

Practice makes perfect: Interpreting facilitates L2 morphological anticipation

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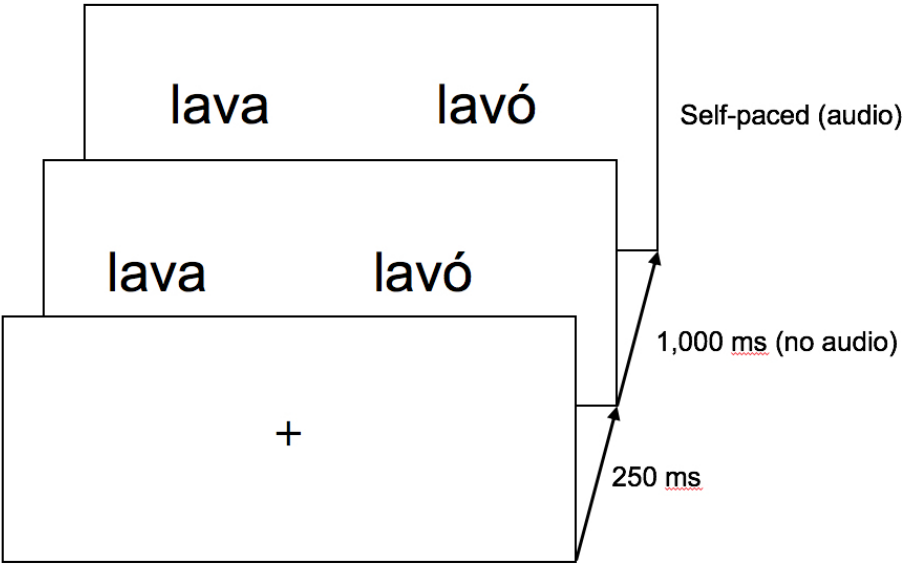


Figure 1. Sample trial in the eye-tracking task.
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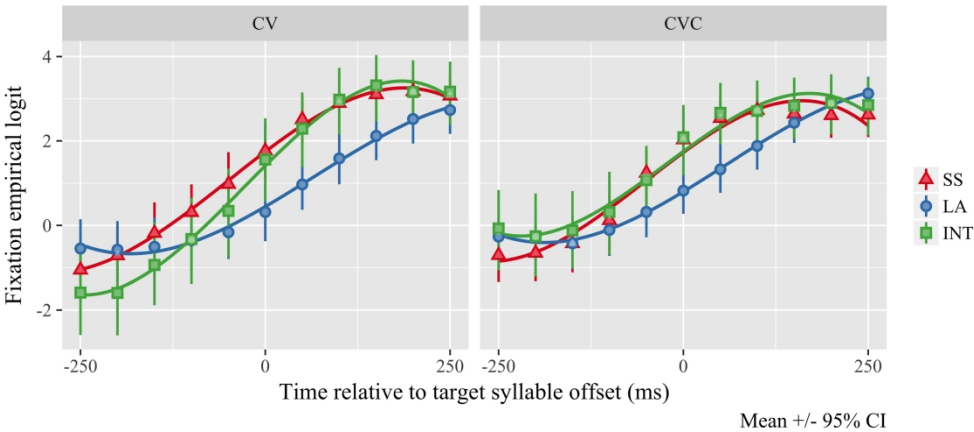


Figure 2. Output for growth curve model fits for effect of group and syllable structure during analysis window. Symbols and point ranges indicate mean \pm SE. Lines represent model fits.

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Highlights

- L2 proficiency only partially explains L2 predictive processing
- Prediction in the L2 can be similar to L1 prediction
- Segmental information is used by natives and non-natives to anticipate morphology
- Interpreting experience enhances L2 anticipation during non-interpreting situations

For Peer Review

RUNNING HEAD: INTERPRETING FACILITATES L2 ANTICIPATION

Practice makes perfect:
Interpreting facilitates L2 morphological anticipation ¹

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Abstract

Anticipation and phonology are essential for communication. Yet, it is unclear how L2 anticipation depends on proficiency, language experience, and anticipatory skills, and how L2 learners use segmental and suprasegmental information to anticipate. We investigated the role of anticipatory skills on anticipation by comparing monolinguals to advanced L2 learners with and without interpreting experience. Furthermore, we examined the role of segmental and suprasegmental information on anticipation by exploring the use of lexical stress and syllabic structure to anticipate verb suffixes in Spanish. Eye-tracking data revealed that all groups anticipated suffixes independent of stress when preceded by CVC syllables. However, only monolinguals and interpreters anticipated with CV syllables, and interpreters anticipated at a faster rate. These findings suggest that native and non-native speakers rely on segmental information to predict morphology during word recognition. Also, interpreters' superior anticipatory skills suggest that anticipatory experience affects L2 anticipation and is trainable.

Keywords: anticipation, morphological processing, interpreting, lexical stress, syllabic structure, segmentals, suprasegmentals.

Practice makes perfect:

Interpreting facilitates L2 morphological anticipation

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; Kann, 2014). Monolinguals constantly predict morphological information of upcoming words (Kamide, 2008) and suffixes within a word (Roll, 2015), but evidence is mixed regarding L2 learners (see Kann, 2014, for a review). Relevant to our study, higher proficiency learners can predict a word's suffix based on suprasegmental information, such as tone (Schremm, Söderström, Horne, & Roll, 2016). However, this is not the case for lower proficiency learners for tone (Gosselke et al., 2018), stress (Sagarra & Casillas, 2018), or vowel duration (Rehrig, 2017). Importantly, it is unclear whether similar results apply to segmental information, and whether higher proficiency learners' superior anticipatory abilities emerge from increased L2 proficiency, language experience, or anticipatory skills. This question is essential to understand how humans gain anticipation expertise and to inform instructional practices.

To investigate the role of anticipatory skills and of suprasegmental and segmental information in L2 anticipation, 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. Proportion of 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

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3 contrastive in English and Spanish, yet it is realized differently in each language, resulting in
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5 cross-linguistic interference in L2 learners (Face, 2005; Lord, 2007). Syllabic structure was
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7 selected because it can be used to reduce competition during lexical activation for speech
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9 production (Cholin, Levelt, & Schiller, 2006). Finally, the visual world paradigm
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11 methodology was employed because it measures attention to upcoming linguistic
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13 information before it has been disclosed by time-locking listeners' eye-movements to a
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15 visual stimulus (e.g., a written word) in response to an oral stimulus (e.g., a sentence) (see
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17 Huettig, Rommers, & Meyer, 2011, for a review).
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21 **Anticipation in monolinguals**

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23 Native speakers use a myriad of information to make linguistic predictions, including
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25 semantics (Altmann & Kamide, 1999), morphology (Grüter, Williams, & Fernald, 2012; Lew-
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27 Williams & Fernald, 2010), and phonology (intonation: Nakamura, Arai, & Mazuka, 2012;
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29 Steinbauer, Alter, & Friederici, 1999; Weber, Rice, & Matthew, 2006; tone: Roll, 2015; Roll,
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31 Horne, & Lindgren, 2011; Roll, Söderström, Frid, Mannfolk, & Horne, 2017; pauses between
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33 clauses: Hawthorne & Gerken, 2014; Kjelgaard & Speer, 1999; vowel duration: Rehrig, 2017).
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35 Such predictions depend on speech rate (slower rates increase prediction), preview time (longer
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37 times increase prediction), task instructions (explicitly instructing participants to predict
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39 increases prediction) (Huettig & Guerra, in press), and age (younger age increases prediction)
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41 (Wlotko, Lee, & Federmeier, 2010). Interestingly, older monolinguals with larger vocabularies
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43 and higher verbal fluency are as effective as younger monolinguals making linguistic predictions
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45 (Federmeier, McLennan, De Ochoa, & Kutas, 2002), suggesting that increasing language
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47 experience may enhance anticipatory abilities.
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Relevant to our study, native speakers seem to use suprasegmental cues to predict morphology within a word. For example, Swedish natives use tone to predict number (singular/plural) (Roll, Horne, & Lindgren, 2010; Söderström, Horne, & Roll, 2015) and tense (present/past) (Roll, Söderström, & Horne, 2013; Roll, Söderström, Frid, Mannfolk, & Horne, 2017), English natives use vowel duration to predict voice (active/passive) (Rehrigh, 2017), and Spanish natives use lexical stress to predict tense (present/past) (Sagarra & Casillas, 2018). However, the vowel duration study mixed vowel duration (suprasegmental) with syllabic structure (segmental), and to our knowledge there is no study investigating whether natives use segmental cues to make predictions.

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, and Guzzardo Tamargo (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 et al., 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 and syllabic structure as predictors of verb tense in *both* beginning and advanced English learners of Spanish, and 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 interpret the sentence as active or passive, but the null results could be due to lack of proficiency (it was assessed subjectively via self-ratings), the use of a contrast known to be acquired late even in monolinguals (active/passive voice), or to vowel duration being confounded with syllabic structure (long duration items contained complex codas; short duration items contained open syllables). Interestingly, 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, language experience, and anticipatory exposure. We isolate the role of anticipatory exposure by comparing L2 learners of equivalent proficiency with and without interpreting experience.

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 (TL), and produce

the message in the TL (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), (3) reading comprehension and WM (Bajo, Padilla & Padilla, 2000) (but see Dong & Cai, 2015, for a review of studies also 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. It allows interpreters to pre-active and produce pre-activated information before hearing it, and is commonly taught in simultaneous interpreting courses (Li, 2015) to decrease cognitive load and to interpret efficiently (Seeber & Kerzel, 2011). To predict, interpreters employ discourse redundancy (Chernov, 2004), 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. Results showed

that they generated more accurate predictions, measured by production of expected referents, when interpreting from their L1 to their L2 than 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 exposure extends to non-interpreting situations. Our goal is to isolate the role of anticipatory exposure from language experience and proficiency, and to inform instructional practices.

Lexical Stress and Syllabic Structure in Spanish and English

We investigate two linguistic variables: lexical stress (suprasegmental) and syllabic structure (segmental). 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. *saBAAna* '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 and does not reduce. These differences may explain why Anglophones encounter difficulties producing (Lord, 2007) and perceiving (Face, 2005, 2006) lexical stress in L2 Spanish. However, Spanish and English monolinguals also use this suprasegmental property in different ways. For

instance, in Spanish and English monolinguals, a prosodically matched prime facilitates perception, 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, but 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 + vocoide sequences to remain open, i.e., codaless (see Hyman, 1975, and Jakobson, 1968, for a review). This preference is evident in resyllabification, a phonological process by which a coda consonant surfaces as the onset of the subsequent syllable (i.e., *Las alas* [la.sa.las], Eng. “the wings”). Given this tendency to avoid coda segments, CVC syllables in English and Spanish can be considered marked, at least with regard to CV syllables. 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. Of crucial importance to the present study, listeners utilize syllabic structure, especially in the first syllable of a word, to reduce competition during lexical access (Cholin, Levelt, & Schiller, 2006). Thus the syllable structure of a lexical item might aid anticipatory processes before some morphological information becomes available.

The present study

Native speakers use suprasegmental (Roll et al., 2010, 2013, 2017; Söderstrom et al., 2015) and segmental information (Sagarra & Casillas, 2018) to anticipate inflectional morphology during word recognition. However, adult L2 learners use suprasegmental properties at higher (Schremm et al., 2016), but not lower proficiency (Gosselke et al., 2018; Sagarra &

Casillas, 2018), and some segmental information at all proficiency levels, but mostly at lower proficiency levels (Sagarra & Casillas, 2018). These studies suggest that post-puberty learners may integrate suprasegmental and segmental information at different stages of the acquisition sequence, and generates the need to conduct further research contrasting these two levels of phonetic/phonological detail within the same sample pool. We investigate how natives and non-natives use suprasegmental (lexical stress: oxytone, paroxytone) and segmental (syllabic structure: CVC, CV) information to predict suffixes. We hypothesize that monolinguals will make stress-suffix associations, following L1 studies on Swedish tone (Roll et al., 2017) and English vowel duration (Rehrig, 2017), and that advanced L2 learners will only anticipate in CVC conditions, based on L2 studies on Spanish syllabic structure (Sagarra & Casillas, 2018). We also expect monolinguals to anticipate earlier than the learners, considering that lexical disambiguation can depend on lexical stress in Spanish (Soto-Faraco et al., 2001) but on vowel reduction in English (Cooper et al., 2002).

In addition, L2 anticipatory studies mix proficiency, language experience and anticipation exposure. We isolate the role of anticipation exposure by comparing equally proficient learners (advanced) with and without extensive interpreting experience. We predict that interpreters will anticipate in CVC, but not CV, conditions like non-interpreters, but will anticipate at a faster rate than non-interpreters (albeit slower than monolinguals). This hypothesis is rooted in studies indicating that interpreting practice results in increased cortical thickness (related to training effects) in brain areas implicated in simultaneous interpreting, but also in other areas related to the production of propositional speech (Hervais-Adelman et al., 2017). Furthermore, various studies have revealed that anticipation during simultaneous interpreting correlates with improvement of overall quality of the interpretation (Kurz & Färber, 2003).

Regarding lexical stress, we hypothesize that interpreters will anticipate with paroxytones, but not oxytones, (i.e., they will predict when the first syllable is tonic). This hypothesis is grounded in the idea put forth by Kuperberg & Jaeger (2016) who posit that prediction depends on the comprehenders’ goals, prior knowledge and the expected utility of making a prediction; as well as Chernov (2004) who defends that prediction is possible during simultaneous interpreting thanks to redundancy at different levels in the text (phonological, semantic, syntactic, etc.). Given the cost of making an error, interpreters may need to accumulate sufficient evidence (via acoustic information) before making a prediction as a general strategy to reduce errors. Specifically, when the speech signal lacks the acoustic correlates associated with a tonic syllable (higher F0, intensity and longer duration), interpreters may not predict until enough information becomes available.

Methods

Participants

The sample pool consisted of 25 Spanish monolinguals (M), 26 non-interpreter advanced English L2 learners of Spanish (NIN), and 12 interpreter advanced English- Spanish learners (IN), between 18 and 50 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 had studied abroad in a Spanish-speaking country between 1 and 48 months. The NIN had no translating or interpreting experience, but the IN 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 – 22 years, $M = 11.80$, $SD = 5.63$). Most of the IN worked in the simultaneous interpreting mode (the interpreter translates the speech at the same time the speaker is talking) and occasionally in consecutive interpreting (the interpreter renders the translation after the speaker finishes one section of the speech), although two of them interpreted mostly in the consecutive mode.

To rule out the possibility of IN performing better than NIN 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 ($K^2(2) = 4.48$, $p = 0.09$) and L2 proficiency ($K^2(1) = 0.01$, $p = 0.90$). Furthermore, the observed effects were statistically not different from zero for all pairwise comparisons for WM (M vs. IN: $t(47.62) = -1.20$, $p = 0.12$; M vs. NIN: $t(33.11) = 0.03$, $p = 0.51$; IN vs. NIN: $t(34.26) = 0.26$, $p = 0.40$) and for L2 proficiency (IN vs. NIN: $t(20) = 1.07$, $p = 0.85$). Table 1 summarizes the descriptive statistics for WM and L2 proficiency.

<INSERT TABLE 1 HERE>

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.

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 IN 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, based on Sagarra & Herschensohn, (2010). 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.

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: 32° horizontal, 25° vertical; averaged calibration error: .25-.5°). The task was presented to participants on a BenQ XL2420TE monitor at a resolution of 1920 x 1080 pixels and 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* 'cauliflower-cauliflowers'; lexical: *mar-marco* 'sea-frame'), and the first syllables of all target words (filler and experimental) were identical. 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 1,000ms later they heard the sound file (e.g. *El primo lavó los coches*, 'the cousin washed the cars'). Then they chose one of the two words as soon as they could by pressing the right or left shift key (see Appendix I 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 1).

<INSERT FIGURE 1 HERE>

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; Ito, Dunn & Pickering, 2017). 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 that two sentences of the same type and condition appeared consecutively.

Statistical Analyses

The time course data from the eye-tracking task were downsampled to bins of 10 and 50 ms and were submitted to three separate series of analyses: one-sided *t*-tests, generalized linear mixed effects models (GLMMs), and growth curve analyses (GCA, Mirman, 2016). For all analyses, the time course was shifted forward 200 ms (the time required to launch a saccade, Matin, Shao, & Boff, 1993). Analyses were conducted in *R* (R Core Team, 2018). Hierarchical models were fit using *lme4* (Bates, Mächler, Bolker, & Walker, 2009). For all statistical assessments causal priority was given to lexical stress. This reflects the fact that lexical stress was the primary variable of interest. Main effects and higher order interactions were assessed using nested model comparisons. Where appropriate, pairwise tests were conducted using the *R* package *multcomp* (Hothorn, Bretz, & Westfall, 2008).

Results

The goal of the first set of analyses was to determine whether participants fixated on targets above chance after hearing the first syllable of the word, i.e., before hearing the suffix. To this end, we analyzed the 10 ms bin centered at the target syllable offset. Specifically, we calculated by-subject target fixations and submitted the scores to one-tailed t -tests for each group, for both oxytone and paroxytone words (the primary variable of interest). We set μ at 50%, and the alternative hypothesis that target fixations would be greater than μ . Thus a statistically significant result indicates that the group in question fixated on the target above chance before hearing the target suffix morphology. To avoid family-wise error, the alpha level for t -tests was Bonferroni-corrected ($0.05 / 6 = 0.008$). The results indicated that only M and IN fixated on the target words above chance at the first syllable offset (i.e., before hearing the suffix). This applied to paroxytone ($t(21) = 2.80$, Estimate = 0.63, CI low = 0.55, $p = 0.005$) and oxytone ($t(21) = 4.77$, Estimate = 0.72, CI low = 0.61, $p < 0.001$) words for M, and paroxytone ($t(9) = 3.46$, Estimate = 0.63, CI low = 0.52, $p = 0.004$) and oxytone ($t(9) = 3.38$, Estimate = 0.68, CI low = 0.53, $p = 0.004$) words for IN. NIN did not fixate on target words above chance at the a priori adjusted alpha level. Table 2 provides a complete list of all t -tests.

<INSERT TABLE 2 HERE>

The second analysis also examined target fixations from the 10 ms bin centered at the target syllable offset. The purpose of this analysis was to complement the previous analysis by determining if target fixations (at the same time point) varied as a function of group (M, NIN, IN), stress (oxytone, paroxytone) and syllable structure (CV, CVC). In this case, the criterion—target fixation (looks to target vs. looks to distractor)—was binary, thus the data were modeled using a GLMM with a binomially distributed error term and a logit linking function. M was the

reference level and the model included by-subject and by-item random intercepts with random slopes for stress and syllable structure. The model yielded a main effect of group ($\chi^2(2) = 11.273$, $p = 0.003$) and syllabic structure ($\chi^2(1) = 7.75$, $p = 0.005$), but there was no effect of stress ($\chi^2(1) = 0.62$, $p = 0.43$), nor were there any higher order interactions. For NIN, the log odds of fixating on the targets was 1.14 +/- 0.32 *SE* lower than M ($z = -3.48$, $p < 0.001$). Target fixations for IN did not differ from M ($z = -1.15$, $p = 0.25$), nor did NIN and IN differ from each other ($z = -1.59$, $p = 0.11$). Overall, the presence of a coda was associated with an increase in the log odds of 0.82 +/- 0.23 *SE* ($z = 3.62$, $p < 0.001$) for fixating on the target words. In sum, at the offset of the target syllable, M fixated on target words more than NIN regardless of stress type, but there was no difference between M and IN. Also, all groups fixated more on target words with CVC than CV first syllables. The model output is available in Appendix II.

The final analysis explored how participants fixated on target words as time progressed. The time course of target fixations were analyzed using GCA, to analyze the non-linear time course trajectories including orthogonal polynomial time terms in the model. Specifically, the time course under analysis was from 250 ms before the offset of the initial syllable of the target word to 250ms after. The empirical logit transformation (Barr, 2008) was applied to the binary responses (fixations to the target or the distractor) after the data were downsampled into 50 ms bins. We modeled the time course using linear, quadratic, and cubic orthogonal polynomials with fixed effects of group, stress, and syllable structure on all time terms. M was set as the baseline, thus the IN and NIN parameters described how the growth curve of the learners differed from the native controls. All models included subject and subject-by-condition random effects on all time terms.

Figure 2 plots the model estimates from the GCA. Model comparisons did not yield significant effects for any of the cubic time terms or stress, thus they were excluded from the final model. There was no effect of group on the intercept ($\chi^2(2) = 4.81, p = 0.09$), but it did significantly affect the linear slope ($\chi^2(2) = 6.19, p = 0.03$), and the quadratic term ($\chi^2(2) = 10.21, p = 0.006$). Specifically, NIN had an overall lower fixation rate than M (Estimate = -0.39, $SE = 0.19, p = 0.05$). The simple effect of NIN on the quadratic time term indicates they were slower at fixating on targets than M (Estimate = 1.04, $SE = 0.31, p = 0.001$). There was also a group by coda interaction on the intercept revealing that IN and NIN fixated on target words less than M in CV, but not CVC, syllables (IN: Estimate = -0.31, $SE = 0.09, p < 0.001$; NIN: -0.18, $SE = 0.07, p = 0.009$). Finally, there was a group by coda interaction on the linear slope for IN (Estimate = 3.30, $SE = 0.37, p < 0.001$), indicating that IN fixated on target words at a faster rate than M with CV syllables. This is visible in the left panel of Figure 2 where the time course for IN begins with a lower rate of target fixations than both the M and NIN, but reaches the same fixation rate as M by the offset of the first syllable. The full model output is available in Appendix III.

<INSERT FIGURE 2 HERE>

Discussion

We investigated whether interpreting exposure facilitates anticipatory abilities in non-interpreting situations, by comparing interpreters to non-interpreters of equivalent L2 proficiency. In particular, we examined whether Spanish monolinguals and advanced English learners of Spanish with and without interpretation experience could predict an upcoming suffix as a function of lexical stress (oxytone, paroxytone) and syllabic structure (CV, CVC). We

found that all groups anticipated suffixes when preceded by CVC syllables, in both oxytone and paroxytone words, but only M and IN were also able to anticipate suffixes following CV syllables. Furthermore, IN anticipated suffixes following CV syllables at a faster rate than M and NIN, and M in turn at a faster rate than NIN. Next, we discuss these findings in detail.

First, our hypothesis that M would predict a word’s suffix regardless of lexical stress (oxytone, paroxytone) and syllabic structure (CV, CVC) was supported. These results are consistent with prior studies showing that natives make predictions based on both suprasegmental information (tone: Roll, 2015; Roll et al., 2011, 2017) and segmental information (syllabic structure: Sagarra & Casillas, 2018). These findings suggest that humans integrate suprasegmental and segmental information during lexical access to predict morphological information within a word, supporting the notion that structural integration and lexical recognition go hand in hand. In addition, our results are in line with studies showing that natives use suprasegmental information to anticipate syntactic information (intonation: Nakamura et al., 2012; Steinhauer et al., 1999; Weber et al., 2006; pauses between clauses: Hawthorne & Gerken, 2014; Kjelgaard & Speer, 1999). Taken together, these studies indicate that native listeners use suprasegmental information to generate expectations at several language levels (e.g., morphology and syntax).

Second, our prediction that the two L2 groups would anticipate in CVC, but not CV, conditions, was partially supported. Concretely, all groups anticipated verbal morphology preceded by CVC syllables, but only M and IN anticipated with CV syllables. That advanced English learners of Spanish predict inflectional morphology based on suprasegmental and segmental information corroborates previous research on advanced learners of Swedish (suprasegments: Schremm et al., 2016) and advanced English learners of Spanish (segments:

Sagarra & Casillas, 2018). Our findings support top-down models associating adults' problems acquiring L2 inflectional morphology to difficulties integrating grammatical information during real-time processing (see Sagarra & Casillas, 2018, for a review). Our findings also support lexical access models claiming that L2 learners can integrate suprasegmental and segmental cues used differently in their L1 for anticipation purposes.

The present study also showed a general tendency for all groups to fixate more on target words with closed (CVC) syllables. A possible explanation for this apparent CVC advantage may be rooted in coda restrictions in English and Spanish. Specifically, these languages show a general preference for codaless syllables, allowing for the possibility that the CVC composition is marked with regard to CV. Consequently, Spanish listeners may perceive marked syllables as more salient acoustically (Hahn & Bailey, 2005) and/or articulatorily (Côté, 1997) than default ones. Previous research showing that listeners utilize syllabic structure, especially in the first syllable of a word, to reduce competition during lexical access (Cholin, Levelt, & Schiller, 2006), suggest that acoustic and articulatory salience could play a role in lexical anticipation. Another possibility is that, because CVC syllables are typically longer than CV syllables, participants have more time to generate a prediction.² This is in line with studies showing a positive correlation between time and anticipation. For example, Kukona, Fang, Aicher, Chen Magnuson (2011) found that longer time elapsed between a verb and a noun yielded stronger prediction. Though identifying why CVC facilitates anticipation more than CV is beyond the scope of our study, it does provide interesting possibilities for future research.

Third, our hypothesis that IN and NIN would anticipate suffixes preceded by CVC, but not CV, but that IN would anticipate at a faster rate than NIN was partially supported. Contrary

² An anonymous reviewer suggested that the CVC advantage may be rooted in the same mechanisms that yield shorter reaction times when perceiving longer stimuli (Raab, 1962). While this hypothesis is plausible, it should be considered with caution, as Raab (1962) focuses on perception of noise, rather than language.

to our expectations, IN were as effective as M anticipating with both syllabic structures and looking at target words, and NIN were unable to anticipate with CV syllables and fixated less on target words than M. The superiority of IN over NIN is in line with studies reporting interpreters' superiority in various language processing and executive function domains (Hervais-Adelman et al., 2017; Bajo et al., 2000; Togato et al., 2015; Yudes et al., 2013). Then, in line with our predictions, IN anticipated at a faster rate than NIN: IN started predicting later than M in the time-course, but did so at a faster rate, reaching the same level of prediction as M by the offset of target syllable. This strategy could be influenced by the use of prediction during interpreting, particularly when prediction error becomes more costly. IN might have adopted a different approach to prediction, in which they gathered as many cues as possible before committing to a prediction. This hypothesis is consistent with Kuperberg & Jaeger (2016), who view prediction as a graded phenomenon that depends on the comprehenders' goals, prior knowledge and the expected utility of making a prediction.

Finally, we hypothesized that IN would anticipate suffixes in paroxytone words, but not oxytones. Specifically, we believed that the acoustic correlates associated with tonic syllables would be necessary for IN to make predictions. This hypothesis was not supported, as all groups fixated on targets independent of stress. This finding is in line with Sagarra & Casillas (2018) in which monolinguals and advanced learners also predicted suffixes independent of stress. The findings of the present work suggest that, in Spanish, listeners may be sensitive to the effects of stress in a general manner in which tonic and atonic syllables are equally informative. That is, a syllable containing higher F0, increased intensity, and increased duration may not be more informative than a syllable that does not vary regarding these cues, but rather prominent syllables are juxtaposed with non-prominent syllables based on relative differences. These

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3 results, coupled with those of Sagarra & Casillas (2018), suggest that, in Spanish, atonic
4 syllables may provide the listener with negative evidence regarding lexical stress and this
5 information is equally useful in L1 and L2 speech perception.
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10 Although our results clearly show that IN are better than NIN at making stress-suffix and
11 syllable-suffix associations, they cannot explain why. Are the IN superior due to their extensive
12 experience anticipating? Or to their substantial exposure to the L2? To separate anticipation
13 exposure from language experience, we conducted an independent samples *t*-test comparing how
14 frequently (% of time on a regular week) IN and NIN used the L2. The results showed a
15 significant difference, $t(23.44) = 2.263, p = .033$, such that IN ($M = 35.42$) reported to use the L2
16 more frequently than NIN ($M = 26.70$). Because IN had both higher anticipation and language
17 experience than NIN, the IN-NIN data cannot discern between these two possible explanations
18 of our interpreter advantage results. However, the IN-M data may help in this respect,
19 considering that M have significantly greater exposure to the target language than IN. If
20 language experience drives the interpreter advantage, M should be significantly better at
21 anticipating than IN. On the contrary, if anticipation is what yields the interpreter advantage, M
22 and IN would be similarly efficient anticipating or IN would be better than M. The lack of
23 significant differences between M and IN in the *t*-tests, GLMMs, and GCAs would point to
24 anticipation experience as the explanatory factor of the interpreter advantage, if it weren't for M
25 fixating on target words more often than IN.
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47 Future research investigating whether a NIN group using the L2 as frequently as the IN
48 group would help determine whether the interpreter advantage results obtained in this study
49 emerge from extensive experience with anticipation or language. Intensive L2 exposure can be
50 accomplished implicitly (via living abroad) or explicitly (via digital training). Considering that
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living abroad for long periods of time is logistically difficult for most L2 learners, future studies should focus on exploring the possibility that explicit training can mimic the interpreter advantage obtained in the present study. Schremm et al.'s (2017) training study is a first step forward in this direction. However, their training mixed exposure to anticipation and to the L2. This difference is essential to determine the underpinnings of the interpretation advantage, the basis of anticipation, and the potential of instructional practices.

In sum, the present study sheds light on linguistic and psycholinguistic models. Our results support the view that suprasegmental and segmental integration is part of spoken word recognition (see Roll, 2015, for a review). Furthermore, our findings suggest segmental information can guide native and non-native anticipation, but the same may not apply to suprasegmental information in Spanish. It follows, then, that suprasegmental and segmental information modulate anticipation mechanisms differently. Specifically, the relative importance of suprasegmental information appears to be language-specific. In contrast, the use of segmental information may be universal (all groups showed more target fixations with CVC, marked, than CV, default). Moreover, post-puberty learners can acquire suprasegmentals realized differently from their L1, giving support to accessibility models for L2 acquisition of inflectional morphology (see Sagarra & Herschensohn, 2010, for a review). Finally, this study takes us a step forward in our understanding of the complexity of anticipation processes.

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 before a comprehensive understanding of the cognitive mechanisms underlying prediction is possible.

Conclusion

We evaluated the role of both anticipatory experience and suprasegmental and segmental information in facilitating native and non-native morphological anticipation during word recognition. Eye-tracking data revealed that all groups anticipated suffixes following CVC syllables, regardless of the type of stress. However, only monolinguals and interpreters anticipated suffixes following CV syllables, and interpreters anticipated them at a faster rate. These findings indicate that segmental information and anticipation experience facilitate lexical anticipation.

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Appendix I *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 II Final model output for GLMM. Reference levels indicated in parenthesis.

	Estimate	SE	z-value	p-value
Intercept (M, CV)	1.60	0.29	5.55	< 0.001 *
Group - NIN	-1.14	0.33	-3.48	< 0.001 *
Group - N	-0.49	0.43	-1.15	= 0.249
Syllable structure - CVC	0.82	0.23	3.62	< 0.001 *

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Appendix III *Final model output of growth curve analysis.*

Term	Estimate	SE	DF	t-value	p-value
Intercept	0.91	0.15	68.09	6.14	< 0.001 *
ot1	0.31	0.33	8438.44	0.94	= 0.348
ot2	-0.16	0.23	54.50	-0.72	= 0.478
Group NIN	-0.39	0.20	68.23	-1.95	= 0.053 .
ot1:Group NIN	-0.81	0.50	67.97	-1.61	= 0.113
ot2:Group NIN	1.04	0.31	55.32	3.35	= 0.001 *
Group N	-0.10	0.26	68.37	-0.36	= 0.720
ot1:Group N	0.07	0.67	70.38	0.10	= 0.917
ot2:Group N	-0.20	0.42	59.32	-0.48	= 0.631
Syllable structure - CVC	0.07	0.05	9317.63	1.40	= 0.162
ot1:CVC	0.28	0.18	7863.16	1.56	= 0.120
ot2:CVC	0.07	0.17	6075.20	0.39	= 0.693
Group NIN:CVC	-0.18	0.07	9270.03	-2.60	= 0.009 *
ot1:Group NIN:CVC	-0.34	0.24	7949.22	-1.41	= 0.160
ot2:Group NIN:CVC	0.08	0.23	6122.18	0.33	= 0.739
Group N:Coda	-0.31	0.09	9243.38	-3.39	< 0.001 *
ot1:Group N:CVC	3.30	0.37	67.44	8.88	< 0.001 *
ot2:Group N:CVC	0.04	0.31	70.94.47	0.13	= 0.897

Table 1. *Descriptive statistics for Participant's WM and Spanish Proficiency test (DELE)*

	WM			DELE		AGE	
	N	M	SD	M	SD	M	SD
Interpreters (N)	12	8.67	1.15	49.17	4.43	39.92	7.11
Non-interpreters (NIN)	26	9.04	2.11	46.27	4.09	27.51	4.73
Monolinguals (M)	25	9.16	1.93				

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Table 2. *One-sided t-tests eye-tracking data for proportion of target fixations at the offset of oxytone and paroxytone target syllables*

Group	Stress	Estimate	t-value	CI low	DF	p-value
M	Paroxytone	0.63	2.80	0.55	21	= 0.005 *
	Oxytone	0.72	4.77	0.61	21	< 0.001 *
IN	Paroxytone	0.63	3.46	0.52	9	= 0.003 *
	Oxytone	0.68	3.38	0.53	9	= 0.004 *
NIN	Paroxytone	0.50	0.05	0.39	26	= 0.480
	Oxytone	0.58	2.13	0.49	26	= 0.021

Alpha = 0.008