, 2015; Roll, Horne, & Lindgren, 2011; pauses between clauses: Hawthorne & Gerken, 2014; Kjelgaard & Speer, 1999; vowel duration: Rehrig, 2017). Such predictions depend on speech rate (slower rates increase prediction), preview time (longer times increase prediction), task instructions (explicitly instructing participants to predict increases prediction) (Huettig & Guerra, 2019), and age (younger age increases prediction) (Wlotko, Lee, & Federmeier, 2010). Interestingly, older monolinguals with larger vocabularies and higher verbal fluency are as effective as younger monolinguals making linguistic predictions (Federmeier, Mclennan, De Ochoa, & Kutas, 2002), suggesting that prediction is not always affected by age.

Relevant to our study, native speakers make use of suprasegmental and segmental information to predict morphology within a word. For suprasegmentals, Swedish speakers use tone to predict number (singular/plural) (Roll, Horne, & Lindgren, 2010; Söderström, Horne, & Roll, 2015; Roll, Söderström, & Horne, 2013) and tense (present/past) (Söderström, Roll, & Horne, 2012; Roll, 2015), Hispanophones use lexical stress to predict tense (present/past) (Sagarra & Casillas, 2018), and Anglophones use vowel duration to predict voice (active/passive) (Rehrigh, 2017) – but this study mixed suprasegmental (vowel duration) and segmental variables. With regard to segmentals, Swedish speakers use the phonotactic frequency of a word's first two segments to predict number (singular/plural) (Roll et al., 2017), and Hispanophones use syllabic structure of a word's first syllable to predict tense (present/past) (Sagarra & Casillas, 2018). Considered together, these studies indicate that native speakers utilize both suprasegmental and segmental information to anticipate a word's suffix.

2.4 Anticipation in L2 Learners

Contrary to native speakers, L2 learners show a high degree of variability when making predictions (Kaan, 2014). Thus, they may (Foucart et al., 2016) or may not (Martin et al., 2013) use contextual cues, and they may (Marull, 2017) or may not (Lew-Williams & Fernald, 2010) use morphological cues. This variability has been attributed to cross-linguistic differences. For instance, Dussias, Valdés Kroff, Guzzardo Tamargo and Gerfen (2013) found that low-proficiency learners of a gendered L1 (Italian) can partially use gender information to make gender agreement predictions in a gendered L2 (Spanish), whereas low-proficiency learners of a genderless L1 (English) cannot. In addition, Hopp (2016) reported that lacking a mental representation of gender marking hinders L2 prediction of gender agreement.

Cross-linguistic effects are also evident in suprasegmental information: higher, but not lower, proficiency learners use suprasegmental information in a word stem to predict its suffix when the L1 lacks the target prosodic distinction (Rehrig, 2017; Schremm, Söderström, Horne, & Roll, 2016), or realizes it differently (Sagarra & Casillas, 2018). For example, advanced (Schremm et al., 2016), but not beginning (Gosselke et al., 2018), L2 learners of Swedish with a non-tonal L1 background make tone-suffix anticipatory associations. Unfortunately, these findings are confounded, because the study with advanced learners examined tone-suffix associations to predict tense in verbs, whereas the one with beginners focused on number-suffix associations to anticipate number in nouns. To address this limitation, Sagarra & Casillas (2018) investigated stress (suprasegmental) and syllabic structure (segmental) as predictors of verb tense in *both* beginning and advanced English learners of Spanish. They found that advanced, but not beginning, learners anticipated suffixes preceded by a CVC stem, but not a CV stem, regardless of the stem stress. Similarly, Rehrig (2017) reported that Chinese learners of English failed to use vowel duration to predict verb suffixes essential to interpreting the sentence as active or passive, possibly due to low proficiency (assessed via self-ratings), the use of a contrast known to be acquired late even in monolinguals (active/passive voice), or vowel duration being confounded with syllabic structure (long duration items contained complex codas; short duration items contained open syllables). Finally, Schremm et al. (2017) reported that beginning learners of Swedish extensively exposed to tone-suffix associations via a digital game training interpreted and produced these associations more effectively than a control group. Unfortunately, these studies mix proficiency with anticipatory experience. We isolate the role of anticipatory experience by comparing L2 learners of equivalent proficiency with and without interpreting experience.

2.5 Anticipation in Interpreters

Simultaneous interpreting is cognitively taxing (Gile, 2015) because it requires interpreters to retain information from the source language in working memory (WM), access meaning, connect to previous information, translate into the target language, and produce the message in the target language (Bajo, Padilla, & Padilla, 2000). This explains why interpreters are better at: (1) detecting written errors than interpreter students, non-interpreter bilinguals, and monolinguals (Yudes, Macizo, Morales, & Bajo, 2013), (2) adapting their strategies to tasks (e.g., repeating information vs. interpreting into their L2) (Togato, Paredes, Macizo & Bajo, 2015), and (3) reading comprehension and WM (Bajo, Padilla & Padilla, 2000) (but see Dong & Cai, 2015, for a review of studies against this WM-interpreter advantage). Furthermore, interpreters exhibit increased cortical thickness in brain areas related to phonetic processing, higher-level formulation of propositional speech, conversion of items from WM into a sequence, and domain-general executive control and attention (Hervais-Adelman et al., 2017). We examine whether this “interpreter advantage” extends to non-interpreting situations, specifically, L2 anticipation.

Anticipation plays a central role in interpreting, allowing interpreters to pre-activate and produce pre-activated information before hearing it, and is commonly taught in simultaneous interpreting courses (Li, 2015) to decrease cognitive load and to facilitate efficient interpreting (Seeber & Kerzel, 2011). To predict, interpreters employ discourse redundancy (Chernov, 2004) and contextual and syntactic knowledge (Moser-Mercer, 1978). This allows interpreters to anticipate often—about 1 sentence every 85 seconds (Van Besien, 1999)—and effectively—they predict accurately 95% of the time (Liontou, 2012). Furthermore, increased levels of prediction are associated with fewer errors and with a more complete interpretation with fewer omissions from the source speech (Kurz & Färber, 2003). Despite the frequency and efficiency of anticipation in interpreters, to our knowledge, there is currently only one study on the subject involving this population. Chernov (2004) investigated interpreters' anticipation of highly constraining sentences with unexpected endings while performing simultaneous interpreting. The results showed that the interpreters generated more accurate predictions when interpreting from their L1 to their L2 than when interpreting from their L2 to their L1. However, the participants' L1s were mixed, the variables were unclear, and statistical analyses were absent.

Our study stakes out new territory by investigating whether interpreters' vast anticipatory experience, developed over a prolonged period of time, extends to non-interpreting situations. This is important to tease apart proficiency from anticipatory experience's effects on lexical anticipation. As previously mentioned, short-term training on the association between prosodic cues and morphology strengthens prediction (Schremm et al., 2017). The present study makes a contribution to prediction models by investigating how experience with interpreting could act as long-term training.

2.6 Lexical Stress and Syllabic Structure in Spanish and English

This study includes two linguistic variables related to morphological anticipation: lexical stress (suprasegmental) and syllabic structure (segmental).[1] Both segments, discrete units of sound identifiable in the speech signal, and suprasegmentals, elements of speech extending over a range of segments, can be used contrastively. Lexical stress, a suprasegmental, refers to the relative prominence of one syllable over the rest of the syllables in a word. Prominent syllables typically have higher pitch, longer duration, and are louder (Hualde, 2013). Lexical stress is contrastive in both Spanish (*SAbana* 'bed sheet' vs. *saBAna* 'savannah') and English (*CONflict* vs. *conFLICT*), but it is realized differently in the two languages. English is typically categorized as a stress-timed language in which the time interval between stressed syllables is approximately the same and is partially modulated by vowel reduction processes. Specifically, unstressed vowels typically have shorter duration and formant frequencies often centralize towards [ə]. Spanish, on the other hand, is generally assumed to be a syllable-timed language in which syllables, both stressed and unstressed, have approximately the same duration and vowel quality tends to remain steady-state. These differences may explain why Anglophones encounter difficulties producing (Lord, 2007) and perceiving (Face, 2005, 2006) lexical stress in L2 Spanish, though it is also clear that Spanish and English monolinguals use

[1] In the present study the terms suprasegmental information and segmental information are used to denote word level metrical/prosodic information (lexical stress) vis-à-vis syllable level prosodic information (syllable structure), respectively. We loosely refer to the linguistic variable syllable structure as being segmental with the sole purpose of describing the presence or absence of a segment in coda position.

this suprasegmental property in different ways. For instance, a prosodically matched prime facilitates perception in Spanish and English monolinguals, but a mismatched prime inhibits (slower RTs) perception in Spanish monolinguals (Soto-Faraco, Sebastián-Gallés, & Cutler, 2001), but not in English monolinguals (Cooper, Cutler, & Wales, 2002). These differences suggest that lexical stress in Spanish is used to reduce the number of competitors for lexical access; this does not seem to be the case in English, likely due to the fact that vowel reduction can efficiently fill this role.

With regard to syllabic structure, both Spanish and English permit open and closed syllables, though there is a presumably universal preference for onset + vocoid sequences to remain open, i.e., codaless (see Hyman, 1975, and Jakobson, 1968, for a review). This preference is evidenced by the fact that some languages allow codas, but no language requires them. Likewise, in some languages onsetless syllables are legal, but no language forbids onsets. Given this tendency to avoid coda segments, CVC syllables in English and Spanish are considered marked with regard to CV syllables under current phonological frameworks. As a result, the mere presence of a coda may be perceived as more salient acoustically (Hahn & Bailey, 2005) or articulatory (Côté, 1997) to the listener. Crucial to our study, the structure of a word's first syllable can reduce competition during lexical access (Cholin, Levelt, & Schiller, 2006), such that initial segments with fewer possible and more frequent endings trigger stronger preactivation (Roll et al., 2017). In other words, the syllable structure of a lexical item might aid anticipatory processes before morphological information becomes available.

2.7 The Present Study

Previous studies suggest that native speakers use suprasegmental and segmental information to predict a word's suffix, and that non-native speakers use this information depending on proficiency (higher proficiency correlates with better anticipation) and frequency of occurrence (lower frequency is associated with fewer lexical competitors) (see Sagarra & Casillas, 2018, for a review). However, most studies examine either natives or non-natives, and suprasegmental or segmental variables, and thus cannot be directly compared. To address this limitation, we investigate native and non-native use of suprasegmental (lexical stress: oxytone, paroxytone) and segmental (syllabic structure: CVC, CV) information to predict word suffixes. In addition, L2 anticipatory studies cannot explain why higher, but not lower, proficiency learners can use linguistic variables to anticipate, as they confound proficiency and anticipatory experience. To tease the two apart, we compare equally proficient learners (advanced) with and without extensive interpreting experience.

The first research question examined whether Spanish monolinguals and advanced English learners of Spanish use suprasegmental and segmental information to anticipate word suffixes, and if they do, whether frequency of occurrence (oxytones and CVC are less frequent than paroxytones and CV) affects their anticipation. We tested four hypotheses. First, based on studies showing that natives use suprasegmental information (Swedish tone: Roll et al., 2010, 2013; Söderstrom et al., 2015; Schremm et al., 2016; English vowel duration: Rehrigh, 2017; Spanish stress: Sagarra & Casillas, 2018) and segmental information (Swedish phonotactic frequency: Roll et al., 2017; Spanish syllabic structure: Sagarra & Casillas, 2018) to anticipate inflectional morphology during spoken word recognition, we predicted that monolinguals would use both stress and syllable structure. Second, we assumed that monolinguals anticipate earlier and faster than non-interpreter L2 learners, considering that lexical stress is a stronger cue for lexical disambiguation in Spanish (Soto-Faraco et al., 2001) than in English (Cooper et al., 2002). Third, we expected the non-interpreter L2 learners to use stress, but only for the less frequent syllable structure (CVC), to anticipate a word's suffix, based on prior work indicating that high proficiency learners use suprasegmental properties (Swedish tone: Schremm et al., 2016) but only for less frequent segmental features (Spanish CVC structure: Sagarra & Casillas, 2018). Fourth, we hypothesized that monolinguals and non-interpreter L2 learners would anticipate earlier and faster with less frequent CVC oxytone words than with more frequent CV paroxytone words, considering earlier studies revealing that cues related to a smaller pool of lexical competitors increase brain activation (suprasegmental: Roll et al., 2015) and strengthen anticipation (segmental: Roll et al., 2017).

The second research question explored whether increased anticipatory experience acquired via interpreting facilitates anticipation in non-interpreting L2 situations. This question generated three hypotheses. First, we assumed that interpreters would predict earlier and faster with less frequent suprasegmental and segmental cues, like the monolinguals and the non-interpreter learners. Second, we expected interpreters to start predicting earlier than non-interpreters and monolinguals because earlier prediction releases cognitive load facilitating interpretation of upcoming speech (Seeber & Kerzel, 2011). Third, we hypothesized that interpreters would anticipate at a faster rate than non-interpreters (albeit slower than monolinguals), based on studies indicating that interpreting practice not only results in increased cortical thickness in brain areas implicated in simultaneous interpreting, but also in other areas related to the production of propositional speech (Hervais-Adelman et al., 2017). Some studies show that the production system is involved during prediction (see Pickering & Gambi, 2018, for a review) and, thus, interpreters' more robust productive system could accelerate their predictive processing.

2.8 Methods

2.8.1 Participants

The sample pool consisted of 25 Spanish monolinguals, 25 non-interpreter advanced English L2 learners of Spanish, and 22 advanced English (L1) – Spanish (L2) interpreters, between 18 and 76 years old. The data were collected at two large universities in the United States and Spain. The monolinguals were born and raised in a monolingual region of Spain, had not been abroad for more than 3 months, and were not proficient in English according to a multiple-choice section adapted from the TOEFL. The learner groups were born and raised in an English monolingual environment, attended school in English, learned Spanish in a formal setting after the age of 12, and most of them had studied abroad in a Spanish-speaking country (range = 0 – 418 months, $M = 22.7$, $SD = 60.8$). The non-interpreters had no translating or interpreting experience. The interpreters had official interpreting certifications (courts, medical interpreting, etc.) or professional training (master's and bachelor's), and had been working as professional interpreters full-time for at least two years (range = 2 – 35 years, M = 14.2, SD = 9.23). Most of the interpreters worked in the simultaneous interpreting mode (the interpreter translates the speech at the same time as the speaker is talking) and occasionally in consecutive interpreting (the interpreter renders the translation after the speaker finishes one section of the speech).

To rule out the possibility of interpreters performing better than non-interpreters due to higher WM or L2 proficiency, we tested for homogeneity of variance for WM (all groups) and L2 proficiency (L2 groups), and then conducted TOST (two one-sided tests) of equivalence for all pairwise comparisons (Lakens, 2017). We tested moderate effects with a Cohen's D of 0.3. The results revealed equal homogeneity for WM ($K_2(1) = 2.29$, $p = 0.13$) and L2 proficiency ($K_2(1) = 0.32$, $p = 0.57$). Furthermore, the observed effects were statistically not different from zero for all pairwise comparisons for WM (monolinguals vs. interpreters: $t(34.69) = 0.49$, $p = 0.69$; monolinguals vs. non-interpreters: $t(47.22) = 0.78$, $p = 0.22$; interpreters vs. non-interpreters: $t(37.72) = 0.639$, $p = 0.737$) and for L2 proficiency (interpreters vs. non-interpreters: $t(42.36) = 1.89$, p = 0.07). Table 2.1 summarizes the descriptive statistics for age, WM, and L2 proficiency.

Table 2. 1 Descriptive statistics for Participant's WM and DELE

		AGE		WM		DELE	
	n	M	SD	M	SD	M	SD
Monolinguals	25	30.52	10.00	9.16	1.93	-	-
Interpreters	23	42.83	12.97	10.48	3.07	48.74	4.27
Non-Interpreters	27	27.44	4.89	9.04	2.11	46.07	4.14

2.8.2 Materials and Procedure

Participants completed a language background questionnaire (5 minutes), a proficiency test (20 minutes), an eye-tracking task (20 minutes), a phonological short-term memory test (10 minutes), a WM test (10 minutes), a gating task (10 minutes), and a production task (15 min), in this order. All tasks were collected individually in one session (approx. 1 hour and 30 minutes). The present work focuses on the eye-tracking data.

2.8.2.1 Screening Tests

The language background questionnaire included questions about the participants' L1 and L2 acquisition, education, stays abroad, and current percentage of use of both languages. The interpreters group had an extra set of questions related to their professional activity: working languages, modes of interpreting most commonly used (consecutive, simultaneous, or sight translation), interpreting training and certification, and years of professional experience. The language proficiency test was an adapted version of the *Diploma de Español como Lengua Extranjera* (DELE) with a total of 56 multiple-choice questions. Three blocks of 12 questions assessed grammar and the last 20 questions evaluated reading comprehension. Correct answers received 1 point and incorrect answers received 0 points.

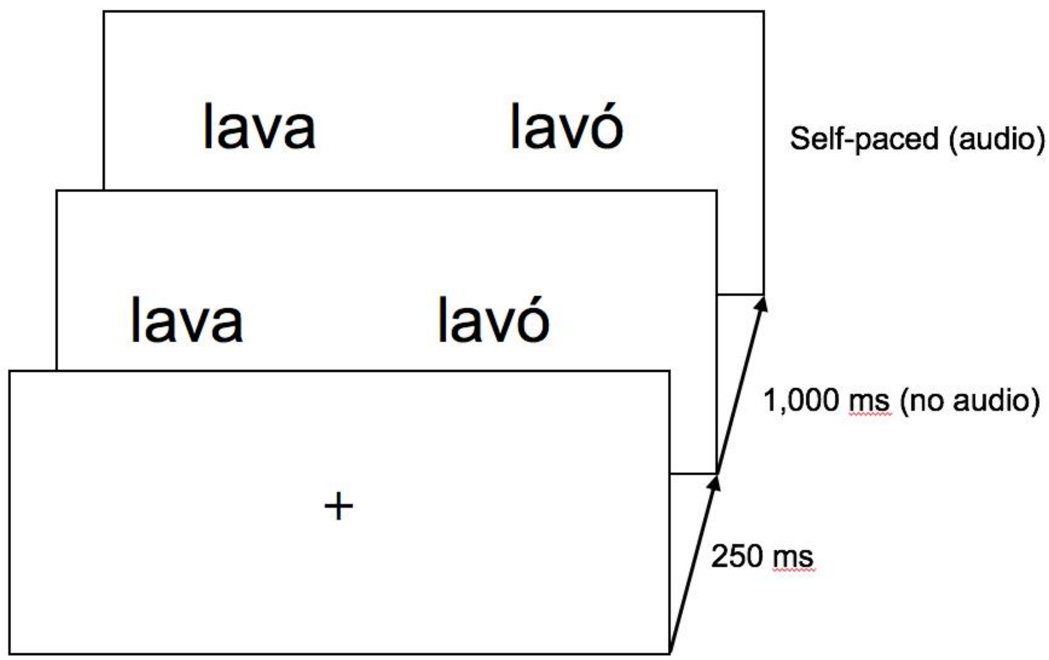
2.82.2 Eye-tracking Task

An EyeLink 1000 Plus desktop mount eye-tracker from SR Research was used to record eye movements (sampling rate: 1k Hz; spatial resolution was less than $.05_o$; averaged calibration error: $.25$-$.5_o$). The task was presented to participants on a BenQ

XL2420TE monitor at a resolution of 1920 x 1080 pixels and using Sol Republic 1601-32 headphones. There were 66 sentences: 18 practice, 16 experimental, and 32 fillers. All sentences were 5 to 7 words long, there were equal proportions of two filler types (number: *col-coles* ‘cabbage-cabbages’; lexical: *mar-marco* ‘sea-frame’), and all word pairs presented to the participant (experimental and filler) had segmentally identical syllables. The target words were paroxytones (8 disyllabic verbs) and oxytones (8 disyllabic verbs). Approximately half of the target words’ first syllable had CV structure (*la.var* ‘to wash’), and the other half had CVC structure, with a rhotic or nasal coda (*fir.mar* ‘to sign’). Finally, the paroxytone and oxytone target words were comparable in terms of overall lexical frequency ($K_2(1) = 2.70$, $p = 0.11$, TOST: $t(37.11) = 0.67$, p = 0.75) as measured by the *LEXESP* Spanish frequency dictionary (Sebastián-Gallés, Carreiras, Cuetos & Martí, 2000).

The procedure was the following: participants rested their heads on a chin-rest and performed a nine-point calibration while looking at a monitor. Then, they completed the practice trials followed by the experimental and filler trials, separated by a 500-ms blank screen. Participants were randomly assigned to one of the two versions of the experiment. The practice trials were identical in both versions, were presented in the same order, and served to familiarize participants to the speaker’s voice, speech rate and acoustic characteristics of the sound files. For each trial (practice, experimental, or filler), the participants completed a drift correction, followed by a fixation point in the center of the screen for 250 ms, they read the target and distractor words (e.g. *lava* - *lavó*, ‘(s)he washes - washed’), and 1,000 ms later they heard the sound file (e.g. *El primo lavó los* *coches*, 'the cousin washed the cars'). Next, they chose one of the two words as soon as they could by pressing the right or left shift key (see Appendix 2.1 for a complete list of stimuli). Participants did not need to listen to the entire sentence, but key presses before the target onset did not stop the sound file nor were they recorded (see Figure 2.1).

Figure 2. 1 Sample trial in the eye-tracking task.



Words rather than images were used, because a pilot eye-tracking task with monolinguals showed that imageability of the target words was low and that participants could not decipher what the image meant even after hearing the target word. Also, words show stronger phonological competitor effects with non-predictive contexts (Huettig & McQueen, 2007). Words were displayed in Arial font and 150pt size, were centered in the left and right halves of the screen, and were counterbalanced (half of present verbs appeared on the left, half as targets and half as distractors, and half of past tense verbs appeared on the right, half as targets and half as distractors).

Auditory stimuli were recorded in a sound-attenuated booth, using a Shure SM58 microphone and a Marantz Solid State Recorder PMD670, at a sampling rate of 44.1 kHz and 16-bit quantization. A female native speaker of Peninsular Spanish recorded each sentence three times, taking into consideration speaking rate and standard intonation. The best iteration was selected according to clarity. Next, volume was normalized at -18dB, and 100ms of leading and trailing silence was added using *Praat* (Boersma & Weenik, 2017). The mean speech rate of all utterances was 3.03 ± 0.49 *SD* syllables per second, and the mean length of all sentences was 2.51 ± 0.22 *SD* seconds. Finally, sentences were organized following a Latin Square design (each block included only one sentence of a specific condition) and were later pseudo-randomized to reduce the chances of two sentences of the same type and condition appearing consecutively.

2.9 Statistical Analysis

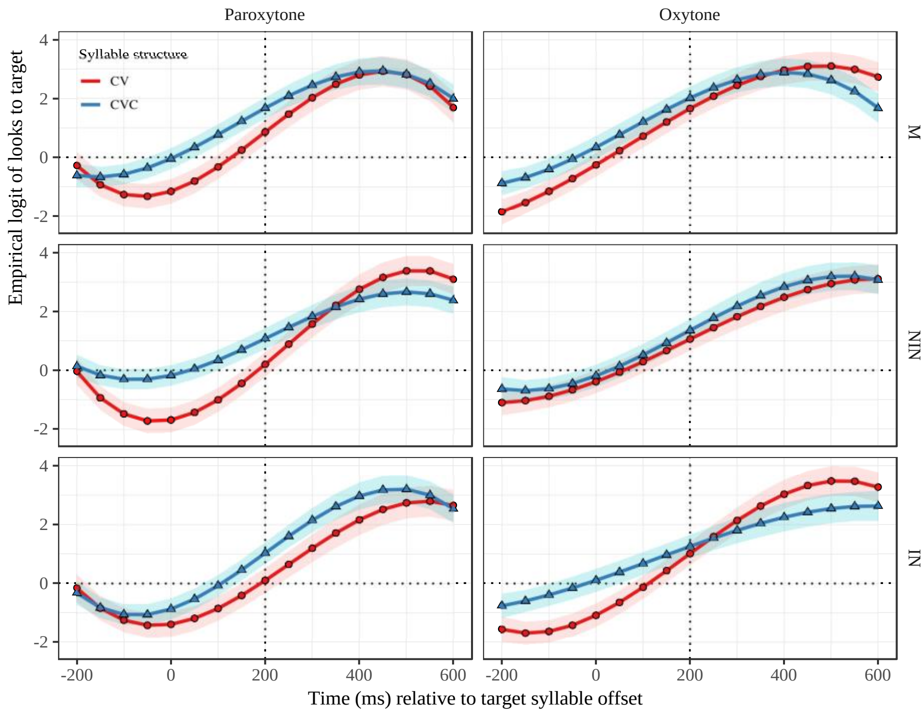
The time course data from the eye-tracking task were analyzed using weighted empirical-logit growth curve analysis (GCA, Mirman, 2016). We used GCA to model how the probability of fixating on target items changed over time and under different suprasegmental and segmental conditions. We downsampled the data to bins of 50 ms which were centered at the offset of the first syllable of target items. The empirical logit transformation (Barr, 2008) was applied to the binary responses (fixations to the target or the distractor). The time course of fixation ranged from 200 ms before target syllable offset to 600 ms after. We chose this window because it captured the portion of the time course in which target fixations began to steadily increase from chance. We modeled the time course using linear, quadratic, and cubic orthogonal polynomials with fixed effects of group, lexical stress, and syllable structure on all time terms. For the group predictor, monolinguals were set as the baseline, thus the interpreters and non-interpreters' parameters described how the growth curve of the learners differed from that of the native controls. Lexical stress and syllable structure were sum coded such that parameter estimates represent the effect size associated with a change from CV to CVC syllables and paroxytone to oxytone stress. All models included by-subject random effects on all time terms and the syllable structure and lexical stress predictors, as well as by-item random effects on all time terms. Main effects and higher order interactions were assessed using nested model comparisons. The analysis was conducted in R (R Core Team, 2019) and the GCA models were fit using lme4 (Bates, Mächler, Bolker, & Walker, 2009). Pairwise comparisons between learner groups were conducted using the R package multcomp (Hothorn, Bretz, & Westfall, 2008).

2.10 Results

Figure 2.2 plots the model estimates from the GCA, and the full model summary is available in Appendices 2.2 and 2.3. We report the results for the monolingual group and then provide comparisons with and between the learner groups. The model intercept estimates the log odds of monolinguals fixating on the target, averaging over the time course, lexical stress and syllable structure. The log odds were $\gamma_{00} = 1.17$ (proportion: .76). The linear, quadratic, and cubic polynomial time terms captured the sigmoid shape of the time course and were retained in the model ($\gamma_{10} = 5.704$; SE = 1.042; $t = 5.476$; $p =$

.001; $\gamma_{20} = -1.373$; SE = 0.423; $t = -3.246$; $p = .001$; $\gamma_{30} = -1.711$; SE = 0.367; $t = -4.658$; $p = .001$).

Figure 2. 2 Growth curve estimates



2

There was a main effect of lexical stress on the quadratic time term ($\chi_2(1) = 4.4$, $p = .036$). Averaging over syllable structure, a change from paroxytonic (e.g. *LAva*) to oxytonic (e.g. *laVÓ*) stress decreased the bowing of the trajectory at the center of the time

2 Growth curve estimates of target fixations as a function of lexical stress and syllable structure for each group during the analysis window. Symbols and lines represent model estimates, and the transparent ribbons represents ±SE. Empirical logit values on y-axis correspond to proportions of 0.12 0.50 0.88 0.98. The horizontal dotted line represents the 50% probability of fixating on the target. The vertical dotted line indicates 200 ms after the offset of the target syllable.

course (γ_{22} = 0.666; SE = 0.305; t = 2.184; p = .029) indicating that monolinguals fixated on oxytonic targets earlier than paroxytonic targets. There was also a main effect of syllable structure on the cubic time term ($\chi^2(1)$ = 4.4, p = .037), as well as a syllable structure × lexical stress interaction on the linear time term ($\chi^2(1)$ = 4.6, p = .032), such that the effect of lexical stress decreased the overall slope (γ_{31} = −0.594; SE = 0.260; t = −2.283; p = .022) and the bowing of the vertices (i.e., turning points) of closed, paroxytonic syllables (γ_{15} = −1.047; SE = 0.464; t = −2.255; p = .024). This indicates that monolinguals fixated on the paroxytone targets slightly later in the time course, whereas they fixated on oxytone targets earlier, but at a slower and steadier rate. The presence of the coda increased the rate of target fixation on paroxytone items, but had little effect on oxytone items (see the upper panels of Figure 2).

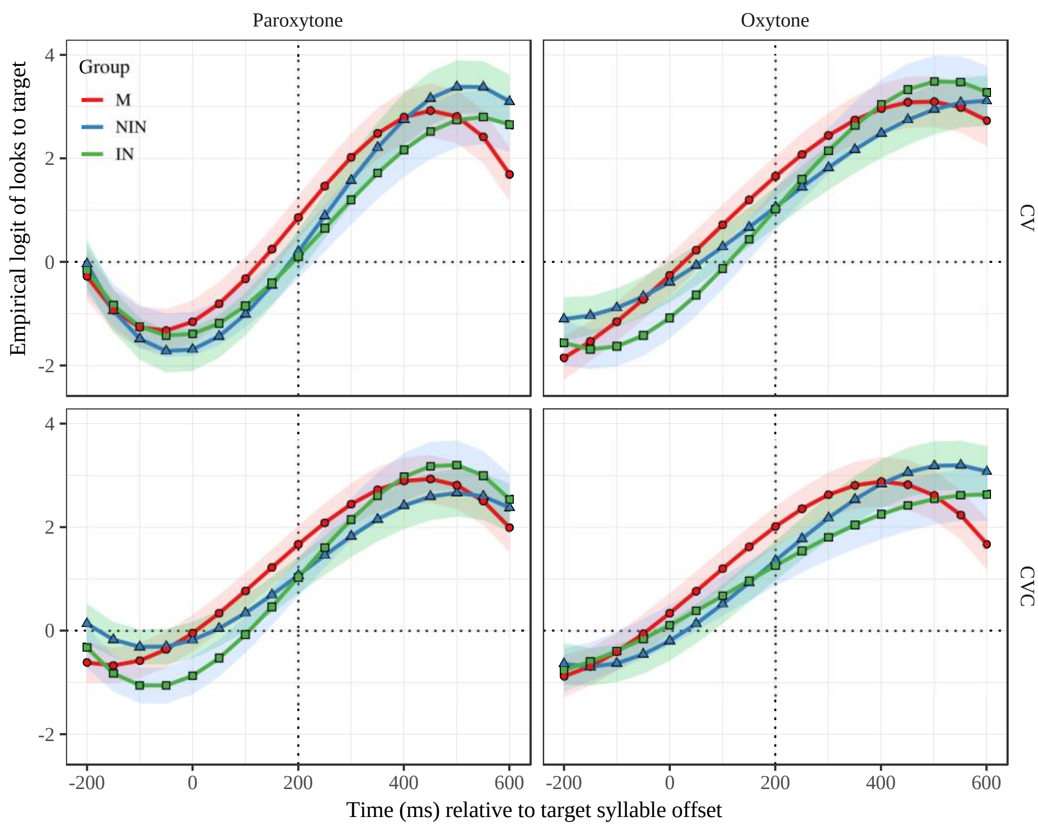
Focusing on the offset of the target syllable, the model estimated target fixations above 50% in all conditions (Paroxytone CV: Probability = 0.702; LB = 0.608; UB = 0.782; Paroxytone CVC: Probability = 0.842; LB = 0.787; UB = 0.884; Oxytone CV: Probability = 0.839; LB = 0.779; UB = 0.886; Oxytone CVC: Probability = 0.882; LB = 0.836; UB = 0.917). Table 2 provides estimates ±SE for all groups in all conditions. Overall, the analyses indicated that the monolinguals group anticipated target suffixes in all conditions, though certain conditions seem to facilitate prediction. Specifically, defaulting from a paroxytone with a CV penult (e.g. *LAva*), one observes earlier target fixations with the addition of a coda and with a shift of stress to the final syllable (e.g. *firMÓ*), suggesting that marked sequences facilitate lexical access in native speakers.

Table 2. 2 Model estimates for probability of target fixations ±SE at 200 ms after the target syllable offset.

Group	Lexical stress	Syllable structure	Probability	LB	UB
M	Paroxytone	CV	0.702	0.608	0.782
	Paroxytone	CVC	0.842	0.787	0.884
	Oxytone	CV	0.839	0.779	0.886
	Oxytone	CVC	0.882	0.836	0.917
NIN	Paroxytone	CV	0.550	0.446	0.649
	Paroxytone	CVC	0.745	0.672	0.807
	Oxytone	CV	0.742	0.661	0.810
	Oxytone	CVC	0.795	0.726	0.851
IN	Paroxytone	CV	0.526	0.420	0.629
	Paroxytone	CVC	0.738	0.661	0.802
	Oxytone	CV	0.735	0.650	0.805
	Oxytone	CVC	0.779	0.704	0.840

With regard to interpreters and non-interpreters, there was a simple interaction of the quadratic time term on the intercept for the non-interpreters group (γ_{23} = 1.819; SE = 0.448; *t* = 4.060; *p* = .001). That is, the non-interpreters had a more bowed trajectory at the offset of the target syllable than monolinguals, indicating that, overall, non-interpreters fixated on targets later than monolinguals. Additionally, there was a lexical stress × syllable structure × non-interpreter group interaction on the linear slope (γ16 = 1.004; SE = 0.271; t = 3.708; p = .001), such that non-interpreters had a steeper slope than monolinguals in CV syllables of paroxytone words. This indicates that non-interpreters fixated on targets later under the default condition (e.g., *LAva*), but earlier in other conditions (e.g., *laVÓ, FIRma, firMÓ*). For the IN group, there was also a simple interaction of the quadratic time term on the intercept (γ_{24} = 1.615; SE = 0.462; t = 3.496; p = .001). Thus, with regard to monolinguals, interpreters also fixated later on targets overall. Finally, there was a lexical stress × syllable structure interaction with interpreters on the cubic time term (γ_{37} = 0.773; SE = 0.275; t = 2.816; p = .005), indicative of sharper vertices for CV oxytone targets. Thus, IN fixated on CV oxytones (i.e., *laVÓ*) at a faster rate than monolinguals, though they did so later in the time course. Interpreters also showed a lower proportion of target fixations than monolinguals 200 ms after the target syllable offset (see the upper right panel of Figure 2.3).

Figure 2. 3 Growth curve estimates per group



3

To sum up, both learner groups showed later target fixations in the default, CV paroxytone condition (i.e., *LAva*). This assertion is corroborated by examining the non-interpreters and interpreters' proportion of target fixations at the target syllable offset (see Table 1). Specifically, the model estimates suggest that non-interpreters did not anticipate

3 Growth curve estimates of target fixations as a function of lexical stress and syllable structure for each group during the analysis window. Symbols and lines represent model estimates, and the transparent ribbons represents ±SE. Empirical logit values on y-axis correspond to proportions of 0.12 0.50 0.88 0.98. The horizontal dotted line represents the 50% probability of fixating on the target. The vertical dotted line indicates 200 ms after the offset of the target syllable.

with CV paroxytones (Probability = 0.55; LB = 0.446; UB = 0.649), but did so at a higher rate in all other conditions (Paroxytone CVC: Probability = 0.745; LB = 0.672; UB = 0.807; Oxytone CV: Probability = 0.742; LB = 0.661; UB = 0.81; Oxytone CVC: Probability = 0.882; LB = 0.836; UB = 0.917). The same was true for the interpreter group (Paroxytone CV: Probability = 0.526; LB = 0.42; UB = 0.629; Paroxytone CVC: Probability = 0.738; LB = 0.661; UB = 0.802; Oxytone CV: Probability = 0.735; LB = 0.65; UB = 0.805; Oxytone CVC: Probability = 0.779; LB = 0.704; UB = 0.84). Importantly, pairwise comparisons (see Appendix 3) showed that the learner groups also differed from each other. In particular, there was a lexical stress × syllable structure interaction on the linear and cubic time terms (γ_{19} = 1.51; SE = 0.28; t = 5.46; p < .001; γ_{39} = −0.81; SE = 0.27; t = −2.95; p = .003, respectively). Figure 3 shows that the learners have nearly identical trajectories for CV paroxytones (*LAva*). In all other conditions, interpreter have steeper slopes with more bowed vertices, indicating later target fixations with regard to non-interpreters. That said, in all conditions the interpreters group fixated on targets in equal proportion to non-interpreters at the offset of the target syllable (the dotted vertical lines), suggesting interpreters fixate on targets later but at a faster rate in some conditions.[4]

[4] The range of participant ages was wider for interpreters (see Table 1). Specifically, the three groups were comparable regarding minimum age, but the interpreters' max age (76) exceeded that of the other groups. To address this possible confound we fit an additional model to the interpreters' data including age as a continuous predictor. There was no effect of age on the intercept ($\chi^2(1)$ = 0.13, p = .721), nor on any of the orthogonal polynomial time terms (Time$_1$ × Age: $\chi^2(1)$ = 0.21, p = .648; Time$_2$ × Age: $\chi^2(1)$ = 1.4, p = .23; Time$_3$ × Age: $\chi^2(1)$ = 0.24, p = .621). Thus, we found no evidence suggesting that the probability of fixating on targets was modulated by age in the interpreter group, and, to the extent possible, we discard the

2.11 Discussion

We investigated whether native and non-native speakers use suprasegmental (lexical stress) and segmental (syllabic structure) information to anticipate verb morphology during spoken word recognition, and whether increased anticipatory experience acquired via interpreting facilitates anticipation in non-interpreting L2 situations. The results showed that all groups used suprasegmental and segmental information to anticipate words (except the advanced learners in CV paroxytone words), that all groups anticipated better in the less frequent conditions (CVC oxytone words), that monolinguals anticipated earlier than L2 learners, and that interpreters anticipated at a faster rate than the rest in some conditions. These findings demonstrate that native and non-native spoken word recognition is modulated by suprasegmental and segmental information, revealing that structural integration and lexical recognition go hand in hand. Additionally, phonological sequences associated with fewer possible endings facilitate prediction, and, anticipatory experience, rather than L2 proficiency alone, enhances L2 prediction.

Our first research question explored whether Spanish monolinguals and advanced English learners of Spanish use suprasegmental and segmental information to anticipate word endings, and whether they anticipate earlier and faster with less frequent CVC oxytone words than more frequent CV paroxytone words. The hypothesis that

possibility that variations in the time courses of interpreters and non-interpreters can be explained by age-related processing differences.

monolinguals would use suprasegmental and segmental information to predict a word's suffix was supported. Our data are consistent with prior studies showing that natives use suprasegmental information to predict morphological information (tone: Roll, 2015; Söderström et al., 2012) and syntactic information (intonation: Nakamura et al., 2012; Weber et al., 2006; pauses between clauses: Hawthorne & Gerken, 2014; Kjelgaard & Speer, 1999), and segmental information to anticipate morphological information (syllabic structure: Sagarra & Casillas, 2018; phonotactic probability: Roll et al. 2017). The influence of these linguistic variables is so robust that listeners anticipate a word's suffix even when it is not present (Sagarra & Casillas, 2018; Söderström et al., 2017). One unanswered question is whether the data of the studies exploring morphological anticipation extend to lexical anticipation. We are currently analyzing the data of a follow-up study investigating this.

Our second hypothesis that monolinguals would anticipate earlier and faster than non-interpreter learners was supported. Our data align with studies showing that lexical disambiguation depends more on lexical stress in Spanish (Soto-Faraco et al., 2001) than English (Cooper et al., 2002). Our findings suggest that learners' native language may have interfered with their L2 perception of lexical stress. However, the lack of a language pair with similar stress and syllabic structure in L1 and L2 prevents us from making strong assertions about this issue. To address this limitation, we plan to collect data with Mandarin Chinese learners of Spanish (Mandarin Chinese and Spanish are both assumed to be syllable-timed languages, but English is stress-timed), keeping syllabic structure constant.

Our third hypothesis that non-interpreter learners would use lexical stress but only less frequent syllabic structure (CVC) was partially supported. As expected, non-interpreters were able to predict suffixes in the CVC condition, similar to Sagarra & Casillas (2018). However, they also anticipated suffixes in the CV condition with the less frequent stress pattern (oxytone verbs, e.g., *laVÓ*). Our data mirror preceding studies showing that high proficiency learners use suprasegmental information, although less extensively than monolinguals (Schremm et al., 2016). Our findings support the notion that L2 predictive processing is qualitatively similar to monolingual prediction (L2 learners benefit from the same facilitatory cues as monolinguals), but quantitatively different (they predict less and cannot predict when neither facilitatory information type is present).

Finally, our fourth hypothesis that monolinguals and non-interpreter learners would anticipate earlier and faster in CVC oxytone words than CV paroxytone words was supported. This is so because oxytones and CVC occur less often and have fewer lexical competitors, which increases brain activation (suprasegmentals: Roll et al., 2015), and strengthens lexical access (Cholin, Levelt, & Schiller, 2006), morphological anticipation in words (segmental: Roll et al., 2017), and semantic anticipation in sentences (natives: DeLong et al., 2005; Martin et al., 2013; non-natives: Foucart et al., 2016). Overall, these studies and our data support a phonological account of syllable typology as it relates to markedness theory (Hayes & Steriade, 2004; de Lacy, 2006) (see Colina, 2009, for an account of the role of syllable structure in Spanish and its interplay with markedness constraints under an Optimality Theory framework). It is noteworthy that the advantage of CVC over CV can also be explained by listeners having a longer time to anticipate in CVC than CV conditions.[5] This alternative explanation is rooted in studies showing that increased time facilitates anticipation (e.g., Kukona, Fang, Aicher, Chen Magnuson, 2011). To further investigate this, we conducted statistical analyses at CV offset of CVC and CV syllables, and we found identical results as at first syllable offset (analyses reported elsewhere due to space limitations).

Our second research question examined whether increased anticipatory experience acquired via interpreting facilitates anticipation in non-interpreting L2 situations. Our first hypothesis that interpreters would predict earlier and faster with less frequent suprasegmental and segmental cues, like the monolinguals and the non-interpreter learners was supported. These findings are discussed above. Our second hypothesis that interpreters would start predicting earlier than the rest was rejected. Indeed, interpreters began predicting *later* than monolinguals and non-interpreters, except in CV paroxytones (e.g., *LAva*), where interpreters and non-interpreters began predicting at the same time. Interpreters' delayed anticipations can be explained in two ways. First, this could be due to interpreters taking a conservative approach to anticipation. In effect, interpreters pay a high price when making anticipation mistakes while interpreting, because they need to restate the utterance ("or actually…") while continuing to listen to the speaker and retaining new input in memory). Moreover, anticipation depends on the

[5] An anonymous reviewer proposes a third possibility, that is, that the CVC advantage may be rooted in the same mechanisms that yield shorter reaction times when perceiving longer stimuli (Raab, 1962). However, Raab (1962) focuses on perception of noise, rather than language.

listener's goals, prior knowledge, and expected utility of anticipating (providing an accurate prediction, in the interpreters' case) (Kuperberg & Jaeger, 2006). Second, interpreters' delayed predictions can also be due to the older age of the interpreter group, a feasible option considering that cognitive functions can decline with age (e.g., WM: Park et al., 2103) and that older adults have a reduced ability to make predictions unless they have larger vocabularies and higher verbal fluency (Federmeier et al., 2002). However, our data indicated that all groups were homogeneous in WM, and additional statistics examining age effects in the interpreter group indicated that age did not impact the interpreters' ability to make predictions (see footnote 3). These two pieces of evidence rule out age as an explanation for the interpreters' delayed predictions.

Our third hypothesis that interpreters would anticipate at a faster rate than non-interpreters, but at the same rate as monolinguals, was partially supported. Thus, interpreters were faster than non-interpreters in all conditions except for CV paroxytones (LAva). This condition involves a larger pool of lexical competitors, which might prone interpreters to adopt a more conservative anticipatory strategy due to the high cost of prediction error. Interestingly, interpreters were also faster than monolinguals in some conditions, i.e., CV oxytones (laVÓ) and CVC paroxytones (FIRma). We attribute interpreters' faster rate to their extensive anticipatory experience. Interpreting experience also makes them faster to non-interpreters in coordination of simultaneous actions (García, Muñoz, & Kogan, 2019) and dual tasks (Morales, Padilla, Gómez-Ariza, & Bajo, 2015; Strobach, Becker, Schubert, & Kühn, 2015). Faster anticipation is important because it facilitates recognition and interpretation of information by limiting the repertoire of potential candidates, saves resources to allow the listener to prepare for upcoming information, and guides top-down deployment of attention by improving information seeking and decision making (Bubic, Cramon, & Schubotz, 2010). Finally, although we explain interpreters' faster anticipation via their extensive anticipatory experience, we acknowledge that their superiority could be due to other measures of language experience, such as increased weekly contact with the L2, or of cognitive abilities, such as stronger resistance to articulatory suppression.

In sum, our data suggest that natives and non-natives use suprasegmental and segmental information to access spoken words (see Roll, 2015, for a review), and anticipate better when there are fewer lexical competitors. Also, adult learners can adjust their weighting of acoustic correlates of stress in an L2-appropriate manner, in support of accessibility models of adult L2 acquisition. Finally, increased anticipatory experience results in later but faster L2 predictions. There is still a wealth of unsolved problems and unanswered questions regarding how humans anticipate information. Does prediction involve pre-activation (Huettig, 2015) or just a state of preparedness (Ferreira & Chantavarin, 2018)? Is pre-activation probabilistic (DeLong, Urbach & Kutas, 2005) or all-or-nothing (see Kuperberg & Jaeger, 2016 for discussion)? Do people predict specific word forms (DeLong, Urbach & Kutas, 2005) or just certain features (semantic, morphological, etc.) (Pickering & Gambi, 2018)? Is prediction pervasive (Dell & Chang, 2014) or confined to certain situations (Nieuwland et al., 2018)? Future research investigating these issues must take place to have a comprehensive understanding of the cognitive mechanisms underlying prediction.

2.12 Conclusion

We evaluated the role of suprasegmental and segmental information and anticipatory experience in native and non-native morphological anticipation during spoken word recognition. Eye-tracking data revealed that monolinguals and L2 learners with and without interpreting experience used suprasegmental and segmental information about lexical stress and syllable structure to predict word suffixes, except the L2 groups in CV paroxytone words. Overall, all groups showed stronger prediction when suprasegmental and segmental information reduced the number of possible lexical items (oxytonic stress and CVC). Also, both learner groups predicted later than monolinguals, but interpreters did so at a faster rate than non-interpreters (all conditions except CV paroxytones) and monolinguals (in CV oxytones and CVC paroxytones). These findings indicate that less frequent suprasegmental and segmental information and anticipatory experience facilitate native and non-native spoken word prediction. This study advances our understanding of the complexity of anticipatory processes by separating L2 proficiency from prediction experience, and by measuring not only whether natives and non-natives anticipate, but also when and how fast they anticipate.

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Appendix 1: Experimental sentences

La mujer llena / llenó la jarra.

El padre bebe / bebió la cerveza.

La madre manda / mandó la carta.

El director firma / firmó la factura.

La niña pinta / pintó la flor.

El niño sube / subió la pared.

El chico saca / sacó la foto.

La chica come / comió la naranja.

El primo lava / lavó los coches.

La prima graba / grabó los cuentos.

La señora canta / cantó la canción.

El señor compra / compró la joya.

El tío guarda / guardó los billetes.

La tía rompe / rompió la nota.

La vecina lanza / lanzó la pelota.

El vecino cambia / cambió la clave.

Appendix 2: Growth curve model fixed effects

Parameter	Estimate	SE	t	p
Intercept (γ_{00})	**1.167**	**0.306**	**3.810**	**< .001**
Time$_1$ (γ_{10})	**5.704**	**1.042**	**5.476**	**< .001**
Time$_2$ (γ_{20})	**−1.373**	**0.423**	**−3.246**	**.001**
Time$_3$ (γ_{30})	**−1.711**	**0.367**	**−4.658**	**< .001**
Syllable structure (γ_{01})	−0.074	0.203	−0.365	.715
Time$_1$ × Syllable structure (γ_{11})	0.772	0.621	1.243	.214
Time$_2$ × Syllable structure (γ_{21})	0.571	0.310	1.842	.066
Time$_3$ × Syllable structure (γ_{31})	**−0.594**	**0.260**	**−2.283**	**.022**
Lexical stress (γ_{02})	−0.092	0.246	−0.373	.709
Time$_1$ × Lexical stress (γ_{12})	0.125	0.616	0.203	.839
Time$_2$ × Lexical stress (γ_{22})	**0.666**	**0.305**	**2.184**	**.029**
Time$_3$ × Lexical stress (γ_{32})	−0.325	0.256	−1.269	.204
Group NIN (γ_{03})	−0.131	0.277	−0.472	.637
Time$_1$ × Group NIN (γ_{13})	0.365	0.912	0.401	.689
Time$_2$ × Group NIN (γ_{23})	**1.819**	**0.448**	**4.060**	**< .001**
Time$_3$ × Group NIN (γ_{33})	0.124	0.385	0.323	.747
Group IN (γ_{04})	−0.255	0.287	−0.889	.374
Time$_1$ × Group IN (γ_{14})	0.668	0.942	0.709	.478
Time$_2$ × Group IN (γ_{24})	**1.615**	**0.462**	**3.496**	**< .001**
Time$_3$ × Group IN (γ_{34})	0.022	0.396	0.056	.956
Syllable structure × Lexical stress (γ_{05})	−0.029	0.126	−0.233	.816
Time$_1$ × Syllable structure × Lexical stress (γ_{15})	**−1.047**	**0.464**	**−2.255**	**.024**
Time$_2$ × Syllable structure × Lexical stress (γ_{25})	0.146	0.282	0.517	.605
Time$_3$ × Syllable structure × Lexical stress (γ_{35})	−0.405	0.224	−1.811	.070
Syllable structure × Lexical stress × Group NIN (γ_{06})	0.028	0.067	0.425	.671
Time$_1$ × Syllable structure × Lexical stress × Group NIN (γ_{16})	**1.004**	**0.271**	**3.708**	**< .001**
Time$_2$ × Syllable structure × Lexical stress × Group NIN (γ_{26})	0.219	0.269	0.815	.415
Time$_3$ × Syllable structure × Lexical stress × Group NIN (γ_{36})	−0.034	0.267	−0.127	.899
Syllable structure × Lexical stress × Group IN (γ_{07})	−0.014	0.069	−0.199	.842
Time$_1$ × Syllable structure × Lexical stress × Group IN (γ_{17})	−0.507	0.278	−1.821	.069
Time$_2$ × Syllable structure × Lexical stress × Group IN (γ_{27})	0.166	0.277	0.600	.548
Time$_3$ × Syllable structure × Lexical stress × Group IN (γ_{37})	**0.773**	**0.275**	**2.816**	**.005**

Appendix 3: Pairwise comparisons between learner groups.

Parameter	Estimate	SE	t	p
IN - NIN (γ_{08})	0.124	0.283	0.436	.663
$Time_1$ × IN - NIN (γ_{18})	−0.302	0.931	−0.325	.745
$Time_2$ × IN - NIN (γ_{28})	0.204	0.457	0.447	.655
$Time_3$ × IN - NIN (γ_{38})	0.102	0.393	0.260	.795
Syllable structure × Lexical stress × IN - NIN (γ_{09})	0.042	0.069	0.615	.538
$Time_1$ × Syllable structure × Lexical stress × IN - NIN (γ_{19})	**1.511**	**0.277**	**5.463**	**< .001**
$Time_2$ × Syllable structure × Lexical stress × IN - NIN (γ_{29})	0.053	0.275	0.194	.846
$Time_3$ × Syllable structure × Lexical stress × IN - NIN (γ_{39})	**−0.807**	**0.273**	**−2.954**	**.003**

Appendix IV Growth Curve Model Random Effects.

Group	Parameter	Variance	SD	Correlations					
Participant	Intercept	0.911	0.954	1.00					
	Syllable structure	0.275	0.524	−.20	1.00				
	Lexical stress	0.789	0.888	−.07	.31	1.00			
	Time$_1$	9.548	3.090	.42	−.17	.02	1.00		
	Time$_2$	1.640	1.281	−.14	.22	.08	.31	1.00	
	Time$_3$	0.980	0.990	−.40	.08	−.18	−.83	−.14	1.00
Item	Intercept	0.264	0.514	1.00					
	Time$_1$	3.831	1.957	.28			1.00		
	Time$_2$	1.304	1.142	−.74			−.37	1.00	
	Time$_3$	0.415	0.644	.19			−.86	−.14	1.00
Residual		13.507	3.675						

Chapter 3: Interpreting experience enhances the use of lexical stress and syllabic structure to predict L2 word endings

3.1 Abstract

Prediction underlies many of life's situations including language. Most studies have focused on how relationships between words trigger prediction, and some show that prediction also happens within a word. Relevant to this study, monolinguals and advanced L2 learners use prosodic cues such as stress and tone in a word's first syllable to predict its suffix. To determine whether the same findings extend to words with non-morphological endings, we investigate whether Spanish monolinguals and advanced English learners of Spanish with and without interpreting experience use stress (stressed, unstressed) and syllabic structure (CV, CVC) information in a word's initial syllable to predict its non-morphological ending. Simultaneous interpreters were included due to their extensive training and experience on prediction of incoming speech. Participants completed a visual-world eye-tracking study where they listened to a sentence while seeing two words on the screen and selected the word they heard with a button press. Results revealed that monolinguals and interpreters predicted word endings under all conditions, but non-interpreters only predicted in the CVC oxytone condition. These findings are relevant for (1) prediction accounts, showing that prediction based on lexical stress and syllabic structure occurs with non-morphological word endings; (2) phonological models, revealing that prosodic information manifested at the segmental level is key for accessing meaning; and (3) second language processing models,

indicating that additional prediction experience via interpreting practice enhances predictive strategies.

3.2 Introduction

Prediction is a crucial brain mechanism for cognition and perception (Lupyan & Clark, 2015). Its role is so relevant that some scholars propose our brains are like prediction machines using top-down expectations to prepare for stimuli that will likely occur (Clark, 2013). In language processing, prediction is essential in facilitating comprehension by preactivating some components of linguistic representations (e.g., a specific morpheme, phoneme or conceptual feature) and allowing the speaker to process them ahead of time (Pickering & Gambi, 2018).

Importantly, prediction takes place at different linguistic levels (morphosyntactic, syntactic, semantic) and via a myriad of cues (contextual, morphological, prosodic). Relevant to our study, native and non-native speakers can anticipate a word's suffix based on prosodic information in its first syllable, such as tone (natives; Roll et al., 2015; non-natives: Schremm, Söderström, Horne, & Roll, 2016) and stress (natives and non-natives: Sagarra & Casillas, 2018). However, natives' and non-natives' ability to incorporate prosodic cues in predicting a word's non-morphological word ending remains elusive. Is prosody a crucial cue for prediction regardless of morphological status? This question is key to understanding the role of prosody in accessing and processing lexical items in a quick and efficient manner during spoken word recognition.

To address this question, we use eye-tracking to investigate whether Spanish monolinguals and advanced English learners of Spanish with and without interpreting experience use lexical stress (paroxytone/oxytone) and syllabic structure (CV, CVC) in a word's initial syllable to predict non-morphological word endings [6] (e.g., *CARne-carNÉ* 'meat-ID card'). Lexical stress was selected as a predictive cue due to its contrastive value in Spanish (*PApa* 'potato', *paPÁ* 'dad') and syllabic structure (i.e., CV and CVC) was chosen because the coda reduces lexical competitors (Lozano-Argüelles, Sagarra, & Casillas, 2019; Sagarra & Casillas, 2018). Interpreters were included because of their experience making predictions during interpreting (Dong & Li, 2019). Our findings will inform prediction, phonological, and second language processing models. In particular, our results will determine whether the prediction within a word depends on the linguistic nature of its ending (morphological or not). Also, our findings will advance the understanding of the interplay of lexical stress and syllabic structure for word segmentation and lexical activation purposes, illuminating whether phonological encoding is similar in natives and non-natives. Finally, comparing monolinguals and non-interpreter and interpreter L2 learners will determine whether L2 prediction is affected by additional practice making predictions during simultaneous interpreting.

Interpreters and Prediction

Current approaches to bilingualism posit that carefully characterizing critical aspects of bilingual language experience is key to fully capturing the complexity of

6 Target words and distractors were not related etymologically and did not vary in terms of inflectional or derivational morphology. For this reason, we refer to the predicted content in this experiment as non-morphological word-endings. We recognize that word endings might contain a morpheme (e.g., the morpheme '*-a*' in '*papa*', indicating feminine gender).

bilingual language control (Sulpizio, Del Maschio, Del Mauro, Fedeli, & Abutalebi, 2020). For instance, studies show that extent and duration of L2 exposure modify neural activity patterns while performing an inhibitory task (DeLuca, Rothman, Bialystok, & Pliatsikas, 2019), and that language use (but not age of L2 acquisition or L2 proficiency) modulates white matter microstructure changes in areas related to language control (Maschio et al., 2019). Simultaneous interpreting is a cognitively complex task that requires concurrent comprehension and production of two languages. Training in simultaneous interpreting is linked to increased working memory (Dong & Cai, 2015), phonological short-term memory (Babcock & Vallesi, 2015), error detection (Yudes, Macizo, Morales, & Bajo, 2013), and reading comprehension (Bajo, Padilla, & Padilla, 2000). Interpreting also modifies neural mechanisms. Trained professionals performing simultaneous interpreting activate a well-defined brain network that allows rapid and efficient switching between two languages, while untrained multilinguals display a distributed neural network (Hervais-Adelman & Babcock, 2019).

Relevant to our study, anticipation is one of the strategies taught in interpreting courses to release the cognitive load during simultaneous interpreting (Li, 2015; Seeber, 2013). A study with a corpus of simultaneous interpreted speech (German-Greek language combination) showed that professional interpreters make predictions approximately once every 100 seconds and they are successful 93% of the time (Liontou, 2012). The strategy of anticipation is often emphasized between syntactically asymmetrical languages (Li, 2015) but has also been found between languages that are more alike (Zanetti, 1999). Interpreters need a great deal of certainty in order to make a prediction due to the high cost of prediction error. When a prediction error is made, interpreters must immediately repair it with a sentence such as “the interpreter meant…”, while continuing to retain in memory the incoming speech from the speaker. Surprisingly, there are only two studies exploring how prediction unfolds during simultaneous interpreting in a controlled experimental setting. In one study, (Chernov, 2004) investigated anticipation during highly predictive contexts and found that there is more prediction in the L1-to-L2 than in the L2-to-L1 direction. Similarly, (Hodzik & Williams, 2017) compared anticipation[7] in a shadowing and a simultaneous interpreting task and reported that context facilitated prediction during simultaneous interpreting and shadowing, but transitional probabilities only facilitated prediction during shadowing. Importantly, these two studies present methodological issues that preclude inferences, which include a low sample pool, a mixture of professional interpreters with interpreting students, an inappropriate task to measure anticipation, and even lack of statistical analyses.

Interestingly, interpreters’ years of experience making predictions facilitates their prediction in non-interpreting situations. Lozano-Argüelles et al. (2019) examined the effects of interpreting practice on L2 anticipation of verbal morphology at the word level. They found that interpreters and non-interpreter bilinguals predict at a lower rate than monolinguals, although interpreters predict at a faster rate than both non-interpreters and

7 This article distinguished between prediction (preactivation without reaching overt production) and anticipation (preactivation with overt production before the speaker has pronounced the specific utterance).

monolinguals. These results show that extensive practice with interpreting facilitates processing strategies during non-interpreting situations. However, it is unclear whether lower L2 prediction rates are due to general prediction patterns in the L2 or to difficulty of processing morphological suffixes. In the present work, we examined prediction at the word level with non-morphological endings to understand whether morphological endings impose a higher cognitive load delaying prediction in the L2, which is crucial to understanding the role of prosodic information during spoken word recognition in native and non-native processing.

3.3 Prediction of morphological information

A large body of research shows that prediction, both between words and within words, facilitates processing. Most studies examining prediction between words have focused on determiner-noun gender agreement. These studies show that Spanish, German and Dutch native speakers use the determiners' gender to predict an incoming noun, but prediction is not uniform among all natives. For example, shorter presentation time of visual context combined with faster speech rate (Huettig & Guerra, 2019), exposure to non-target gender assignment (Hopp, 2016), and the multiple associations of a determiner (in Dutch '*de*' is used for singular common nouns, but also for plural nouns of both common and neuter gender) have been found to hinder prediction of gender agreement (Kochari & Flecken, 2018). This variability is enhanced in L2 populations. For instance, intermediate Italian-Spanish learners predict only with feminine gender nouns (marked) (Dussias, Valdés Kroff, Guzzardo Tamargo, & Gerfen, 2013), advanced-low English-Spanish learners anticipate only with transparent gender nouns (Halberstadt, Valdés

Kroff, & Dussias, 2018), and intermediate English-Spanish learners cannot predict gender at all (Lew-Williams & Fernald, 2010).

Recently, scholars have turned their attention to predictive processes within a word, focusing on the role of suprasegmental and segmental prosodic cues to anticipate a word's suffix. For suprasegmental cues, Swedish natives use word tones to predict tense and number morphology, and the least common cue in terms of type frequency is linked to stronger prediction (Roll, Horne, & Lindgren, 2010; Söderström, Roll, & Horne, 2012). Similarly, Spanish natives exploit lexical stress in the first syllable of a verb to predict tense (past, present), and anticipate better with oxytone stress, which produces less lexical competitors (Lozano-Argüelles et al., 2019; Sagarra & Casillas, 2018). These studies suggest that phonotactic probability facilitates the use of suprasegmental cues to predict morphological information within a word. The same applies to segmental cues. Thus, Swedish natives use phonotactic frequency of the two first segments of a word to anticipate number morphology, such that the fewer possible outcomes and the more frequent those outcomes are, the stronger preactivation is (Roll, Söderström, Frid, Mannfolk, & Horne, 2017). Along the same line, Spanish natives showed increased prediction syllabic structure triggered less lexical competitors due to lower type frequency (i.e., CVC).

In the case of L2 learners, research reveals a more complex picture. Some studies show that upper intermediate learners of Swedish L2 and advanced learners of Spanish use word tones and lexical stress, respectively, to predict morphological endings (Sagarra & Casillas, 2018; Schremm et al., 2016). In contrast, other studies reveal that beginning learners do not use Swedish word tones (Gosselke Berthelsen, Horne, Brännström, Shtyrov, & Roll, 2018) or Spanish stress (Sagarra & Casillas, 2018) to predict suffixes. Interestingly, while the Spanish L2ers followed the same facilitatory pattern as the Spanish monolinguals (unstressed initial syllables increased prediction rate), Swedish L2ers did not display a facilitatory effect of Accent 1 (associated with lower type frequency) over Accent 2. The lack of frequency effects in the Swedish L2ers could be due to the use of different experimental techniques. While the study with monolinguals was based on EEG data, the study with L2ers relied on reaction times, which might not be sufficiently fine-grained to capture these differences. Taken together, L1 studies investigating suprasegmental and segmental cues to morphology during spoken word recognition indicate that prosody is crucial for morphological prediction, and that less frequent patterns (oxytone stress, CVC syllabic structure, lower phonotactic frequency, and accent 1 in Swedish) facilitate morphological prediction.

3.4 Prediction of semantic information

A second bulk of research has examined how constraining contexts lead to the prediction of specific lexical items. When reading a high-cloze probability sentence such as “To have fresh milk you have to milk a cow/an animal”, English native speakers predict the expected item (‘a cow’) and display a surprisal effect (N400) when presented with an unexpected item (‘an animal’) (English: DeLong, Urbach, & Kutas, 2005; Martin et al., 2013; Dutch: Otten & Van Berkum, 2009). The same effect is found when listening to sentences (Foucart, Ruiz-Tada, & Costa, 2015). Along the same line, native speakers of English use the semantic information encoded in a verb to predict semantic features of an incoming noun (Altmann & Kamide, 1999, 2007). As with morphosyntactic prediction, studies show mixed results and Nieuwland et al. (2018) failed to replicate the same effect at the article. This could be due to a variable relationship between the noun and the determiner in English (‘a cow’ but ‘an enormous cow’). In the case of L2 learners, French and Catalan learners of Spanish predict nouns of constraining sentences in a similar manner to monolinguals (Foucart, Martin, Moreno, & Costa, 2014). Nevertheless, this predictive effect seems to be restricted to languages that are closely related (as in Foucart et al., 2014) and Spanish learners of English do not show a prediction effect at the article (although they do at the noun) (Martin et al., 2013).

In sum, prior research on semantic prediction has focused on how a constraining context or the semantic information of the verb lead to prediction of a specific lexical item or its semantic features. However, it is unclear whether similar processes occur within a word. Does prediction within a word also happen with non-morphological word endings? To answer this question, the present study focuses on the use of stress and syllabic structure to predict the final syllable of nouns in Spanish.

3.5 Prosodic Cues

In this section we first analyze the relevance of the syllable as a phonological segment used for segmentation and lexical access in Spanish. Then, we continue our discussion of how syllabic structure and lexical stress affect lexical access, and we conclude by summarizing previous studies on the topic. Syllables are fundamental sublexical units in phonology and syllabification strategies —i.e., speech segmentation using syllabic information— are specific to each language. French native speakers strongly rely on syllabic information to encode words (Mehler, Dommergues, Frauenfelder, & Seguí, 1981), whereas English natives do not seem to use syllables to access a lexical item (Cutler, Mehler, Norris, & Segui, 1986), which could be in part due to English presenting a higher rate of ambisyllabicity. Intervocalic consonants before unstressed vowels can be part of either syllable, e.g., the /l/ in *balance* could belong to either the first or the second syllable. In the case of Spanish, results show more variability than in French. Hence, some studies point out that syllabic information does not facilitate word activation (Sebastian-Gallés, Dupoux, Seguí, & Mehler, 1992), while others find an activation effect replicating the French findings (Bradley, Sánchez-Casas, & García-Albea, 1993). Simonet (2019) proposes this may be associated with segmentation being more vulnerable in Spanish and taking place later at a higher processing level. The author argues that, overall, Romance languages (French, Catalan, Italian, and Spanish) use syllabification as a speech segmentation strategy. Furthermore, there seems to be an interaction between syllabification and lexical stress, such that, in Catalan, unstressed (but not stressed) first syllables facilitate word activation (Sebastian-Gallés et al., 1992). Given the relevance of syllabification in Spanish and its interaction with lexical stress, it could be possible that the information contained in the first syllable of a word is used to anticipate the word-ending before it becomes available regardless of the type of word ending (morphological vs. non-morphological).

Regarding syllabic structure, there seems to be a general preference for open (CV, default) syllables over closed syllables (CVC, marked) (Hyman, 1975; Jackobson, 1968), implying that a coda can make a syllable more salient for the listener. Importantly, information contained in the first syllable is used to reduce the number of competitors and, hence, the more information the listener has —i.e. syllables with a coda—, the fewer competitors during lexical activation (Cholin, Levelt, & Schiller, 2006). Previous studies support this hypothesis by showing that the presence of a coda (CVC) facilitates a stronger prediction effect in Spanish natives and interpreter L2 learners of Spanish (Lozano-Argüelles et al., 2019), and non-interpreter advanced L2 learners of Spanish can only anticipate morphology when the first syllable of the verb contains a coda (Sagarra & Casillas, 2018).

Finally, lexical stress is defined as the relative prominence of one syllable in relation to the rest of the syllables in a word and is a suprasegmental used contrastively both in Spanish (PApa ‘potato’ vs. paPÁ ‘dad’) and in English (PREsent vs. preSENT). Despite this similarity between both languages, prior findings reveal that Spanish and English natives use lexical stress differently. In both languages, a prosodically matched prime facilitates perception (i.e. faster reaction times), but a mismatched prime inhibits perception only in Spanish natives (Cooper, Cutler, & Wales, 2002; Soto-Faraco, Sebastián-Gallés, & Cutler, 2001). These results indicate that lexical stress could be used to reduce the number of competitors during lexical access only in Spanish. A possible explanation is that English, often considered a stress-timed language, tends to undergo vowel reduction processes when the vowel is in an unstressed position, whereas Spanish, regarded as a syllable-timed language, roughly maintains the same duration for all vowels. English natives might rely on vowel reduction, a segmental, for lexical access, rather than on lexical stress. Another notable difference between English and Spanish is stress patterns. Whereas most words in English start with a stressed syllable (approximately 90%) (Cutler & Carter, 1987), the most frequent stress pattern in Spanish is stress on the penultimate syllable (around 75%) (Toro-Soto, Rodríguez-Fornells, & Sebastián-Gallés, 2007), which is only initial stress in the case of disyllables. This has important implications for signal segmentation and lexical access. In English, strong syllables trigger segmentation of continuous speech, as shown in a word spotting experiment in which English natives took longer to recognize a word when the first syllable was unstressed (Cutler & Norris, 1988). Crucially for our study, if English natives continue to use the same strategy, we would expect them to predict only when the target word starts with a stressed syllable.

3.6 The Study

Our study investigates whether native speakers of Spanish use lexical stress (stressed vs. unstressed first syllable) and syllabic structure (open vs. closed syllables) in the first syllable of a word to predict word endings, and whether advanced English L2 learners of Spanish with and without interpreting experience can learn to use this information in a similar way to natives. Research indicates that natives and non-natives use suprasegmental cues instantiated in the stem (e.g., word tones in Swedish, lexical stress in Spanish) to predict suffixes (e.g., number marking and verbal morphology in Swedish, verbal morphology in Spanish) (Lozano-Argüelles et al., 2019; Roll et al., 2015; Sagarra & Casillas, 2018; Söderström et al., 2012). However, it is unclear whether prediction only applies to the prediction of morphological suffixes or whether it happens regardless of the type of word ending. Our research question is: Do lexical stress and syllabic structure facilitate prediction of word endings among monolinguals and advanced English learners of Spanish with and without interpreting experience?

First, we hypothesize that monolinguals will use lexical stress and syllabic structures to predict word endings, but they will do so at a lower rate than in Sagarra & Casillas (2018) and Lozano-Argüelles et al. (2019). Previous work has explored semantically related words (e.g., *lava*-*lavó*, 's/he washes-washed') We expand this line of research to semantically unrelated words (e.g., *papa*-*papá*, 'potato-dad'). Semantic relatedness is important because the beginning of semantically unrelated words activates a broader network of semantic neighbors and might delay prediction. Moreover, it is still unknown whether prediction is possible due to the semantic relatedness of both words (smaller competitor pool), or whether prediction also takes place when target and competitor are phonologically related (shared initial syllable) but semantically unrelated (larger competitor pool). We expect that items related only at the phonological level will be more difficult to process and will yield lower prediction rates. This is in line with previous studies showing that cues linked to more lexical competitors result in lower prediction rates (Roll et al., 2015; Sagarra & Casillas, 2018) because of the larger competitor pool. Specifically, we anticipate that monolinguals will not be able to predict word endings with CV stressed initial syllables, and that, similar to previous studies, both CVC and unstressed initial syllables (less frequent) will facilitate prediction.

Second, we predict that non-interpreters will only anticipate word endings when preceded by a CVC unstressed syllable (*carNÉ*, 'ID'). We expect that the semantic unrelatedness of target and distractor words in the present experiment will be especially detrimental to learners because they will need to activate an even bigger pool of lexical competitors in two languages. Based on Lozano-Argüelles et al. (2019) and Sagarra & Casillas (2018), CVC unstressed syllables facilitated prediction due to their lower frequency and reduced pool of lexical competitors. Non-interpreters should be able to make a prediction with the most facilitative condition, i.e. CVC unstressed initial syllables. Moreover, in the CVC unstressed condition, non-interpreters should activate a larger pool of lexical competitors and start making a prediction later than monolinguals. Third, based on Lozano-Argüelles et al. (2019), interpreters will display a similar prediction pattern to that of non-interpreters, predicting only in the CVC unstressed condition, but doing so at a faster rate than the advanced learners. This is because interpreters often wait to commit to a specific lexical decision due to the high cost of making an error and having to repair it. In the current study, we expect activation of a higher number of lexical competitors to also slow down interpreters' expectations, but interpreting experience will accelerate their speed of prediction.

Our findings will shed light on prediction models showing whether lexical stress and syllabic structure can also be used in the prediction of word endings that are not morphological suffixes. Additionally, results will inform phonological models, indicating the role of prosody (i.e., lexical stress) in prediction, and whether different syllabification strategies can be learned in the L2. This is crucial in understanding the role of lexical stress for lexical access, revealing whether it is included in all items of the mental lexicon of the speaker, or whether it is only relevant for prediction in words that can be decomposed into multiple morphemes. Finally, this study will clarify whether anticipatory experience during simultaneous interpreting affects L2 prediction of non-morphological endings. This will help to elucidate which factors can modify L2 processing strategies during spoken word recognition.

3.7 Methods

3.7.1 Participants

We collected data in the U.S. and in two monolingual regions of Spain. There were three groups of participants: Spanish monolinguals (n = 32, 18 females), English L1 advanced learners of Spanish without interpreting experience (n = 26, 17 females), and English L1 advanced learners of Spanish with interpreting experience (n = 23, 17 females). Monolinguals were born and raised in a monolingual region of Spain, and despite taking English classes during high school, they reported their English level was low and they did not use it on a regular basis. They were between 18 and 47 years old (*M* = 30.63, *SD* = 8.89). Most of them had not spent a significant amount of time in an English-speaking country (*M* = 0.25, *SD* = 0.84, in months).

Both interpreter and non-interpreter groups were born and raised in an English monolingual environment with English monolingual parents. Their schooling (elementary through high school) was in English. Non-interpreters and interpreters were between 19 and 76 years old (non-interpreters: *M* = 30.16, *SD* = 6.22; interpreters: *M* = 41.70, *SD* = 12.82) and started acquiring Spanish after the age of 13 (non-interpreters: *M* = 13.15, *SD* = 2.89; interpreters: *M* = 14.61, *SD* = 3.83) becoming fluent around the age of 20 (non-interpreters: *M* = 20, *SD* = 3.07; interpreters: *M* = 20.74, *SD* = 3.14). Most had spent time in a Spanish-speaking country (non-interpreters: *M* = 19.31, *SD* = 16.45, in months;

interpreters: *M* = 35.61, *SD* = 85.53) and reported using Spanish on a regular basis (non-interpreters: *M* = 28.65, *SD* = 17.97, weekly % of time; interpreters: *M* = 30.65 *SD* = 14.48, weekly % of time).

Two one-sided tests of equivalence were conducted to verify that advanced learners and interpreters had equivalent L2 proficiency, and that the three groups had comparable working memory. Moderate effects were tested with a Cohen's *d* of 0.3. For L2 proficiency, advanced learners and interpreters showed L2 proficiency effects statistically not different from zero ($t(45.1) = 0.906$, $p = 0.815$)[8]. As for working memory, all pairwise comparisons were statistically not different from zero (monolinguals vs. interpreters: $t(33.48) = -0.770$, $p = 0.777$; monolinguals vs. advanced learners: $t(40.07) = -0.196$, $p = 0.577$; interpreters vs. advanced learners: $t(45.91) = -0.541$, $p = 0.295$).

All interpreters had a master's in interpreting or had official interpreting court certifications. Crucially, they used both consecutive interpreting (the speaker utters a speech section that is interpreted directly after) and simultaneous interpreting (the interpreter translates at the same time the speaker is talking) on a regular basis. At the time of testing, they had been working as professional interpreters between 2 and 35 years (*M* = 12.43, *SD* = 10.10), and they worked on average 18 hours per week (*SD* = 6.89).

8 Five non-interpreter learners were removed from the initial sample of 31 non-learner participants to ensure L2 proficiency comparability with interpreter participants.

3.7.2 Materials

All data were collected individually in one session (approx. 50 min). In order to determine eligibility to participate in the experiment, the two learner groups (non-interpreters, interpreters) completed the Spanish proficiency test before the experiment (15 min). Data were collected individually in about 1 hour in this order: language background questionnaire (5 minutes), eye-tracking task (15 minutes), phonological short-term memory test (10 minutes), working memory test (10 minutes), and translation task (5 minutes). This study will focus on the eye-tracking task.

3.7.2.1 Screening tests

The Spanish proficiency test was an abbreviated version of the DELE (*Diploma de Español como Lengua Extranjera*), based on Sagarra & Herschensohn (2011). The test included 56 multiple choice questions assessing grammar and vocabulary knowlege. Correct answers received one point and incorrect answers were given zero points. A minimum of 40 points was required to participate in the experiment. The language background questionnaire included questions regarding participants' age, parents' languages, time spent in an L2 country, languages of schooling, age of acquisition of the L2, age when they became fluent in the L2, and weekly percentage of use of the L1 and L2. Moreover, interpreters answered information about their working language combinations, official training or certifications in interpreting, topics they specialized in, years of work experience, and hours interpreting in a regular week.

3.7.2.2 Eye-tracking Task

Eye movements were recorded using an EyeLink 1000 Plus desktop mount (SR Research) with a sampling rate of 1k Hz, a spacial resolution: 32° horizontal, 25° vertical, and an averaged calibration error of .25°-.5°. Stimuli were presented on a BenQ XL2420TE monitor with a 1920x1080 pixel resolution and Sol Republic 1601-32 headphones. The experiment consisted of 72 sentences (8 practice, 16 experimental, and 48 fillers). All sentences were between 7 and 13 words long (M = 10.20, SD = 1.68). Fillers belonged to two other categories equally distributed (prediction based on verb information: *La señora bebió/sacó la leche/fruta de la nevera*, 'The lady drank/ took the milk/fruit from the fridge'; prediction based on collocations: *La mujer peleó con uñas y dientes/puños por el esposo*, 'The wife fought tooth and nails/fists for her husband'). For the experimental trials, target and distractor words had the same number of syllables (between 2 and 3), and the first syllable of both target and distractor items was identical except for lexical stress. Half of the subject nouns were animate (*los expertos*, 'the experts') and half inanimate (*el glosario*, 'the glossary'). Half of the target words were paroxytone (*PApa*, 'potato) and half were oxytone (*paPÁ*, 'dad). Moreover, half had a coda in the first syllable (*carne/carné*, 'meat/ID card'), and half did not (*papa/papá*, 'potato/dad').

We created two versions of the experiment and assigned participants randomly to one of them. Each version included one of the two conditions of every word pair (e.g., version 1 contained *papa*, versión 2 contained *papá*). Sentences (fillers and experimental) were organized using a Latin Square design. Practice trials followed the same order in both versions. For the visual stimuli, we used words instead of pictures because of the low imageability of some of the target words. Previous research shows that words are more discernible between phonological competitors in non-predictive contexts (Huettig & McQueen, 2007). Each word (target and distractor) was centered in the left and right halves of the screen in Arial font 150pt size. Half of the target words appeared on the right and half on the left, and half of the paroxytone words appeared on the right and half on the left. Experimental and filler sentences were distributed into pairs (condition 1 and condition 2) and then randomized in three different lists. Sentences were recorded in a professional sound booth, using a AKG Solid Tubem microphone, a MIDAS Venice F32 audio interface, and a Sonar 4 STUDIO EDITION Sound Forge 10 recording software. After segmenting all the selected iterations (from sentence onset to sentence offset), we used Praat (Boersma & Weenik, 2017) to normalize the scale peak intensity, and added 100 ms of leading silence to each file.

3.7.3 Procedure

For the eye-tracking task, participants first sat in front of the monitor with their heads stabilized with a chin-rest and performed a 9-point calibration. They received instructions in Spanish, indicating them to look towards the words on the screen and select the word they heard in the audio as soon as they could recognize it by pressing the right or left shift key on a regular English keyboard. They were instructed to select the word as soon as they recognized it without waiting until the end of the sentence. For every trial, participants completed a drift correction, looked a 250ms fixation sign, and saw two words on the screen (target, distractor) for 1,000ms, listened to a sentence, and chose one of the two words on the screen by pressing a button. Afterwards, a rectangle appeared around the selected words confirming the participants' word selection. Button presses before the onset of the target word were not recorded.

3.8 Statistical Analysis

Eye-tracking data were extracted using DataViewer (SR-Research) and downsampled to 50 ms bins. We used R (Version 3.6.1; R Core Team, 2019) to carry out statistical analyses, as well as the packages *lme4* (Bates, Mächler, Bolker, & Walker, 2009) to fit the models and *multcomp* (Hothorn, Bretz, & Westfall, 2008) for pairwise comparisons between learner groups. Empirical-logit growth curve analysis (GCA, Mirman, 2014) was used to analyze eye fixations towards the target. Specifically, we modeled the probability of fixating on target words over the time course. In order to capture the time frame when fixations towards the target departed from chance, we analyzed the time window comprised between 200 ms before the offset of the target syllable and 600 ms later. Humans roughly take 200 ms to launch a saccade after hearing a stimulus (Salverda, Kleinschmidt, & Tanenhaus, 2014). We adjusted the time course to be centered around 200 ms after the offset of the target syllable such that the model intercept would reveal probability of looks towards the target. The time course was modeled using the linear, quadratic and cubic orthogonal polynomials. Binary responses (fixations to target or distractor) were transformed with the empirical logit ("Analyzing 'visual world' eyetracking data using multilevel logistic regression," 2008). For all time terms, group (monolinguals, non-interpreters, interpreters), lexical stress (paroxytone, oxytone), and syllabic structure (CV, CVC) were entered as fixed effects, and lexical stress and syllabic structure were sum coded such that parameter estimates represented effect sizes of change from CV to CVC syllables and paroxytone to oxytone stress. Models included subject and item as random intercepts on all time terms, as well as by-participant random slopes for syllabic structure and lexical stress on all time terms. Also, monolinguals were used as the baseline group predictor. The models' parameters in the learner groups showed differences in the growth curve between the learners and the monolingual group, and pairwise comparisons contrasted both learner groups. Finally, nested model comparisons served to evaluate main effects and higher order interactions.

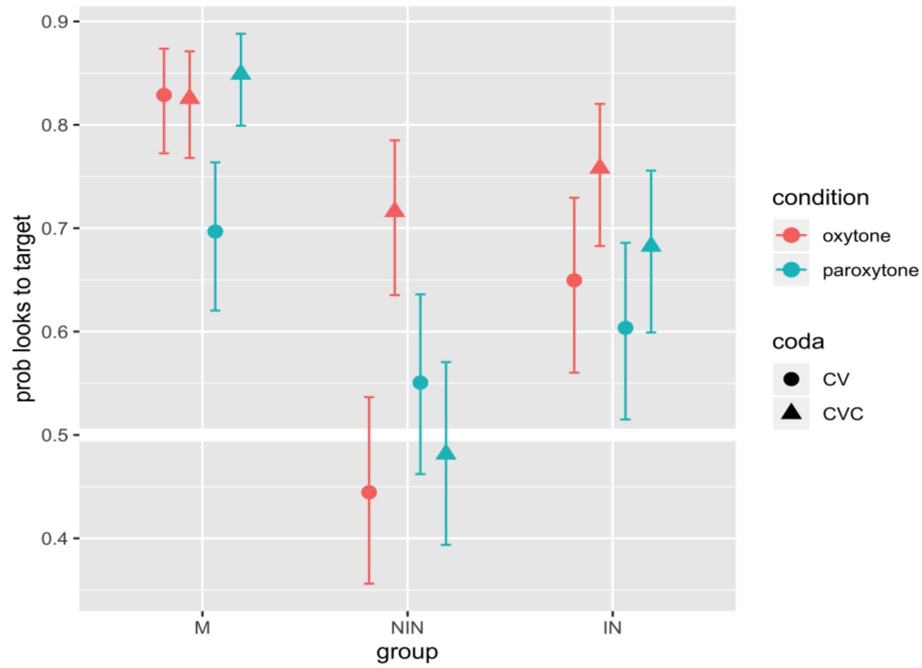
3.9 Results

The full model summary can be found in Appendices 2, 3 and 4. We begin by reporting significant findings for monolinguals and then compare them with the two learner groups. The GCA model intercept represents the log odds of the baseline group (monolinguals) fixating on the target, holding all conditions equal (time course, lexical stress and syllabic structure). The log odds were γ_{00} = 1.29 (proportion: .78). The linear and cubic time terms captured the sigmoid shape of the function (γ_{10} = 5.43; SE = 0.56; t = 9.63; p < .001; γ_{30} = −1.93; SE = 0.24; t = −7.90; p < .001).

There was a main effect of lexical stress on the linear term ($\chi^2(0)$ = 3, p < .001), such that holding syllabic structure constant, a change from paroxytone (e.g., *PApa*) to oxytone (e.g., *paPÁ*) increased the steepness of the slope (γ_{32} = 0.80; SE = 0.29; t = 2.75; p = .006). This suggests that monolinguals fixate on oxytonic targets at a higher rate than on paroxytonic targets. There was also an interaction on the quadratic term approaching significance, such that a change from no coda to coda increased looks towards the target, but only in the paroxytone condition (γ_{25} = 0.50; SE = 0.26; *t* = 1.95; *p* = .051).

In line with the effects described above, we see that the probability that monolinguals will look towards the target at the offset of the target's first syllable are above 80% for all conditions except for CV paroxytones (e.g., *PApa*) (CV Paroxytone: Probability = 0.697; LB = 0.62; UB = 0.764, CV Oxytone: Probability = 0.829; LB = 0.772; UB = 0.874, CVC Paroxytone: Probability = 0.849; LB = 0.799; UB = 0.888, CVC Oxytone: Probability = 0.825; LB = 0.768; UB = 0.871). Figure 3.1 shows model estimates of probability of looks towards target for all groups. In sum, monolinguals anticipate word endings above chance in all conditions and the stress final with coda condition (e.g., *carNÉ*) seems to increase prediction.

Figure 3. 1 Probability of looks to target



9

For the non-interpreter group, we found a simple effect of group such that, averaging over all conditions, non-interpreters predicted at a lower rate than monolinguals ($\gamma_{21} = -0.69$; SE = 0.25; $t = -2.82$; $p = .005$). Furthermore, there was an effect of group on the quadratic and cubic terms ($\gamma_{14} = 1.91$; SE = 0.38; $t = 5.01$; $p < .001$; $\gamma_{34} = 1.11$; SE = 0.33; $t = 3.38$; $p < .001$), indicating that non-interpreters had a more bowed time course with steeper inflection points (i.e., sharper vertices) than monolinguals. That is to say, non-interpreters anticipated at a faster rate than monolinguals, but did so later in the time course. An interaction of syllable structure and

9 Figure 1: Model estimates reflecting probability looks towards target 200 ms after the offset of the target syllable. The thick white line represents the 50% probability of fixating on the target. Circles and triangles represent means, whiskers depict upper and lower bounds.

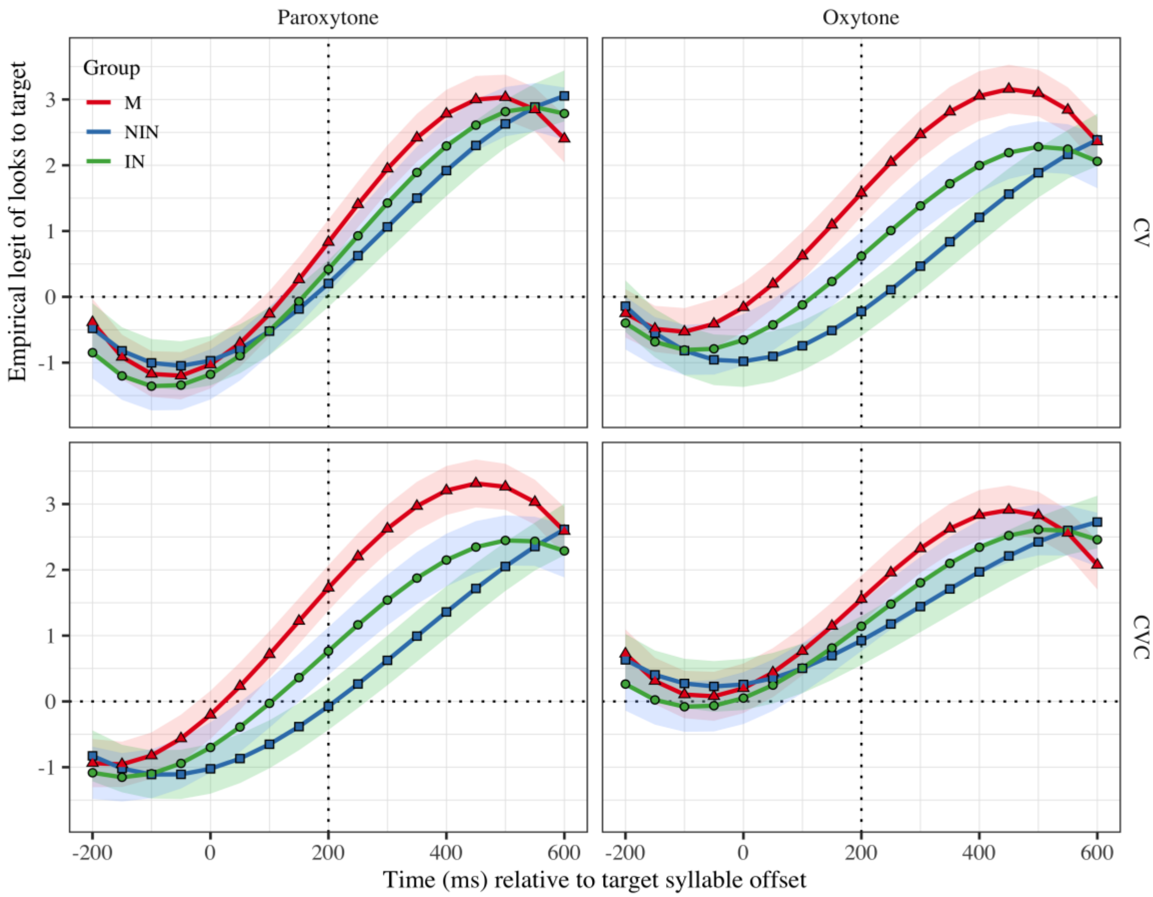
lexical stress on the intercept and the quadratic term (γ_{06} = 0.41; SE = 0.06; t = 6.46; p < .001; γ_{26} = −0.66; SE = 0.26; t = −2.56; p = .011) revealed that, averaging over the time course, we see that the addition of the coda is more beneficial for the advanced learners than for the monolinguals (who were already predicting at high rates). Furthermore, at the offset of the target syllable, the interpreters' curve is less bowed, indicating that the monolinguals focus on targets at a faster rate. We see that non-interpreters predict word endings in the CVC oxytone condition (e.g., *carNÉ*) (Probability = 0.716; LB = 0.635; UB = 0.785), but not in the rest of conditions (CV Paroxytone: Probability = 0.551; LB = 0.462; UB = 0.636, CV Oxytone: Probability = 0.445; LB = 0.356; UB = 0.537, CVC Paroxytone: Probability = 0.481; LB = 0.394; UB = 0.57).

Unlike the non-interpreters, interpreters predicted at the same rate as the monolinguals (γ_{31} = −0.48; SE = 0.25; t = −1.90; p = .057). The group effect on the quadratic time term (γ_{24} = 0.76; SE = 0.39; t = 1.96; p = .05) indicated that interpreters had a more bowed time course than monolinguals and fixated on targets later on the time course than monolinguals. Also, the interaction of syllabic structure and lexical stress on the intercept (γ_{16} = 0.21; SE = 0.06; t = 3.22; p = .001) revealed that stressed CVC syllables produced more looks at target words in the interpreters than the monolinguals. Furthermore, model estimates indicate that interpreters predicted word endings under all conditions (CV Paroxytone: Probability = 0.604; LB = 0.515; UB = 0.686, CV Oxytone: Probability = 0.65; LB = 0.56; UB = 0.729, CVC Paroxytone: Probability = 0.683; LB =

0.599; UB = 0.756), and that they predicted more in CVC unstressed syllables (e.g., *carNÉ*) (Probability = 0.758; LB = 0.683; UB = 0.82).

Finally, the comparison of non-interpreters and interpreters produced a main effect of group on the quadratic term (γ_{28} = 1.15; SE = 0.41; t = 2.80; p = .005), revealing that, holding all variables constant, non-interpreters started to predict later in the time course than interpreters. Moreover, the interaction of syllabic structure and lexical stress was significant (γ_{09} = 0.20; SE = 0.07; t = 2.97; p = .003), such that adding a coda and changing from paroxytone to oxytone was more beneficial for non-interpreters than for interpreters. Figure 3.2 shows growth curve estimates for all groups and conditions.

Figure 3. 2 Growth curve analysis for each group and condition



10

10 Figure 2: Growth curve estimates of target fixations as a function of lexical stress and syllable structure for each group during the analysis window. Symbols and lines represent model estimates, and the transparent ribbons represent ±SE. Empirical logit values on y-axis correspond to proportions of 0.12, 0.50, 0.88, and 0.98. The horizontal dotted line represents the 50% probability of fixating on the target. The vertical dotted line indicates 200 ms after the offset of the target syllable.

3.10 Discussion

The goal of this study was to evaluate whether monolinguals and adult L2 learners with and without interpreting experience use lexical stress (stressed, unstressed) and syllabic structure (CVC, CV) in a word's first syllable to predict its end. The findings indicate that natives and the interpreter learners use lexical stress to anticipate word endings under all conditions, but non-interpreter learners can only predict word endings preceded by CVC unstressed syllables, the least frequent type of stress and syllabic structure. These findings show that prosody plays a central role in monolingual prediction within a word and that additional experience making predictions during simultaneous interpreting facilitates prediction in the L2.

First, we discuss the question of whether monolinguals are able to use lexical stress to predict word endings. We expected native speakers to predict at lower rates than previously found in the unstressed conditions (e.g., *paPÁ*, 'dad' and *carNÉ*, 'ID') and the CVC stressed condisitons (e.g., *CARne*, 'meat'), but not to predict in the CV stressed conditions (e.g., *PApa*). Our findings did not support this hypothesis. In effect, the monolinguals anticipated in all four conditions at similar rates as in previous studies (above 80% in all conditions except for CV stressed initial syllables). In line with Lozano-Argüelles et al. (2019), oxytone words were predicted at a higher rate than paroxytone words and adding a coda (i.e., CVC condition) increased prediction rate, but only in paroxytone words. These findings suggest that in monolingual processing, the same strategies underlie the prediction of both verbal morphology (a suffix) (e.g., *FIRma-*

firMÓ '(s)he / signs-signed') and word endings in general (e.g., *CARne-carNÉ*). Previous research associated less frequent suprasegmental (Söderström et al., 2012) and segmental cues (Roll et al., 2017) with stronger prediction patterns of morphological suffixes. The present findings contribute to this line of research by showing that similar processes occur for lexical items not involving inflectional morphemes. Our results support the notion of the syllable as a fundamental sublexical unit for predictive processing (see Simonet, 2019, for a review). Also, our data rule out the possibility of speakers selecting the most frequent stress pattern (in Spanish, around 75% of words follow paroxytone stress) by showing the opposite trend. That is, lower type frequency of lexical stress pattern (oxytone words) produces more target-like and earlier predictions because it is linked to fewer lexical competitors.

Second, we asked whether advanced L2 learners would be able to use stress and syllabic structure to predict word endings. We hypothesized that advanced learners without interpreting experience would only anticipate with CVC unstressed syllables (e.g., *carNÉ*, 'ID'). Results support our hypothesis: the non-interpreters only predicted above chance at the offset of the target syllable when preceded by unstressed CVC syllables. Also, non-interpreters predicted less and later than monolinguals, and stressed CVC syllables (e.g., *CARne*, 'meat') facilitated prediction more among non-interpreters than in the case of monolinguals. Non-interpreter results are consistent with those obtained by Sagarra & Casillas (2018). They found that both monolinguals and advanced learners followed similar predictive patterns benefiting from unstressed CVC syllables. Nevertheless, the current study shows that non-interpreters had greater difficulty predicting non-morphological endings than morphological suffixes. Two different reasons could explain why non-morphological endings are more difficult. One possibility could be that prediction within nouns is different from prediction within verbs. Neuroimaging studies show that the processing of inflected nouns and verbs engages different neural systems, both in typical populations (Tyler, Bright, Fletcher, & Stamatakis, 2004) and atypical populations (with aphasia Kambanaros & Steenbrugge, 2006; with Parkison's disease Boulenger et al., 2008). However, the verbs vs. nouns explanation is unlikely because previous research has found preactivation of both verbal morphological suffixes (Roll et al., 2015; Söderström et al., 2012) and nominal morphological suffixes (Roll et al., 2010; Roll, Söderström, & Horne, 2013; Söderström, Horne, & Roll, 2015). Another possibility is that the lack of semantic connection between target and distractor words might hinder prediction by activating too many semantic competitors. In the present study, the target and distractor words are not semantically related and, therefore, may activate a higher number of lexical competitors than the words used by Sagarra & Casillas (2018) & Lozano-Argüelles et al. (2019)'s studies (where target and distractor only differed in verbal tense). L2 speakers activate an even larger number of competitors than monolinguals due to activation in both their L1 and L2 and thus need more time to make a decision between the two words presented on the screen. This explanation is consistent with Kaan (2017)'s proposal that L2 learners might have difficulties inhibiting irrelevant candidates while making linguistic predictions. In practical terms, this would mean that phonology alone triggers prediction and lexical access for monolinguals, while processing phonology is more vulnerable to semantic interference in the case of L2 learners.

With regard to the interpreter group, we had predicted that they would only anticipate word endings preceded by unstressed CVC syllables, and that they would predict faster than non-interpreters. Contrary to our expectations, like the monolinguals, the interpreters predicted above chance in all conditions. The only significant differences between interpreters and monolinguals were time of prediction (interpreters predicted later) and strength of the interaction (adding a coda to oxytone targets was more beneficial for interpreters). In addition, non-interpreters predicted later than interpreters and the interaction between lexical stress and syllabic structure was stronger for the non-interpreters. Earlier predictions suggest that interpreters are faster at processing all lexical competitors and selecting a specific candidate than non-interpreters, although slower than monolinguals. This difference in speed between interpreters and monolinguals could be attributed to increased lexical competition from the interpreters' L1. This finding supports models positing that prediction is probabilistic in nature, rather than an all-or-nothing phenomenon (Kuperberg & Jaeger, 2016).

These results show a different picture than that depicted in Lozano-Argüelles et al. (2019) and indicate that interpreting experience plays a crucial role when predicting in non-interpreting situations. Why does interpreting have a greater impact in the prediction of noun endings (e.g., *carne*, 'meat') than verb endings (e.g., *firma*, '(s)he signs')? Quite simply, interpreting training increases white matter in brain areas related to speech processing, specifically those in charge of phonological processing and mapping speech sounds onto articulatory and lexical representations (Hervais-Adelman, Moser-Mercer, Murray, & Golestani, 2017). This advantage might be the result of having to simultaneously monitor two incoming streams of speech in two different languages (speech input from the speaker and their own interpretation). One explanation could be that phonological representations have become stronger in the interpreters' L2, deeming their predictive processing based on prosodic cues similar to that of monolinguals. Interpreters might have extracted stress type frequency from the input and include it in phonological representation of lexical items, which, in turn, allows them to better categorize each lexical item (Bybee, 2001). However, in the case of verbal suffixes, L2 learners (interpreters and non-interpreters) may struggle predicting morphosyntactic information. According to the RAGE hypothesis (Reduced Ability to Generate Expectations, Grüter & Rohde, 2013), L2 learners can integrate L2 morphosyntactic information, but they experience difficulties making predictions based on morphosyntactic information. This might explain why interpreters are clearly superior to non-interpreters when predicting noun endings, but they perform closer to non-interpreters in the case of verbal suffix prediction.

Results from both interpreters and non-interpreters also reveal that L2 learners can readjust their use of stress to process the L2. As previously explained, English natives rely on initial stressed syllables to segment continuous speech (Cutler & Norris, 1988). Our findings show that both learner groups exploited unstressed syllables to predict word endings (only for CVC syllables in the case of non-interpreters). Importantly, a shift in processing strategies based on lexical stress under all conditions (stressed, unstressed, CV, and CVC) ensues from extended practice with interpreting. This is in line with research linking interpreting with neural enhancement of brain regions associated with articulatory processing (Hervais-Adelman et al., 2017).

In order to situate current findings within a larger picture, we compare the present study to similar experiments. The present study shares the following aspects with Sagarra & Casillas (2018): (1) lexical stress and syllabic structure are used to predict word endings; (2) target and distractor have identical first syllables, only distinguishable by lexical stress; (3) all words are disyllabic (except for two word pairs that were trisyllabic in the present study); (4) the same experimental paradigm was used, the visual world paradigm based on words (rather than pictures); (5) participant groups shared the same characteristics, and (6) lexical frequency was equivalent across conditions and experiments. To discard the option that our findings differed from those of Sagarra & Casillas (2018) due to differences in the lexical frequency of the words, we compared the lexical frequencies of these two studies using two dictionaries of frequencies: NIM web application (Guasch, Boada, Ferré, & Sánchez-Casas, 2013) and Corpus del Español News on the Web (NOW) (Davies, 2019). Two one-sided tests of equivalence were performed comparing frequency in the 2018 study and the present study, and revealed no significant differences, (NIM: verb endings $M = 93.06$, noun endings: $M = 152.37$; $t(37.01) = -0.191$, $p = 0.575$; NOW: verb endings: $M = 132751.30$; verb endings: $M = 166100.20$; $t(52.1) = 0.559$, $p = 0.289$).

If the 2018 and the present study used words with similar lexical frequency, what else can explain the differences in the results? Sagarra and Casillas (2018) examined prediction of morphological verb endings and presented semantically related word pairs (e.g., *canta – 161wede* 's/he sings – sang'). In contrast, the present study explored prediction of non-morphological noun endings and presented semantically unrelated word pairs (e.g., *carne – carné* 'meat – ID'). To determine whether these distinctions explain the differences in the findings, we have designed a follow-up study examining the role of lexical prediction and syllabic structure on the prediction of morphological noun endings with semantically related word pairs (e.g., *Silla-siLLÓN* 'chair-armchair', *MONte-monTÓN* 'hill-pile').

The present study is crucial in informing phonological, lexical access and prediction models in the L1 and the L2. First, our findings provide compelling evidence that prosodic information in the syllable is crucial for native speakers of Spanish to access and predict lexical items. Prosody, in particular lexical stress, is crucial for prediction and for a more effective processing of Spanish. Second, we show for the first time that predictive processes within a word happen even when word pairs presented to a speaker are semantically unrelated, suggesting that connections are not only morphophonological as previous studies reported, but also phonolexical. We cannot directly compare the present study with Lozano-Argüelles et al. (2019) because of the difference in grammatical category between target words in both experiments (verbs vs. nouns). Our follow-up study will contribute to elucidating the distinction between morphophonological and phonolexical connections by researching the prediction of morphological endings within a noun.

Taken together, our findings also inform lexical access models by showing how the interplay of phonological and semantic connections functions differently during L1 and L2 predictive processing. On the one hand, native speakers use lexical stress in a similar manner to predict morphological and non-morphological endings. On the other hand, second language learners without interpreting experience can only exploit lexical stress predictively with less common prosodic conditions (i.e., oxytonic stress with a coda) due to the semantic unrelatedness of word pairs. Thus, prosodic processing is affected by semantic interference during L2 processing (i.e., activation of more competitors in both languages). Crucially, interpreting experience enhances L2 prediction making it comparable to native processing. Explaining the reasons there are underlying differences in processing is beyond the scope of this article, but we hypothesize that it could be due to a combination of additional practice making predictions and the strengthening of phonological representations resulting from experience with simultaneous interpreting.

3.11 Conclusions

We examined the role of interpreting experience, as well as lexical stress and syllabic structure in the first syllable of a noun in how speakers of various groups predict its non-morphological ending (e.g., *PApa-paPÁ*, ‘potato-dad’ and *CARne-carNÉ*, ‘meat-ID’). The eye-tracking results revealed that monolingual speakers and advanced L2 learners with extensive interpreting experience predict upcoming word endings based on lexical stress cues, although advanced L2 learners without interpreting experience can only do so under the least common -and most facilitative- condition: verbs with a CVC unstressed first syllable. These results suggest that prosodic information in the initial syllable is essential for both lexical prediction and lexical access in L1 processing, but it is more vulnerable to other factors during L2 prediction (i.e., interference from an increased number of lexical competitors). In line with Kuperberg & Jaeger (2016), interpreters' superior performance shows that language processing demands reshape predictive processing strategies to adapt to task demands by changing the allocation of cognitive resources.

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Appendix 1: Eye-tracking experimental sentences

Las expertas indican que ingles son una parte de la pierna

Las expertas indican que inglés es un idioma hablado en muchos países

El diccionario dice que carne es la parte muscular del cuerpo

El diccionario dice que carné es un documento oficial

Los entendidos señalan que gárgara es el movimiento de líquidos en la boca

Los entendidos señalan que garganta es la parte anterior del cuello

El glosario aclara que gesto es un movimiento de la cara

El glosario aclara que gestor es la persona que administra

Las profesoras recuerdan que príncipe es el hijo heredero del rey

Las profesoras recuerdan que principio es el comienzo de algo

El manuscrito muestra que bombo es un tambor muy grande

El manuscrito muestra que bombón es una pieza pequeña de chocolate

La maestra menciona que costa es la orilla del mar

La maestra menciona que costal es un saco grande con semillas

El texto explica que sarta es una serie de sucesos

El texto explica que sartén es un objeto para calentar comida

Los investigadores apuntan que papa es una planta comestible

Los investigadores apuntan que papá es quien ejerce de padre

La enciclopedia define que capo es un jefe de la mafia

La enciclopedia define que capó es una parte del coche

Los manuales establecen que bala es una pieza esférica de hierro

Los manuales establecen que balón es una pelota grande para jugar

La guía informa que cala es una playa pequeña

La guía informa que caló es el dialecto de la etnia gitana

Los académicos enseñan que copo es una porción de nieve

Los académicos enseñan que copón es una copa grande

Los técnicos revelan que gorro es una tela que cubre la cabeza

Los técnicos revelan que gorrón es una persona aprovechada

Las periodistas subrayan que luna es un satélite de la tierra

Las periodistas subrayan que lunar es una pequeña mancha en la piel

El libro sugiere que mesa es un mueble para escribir o comer

El libro sugiere que mesón es un restaurante tradicional

Appendix 2: Growth curve model fixed effects

Parameter	Estimate	SE	*t*	*p*
Intercept (γ_{00})	1.291	0.189	6.834	< .001
Time$_1$ (γ_{10})	5.430	0.564	9.626	< .001
Time$_2$ (γ_{20})	−0.483	0.318	−1.520	.129
Time$_3$ (γ_{30})	−1.929	0.244	−7.902	< .001
Syllable structure (γ_{01})	−0.151	0.108	−1.401	.161
Lexical stress (γ_{11})	−0.148	0.118	−1.253	.210
Group NIN (γ_{21})	−0.694	0.246	−2.820	.005
Group IN (γ_{31})	−0.478	0.252	−1.900	.057
Time$_1$ × Syllable structure (γ_{02})	0.367	0.290	1.266	.206
Time$_2$ × Syllable structure (γ_{12})	0.243	0.217	1.122	.262
Time$_3$ × Syllable structure (γ_{22})	−0.174	0.152	−1.147	.251
Time$_1$ × Lexical stress (γ_{32})	0.795	0.290	2.747	.006
Time$_2$ × Lexical stress (γ_{03})	−0.016	0.217	−0.076	.940
Time$_3$ × Lexical stress (γ_{13})	−0.049	0.152	−0.321	.748
Syllable structure × Lexical stress (γ_{23})	−0.094	0.098	−0.961	.337
Time$_1$ × Group NIN (γ_{33})	−0.837	0.741	−1.129	.259
Time$_1$ × Group IN (γ_{04})	−0.247	0.757	−0.326	.744
Time$_2$ × Group NIN (γ_{14})	1.911	0.382	5.006	< .001
Time$_2$ × Group IN (γ_{24})	0.764	0.390	1.959	.050
Time$_3$ × Group NIN (γ_{34})	1.108	0.328	3.382	< .001
Time$_3$ × Group IN (γ_{05})	0.607	0.335	1.815	.070
Time$_1$ × Syllable structure × Lexical stress (γ_{15})	−0.153	0.290	−0.530	.596
Time$_2$ × Syllable structure × Lexical stress (γ_{25})	0.497	0.255	1.950	.051
Time$_3$ × Syllable structure × Lexical stress (γ_{35})	−0.112	0.152	−0.736	.462
Syllable structure × Lexical stress × Group NIN (γ_{06})	0.406	0.063	6.455	< .001
Syllable structure × Lexical stress × Group IN (γ_{16})	0.206	0.064	3.217	.001
Time$_2$ × Syllable structure × Lexical stress × Group NIN (γ_{26})	−0.661	0.259	−2.556	.011
Time$_2$ × Syllable structure × Lexical stress × Group IN (γ_{36})	−0.251	0.264	−0.951	.342

Appendix 3: Growth curve model random effects

Group	Parameter	Variance	SD	Correlations					
Participant	Intercept	0.873	0.934	1.00					
	Syllable structure	0.260	0.510	−.10	1.00				
	Lexical stress	0.444	0.666	−.26	−.04	1.00			
	$Time_1$	6.922	2.631	.26	−.04	.00	1.00		
	$Time_2$	1.169	1.081	−.31	−.11	.17	−.14	1.00	
	$Time_3$	0.590	0.768	−.30	.12	−.04	−.83	.05	1.00
Item	Intercept	0.250	0.500	1.00					
	$Time_1$	2.309	1.520	−.23			1.00		
	$Time_2$	1.128	1.062	−.75			.04	1.00	
	$Time_3$	0.367	0.606	.11			−.98	.16	1.00
Residual		14.783	3.845						

Appendix 4: Pairwise comparisons between learner groups

Parameter	Estimate	SE	*t*	*p*
IN - NIN (γ_{08})	−0.216	0.264	−0.819	.413
Time$_1$ × IN - NIN (γ_{18})	−0.590	0.794	−0.743	.458
Time$_2$ × IN - NIN (γ_{28})	1.147	0.409	2.804	.005
Time$_3$ × IN - NIN (γ_{38})	0.501	0.351	1.427	.154
Syllable structure × Lexical stress × IN - NIN (γ_{09})	0.199	0.067	2.966	.003
Time$_2$ × Syllable structure × Lexical stress × IN - NIN (γ_{19})	−0.410	0.277	−1.482	.138

Chapter 4 - Anticipation experience and working memory effects on in L1 and L2 morphological prediction

4.1 Abstract

Prediction pervades L1 processing, but is unsteady in adult L2 processing. L2 prediction variability is associated with frequency, L1 and L2 experience, and prior anticipatory experience via interpreting. However, these factors cannot explain variability at advanced L2 proficiency levels, and it is unclear whether interpreters are better predictors due to higher anticipatory experience or higher working memory (WM) capacity. We tease apart the effects of prior anticipatory experience and WM to explore additional explanations for advanced learners'variability making L2 predictions. Spanish monolinguals and English L2 learners of Spanish with and without interpreting experience completed a visual-world paradigm eye-tracking task and a number-letter sequencing working memory task. The eye-tracking task measured prediction of verbal morphology (present, past) based on suprasegmental cues (lexical stress: paroxytone, oxytone) and segmental cues (syllabic structure: CV, CVC). Results revealed that interpreters' use of cognitive resources during L2 prediction is closer to monolinguals than to non-interpreters. Also, with more lexical competitors, higher WM facilitates prediction in monolinguals and interpreter L2 learners, but hinders prediction in non-interpreter L2 learners. These findings indicate that prior anticipation experience and working memory modulate L2 prediction, and that attention to L1 and L2 morphology is cognitively demanding .

4.2 Introduction

The human brain is constantly linking information from past experiences to predict the future. These predictions facilitate perception by presensitizing relevant representations (Bar, 2007). Language comprehension is predictive in nature (Kuperberg & Jaeger, 2016) and occurs both at the word level (tone: Roll et al., 2015; stress: Sagarra & Casillas, 2018) and at the sentence level (context: Martin et al., 2013; semantic information in the verb: Altmann & Kamide, 1999; phonology: Nakamura, Arai, & Mazuka, 2012; determiner's gender: Lew-Williams & Fernald, 2010). L1 prediction is ubiquitous and largely depends on characteristics of the task (e.g., frequency, speech rate, preview time, explicitness) (Huettig & Guerra, 2019) and of the participant (e.g., age, processing speed, working memory (WM), literacy) (see Huettig, 2015, for a review). This variability has been linked to prior prediction experience (Lozano-Argüelles & Sagarra, 2019) and language experience (L1 transfer: Dussias, Valdés Kroff, Guzzardo Tamargo, & Gerfen, 2013; L2 proficiency: Sagarra & Casillas, 2018). We explore additional explanation for L2 prediction variability in terms of prior prediction experience and individual cognitive differences.

Previous research shows that anticipatory experience via interpreting enhances L2 prediction of morphology (Lozano-Argüelles & Sagarra, 2019). However, it is unclear whether enhanced L2 prediction skills are due to additional experience making predictions during interpreting or to the superior WM characteristic of interpreters (Dong & Cai, 2015). To tease apart the effects of prior prediction experience and of WM skills, we investigated how WM underlies prediction in monolinguals, interpreter and non-interpreter L2 learners. Prediction involves associating input with prior experience to generate expectations about what is likely to happen next (Bar, 2007). Hence, WM could play a crucial role in linking incoming cues to information stored in long term memory during the prediction process.

WM is the temporary storage and processing of information that allows us to accomplish cognitively complex tasks (Baddeley, 2007). WM has been found to facilitate L2 morphosyntactic processing, in particular, at low proficiency levels. This finding has lead some scholars to suggest that one of the reasons why adult L2 learners have persistent difficulties processing inflectional morphology is because it is cognitively taxing (see Sagarra, 2012, for a review). With regard to WM and L2 prediction, to our knowledge there are only two previous studies (Perdomo & Kaan, 2019; Sagarra & Casillas, 2018) and they did not show an association. However, these studies used mixed effects models which only analyze a specific time point, rather than the progression of prediction over time. The present study addresses this limitation by including WM in a growth curve analysis.

In particular, we examine how anticipatory experience acquired via interpreting and individual differences in WM impact L1 and L2 morphological prediction during spoken word recognition. To investigate this issue, Spanish monolinguals and adult advanced L2 learners of Spanish with and without interpreting experience performed an eye-tracking task and a working memory task. Our findings will determine how anticipatory experience and WM contribute to predicting morphology. Comparing interpreters and non-interpreters allows us to differentiate how, on the one hand, increased anticipatory experience and, on the other hand, superior WM capacity facilitate prediction.

4.3 L1 and L2 phonological prediction within a word

Spoken word recognition involves the automatic activation of word forms based on segmentals, that is vowels and consonants, and suprasegmentals, that is prosodic information such as tone or stress (Soto-Faraco, Sebastián-Gallés, & Cutler, 2001). In particular, phonological cues in auditory speech help listeners to build predictions about word endings. In this regard, native speakers show robust prediction strategies based on both segmental and suprasegmental cues (Rehrig, 2017; Roll, Söderström, Frid, Mannfolk, & Horne, 2017; Roll et al., 2015; Sagarra & Casillas, 2018). Similar to other areas of language processing, L2 prediction presents more variability. Some studies argue that L2ers cannot use phonological information for prediction (Gosselke Berthelsen, Horne, Brännström, Shtyrov, & Roll, 2018) and others show that it is possible (Schremm, Söderström, Horne, & Roll, 2016).

Studies show that Swedish, English, and Spanish speakers use suprasegmental information to predict morphology. Thus, Swedish natives take advantage of the tone instantiated in the stem of a word to predict both verbal (tense) (Roll et al., 2015; Söderström, Roll, & Horne, 2012) and nominal (number) suffixes (Roll, Horne, & Lindgren, 2010; Roll, Söderström, & Horne, 2013; Söderström, Horne, & Roll, 2015). In turn, English natives employ vowel duration to predict voice (Stromswold, Lai, Rehrig, & Lacy, 2016) and Spanish natives use lexical stress to predict verbal morphology (tense) (Sagarra & Casillas, 2018).

Contrary to robust L1 results, L2 speakers predicting morphology based on prosodic cues show mixed results. For example, advanced Mandarin learners of English are unable to predict word suffixes indicating voice based on vowel length and it is unclear whether this is due to lack of proficiency, lack of the predictive cue (vowel length) in their L1, or a confound between segmental and suprasegmental cues (long vowels were followed by a coda, whereas short vowels were not) (Rehrig, 2017). Similarly, beginning German learners of Swedish are unable to use tone instantiated in the stem to predict number morphology (Gosselke Berthelsen et al., 2018). Nonetheless, other studies indicate that L2ers are able to integrate prosody predictively. Indeed, advanced L2 Swedish learners of non-tonal L1 backgrounds used tone to predict verbal morphology indicating tense (Schremm et al., 2016), despite the lack of explicit training and the absence of cue in their L1. In the same vein, advanced, but not beginning, L2 learners of Spanish used stress to predict verbal morphology, although only when the first syllable contained a coda (CVC) (Sagarra & Casillas, 2018). Finally, beginning L2 learners improve their predictive processing (reflected in shorter reaction times and increased accuracy) after playing with a digital game aiming to strengthen the association between tones and suffixes in Swedish (Schremm, Hed, Horne, & Roll, 2017). ERP data also suggests that short-term training increases predictive processing in low to intermediate learners of Swedish, as shown in the post-training appearance of PrAN and LAN EEG effects (Hed, Schremm, Horne, & Roll, 2019). Interestingly, learners did not show a P600 effect, indicating different patterns between L1 and L2 prediction. However, these findings must be taken with caution due to the lack of a control group which makes it difficult to discern how much improvement was due to increased tone-suffix association or to increased exposure to the L2.

With regard to segmental information, Swedish speakers use both type and token frequency of the first two segments of a word to predict number morphology (singular/plural) of a word (Roll et al., 2017). Similarly, Spanish natives exploit segmental information predictively. Using the syllabic structure (CV/CVC) of the first syllable can facilitate verbal morphology prediction (present/past) (Sagarra & Casillas, 2018). The same patterns are found in the case of non-native predictive processing of segmental information. Advanced L2 speakers of Spanish benefit from the presence of a coda (CVC) in the first syllable of a word and use it predictively, whereas they cannot predict when the coda is absent (CV), regardless of proficiency (Sagarra & Casillas, 2018).

The studies presented thus far provide evidence that prosody at the segmental and suprasegmental level plays an important role in how natives process language predictively and that advanced L2 speakers do so only when more facilitatory cues are present. However, previous studies have not determined which factors could modulate prediction of morphological suffixes based on prosodic information. The present paper contributes to this growing area of research by analyzing the role of working memory as a mediating factor in predictive processing at the word level.

4.4 Prediction and Interpreters

Interpreters have received attention from psycholinguists because their sustained exposure to a highly demanding task offers a unique opportunity to investigate the adaptive mechanisms of bilingual processing. Simultaneous interpreting is highly and jointly demanding for both the verbal and executive systems and, therefore, interpreters' cognitive adaptations go beyond the effects of L2 proficiency and exposure, elucidating how usage-driven changes can occur in the bilingual mind (García, 2019). For instance, neural data indicates that extensive practice with simultaneous interpreting triggers a similar brain network as that found in dense code-switchers, revealing that interpreting is an extreme form of bilingual language control related to domain-general cognitive resource management (Hervais-Adelman & Babcock, 2019).

Some models on interpreting propose prediction as an optional step during simultaneous interpreting (Moser-Mercer, 1978) or as one of the strategies allowing to better cope with a high cognitive load (Dong & Li, 2019). In a specific theory for prediction in simultaneous interpreting, Amos & Pickering (2020) defend that interpreting is an ecologically unique context to research prediction because of the obvious advantages of anticipating information while simultaneously interpreting. According to their account, interpreters use semantic, syntactic and phonological prediction to facilitate rapid and accurate comprehension of the speaker. Predictions are initially made through the production system in the source language, and the representation of the predicted lexical item automatically activates its translation equivalent in the target language. Such is the relevance of prediction during interpreting that most simultaneous interpreting courses include exercises to train prediction (Li, 2015). Corpus studies show that predictions occur relatively often (Van Besien, 1999) and that, most of the time, these predictions are accurate (Liontou, 2012). Furthermore, prediction during simultaneous interpreting correlates with a higher degree of completeness in the interpretation and fewer errors (Kurz & Färber, 2003).

Interpreters' additional practice with prediction offers a unique opportunity to explore the role of increased prediction experience on L2 processing. Indeed, interpreting enhances the use of prediction in L2 processing in general. Interpreters make faster predictions with verbal morphology than non-interpreter L2 speakers matched in L2 proficiency (Lozano-Argüelles & Sagarra, 2019). In the case of non-morphological word endings in nouns, the effects of prediction experience are even more prevalent. Interpreters use lexical stress to predict similarly to monolinguals, while non-interpreters can only predict when there are less lexical competitors (Lozano-Arguelles & Sagarra, under review). However, it is still unclear whether factors other than additional prediction experience could also explain mixed results in L2 prediction. In particular, interpreting demands intensive use of cognitive resources under time pressure. In this study, we compare how WM mediates the prediction of morphology in monolinguals, interpreters and non-interpreter L2 learners to better understand how cognitive resources support L1 and L2 prediction, and whether interpreting experience drives processing changes in bilinguals. In the next section, we summarize studies on the effects of WM on morphological and prosodic processing, as well as the impact of interpreting experience on WM capacity.

4.5 WM and Prediction

WM is the ability to retain information in memory while mentally manipulating it (Baddeley, 1992). This capacity of tracking what we are doing while remembering what we just did and planning what we will do next underlies many everyday activities such as movement control, reasoning or mental arithmetic (Davies & Logie, 1993). Importantly, WM has been linked to a myriad of language aspects such as reading, auditory comprehension and vocabulary acquisition. Different theories have attempted to explain the relationship between WM and language processing, with models divided between domain specific and domain-free models, and also between multiple resource or single resource models. Domain specific models posit that WM limits language processing, and while single resource models propose a trade-off between processing and storage components (Just & Carpenter, 1992), multiple resource models defend that each component functions independently (Baddeley, 2007). Alternatively, domain-free connectionist models attribute WM limitations to domain-general attentional processes (Cowan, 2005).

Previous research has established a relationship between WM and different aspects of second language acquisition, such as L2 comprehension, production and morphosyntactic processing. Overall, these studies seem to indicate that L2 processing requires attention to form, which is cognitively more taxing than attention to meaning (see Sagarra, 2012, for a review). In particular, the role of WM mediating L2 morphosyntactic processing is unclear. Some studies have concluded that WM correlates with successful processing of L2 syntactically complex sentences (Miyake & Friedman, 1998), supporting single-resource WM models that predict that lower WM limits processing capacity in the L2. By contrast, other research has shown no WM effects on processing of long-distance *wh*-movement, garden-path, and temporarily ambiguous sentences in L2 English (Juffs & Harrington, 2011). These findings are consistent with multiple-resource WM models, which sustain that WM should not limit L2 processing.

Among all bilingual processing, interpreting is probably the most demanding language processing task. WM allows holding in memory the incoming message while processing it to produce a translation in the target language. Specifically, in Dong & Li (2019)'s model, interpreting requires language control (achieved through focused attention) and processing control (achieved through divided attention) and WM is essential for both types of control. The cognitive complexity of interpreting gave rise to the 'interpreter advantage hypothesis', according to which the task-specific cognitive abilities developed by interpreters can be generalized to more efficient linguistic and executive skills during non-interpreting activities (García, 2014). In the case of WM, research shows that extensive practice with interpreting is associated with an advantage in WM span (Christoffels, Groot, & Kroll, 2006; Padilla, Bajo, Cañas, & Padilla, 1995; Signorelli, Haarmann, & Obler, 2011). Some studies have failed to find this interpreter advantage in WM (Chincotta & Underwood, 1998; Liu, Schallert, & Carroll, 2004). However, Dong & Li (2019) pointed out that this could be due to methodological issues in the above mentioned studies, such as low sample pool, participant groups not matched in age, or not enough training or experience with interpreting. Importantly, longitudinal studies show that interpreting training and experience, as opposed to mere exposure to the L2, train different memory components. In particular, consecutive interpreting training has been linked to improvements of updating efficiency (while exposure to L2 classes did not improve updating efficiency) (Dong, Liu, & Cai, 2018). Similarly, simultaneous interpreting training yields enhancement in verbal short term memory (while translation training or training in a variety of non-language subjects does not have memory benefits) (Babcock, Capizzi, Arbula, & Vallesi, 2017).

Relevant to our study, WM has also been linked to processing incoming speech and to language prediction. First, WM predicts the ability to process spoken language. For instance, listeners with increased WM capacity displayed better speech perception in noise (Foo, Rudner, Rönnberg, & Lunner, 2007) and training WM significantly improves speech perception in noise (Ingvalson, Dhar, Wong, & Liu, 2015). Also, training (rather than improvement of the sound quality) leads to increased efficiency of available WM capacity in low-intelligibility speech (Francis & Nusbaum, 2009). Based on these findings, Francis & Nusbaum (2009) proposed a model of speech perception in which signal cues are used to generate hypotheses which are in turn contrasted against the incoming signal to derive a more refined use of incoming cues. As a result, learning enhances perception by improving the efficiency of a resource-limited mechanism.

Second, because prediction involves contrasting incoming input with past experiences stored in memory, it is reasonable to hypothesize that WM mediates predictive processing. Indeed, some research has found a correlation between higher WM and stronger prediction of a noun based on the determiner's gender in native speakers. This finding supports the notion that WM allows us to hold and bind arbitrary pieces of information (Huettig & Janse, 2016). In contrast, another study found that native speakers can predict upcoming words (both low and high WM span), but only the low WM capacity group shows an additional processing effect in the unexpected condition. This effect is possibly related to an increased processing load while trying to resolve the prediction error or to the inability to suppress the original prediction (Otten & Van Berkum, 2009). Differences between Huettig & Janse (2016) & Otten & Van Berkum (2009) could be due to using different techniques (eye-tracking and EEG respectively), but also to the sentences used to measure prediction. In the case of Otten & Van Berkum (2009), more adjectives were included between the determiner and the noun, giving the listeners more time to make a prediction. This extra time could have made differences between listeners with low and high WM span disappear. In the case of L2 learners, we know that increasing the cognitive load while making predictions reduces the ability to make predictions, indicating that limiting cognitive resources precludes their ability to make predictions (Ito, Corley, & Pickering, 2017). Nevertheless, this experiment did not include a direct measure of WM and, hence, results are not conclusive. Importantly, other studies focusing on the predictive use of prosody only found a marginal effect of WM on accuracy in an offline prediction gating task (Sagarra & Casillas, 2018) or no WM effects during an eye-tracking task (Perdomo & Kaan, 2019).

Collectively, these studies support the claim that WM is a crucial cognitive component for language processing (both L1 and L2), speech perception and interpreting practice. However, the relationship between WM and prediction remains unclear. Huettig & Janse (2016) suggested that WM mediates prediction of nouns based on morphological cues, and Perdomo & Kaan (2019) indicated that WM does not affect prediction of syntax based on prosody. Importantly, Sagarra & Casillas (2018) found that WM was irrelevant for predicting morphology based on prosody during an online task, but found a marginal effect of WM during an offline task. The difference between online and offline findings highlights the need to continue investigating the role of WM during prediction of morphology. This issue is crucial to fully understand how cognitive resources link prosodic and morphological information to make predictions. We now describe the prosodic cues used in the present experiment.

4.6 Prosodic Information

Prosody is key during speech comprehension and it influences different linguistic representation levels such as syntactic analysis. For example, coinciding syntactic and prosodic boundaries facilitate processing, whereas conflicting boundaries produce the opposite effect (Speer, Kjelgaard, & Dobroth, 1996). Related to prediction, several types of prosodic information have been identified as cues for anticipation such as Japanese intonation (Nakamura et al., 2012), English intonation (Perdomo & Kaan, 2019), English vowel duration (Rehrig, 2017), Swedish tones (Roll et al., 2015), and Spanish stress (Sagarra & Casillas, 2018). The present study investigates the effects of WM on the prediction of verbal morphology (present/past), based on lexical stress (suprasegmental information) and syllabic structure (segmental information) in Spanish.

Lexical stress, understood as the prominence of a syllable in relation to other syllables in a word, distinguishes meaning both in English (*PREsent* vs. *preSENT*) and in Spanish (*PApa* ‘potato’ vs. *paPÁ* ‘dad’). English is a stress-timed language with time intervals between stressed syllables remaining relatively stable. This is partly achieved through vowel reduction processes where unstressed vowels exhibit shorter duration and centralized formant frequencies towards [ə]. In contrast, Spanish is a syllable-timed language in which both stressed and unstressed syllables are stable, displaying roughly the same duration and vowel quality patterns. Moreover, English and Spanish natives use stress differently for lexical access. While a prosodically matched prime facilitates perception for Spanish monolinguals and a mismatched prime hinders perception (Soto-Faraco et al., 2001), English monolinguals are not affected by mismatched primes (Cooper, Cutler, & Wales, 2002). Both articles together point out that Spanish natives utilize lexical stress to decrease the number of competitors during lexical access, while English natives possibly rely on other cues like vowel reduction. These distinctions between the two languages might be the reason why English L2 speakers of Spanish experience difficulties when perceiving (Face, 2005, 2006) and producing (Lord, 2007) stress.

Syllabic structure presents a more similar behavior in English and Spanish. Both languages allow open and closed syllables and it seems that open syllables (CV), as opposed to syllables with a coda (CVC), are universally preferred (Hyman, 1975; Jakobson, 1968). This becomes evident by observing that many languages permit codas, but none require their presence. Because of this extended bias towards CV syllables, CVC syllables are deemed as marked in English and Spanish, making them more acoustically (Hahn & Bailey, 2005) or articulatory (Côté, 1997) salient. Importantly, the syllabic structure in the first syllable of a word is used to reduce lexical competitors (Cholin, Levelt, & Schiller, 2006). This is relevant for prediction and research shows that initial segments that allow fewer endings with a higher frequency produce a more robust preactivation (Roll et al., 2017). In relation to our study, this means that syllabic structure in the initial syllable is an important factor for predictive processing of morphological endings.

4.7 The present study

Prior research on L2 prediction has pointed out that proficiency and L1-L2 typological similarity are important factors determining whether an L2 speaker is able to predict information in the L2 or not. However, it is unclear why even at advanced proficiency levels some L2 learners still cannot make predictions (Hopp, 2015). Lozano-Argüelles & Sagarra (2019) showed that anticipatory experience also enhanced L2 prediction, but findings were confounded because the study did not address the role of differences in cognitive resources. Research shows that WM influences L1 prediction of nouns based on morphological information, but it does not impact L1 and L2 prediction of syntax based on prosodic cues. Importantly, research on L1 and L2 prediction of morphology based on prosody showed inconclusive findings with null effects of WM in an online task and marginal effects on an offline task. In order to understand the role of WM to predict morphology, we investigate the relationship between WM and prediction of verbal morphology in Spanish native speakers, and L2 speakers of Spanish with and without interpreting experience. These issues are key to clarify: (1) how cognitive resources support L1 and L2 prediction of morphology and (2) how WM and additional anticipatory experience independently contribute to L2 prediction. We conducted a visual-world eye-tracking study with Spanish monolinguals, and English L2 learners of Spanish with and without interpreting experience. They saw two words on the screen while listening to a sentence and were asked to select with a button press which of the two words appeared in the sentence as soon as they could recognize it.

The first research question of the present study is: *does WM mediate monolingual prediction of verbal morphology based on prosodic cues?* We expect that WM will modulate prediction for monolinguals, based on studies showing that prediction between words correlates with WM capacity in native speakers (Huettig & Janse, 2016). Our results will contribute to this line of research by revealing whether such a linear relationship also takes place at prediction within a word. Furthermore, we expect to see greater differences between participants with higher and lower WM in paroxytone and CV, than in oxytone and CVC, following research indicating that paroxytone stress and CV syllabic structure complicate prediction due to their association with a higher number of lexical items (Lozano-Argüelles & Sagarra, 2019; Sagarra & Casillas, 2018). Since a greater number of alternatives requires more WM capacity (Cowan, 1997), we also hypothesize that monolinguals with higher WM will predict more. These findings will inform how monolinguals use WM for lexical access and morphological processing.

The second research question is: *does WM mediate L2 prediction of verbal morphology based on prosodic cues?* We hypothesize that WM will not modulate non-interpreter L2 learners' ability to predict, because L2 processing is more effortful than L1 processing. We based our hypothesis on research showing that L2 prediction based on prosodic cues is not mediated by WM in beginning, intermediate and advanced L2 learners (Perdomo & Kaan, 2019; Sagarra & Casillas, 2018). Even though WM correlates with L2 morphosyntactic processing at early stages of L2 acquisition (Sagarra, 2012), prediction entails a higher cognitive load, exceeding processing capacity of L2 learners even at advanced proficiency levels. Findings will inform SLA models by revealing how an executive function component (i.e., WM) modulates L2 prediction.

Finally, the third research question is: *does interpreting experience enhance the use of cognitive resources during L2 prediction?* Similar to monolinguals, we hypothesize that interpreters' WM will be correlated with prediction abilities (higher WM is linked with stronger prediction). Prior studies show how interpreting experience enhances L2 prediction (Lozano-Argüelles & Sagarra, 2019) and WM (Dong & Cai, 2015). Moreover, we expect that differences between interpreters with high and low WM will be greater for conditions associated with more lexical competitors, that is, paroxytone and CV conditions. According to Francis & Nusbaum (2009), listeners improve the use of WM by refining perception of incoming phonological cues. In the case of interpreters, practice with prediction during cognitively demanding circumstances (i.e., interpreting) will trigger switching from relying more strongly on segmental information for lexical access (Cooper et al., 2002), to a greater reliance on suprasegmental information like Spanish natives (Soto-Faraco et al., 2001). This attunement of the use of suprasegmental and segmental information in the interpreters' L2 will result in an enhanced use of WM during L2 prediction. These findings are essential for WM models, advancing our knowledge about how prediction experience enhances the use of WM during L2 processing.

4.8 Methods

4.8.1 Participants

The study included three groups of participants: 25 Spanish monolinguals and 57 L1 English-L2 Spanish late bilinguals, 25 non-interpreters and 22 interpreters. They were between 18 and 76 years old (monolinguals: M = 30.52, SD = 10.00; non-interpreters: M = 27.96, SD = 4.69; interpreters: M = 43.23, SD = 13.12). The monolinguals grew up in a monolingual region in Spain and, despite formal exposure to English, they reported limited proficiency and no regular exposure to English in their daily lives. The L2 learner groups grew up in an English monolingual environment, started learning Spanish after puberty in a formal setting, and most of them spent time in a Spanish speaking country (non-interpreters: M = 12.68, SD = 15.13; interpreters: M = 34.14; SD = 86.99, in months).

Both learner groups used their L2 on a regular basis (non-interpreters: M = 27.24, SD = 12.91; interpreters: M = 31.59; SD = 14.59, % of time per week). Crucially, both learner groups had equivalent proficiency in their L2 as measured with a simplified multiple-choice version of the DELE (*Diploma de Español Lengua Extranjera*) (interpreters vs. non-interpreters: $t(42.36) = 1.89$, $p = 0.07$). The non-interpreters did not have professional experience or training in either translation or interpreting techniques, whereas interpreters were formally trained through masters or professional interpreting certifications, and had worked as interpreters for at least 2 years (M = 14.16, SD = 9.23). Most interpreters work in the simultaneous interpreting mode (interpreter translates while the speaker is talking), although some reported working also in consecutive mode (the interpreter starts the translation after the speaker finishes a speech section).

We conducted three one-sided tests to verify that all three groups had equivalent working memory (Lakens, 2017). This ruled out the possibility of a group performing better than another because of superior WM. A Cohen's D of 0.3 was used to test moderate effects. Results revealed that all three groups were homogeneous in WM (monolinguals vs. interpreters: $t(34.69) = 0.49$, $p = 0.69$; monolinguals vs. non-interpreters: $t(47.22) = 0.78$, $p = 0.22$; interpreters vs. non-interpreters: $t(37.72) = 0.639$, $p = 0.737$).

4.8.2 Materials and Procedure

A background questionnaire (5 min) and a proficiency test (L2 speakers) (15 min) were completed before the rest of the tasks. These two tasks served as screening tests, ensuring suitability for the study in terms of age of L2 acquisition and L2 proficiency level. Next, participants completed an eye-tracking task (15 min), phonological short term memory task (10 min), WM task (10 min), and production task (15 min). All tasks were completed during one individual session of approximately one hour and fifteen minutes. The present study focuses on the WM and eye-tracking tasks.

4.8.2.1 Screening Tests

The background questionnaire gathered information about the participant's L1 and L2 language acquisition, other languages spoken, age, L2 age of acquistion, time spent in an L2 country, schooling languages, and percentage of weekly time speaking each language. The interpreters were also asked about their professional training, years of work experience, and professional training and certifications. The L2 proficiency test was administered only to the L2 speaker groups and consisted of a simplified version of the *Diploma de Español como Lenguage Extranjera* (based on Sagarra & Herschensohn, 2011) that included 56 multiple choice questions. Participants received 1 point per correct response and 0 per incorrect answer. They needed a minimum of 40 points in order to be included in the study.

4.8.2.2 Eye-tracking Task

Eye-movements were recorded with the EyeLink 1000 Plus desktop mount (SR Research), with a sample rate of 1k Hz, the spatial resolution 32° horizontal, 25° vertical, and an averaged calibration error of .25°-.5°. The experiment was displayed to participants on a BenQ XL2420TE monitor using a resolution of 1920 x 1080 pixels and they received the audio through Sol Republic 1601-32 headphones.

The task included 66 sentences: 18 were practice, 16 experimental, and 32 fillers. All sentences were between 5 and 7 words long and all word-pairs shared the initial syllable. All sentences were semantically plausible for both target and distractor, making the stress (or lack thereof) in the first syllable the only predictive cue. Half of the targets had a stressed first syllable (*CANta*, ‘he/she sings’) and half had an unstressed first syllable (*canTÓ*, ‘he/she sang’). Moreover, 9 of the target words contained a coda in the first syllable (CVC *cambia-cambió*, ‘(s)he changes/changed’) and 7 of the target words did not (*bebe-bebió*, ‘(s)he drinks/drank’). Location of the target word on the screen was counterbalanced for left and right sides of the screen. Half of the fillers presented words varying in number (*mes-meses* ‘month-months’) and meaning (*par-parque* ‘pair-park’).

For both filler types, half of the targets contained a long initial vowel (monosyllabic words: *mes*, *par*), and half had a short initial vowel (disyllabic: *meses*, *parque*). Although images are common in the visual-world paradigm, written words were selected for this experiment due to the low imageability of target words. Previous research shows that written words are suitable for research focused on the phonological representation of words (Huettig & McQueen, 2007).

Sentences were distributed between two versions of the experiment such that each version included only one condition of each sentence pair (e.g., version 1: *El vecino CAMbia la clave* 'The neighbor changes the password'; version 2: *El vecino camBIÓ la clave* 'The neighbor changed the password'). Practice trials remained equal in both versions of the experiment and participants randomly completed one of the two versions. During the eye-tracking task, participants sat in front of a screen with their heads on a chin-rest, while wearing headphones. They performed a nine-point calibration and were instructed to select as fast as possible the word they heard in the sentence by pressing the right or left shift key on the keyboard. Bottom presses before the target word were not recorded. Every trial contained: a drift correction, a fixation point displayed during 250 ms, the two words (target and distractor) on the left and right sides of the screen shown for 1000 ms as the familiarization phase, and the audio containing the sentence.

4.8.2.3 Working Memory Task

To assess participants' WM, we used the non-linguistic letter-number sequencing test adapted from the Wechsler Adult Intelligence Scale test (WAIS) (Wechsler, 1997). Participants listened to a series of numbers and letters in their L1 and were asked to remember and organize them, typing first the numbers in ascending order and then the letters in alphabetical order. There were two practice trials and 20 experimental series. They received 1 point per correct series (correct numbers/letters and order) and 0 per incorrect series (incorrect numbers/letters or order). Due to technical failure, WM data from one participant was missing.

4.9 Statistical Analysis

We used the software DataViewer (SR-Research) to downsample to 50 ms bins and extract the eye-tracking data. Working memory data were extracted from ePrime (Version 2.0.10). All data cleaning and statistical analyses were performed with R (Version 3.6.1; R Core Team, 2019). Models were fit with the package *lme4* (Bates, Mächler, Bolker, & Walker, 2009) and the *multcomp* package (Hothorn, Bretz, & Westfall, 2008) served to compare the learner groups. Fixations towards target were analyzed with the empirical-logit growth curve analysis (GCA, Mirman, 2014). The model represented the probability of looks towards the target over the time course. We selected the time window between 200 ms before the offset of the target syllable until 600 ms after. This allowed us to capture the time frame when fixations towards target started to increase above chance. The model was centered 200 ms after the offset of the target syllable, the approximate amount of time the human mind takes to direct looks towards a target after having heard a stimulus (Salverda, Kleinschmidt, & Tanenhaus, 2014). We modeled the time course with the linear, quadratic and cubic orthogonal polynomials and used the empirical logit (Barr, 2008) to transform binary responses (looks towards target or distractor). We included group (monolinguals, non-interpreters,

interpreters), lexical stress (paroxytone, oxytone), syllabic structure (CV, CVC), and WM (0-20) as fixed effects for all time terms. We sum coded lexical stress and syllabic structure, and parameter estimates represent effect sizes of change from CV to CVC syllables and paroxytone to oxytone stress. Similarly, WM was standardized to avoid convergence issues and improve readability of the model output. We included subject and item as random intercepts for all time terms and also by-participant random slopes for syllabic structure and lexical stress on all time terms. The baseline group predictor was the monolinguals and model parameters in the growth curve indicated differences between the learners and the monolingual group. We used pairwise comparisons to contrast non-interpreters from interpreters. Also, we used nested model comparisons to assess main effects and higher order interactions. Finally, only significant main effects and interactions are reported.

4.10 Results

We first report significant results for the monolingual group and continue comparing them with the learner groups. The GCA model intercept corresponds with the log odds of the baseline group (monolinguals) looking at the target when holding all conditions equal (time course, stress, syllabic structure, and working memory). The linear, quadratic and cubic time terms captured the sigmoid shape of the function (γ_{10} = 5.42; SE = 0.75; t = 7.26; p < .001; γ_{20} = −1.37; SE = 0.40; t = −3.46; p < .001 ;γ_{30} = −1.68; SE = 0.30; t = −5.64; p < .001). The full model summary is included in Appendices 1, 2, 3, and 4.

4.10.1 Monolingual group

There was a main effect of syllabic structure on the linear term, indicating that a change from CV to CVC increased the steepness of the slope ($\gamma_{11} = -0.06$; SE = 0.14; $t = -0.46$; $p = .644$). Also, there was a main effect of lexical stress on the quadratic time term ($\chi\_2(1) = 4.4$, $p = .036$), showing that a change from paroxytone (stressed initial syllable) to oxytone (unstressed initial syllable) increased the steepness of the slope ($\gamma_{22} = -0.25$; SE = 0.16; $t = -1.55$; $p = .121$) and decreased the bowing of the vertices (i.e., turning points) ($\gamma_{32} = -0.27$; SE = 0.38; $t = -0.72$; $p = .472$). This indicates that monolinguals started to fixate on oxytone targets earlier in the time course than on paroxytone targets and that they showed a higher prediction rate at the intercept for oxytonic targets. Regarding lexical stress and syllabic structure, the significant interaction on the cubic term ($\gamma_{35} = -0.12$; SE = 0.41; $t = -0.29$; $p = .771$) indicated sharper vertices with CV paroxytones. This suggests that monolinguals fixated on CV paroxytones later in the time course, but did so at a faster rate.

The interaction of WM and stress on the linear and quadratic time terms ($\chi_2(1) = 5.4$, $p = .02$) ($\chi_2(1) = 5.7$, $p = .017$) showed that monolinguals had a more bowed curve in paroxytone words ($\gamma_{26} = 0.00$; SE = 0.07; $t = 0.02$; $p = .983$). That is, higher WM monolinguals predicted earlier than lower WM monolinguals in paroxytone words, but WM did not affect the prediction of oxytone words.

The interaction of WM and syllabic structure on the linear term ($\chi_2(1) = 4.2$, $p = .041$) indicated that higher WM monolinguals predicted earlier than lower WM monolinguals with CVC initial syllables ($\gamma_{18} = 0.89$; SE = 0.28; $t = 3.23$; $p = .001$). This interaction points out that although WM capacity did not modulate prediction in words with CV initial syllables, all monolinguals predicted suffixes by the offset of the first syllable.

Finally, regarding prediction at first syllable offset, monolinguals anticipated verb endings above 80% rate for all conditions, with the exception of CV paroxytones (e.g., *LAva*, '(s)he washes'). Within the remaining conditions, the one that yielded greater prediction was CVC oxytone (e.g., *firMÓ*, '(s)he signed') (CV paroxytone: Probability = 0.702; LB = 0.608; UB = 0.782, CV oxytone: Probability = 0.839; LB = 0.779; UB = 0.886, CVC paroxytone: Probability = 0.842; LB = 0.787; UB = 0.884, CVC oxytone: Probability = 0.882; LB = 0.836; UB = 0.917).

4.10.2 Non-interpreter L2 group

There was a main effect of group on the quadratic term ($\chi^2(2) = 16.8$, $p = .001$), showing that monolinguals predicted significantly more than non-interpreters ($\gamma_{23} = -0.03$; SE = 0.10; $t = -0.27$; $p = .789$). The model also showed an interaction of syllabic structure and lexical stress for non-interpreters ($\gamma_{07} = -0.16$; SE = 0.25; $t = -0.65$; $p = .519$), indicating that adding a coda to the paroxytone condition was more beneficial for non-interpreters than for monolinguals. Moreover, the interaction of lexical stress × group × WM on the linear and quadratic time terms for non-interpreters ($\chi^2(2) = 6$, $p = .049$) ($\chi^2(2) = 7.1$, $p = .028$) revealed that, averaging across syllabic structures, lower WM non-interpreters predicted earlier than higher WM non-interpreters, but only for the oxytone condition. WM did not make a difference for the paroxytone condition ($\gamma_{010} = 0.68$; SE = 0.30; $t = 2.27$; $p = .023$).

4.10.3 Interpreter L2 group

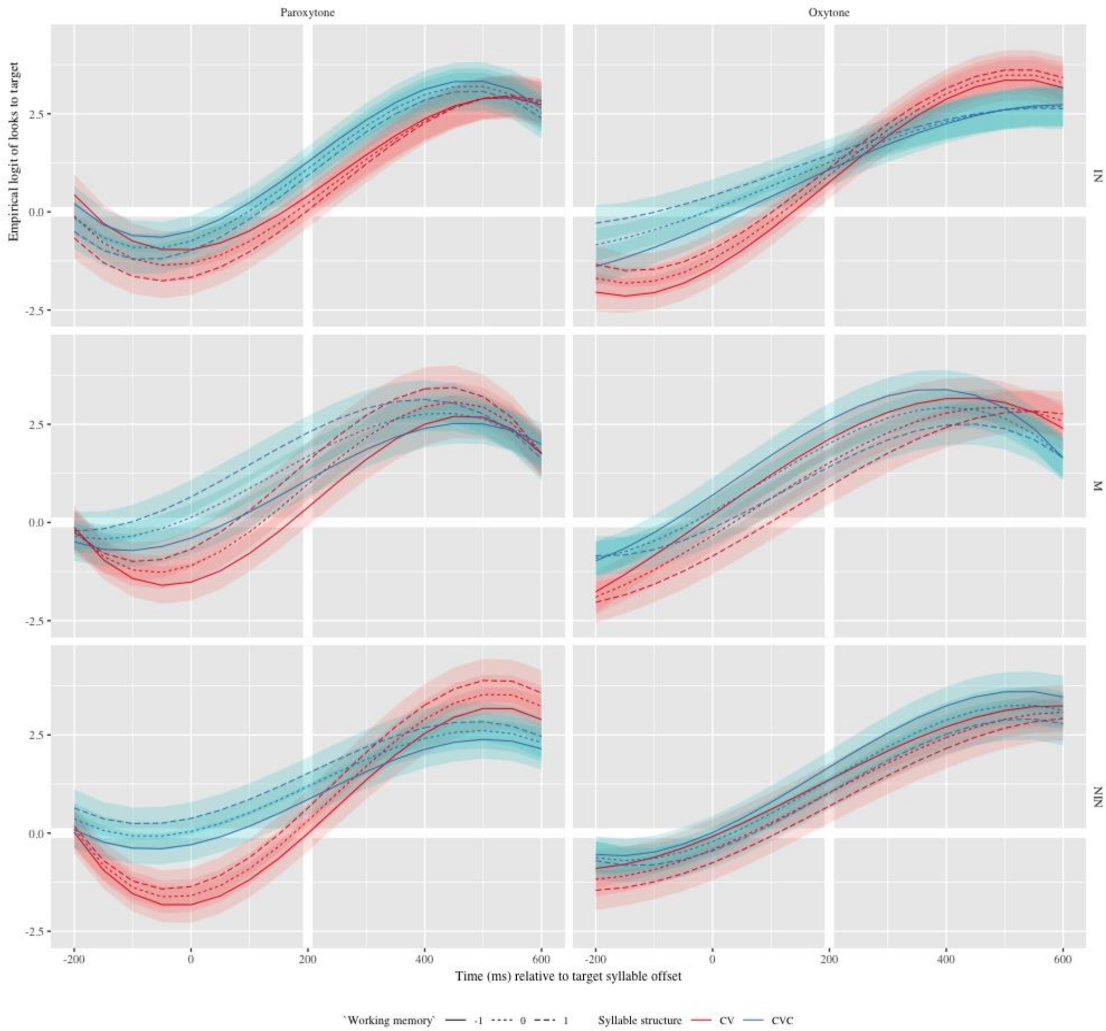
Like the non-interpreters, the interpreters predicted at a lower rate than monolinguals (main effect of group) (γ_{24} = 1.61; SE = 0.48; t = 3.36; p < .001). Then, the interaction of syllabic structure and lexical stress on the linear time term (γ_{28} = −0.67; SE = 0.28; t = −2.38; p = .017) and the cubic time term (γ_{39} = 0.25; SE = 0.33; t = 0.77; p = .441) revealed that the slope was steeper for the interpreters' group in the CVC paroxytone condition (e.g., *FIRma*). In other words, interpreters predicted later but at a faster rate in CVC paroxytones. Also, the interaction of lexical stress × group (IN) × WM on the intercept (γ_{19} = −0.00; SE = 0.27; t = −0.00; p = .997), the linear term (γ_{37} = −0.08; SE = 0.29; t = −0.27; p = .79) and the quadratic term (γ_{210} = 0.77; SE = 0.30; t = 2.58; p = .01) showed a steeper slope in the paroxytone condition. In effect, higher WM interpreters wait longer to make a prediction than lower WM interpreters with paroxytones, but predict at a faster rate and reach the same prediction level by the offset of the target syllable. Overall, interpreters' WM curves are closer together, indicating that WM differences between high and lower capacity groups are smaller for interpreters than for monolinguals.

4.10.4 Interpreter and non-interpreter L2 groups

The comparison of the two L2 groups yielded an interaction of lexical stress, group and WM on the intercept (γ_{19} = −0.00; SE = 0.27; t = −0.00; p = .997), indicating that in the oxytone condition, high WM interpreters predicted earlier, while non-interpreters with lower WM started predicting earlier. Furthermore, the interaction of syllabic structure, lexical stress and group on the linear time term (γ_{08} = −0.57; SE = 0.26;

$t = -2.17$; $p = .03$) and the cubic time term ($\gamma_{28} = -0.67$; SE = 0.28; $t = -2.38$; $p = .017$) showed that interpreters had a steeper slope in CVC paroxytones and non-interpreters had sharper vertices in CV paroxytones. Thus, interpreters predicted at a faster rate than non-interpreters in CVC paroxytones and non-interpreters were faster than interpreters in the CV paroxytones. Finally, both L2 groups predicted similarly at the offset of the target syllable (Non-interpreters: CV Paroxytone: Probability = 0.55; LB = 0.446; UB = 0.649, CV Oxytone: Probability = 0.742; LB = 0.661; UB = 0.81, CVC Paroxytone: Probability = 0.745; LB = 0.672; UB = 0.807, CVC Oxytone: Probability = 0.795; LB = 0.726; UB = 0.851; Intepreters: CV Paroxytone: Probability = 0.526; LB = 0.42; UB = 0.629, CV Oxytone: Probability = 0.735; LB = 0.65; UB = 0.805, CVC Paroxytone: Probability = 0.738; LB = 0.661; UB = 0.802, CVC Oxytone: Probability = 0.779; LB = 0.704; UB = 0.84).

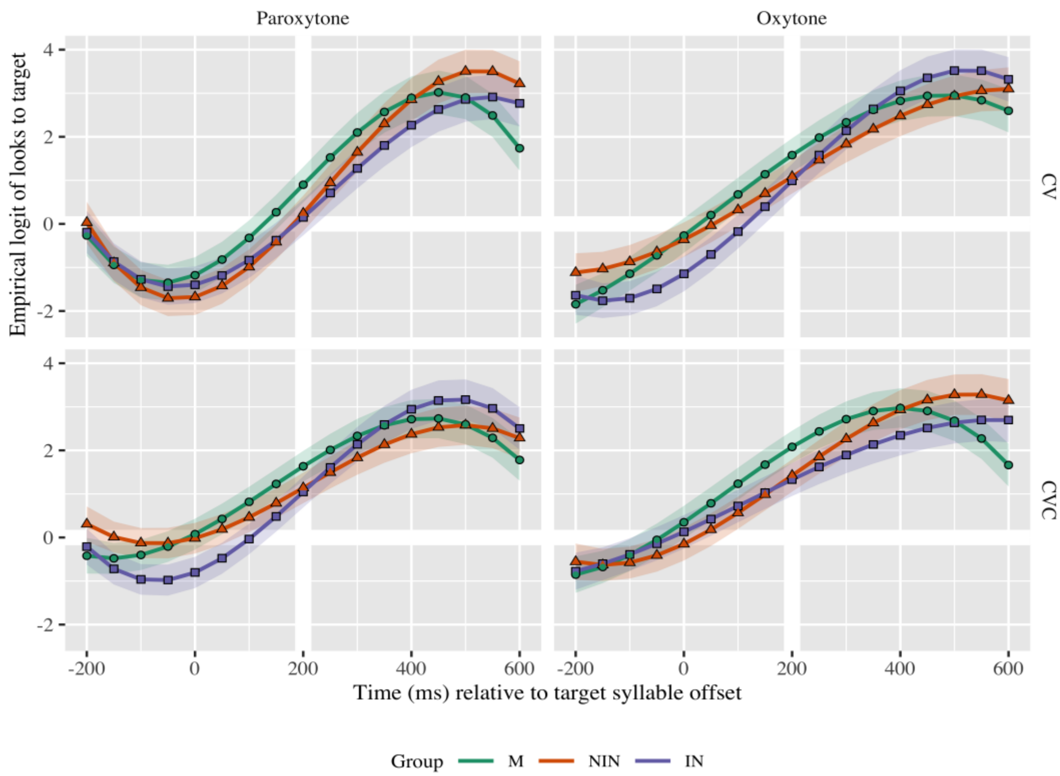
Figure 4. 1 Growth curve estimates per group, WM and condition



11

11 Figure 1: Growth curve estimates of target fixations as a function of lexical stress and syllable structure and WM per group during the analysis window. Lines represent model estimates at -1, 0, and 1 standard deviations of WM. The transparent ribbons represent ±SE. Empirical logit values on the y-axis correspond to proportions of 0.12, 0.50, 0.88, and 0.98. The thick horizontal white line represents the 50% probability of fixating on the target. The thick vertical white line indicates 200 ms after the offset of the target syllable.

Figure 4. 2 Growth curve estimates per group



12

4.11 Discussion

The purpose of the present study was to evaluate the role of WM in the prediction of L1 and L2 spoken words, and to tease apart the effects of anticipatory experience and WM. Spanish monolinguals and advanced adult English learners of Spanish with and without interpreting experience completed a visual world paradigm task including verbs

12 Figure 2: Growth curve estimates of target fixations as a function of lexical stress and syllable structure per group during the analysis window. Symbols and lines represent model estimates at mean WM, and the transparent ribbons represent ±SE. Empirical logit values on the y-axis correspond to proportions of 0.12, 0.50, 0.88, and 0.98. The thick horizontal white line represents the 50% probability of fixating on the target. The thick vertical white line indicates 200 ms after the offset of the target syllable.

with initial syllables varying in stress (if paroxytone present tense, then more competitors: *BEbe*; if oxytone past tense, then fewer competitors: *beBIÓ*) and syllabic structure (if CV, then more competitors: *BEbe*; if CVC then fewer competitors: *CANta*). Results revealed different interactions between WM and both lexical stress and syllabic structure for each group. In particular, our findings showed that higher WM monolinguals had increased prediction in the paroxytone and CVC conditions, lower WM non-interpreters showed increased prediction in the oxytone condition, and higher WM interpreters were faster predicting paroxytone conditions. These findings indicate that the relationship between WM and prediction is different in L1 and L2 processing, and that both WM and anticipatory experience contribute to explaining differences in L2 prediction.

4.11.1 Monolingual findings

The first research question examined whether WM mediates monolingual prediction of verbal morphology based on prosodic cues. The hypotheses that higher WM would increase accurate predictions and that WM effects would be more evident in the condition with more lexical competitors (i.e., CV paroxytones) were partially supported. On the one hand, as expected, the interaction of WM and lexical stress revealed that higher WM monolinguals predicted earlier than lower WM monolinguals in paroxytone words (the stress pattern linked to more lexical competitors). This seems to indicate that when the cognitive load is higher due to an increased number of lexical competitors, a higher WM capacity facilitates prediction of morphological endings. Conversely, when the cognitive load is lower because of fewer lexical competitors, WM capacity does not impact prediction. Contrary to previous findings showing a correlation between prediction and WM (Huettig & Janse, 2016), our study shows a more nuanced relationship between linguistic prediction and WM. Our results are consistent with research showing that morphological processing is cognitively taxing for both natives and L2 learners. In effect, Hartsuiker & Barkhuysen (2006) showed that low WM natives made more agreement errors than high WM natives when the cognitive load was increased. We extend these findings to anticipatory processing and show that more lexical competitors increase the cognitive demand and lower prediction for monolinguals with lower WM.

On the other hand, against our initial expectation, the interaction between WM and syllabic structure showed that higher WM monolinguals predicted earlier in words with CVC initial syllables (the syllabic structure yielding fewer lexical competitors). This interaction contradicts results for lexical stress, indicating that increased cognitive resources facilitate prediction under less cognitively demanding circumstances. One possible explanation for this finding is that, although adding a coda to the initial syllable reduces the number of lexical competitors, processing an additional segment is cognitively more costly. Thus, monolinguals with higher WM are capable of making a prediction earlier. Another option is that our experimental design has manufactured this effect. According to Soto-Faraco et al. (2001), listeners use all available cues for lexical access that allow distinction between word pairs. In our experiment, the initial syllable in every word pair presented to participants differed in terms of lexical stress (i.e., suprasegmentally). Hence, it is possible that participants favored attention to suprasegmental cues, over segmental cues.

In parallel to the aforementioned findings, there was a main effect of lexical stress and a main effect of syllabic structure, indicating that monolinguals predicted earlier in the oxytone (*beBIÓ*) and CVC conditions (*CANta*). The model also showed an interaction between lexical stress and syllabic structure, such that monolinguals predicted CV paroxytones later but faster. These results show that cues related to fewer lexical competitors favor prediction and that, when more lexical competitors are present, prediction is delayed. The lexical stress and syllabic structure findings mirror prior research on L1 morphological prediction with prosodic cues (Roll et al., 2015; Sagarra & Casillas, 2018; Söderström et al., 2012). Taken together, the results of these studies and the current one indicate that prosody aids the predictive construction of lexical representations.

4.11.2 Non-interpreter L2 findings

The second research question explored whether WM mediates L2 prediction of verbal morphology based on prosodic cues. The prediction that WM would not affect prediction of morphological suffixes in non-interpreter L2 learners was not supported. Results showed a significant interaction of lexical stress and WM, indicating that lower WM non-interpreters predicted earlier oxytone targets than higher WM non-interpreters. Surprisingly, lower WM capacity seems to be advantageous for predicting morphology when lexical competition is reduced (i.e., oxytone words). We speculate that this is because lower WM capacity allows us to hold less lexical competitors in memory. When the possibilities are reduced through a less common stress pattern, lower WM non-interpreters are able to make a prediction earlier. Higher WM non-interpreters contemplate more possibilities and take longer to make a prediction. These findings suggest that L2 morphological prediction is cognitively demanding and that difficulties in L2 prediction might be in part due to cognitive constraints. Our results contradict previous research showing no WM effects on L2 prediction (Perdomo & Kaan, 2019; Sagarra & Casillas, 2018). One possible explanation for this difference is the type of analyses conducted. While previous studies used linear mixed-effects models, the present study used growth curve analyses. GCA is particularly interesting for our data because it provides information about the trajectory of prediction over time, rather than limited information at one specific time point (as is the case with linear mixed-effects models). Interestingly, Huettig & Janse (2016) also found a WM effect using a combination of principal component analysis and multiple regressions to assess the contribution of WM to prediction performance in an eye-tracking task. Alternatively, mixed WM tasks could also explain why some studies find WM effects, while others do not. Huettig & Janse (2016) included the nonword repetition task, the backward digit span, and the Corsi block task, Perdomo & Kaan (2019) chose the forward and backward digit span, and Sagarra & Casillas (2018), similar to the present study, selected the letter-number sequencing task. Future research should take into account differences regarding statistical analyses and WM tasks.

Furthermore, a group effect indicated that monolinguals predicted more than non-interpreters. Explaining why L2ers predict to a lesser extent than monolinguals is beyond the scope of the present study. Nonetheless, differences between Spanish and English in the use of lexical stress for lexical access could be one of the reasons. Spanish is believed to be a syllable-timed language, while English is a stress-timed language. English learners of Spanish might transfer their L1 strategy of relying on segmental information (Cooper et al., 2002), instead of favoring stress (Soto-Faraco et al., 2001) for lexical access. To test this L1 transfer hypothesis, we are currently collecting data with Mandarin Chinese (syllabe-timed) learners of Spanish. Our results replicate prior findings of L2 prediction of morphological suffixes showing that L2 learners can make predictions in the L2 (Lozano-Argüelles & Sagarra, 2019; Sagarra & Casillas, 2018; Schremm et al., 2016). Collectively, our findings are consistent with prediction accounts indicating that L2 prediction is possible but more effortful than L1 prediction (Kaan, 2014).

4.11.3 Interpreter L2 findings

The third research question investigated whether interpreting experience enhances the use of cognitive resources during L2 prediction. We expected that interpreters would show a correlation between WM and prediction abilities and that WM would have a stronger effect on conditions with more competitors (CV and paroxytone). This was partially supported. On the one hand, WM effects showed that high WM interpreters waited longer to make a prediction but were faster than monolinguals in the paroxytone words. This indicates that interpreters' cognitive resources, similar to monolinguals, support prediction when cognitive load is higher (i.e., paroxytone words linked to more competitors). Different reasons could explain why interpreters' use of WM for prediction is closer to monolinguals than that of non-interpreters. First, according to Dong & Li

(2019) model, processing control in interpreting is achieved through divided attention (to concurrent input and output) via coordination and WM. They propose that interpreting training enhances coordination ability, WM capacity, and language processing efficiency. However, this possibility is ruled out by our results because both interpreters and non-interpreter had comparable WM scores. Second, it is possible that interpreters' increased exposure to the L2 under cognitively demanding circumstances has enhanced their perception of incoming phonological cues. This alternative is consistent with Francis & Nusbaum (2009), that proposes that language experience enhances the use of WM during L2 processing through improved attention to phonological cues.

On the other hand, WM did not affect prediction under the rest of the conditions. This finding is consistent with our monolingual data, indicating that WM in natives and interpreters only contributes to prediction when the cognitive load is increased due to more lexical competitors (paroxytone words). Also, interpreters made faster predictions in CVC paroxytones than non-interpreters, indicating that additional prediction experience via interpreting enhances prediction in the L2. This is consistent with studies showing superior prediction skills in interpreter L2 learners (Lozano-Argüelles & Sagarra, 2019).

Besides the findings detailed above, a group effect revealed that interpreters predicted less than monolinguals. In effect, L2 prediction is constrained by additional cognitive demands Again, this finding goes in line with research showing that L2 learners are able to generate predictions, but to a lesser extent than monolinguals (Kaan, 2014; Lozano-Argüelles & Sagarra, 2019; Sagarra & Casillas, 2018). Finally, interpreters started to predict later but at a faster rate than monolinguals in CVC paroxytones. One of the comprehension tactics interpreters receive in their training is delaying their translation into the target language (Gile, 1995). This strategy allows for improved comprehension of the source text, but it is more cognitively demanding because of the accumulation of information in short term memory. We hypothesize that this strategy is transferred to prediction and interpreters are cautious before committing to a prediction under conditions with more lexical competitors (i.e. paroxytone words). Taken together, these findings are crucial for WM models, advancing our knowledge about how additional prediction experience enhances the use of WM during L2 processing.

4.12 Conclusion

The present study investigated the role of WM in L1 and L2 prediction during spoken word recognition, disentangling the effects of WM and anticipatory experience. Spanish monolinguals and advanced adult English learners of Spanish with and without interpreting experience performed an eye-tracking task with verbs with initial syllables varying in stress (*BEbe*, *beBIÓ*) and syllabic structure (*BEbe*, *CANta*), as well as a working memory task. While for monolinguals and interpreters WM facilitated prediction when cognitive load was higher (more lexical competitors), for non-interpreters WM affected prediction under less cognitively demanding conditions (fewer lexical competitors). These findings inform L1 and L2 prediction models by showing that anticipation of morphology is cognitively taxing. In sum, our results show that prediction of morphology depends on cognitive resources available and that WM and anticipatory experience independently contribute to explaining differences in L2 prediction. Finally, our findings emphasize the relevance of prosody as a key for efficient access to semantic and morphological information in Spanish. This is an important issue with pedagogical implications. Given the difficulties that L2 learners of Spanish have perceiving and producing stress (Face, 2005, 2006), reinforcing prosody in the L2 classroom is necessary in order to foster more efficient processing.

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Appendix 1: Model estimates at mean working memory for probability of target fixations ±SE at 200 ms after the target syllable offset.

Group	Lexical stress	Syllable structure	Probability	LB	UB
IN	Paroxytone	CV	0.5557090	0.452889	0.653969
	Oxytone		0.7183451	0.633892	0.789777
	Paroxytone	CVC	0.7502358	0.677771	0.810949
	Oxytone		0.7797976	0.708565	0.837609
M	Paroxytone	CV	0.7260934	0.638534	0.799115
	Oxytone		0.8210651	0.757819	0.870614
	Paroxytone	CVC	0.8438534	0.791731	0.884828
	Oxytone		0.8824267	0.838330	0.915705
NIN	Paroxytone	CV	0.5784809	0.477393	0.673392
	Oxytone		0.7360172	0.655627	0.803272
	Paroxytone	CVC	0.7665572	0.698239	0.823321
	Oxytone		0.7953144	0.728578	0.849041

Appendix 2: Growth curve model fixed effects

Parameter	Estimate	SE	t	p
Intercept (γ_{00})	1.176	0.214	5.497	< .001
$Time_1$ (γ_{10})	5.421	0.746	7.262	< .001
$Time_2$ (γ_{20})	−1.372	0.396	−3.464	< .001
$Time_3$ (γ_{30})	−1.677	0.297	−5.644	< .001
Syllable structure (γ_{01})	−0.185	0.105	−1.773	.076
$Time_1$ × Syllable structure (γ_{11})	0.819	0.375	2.183	.029
$Time_2$ × Syllable structure (γ_{21})	0.424	0.240	1.769	.077
$Time_3$ × Syllable structure (γ_{31})	−0.251	0.161	−1.553	.121
Lexical stress (γ_{02})	−0.063	0.135	−0.463	.644
$Time_1$ × Lexical stress (γ_{12})	−0.270	0.376	−0.720	.472
$Time_2$ × Lexical stress (γ_{22})	0.575	0.241	2.386	.017
$Time_3$ × Lexical stress (γ_{32})	−0.579	0.161	−3.587	< .001
Group NIN (γ_{03})	−0.081	0.276	−0.294	.768
$Time_1$ × Group NIN (γ_{13})	0.441	0.923	0.477	.633
$Time_2$ × Group NIN (γ_{23})	1.823	0.471	3.871	< .001
$Time_3$ × Group NIN (γ_{33})	0.149	0.383	0.389	.698
Group IN (γ_{04})	−0.229	0.283	−0.811	.417
$Time_1$ × Group IN (γ_{14})	0.889	0.944	0.942	.346
$Time_2$ × Group IN (γ_{24})	1.615	0.480	3.360	< .001
$Time_3$ × Group IN (γ_{34})	0.028	0.391	0.072	.943
Syllable structure × Lexical stress (γ_{05})	−0.027	0.100	−0.268	.789
$Time_1$ × Syllable structure × Lexical stress (γ_{15})	−0.120	0.410	−0.292	.771
$Time_2$ × Syllable structure × Lexical stress (γ_{25})	0.104	0.289	0.360	.719
$Time_3$ × Syllable structure × Lexical stress (γ_{35})	−0.491	0.226	−2.172	.030
Lexical stress × Working memory (γ_{06})	0.362	0.219	1.649	.099
$Time_1$ × Lexical stress × Working memory (γ_{16})	−0.162	0.251	−0.645	.519
$Time_2$ × Lexical stress × Working memory (γ_{26})	−0.862	0.250	−3.450	< .001
Syllable structure × Working memory (γ_{36})	−0.004	0.057	−0.076	.939
$Time_1$ × Syllable structure × Lexical stress × Group NIN (γ_{07})	0.895	0.277	3.229	.001
Syllable structure × Lexical stress × Group NIN (γ_{17})	0.001	0.069	0.022	.983
$Time_3$ × Syllable structure × Lexical stress × Group NIN (γ_{27})	−0.001	0.273	−0.003	.997
$Time_1$ × Lexical stress × Group IN:Working memory (γ_{37})	0.684	0.301	2.273	.023
Syllable structure × Lexical stress × Group IN (γ_{08})	−0.034	0.070	−0.483	.629
$Time_1$ × Syllable structure × Working memory (γ_{18})	0.239	0.113	2.107	.035
$Time_1$ × Syllable structure × Lexical stress × Group	−0.671	0.281	−2.384	.017

IN (γ_{28})				
Lexical stress × Group NIN × Working memory (γ_{38})	−0.076	0.285	−0.266	.790
Time$_2$ × Syllable structure × Lexical stress × Group NIN (γ_{09})	0.299	0.275	1.087	.277
Lexical stress × Group IN × Working memory (γ_{19})	−0.567	0.261	−2.171	.030
Time$_2$ × Syllable structure × Lexical stress × Group IN (γ_{29})	0.177	0.280	0.633	.527
Time$_3$ × Syllable structure × Lexical stress × Group IN (γ_{39})	0.846	0.277	3.052	.002
Time$_2$ × Lexical stress × Group NIN:Working memory (γ_{010})	0.701	0.325	2.155	.031
Time$_1$ × Lexical stress × Group NIN:Working memory (γ_{110})	0.251	0.326	0.770	.441
Time$_2$ × Lexical stress × Group IN:Working memory (γ_{210})	0.772	0.299	2.580	.010

Appendix 3: Growth curve model random effects

Group	Parameter	Variance	SD	Correlations					
Participant	Intercept	0.869	0.932	1.00					
	Syllable structure	0.179	0.423	−.14	1.00				
	Lexical stress	0.666	0.816	−.01	.21	1.00			
	$Time_1$	9.495	3.081	.42	−.14	.06	1.00		
	$Time_2$	1.806	1.344	−.06	.18	.08	.37	1.00	
	$Time_3$	0.933	0.966	−.35	.01	−.26	−.79	−.16	1.00
Item	Intercept	0.229	0.479	1.00					
	$Time_1$	3.911	1.978	.21			1.00		
	$Time_2$	1.363	1.168	−.75			−.43	1.00	
	$Time_3$	0.402	0.634	.27			−.86	−.08	1.00
Residual		13.484	3.672						

Appendix 4: Pairwise comparisons between learner groups.

Parameter	Estimate	SE	t	p
IN - NIN (γ_{08})	0.148	0.282	0.524	.600
$Time_1$ × IN - NIN (γ_{18})	−0.448	0.941	−0.476	.634
$Time_2$ × IN - NIN (γ_{28})	0.208	0.478	0.436	.663
$Time_3$ × IN - NIN (γ_{38})	0.121	0.389	0.311	.756
Syllable structure × Lexical stress × IN - NIN (γ_{09})	0.035	0.069	0.508	.612
Lexical stress × IN - NIN × wm_std (γ_{19})	0.492	0.236	2.086	.037
$Time_1$ × Syllable structure × Lexical stress × IN - NIN (γ_{08})	1.566	0.279	5.610	< .001
$Time_2$ × Syllable structure × Lexical stress × IN - NIN (γ_{18})	0.122	0.278	0.440	.660
$Time_3$ × Syllable structure × Lexical stress × IN - NIN (γ_{28})	−0.847	0.276	−3.073	.002
$Time_1$ × Lexical stress × IN - NIN:wm_std (γ_{38})	−0.433	0.272	−1.590	.112
$Time_2$ × Lexical stress × IN - NIN:wm_std (γ_{09})	−0.071	0.270	−0.261	.794