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ORIGINAL ARTICLE

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

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Abstract

Prediction underlies many life's situations including language. Monolinguals and advanced L2 learners use prosodic cues such as stress and tone in a word's first syllable to predict the word's suffix. To determine whether the same findings extend to words with non-morphological endings, we investigate whether Spanish monolinguals and advanced learners of Spanish with and without interpreting experience use stress (stressed, unstressed) and syllabic structure (CV, CVC) in a word's initial syllable to predict its ending. This is crucial to understand whether associations underlying prediction are morphophonolexical associations or purely phonolexical. Interpreters were included due to their extensive experience predicting incoming speech. Participants completed an eye-tracking study where they listened to a sentence while seeing two words and selected the word they heard. 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 phonolexical associations trigger prediction; (2) phonological models, revealing that stress and syllable information in the initial syllable are key for accessing and predicting meaning; and (3) L2 processing models, indicating that L2 learners with interpreting experience use suprasegmental information to access and predict lexical items similar to monolinguals.

Keywords: prediction; prosodic cues; interpreting; L2 processing

Introduction

Prediction is a crucial brain mechanism for cognition and perception (Lupyan & Clark, 2015). Some scholars posit that 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 pre-activating some components of linguistic representations (e.g., a specific morpheme,

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phoneme or conceptual feature) (Pickering & Gambi, 2018). For example, native and non-native speakers use prosodic information in a word's first syllable to anticipate its suffix, by means of probabilistic tone-suffix tense and number association (Swedish speakers: Roll et al., 2015; Swedish advanced L2 learners: Schremm et al., 2016) and stress-suffix tense associations (Spanish speakers and advanced L2 learners: Sagarra & Casillas, 2018). However, it is unclear whether native and non-native speakers also use prosodic information to anticipate a non-morphological word's ending.

This question is relevant for prediction, phonological, and L2 processing models. First, the comparison of morphophonological associations and phonolexical associations will inform recent proposals defending that one of the factors explaining adult L2 learners' persistent difficulty in acquiring morphosyntax consists of inflectional morphology being cognitively taxing (see Sagarra, 2021, for a review). Second, the present study will advance the understanding of the interplay of lexical stress and syllabic structure for word segmentation and lexical activation purposes, illuminating whether the associations enabling prediction are similar in monolinguals and L2 learners. Finally, this study will indicate whether increased anticipatory experience acquired via interpreting facilitates L1 and L2 formation of stress-non-morphological associations.

In particular, we investigated lexical stress as a predictive cue due to its contrastive value in Spanish (*PApa* "potato," *paPÁ* "dad") and syllabic structure due to its relevance for prediction in Spanish (i.e., CV and CVC) (Lozano-Argüelles et al., 2020; Sagarra & Casillas, 2018). We selected Spanish monolinguals and Spanish L2 learners with and without interpreting experience to evaluate differences between L1 and L2 prediction. Interpreters were included to test whether prediction experience during interpreting (Dong & Li, 2019) enhances prediction during non-interpreting situations. Finally, we used eye-tracking to determine whether attention is directed toward the target word before it has been said (i.e., after hearing the first syllable of the target word).

Spoken word recognition

Languages have a fairly limited repertoire of phonemes, and many words are only distinguished by minimal phonological changes. The process of recognizing a word involves distinguishing the sounds from other possible words, and it is affected by phonological competitors. Differences on segmental information (e.g. *pin* vs. *bin*) trigger activation of different meanings in the mind of an English speaker. However, suprasegmental changes (e.g. *CONtent* vs. *conTENT*) are more complex. Suprasegmental information has been extensively studied in spoken-word recognition in a variety of languages. For instance, Cantonese native speakers use suprasegmental (tone) and segmental information to distinguish between words (Cutler & Chen, 1995), Mandarin speakers use suprasegmental information to constrain lexical recognition (Fox & Unkefer, 1985), and native speakers of Japanese use pitch accent information to activate and select among different candidates during spoken-word recognition (Cutler & Otake, 1999).

The contribution of lexical stress to lexical access during spoken-word recognition has received a great deal of attention. In Spanish, a prosodically matched prime

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facilitates perception (i.e., faster reaction times), but a mismatched prime inhibits perception, indicating that both suprasegmental (lexical stress) and segmental information reduce lexical competitors (Soto-Faraco et al., 2001). However, a similar study in English yielded different results. While prosodically matched primes facilitated perception for English speakers, mismatched primes did not inhibit perception. These results indicate that although English speakers can exploit suprasegmental correlates during spoken-word recognition, segmental information has a stronger role in lexical activation (Cooper et al., 2002). Dutch falls between Spanish and English. Both Dutch and English have lexical stress and an opposition between strong and weak syllables. One could expect Dutch speakers to rely on segmental patterns more than on suprasegmental information just like English speakers. However, Dutch speakers use suprasegmental information to activate lexical representations and, like in Spanish, mismatching suprasegmental information hindered word activation (Cutler & Van Donselaar, 2001). One possibility is that English segmental and suprasegmental correlates are interconnected (stressed syllables tend to have full vowels, and unstressed syllables almost always have reduced vowels), but the interdependence in Dutch is looser. Alternatively, Dutch words can be uniquely identified after 80% of the word's phonemes, but when stress is also taken into account, the word can be uniquely identified after 66% of phonemes (van Heuven & Hagman, 1988). Although this analysis does not exist for English, Cutler and Van Donselaar (2001) hypothesized that the advantage of adding stress would be considerably smaller in English, given that listeners benefit more from stress information in Dutch than in English (Leyden & Heuven, 1996).

Studies described in this section show that native speakers use suprasegmental information to ensure that spoken-word recognition occurs efficiently, but can L2 learners also exploit these cues? Prior studies indicate that L2 learners struggle recognizing a prosodic feature absent in their L1. For instance, French speakers have difficulties identifying L2 Spanish stress (Dupoux et al., 1997), and both French (Nishinuma, 1994) and English learners (Nishinuma et al., 1996) have difficulties detecting accent type changes in L2 Japanese. Furthermore, Finnish, Dutch, and French speakers learned to segment in an artificial language more effectively when L1 and L2 suprasegmental properties matched (Vroomen et al., 1998). In the same line, English natives and L2 learners of English (Dutch L1) used suprasegmental cues in English words but did so differently (Cooper et al., 2002). While English natives used suprasegmental correlates more effectively in two syllables than in one syllable, English L2ers used suprasegmental information in both mono- and disyllabic primes, outperforming English natives when assigning stress to monosyllabic fragments. Importantly, L2 perception of suprasegmental categories can be trained. After a 2-week training task, English L1 speakers improved their perception of Mandarin tones and that this improvement lasted over time (Wang et al., 1999). The authors hypothesize that, similar to the acquisition of phonemes unique to the L2, the acquisition of suprasegmental correlates unique to the L2 benefits from increased language experience, whereas acquiring prosodic features that differ between the L1 and L2 does not progress with L2 proficiency.

In sum, suprasegmental information is key during L1 spoken-word recognition and L2 learners can efficiently use suprasegmental information for lexical access, but this ability is modulated by the L1. The present study focuses on whether adult

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English learners of Spanish can adapt their use of lexical stress in a predictive manner similar to Spanish monolinguals. Next section offers a review on how prosodic cues aid prediction.

Prediction of morphological information

A large body of research shows that prediction between 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 reliability of the cue (e.g., in Dutch "*de*" is used not only for singular common nouns but also for plural nouns of both common and neuter gender) hinder prediction of gender agreement (Kochari & Flecken, 2018). Variability in prediction is even greater in L2 populations. For instance, intermediate Italian–Spanish learners predict only with feminine gender nouns (marked) (Dussias et al., 2013), advanced-low English–Spanish learners anticipate only with transparent gender nouns (Halberstadt et al., 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. Native speakers show strong prediction based on both segmental and suprasegmental cues. For suprasegmental cues, Swedish natives use word tones to predict tense and number morphology and the least common cue is linked to stronger prediction (Roll et al., 2010; Söderström et al., 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 fewer lexical competitors (Lozano-Argüelles et al., 2020; 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 et al., 2017). Along the same line, Spanish natives showed increased prediction with less frequent syllabic structure (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 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 et al., 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 less frequent Accent 1 over more frequent Accent 2 (Schremm et al., 2016). The lack of frequency effects in the Swedish L2ers could be due to the use

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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. Taken together, L2 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.

The present study builds upon Sagarra and Casillas (2018) and Lozano-Argüelles et al. (2020). In both studies, participants looked at two verbs (*FIRma/firMÓ* "(s)he signs/signed") while listening to a sentence (*El director firma la factura* "the director signs the bill"). Sagarra and Casillas (2018) showed that advanced, but not beginning, L2 learners generated morpholexical predictions. Lozano-Argüelles et al. (2020) revealed that interpreters, known for their extensive prediction experience, made faster predictions than non-interpreters.

Prosodic cues

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 et al., 1981), whereas English natives do not seem to use syllables to access a lexical item (Cutler et al., 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 with French. Some studies point out that syllabic information does not facilitate word activation (Sebastian-Gallés et al., 1992), while others find an activation effect replicating the French findings (Bradley et al., 1993). Simonet (2019) proposes that this may be associated with segmentation being more vulnerable in Spanish and taking place later at a higher processing level. He argues that Romance languages use syllabification as a speech segmentation strategy. Indeed, syllabification is associated with lexical stress: in Catalan, unstressed (but not stressed) first syllables facilitate word activation (Sebastian-Gallés et al., 1992). Reading studies also propose syllables as crucial units in Spanish. Research shows that syllable frequency influences visual word recognition, suggesting that Spanish readers consistently use the syllable for lexical access during visual word recognition (Carreiras et al., 1993). Given the relevance of syllabification in Spanish and its association with lexical stress, it could be possible that the information contained in the first syllable of a word is used to anticipate its ending before it becomes available, regardless of whether the ending is morphological or not.

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. Importantly, the more information provided in the first syllable reduces the number of lexical competitors (Cholin et al., 2006). For example, CVC syllables yield stronger predictions than CV syllables in Spanish natives and English–Spanish interpreters (Lozano-Argüelles et al., 2020), and English–Spanish non-interpreter

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advanced learners can only anticipate verbal suffixes when the first syllable has a CVC structure (Sagarra & Casillas, 2018). Furthermore, Spanish is a quantity-sensitive language, and syllable weight plays an important role in stress perception. Syllable weight (number of segments) of both final and penultimate syllables impacts stress placement, such that light penultimate syllables (CV) usually carry stress final, and this association is less likely with heavy penultimate syllables (CVC) (Waltermire, 2004). For example, it is rather uncommon that words with penultimate heavy syllables (i.e., CVC) and light final syllables (i.e., CV) have final stress (e.g.,*carNÉ*). On the contrary, paroxytone stress is very common for this type of words (e.g., *CARne*).

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, research shows 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 et al., 2002; Soto-Faraco et al., 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 et al., 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 word endings only when the target word starts with a stressed syllable.

Interpreters and prediction

Current approaches to bilingualism posit that accounting for critical aspects of bilingual language experience is key to fully capturing the complexity of bilingual language control (Sulpizio et al., 2020). For instance, the extent and duration of L2 exposure modify neural activity patterns while performing an inhibitory task (DeLuca et al., 2019), and 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,

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2015), error detection (Yudes et al., 2013), and reading comprehension (Bajo et al., 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, 2020).

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 s 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 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, including a low sample pool, a mixture of professional interpreters with interpreting students, an inappropriate task to measure anticipation, and even absence of statistical analyses.

Interestingly, interpreters' years of experience making predictions facilitate their prediction in non-interpreting situations. Lozano-Argüelles et al. (2020) examined the effects of interpreting practice on L2 anticipation of verbal morphology. They found that interpreters and non-interpreter L2 learners' prediction rate is lower than monolinguals, although interpreters' prediction speed is faster than non-interpreters and monolinguals. This means that interpreters' prediction occurs in a more abrupt way, they start predicting later in the time course (although before the offset of the target syllable), but reach a decision faster than monolinguals and non-interpreters. These results show that extensive practice interpreting facilitates prediction in non-interpreting situations.

The study

Our study investigates whether monolinguals and advanced English learners of Spanish with and without interpreting experience use lexical stress and syllabic structure to predict the non-morphological end of a word. This is key to understanding what type of associations facilitate processing.

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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 and Casillas (2018) and Lozano-Argüelles et al. (2020) because these two earlier studies examined stress-suffix associations and there is robust evidence that L2 processing of inflectional morphology is cognitively demanding (see Sagarra, 2021, for a review). Specifically, we anticipate that monolinguals will be less 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 show stronger prediction with 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. (2020) and Sagarra and Casillas (2018), CVC unstressed syllables facilitated prediction due to their lower frequency and reduced pool of lexical competitors. Non-interpreters will be able to make a prediction with the most facilitative condition, that is, CVC unstressed initial syllables. Moreover, in the CVC unstressed condition, non-interpreters will activate a larger pool of lexical competitors and start making a prediction later than monolinguals. Third, following Lozano-Argüelles et al. (2020), 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.

Methods

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:

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$M = 28.65$, $SD = 17.97$, weekly % of time; interpreters: $M = 30.65$ $SD = 14.48$, weekly % of time).

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 hr per week ($SD = 6.89$).

Materials

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

Screening tests

The Spanish proficiency test was an abbreviated version of the *Diploma de Español como Lengua Extranjera* (DELE), based on Sagarra and Herschensohn (2011). The test included 56 multiple choice questions assessing grammar and vocabulary knowledge. 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' L1, time spent in an L2 country, languages of schooling, L2 age of acquisition, 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.

Two one-sided tests of equivalence were conducted to verify that non-interpreter 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, non-interpreters and interpreters showed L2 proficiency effects statistically not different from zero ($t(45.1) = .906$, $p = .815$)[1].

As for WM, participants completed the letter-number sequencing test (adapted from Wechsler, 1997). Participants heard a series of numbers and letters and had to memorize them and remember them, first number in numerical ascending order and then letters in alphabetical order (e.g. "C-7-3-A," "37AC"). Two one-sided tests of equivalence showed that groups had equivalent WM. All pairwise comparisons were statistically not different from zero (monolinguals vs. interpreters: $t(33.48) = -.770$, $p = .777$; monolinguals vs. advanced learners: $t(40.07) = -.196$, $p = .577$; interpreters vs. advanced learners: $t(45.91) = -.541$, $p = .295$).

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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 1920 × 1080 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 de la nevera*, "The lady drank/took the milk 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 (our target syllable) of both target and distractor items was identical except for lexical stress. Animacy has an impact on the processing of gender agreement (see Sagarra & Herschensohn, 2011, for a review). Because animacy can affect L2 processing, half of the subjects were animate (e.g., *los expertos*, "the experts") and half inanimate (e.g., *el glosario*, "the glossary"). Half of the target words were paroxytone (*BAla*, "bullet"), and half were oxytone (*baLÓN*, "ball"). See Appendix 6 for acoustic correlates of target words. Moreover, half of target nouns had a coda in the first syllable (*carne/carné*, "meat/ID card"), and half did not (*bala/balón*, "bullet/ball").

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. For example, participants on version 1 heard *Los manuales establecen que bala es una pieza esférica de hierro* and on version 2 heard *Los manuales establecen que balón es una pelota grande para jugar*). Sentences (fillers and experimental) were organized using a Latin Square design. Practice trials followed the same order in both versions.

For the visual stimuli, a pilot study of Sagarra and Casillas (2018) using pictures showed that monolingual speakers could not access target words fast enough. For instance, in a drawing depicting "he ate," it was impossible to know whether participants were activating *man*, *boy*, *ate*, *eat*, etc. For this reason, we used written words in the present visual-world paradigm experiment. Previous research shows that words, as opposed to pictures, are particularly appropriate to investigate phonological representations 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 150 pt 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 (conditions 1 and 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.

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The present study shares the following aspects with Sagarra and 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 and 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 et al., 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: $M = 152.37$; $t(37.01) = -.191$, $p = .575$; NOW: verb endings: $M = 132{,}751.30$; verb endings: $M = 166{,}100.20$; $t(52.1) = .559$, $p = .289$). Finally, sentences in Sagarra and Casillas (2018) were more constraining (the verb was highly expected in SVO sentences like *El marido* … "The husband …") than in the current study (*El diccionario dice que*… "The dictionary says that"). The less constraining context of the present study could activate a larger number of competitors and therefore hinder prediction. However, this possibility is unlikely because filler sentences in the current experiment had a more constraining structure (*La señora bebió/sacó la leche de la nevera*, "The lady drank/took the milk from the fridge").

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 toward 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 250 ms fixation sign, and saw two words on the screen (target, distractor) for 1,000 ms, listened to a sentence, and chose one of the two words on the screen by pressing a button. Afterward, a rectangle appeared around the selected words confirming the participants' word selection. Button presses before the onset of the target word were not recorded.

Statistical analysis

Eye-tracking data were extracted using DataViewer (SR-Research) and down-sampled to 50 ms bins. We used R (Version 4.0.3; R Core Team, 2019) to carry out statistical analyses, as well as the packages lme4 (Bates et al., 2009) to fit the models and multcomp (Hothorn et al., 2008) for pairwise comparisons between learner groups. Empirical-logit growth curve analysis (GCA, Mirman, 2014) was used to analyze eye-fixations toward the target. A GCA statistical model was used to analyze longitudinal data and measure eye-fixations chronologically.

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Higher-order polynomials were employed because changes over time are often non-linear. The time course was modeled using the linear ($Time^1$), quadratic ($Time^2$), and cubic ($Time^3$) orthogonal polynomials. Polynomial components function independently, such that a given effect is interpreted differently depending on the time term it appears (i.e., how much they predict, when they predict, or how abrupt their prediction is) (see Mirman, 2014, for a detailed explanation).

In order to capture the time frame when fixations toward 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 et al., 2014). This time window allowed us to center the time course around 200 ms after the offset of the target syllable. As a result, the model intercept reveals probability of looks toward the target before reaching the disambiguating segment, which is conceptually similar to a *t* test (Mirman, 2014). Binary responses (fixations to target or distractor) were transformed with the empirical logit (Barr, 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 evaluated main effects and higher-order interactions. Using a forward stepwise procedure, we started by adding time terms (linear, quadratic, and cubic) and then continued adding lexical stress, syllabic structure, and group to the model. All effects and time terms improved the model fit and were retained. 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 $\gamma_{00} = 1.29$ (proportion: .78). The full model summary can be found in Appendices 2, 3, 4, and 5.

Results

Accuracy of responses

Participants demonstrated adequate attention to the experiment as reflected in the accuracy of their button presses: monolinguals 97.49%, non-interpreters 96.13%, and interpreters 97.50%. Only correct trials were included in the model. Figure 1 plots the proportion of fixations on the target over time, showing that looks toward target depart from chance after hearing the first syllable of the target word.

Prediction rates

We report model estimates of probability of looks toward the target at the offset of the target's first syllable. Figure 2 shows model estimates of probability of

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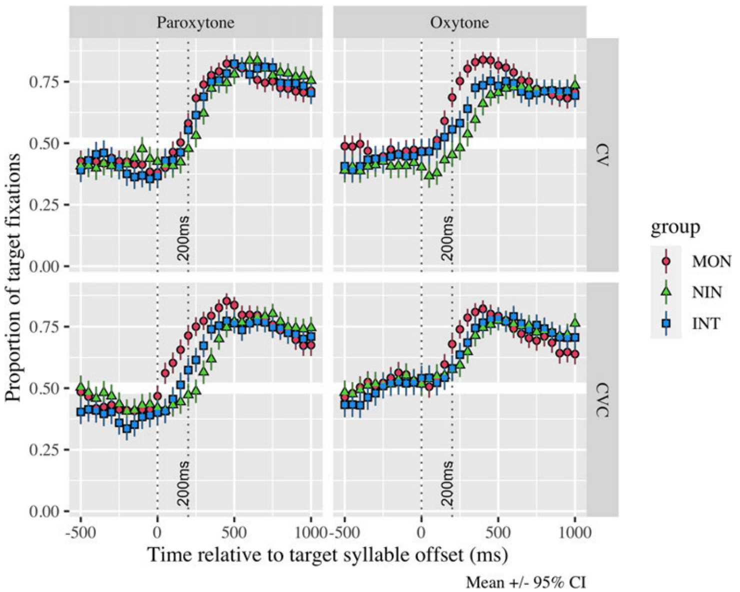

Figure 1. Proportion of Fixations on the Target Over the Time Course.

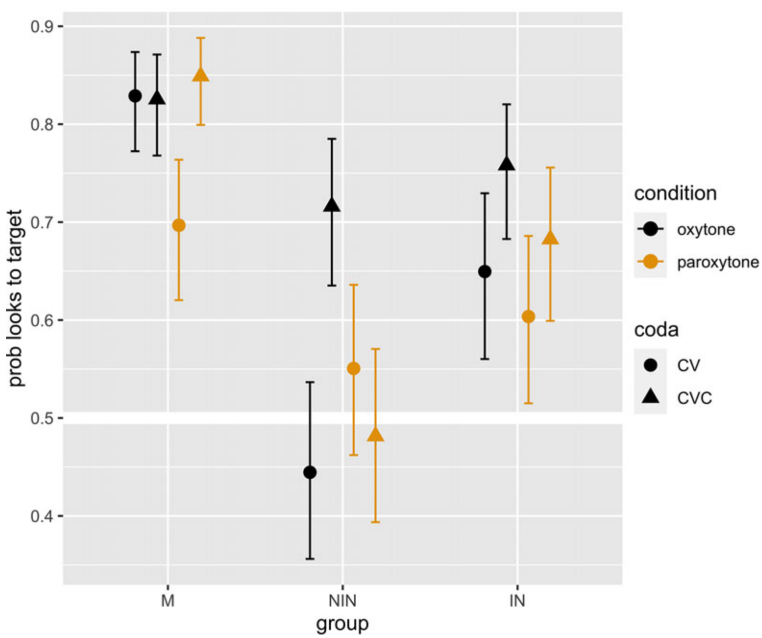

Figure 2. Model Estimates Reflecting Probability Looks Toward Target 200 ms after the Offset of the Target Syllable. The thick White Line Represents the 50% Probability of Fixating on the Target. Circles and Triangles Represent Means, Whiskers Depict Upper and Lower Bounds.

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looks toward target for all groups, and Appendix 5 contains a table displaying all probabilities for each group and each condition. For monolinguals, the probability of anticipation was above 80% for all conditions except for CV paroxytones (e.g., *BAla*) (CV Paroxytone: Probability = .697; LB = .62; UB = .764, CV Oxytone: Probability = .829; LB = .772; UB = .874, CVC Paroxytone: Probability = .849; LB = .799; UB = .888, CVC Oxytone: Probability = .825; LB = .768; UB = .871). This means that monolinguals anticipated word endings above chance in all conditions and the stress final with coda condition (e.g., *carNÉ*) seemed to increase prediction. Moving to the learner groups, non-interpreters predicted word endings in the CVC oxytone condition (e.g., *carNÉ*) (Probability = .716; LB = .635; UB = .785), but not in the rest of conditions (CV Paroxytone: Probability = .551; LB = .462; UB = .636, CV Oxytone: Probability = .445; LB = .356; UB = .537, CVC Paroxytone: Probability = .481; LB = .394; UB = .57). By contrast, interpreters predicted word endings under all conditions (CV Paroxytone: Probability = .604; LB = .515; UB = .686, CV Oxytone: Probability = .65; LB = .56; UB = .729, CVC Paroxytone: Probability = .683; LB = .599; UB = .756), and their prediction rate was higher in CVC unstressed syllables (e.g., *carNÉ*) (Probability = .758; LB = .683; UB = .82).

Group effects

We found an effect of group on the intercept such that, averaging over all conditions, non-interpreters predicted at a lower rate than monolinguals ($\gamma_{21} = -.69$; $SE = 0.25$; $t = -2.82$; $p = .005$). Furthermore, there was an effect of group on the quadratic and cubic terms ($\gamma_{14} = 1.91$; $SE = 0.38$; $t = 5.01$; $p < .001$; $\gamma_{34} = 1.11$; $SE = .33$; $t = 3.38$; $p < .001$), indicating that non-interpreters anticipated later in the time course than monolinguals and that non-interpreters' anticipation rate was more abrupt. Interpreters' group estimates from the intercept and the quadratic time term indicated that interpreters tended to predict less and later than monolinguals ($\gamma_{31} = -.48$; $SE = 0.25$; $t = -1.90$; $p = .057$) ($\gamma_{24} = .76$; $SE = 0.39$; $t = 1.96$; $p = .05$). Nevertheless, these results did not reach significance. Pairwise comparisons of non-interpreters and interpreters produced a main effect of group on the quadratic term ($\gamma_{28} = 1.15$; $SE = 0.41$; $t = 2.80$; $p = .005$), revealing that, holding all variables constant, non-interpreters started to predict later in the time course than interpreters.

Lexical stress effects

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., *BAla*) to oxytone (e.g., *baLÓN*) increased the steepness of the slope ($\gamma_{32} = .80$; $SE = 0.29$; $t = 2.75$; $p = .006$). This suggests that monolinguals predicted oxytonic targets at a higher rate than on paroxytonic targets.

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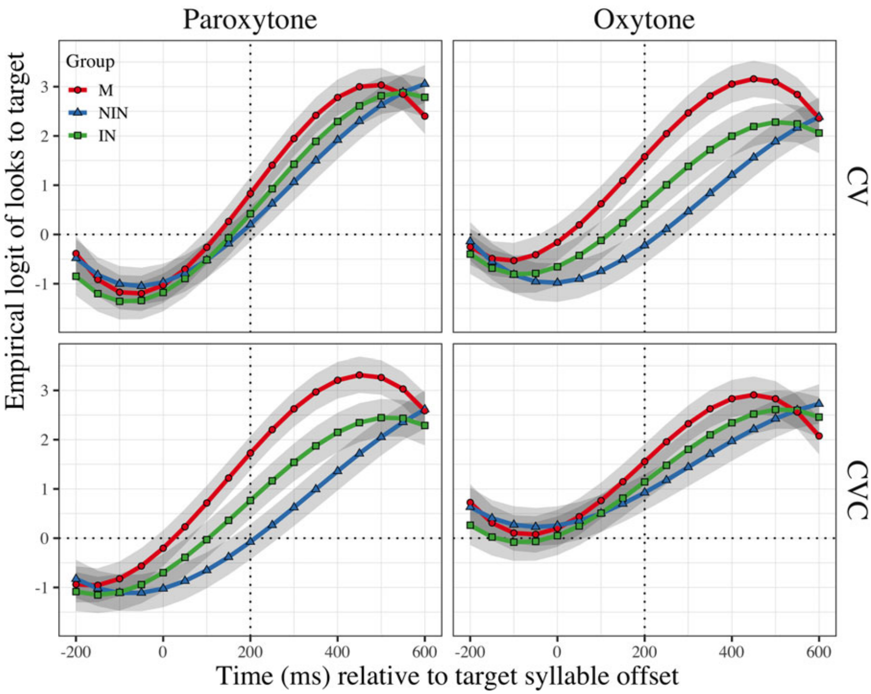

Figure 3. Growth Curve Estimates of Target Fixations as a Function of Lexical Stress and Syllable Structure for Each Group During the Analysis Window. Symbols and Lines Represent Model Estimates, and the Transparent Ribbons Represent ± *SE*. Empirical Logit Values on y-axis Correspond to Proportions 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.

Interactions

There were four interactions of group, syllabic structure, and lexical stress. For interpreters, the interaction appeared on the intercept ($\gamma_{16} = .21$; $SE = 0.06$; $t = 3.22$; $p = .001$), revealing that stressed CVC syllables (*CARne*, "meat") produced more looks at target words in the interpreters than the monolinguals. For non-interpreters, the interactions were on the intercept and the quadratic term ($\gamma_{06} = .41$; $SE = 0.06$; $t = 6.46$; $p < .001$; $\gamma_{26} = -.66$; $SE = 0.26$; $t = -2.56$; $p = .011$), indicating that, averaging over the time course, the addition of the coda was more beneficial for non-interpreters than for the monolinguals (who were already predicting at high rates). Furthermore, at the offset of the target syllable, the non-interpreters' curve is less bowed, indicating that the monolinguals focused on targets at a faster rate (monolinguals' fixation on targets was more abrupt). When comparing interpreters and non-interpreters, there was a significant interaction of group, syllabic structure, and lexical stress on the intercept ($\gamma_{09} = .20$; $SE = 0.07$; $t = 2.97$; $p = .003$), such that adding a coda and changing from paroxytone to oxytone were more beneficial for non-interpreters than for interpreters. Figure 3 shows growth curve estimates for all groups and conditions.

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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 interpreters use lexical stress to anticipate word endings under all conditions, but non-interpreters only predicted 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 spoken-word recognition and prediction and that L2 learners can use prosody in a similar manner, provided that they have additional experience making predictions.

First, we discuss whether monolinguals predict word endings based on lexical stress and syllabic structure. We expected native speakers to predict at lower rates than previously found in the unstressed conditions (e.g., *baLÓN*, "ball" and *carNÉ*, "ID") and the CVC stressed conditions (e.g., *CARne*, "meat"), but not to predict in the CV stressed conditions (e.g., *BAla*). Our findings did not support this hypothesis. In effect, 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. (2020), oxytone words (marked form) were predicted at a higher rate than paroxytone words (canonical form). These findings suggest that, in Spanish 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*). Hence, the associations facilitating prediction are not only morphophonolexical (prosody-morphology) but also phonolexical (prosody-meaning). Previous findings showed that both monolinguals and L2 learners relied on the distributional regularities linking stress and verbal morphology in Spanish, and tones with number or verbal morphology in Swedish (Roll, 2015; Roll et al., 2015). This type of connection involves a double association: prosody and morphology (e.g., present tense verbs in Spanish are paroxytone, past tense are oxytone), and prosody and meaning. We showed that prediction in Spanish can exclusively rely on prosody-meaning associations.

Thus, our results support the syllable as a fundamental sublexical unit for processing in Spanish (see Simonet, 2019, for a review). Spanish monolinguals use the syllable to segment speech, initiate a lexical search, and predict the word ending, such that syllabic information is computed for categorization, lexical activation, and prediction. In particular, lexical stress in the first syllable can trigger prediction of word endings (morpholexical: Sagarra and Casillas (2018) and lexical information: the present study) and prediction is modulated by syllabic structure, such that CVC syllables facilitate prediction. This is compelling evidence that phonolexical representations of Spanish monolinguals include information of syllabic structure and prosody and, hence, any model of lexical access should take them into account. Both lexical stress and syllabic structure work together to reduce the number of lexical competitors and facilitate lexical access and prediction.

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

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syllables (e.g., *carNÉ*, "ID"). Results support our hypothesis: the non-interpreters only predicted above chance at the offset of the target syllable with unstressed CVC syllables. Also, non-interpreters predicted less and later than monolinguals, and adding a coda to the stressed syllables (e.g., *CARne*, "meat") was more beneficial for non-interpreters than for monolinguals, even though non-interpreters were still unable to predict under this condition. Non-interpreter results are consistent with those obtained by Sagarra and Casillas (2018). In their study, 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. Contrary to Spanish monolinguals, non-interpreters rely on distributional regularities linking stress with a verbal suffix. In Spanish, lexical stress carries a high functional load in the verbal paradigm. Verbs conjugated in the present are always paroxytones, while verbs in the preterite are oxytones only for the first and third person singular, meaning that this association is highly available, but not reliable because of exceptions. It could be possible that weak and unstable phonological representations make non-interpreters over rely on the distributional regularities of stress-suffix associations in Spanish. When this association is purely lexical, as in the present experiment, non-interpreters are unable to make predictions. Another possibility is that lack of knowledge of target words affected their ability to predict. Some words were rather infrequent because of the difficulty finding word pairs fitting the experiment's requirements (nouns, sharing first syllable, contrasting stress in the first syllable).[2] Future research should investigate how lexical frequency and knowledge of the lexical item affect L2 phonolexical prediction.

Why did they make predictions under CVC oxytones then? Previous research showed that advanced L2 learners of Spanish are able to use the relationship between syllabic structure and stress for perceiving Spanish (Face, 2005). In the present study, non-interpreters know that oxytones are less frequent than paroxytones, CVC syllables are less frequent than CV, and that the combination of CVC and oxytones is even less frequent. This rare combination of stress and syllabic structure (e.g., *carNÉ*) significantly reduces the number of competitors, allowing non-interpreters to make predictions. This supports the idea that processing mechanisms underlying native and L2 processing are the same, but L2 processing is affected by interfering factors such as competing information or inconsistent lexical representations (Kaan, 2014). Alternatively, non-interpreters' difficulties identifying stress could be due to the acoustic correlates of our stimuli, as they did not prototypically fit Spanish stress. The acoustic correlates signaling stress (f0, intensity, and duration) are simultaneously correlates for other prosodic phenomena (intonation or rhythm), explaining why our stimuli deviate from the norm. We believe that this explanation is unlikely because both L1 and L2 speakers in the present study (monolinguals and interpreters) were able to use stress predictively. Moreover, lack of manipulation of our stimuli renders a more ecologically valid experiment.

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, and like the monolinguals, the interpreters predicted above chance in all conditions. The only

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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). These results indicate that interpreting experience plays a crucial role when predicting in non-interpreting situations. Associative learning theory posits that learning the association between a cue and its come blocks later learning of other cues with the same outcome. In the case of stress, English L2 learners of Spanish first transfer their segmentation strategies from English, precluding them of using stress for segmenting and accessing L2 speech. Previous research showed that when stress is connected to morphology with a clear pattern, advanced learners (but not beginners) can make predictions (Sagarra & Casillas, 2018). The present experiment focused on phono-lexical associations and showed that advanced proficiency is not enough for using stress predictively. Interpreters in this study have stopped over-relying on distributional regularities of stress-suffix associations in Spanish. These results support the Unified Competition Model, which states that L2 learners gradually focus on reliable cues over available cues as L2 experience increases (see MacWhinney, 2012, for a review).

Why are interpreters better at making predictions? One explanation is that experience in making predictions during simultaneous interpreting enhanced L2 prediction. Interpreters' training and experience influences processing of prediction (Lozano-Argüelles et al., 2020) and other structures. For instance, interpreters adapt parsing strategies of syntactically ambiguous sentences depending on whether they are reading their L1 or translating into their L2 (Togato et al., 2015). Another possibility could be that phonological representations in the interpreters' L2 have become more intricate, deeming their predictive processing based on prosodic cues similar to that of monolinguals. This is in line with research showing that interpreting training increases white matter in brain areas related to speech processing, specifically those involved in articulatory and lexical representations (Hervais-Adelman et al., 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). Nevertheless, differences between interpreters and non-interpreters could also be due to enhanced oral comprehension abilities. Because our proficiency test measured grammar and vocabulary knowledge, the present study cannot disentangle whether interpreters' superior performance is due to increased prediction or enhanced processing abilities. Future research should include measures of online L2 oral comprehension abilities to elucidate this question.

Results from both interpreters and non-interpreters also reveal that L2 learners can exploit L2 suprasegmental cues different from the L1. We had seen that 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). A shift in processing strategies based on lexical stress under all conditions (stressed, unstressed, CV, and CVC) ensues from extended practice with interpreting. This finding is interesting because it shows that segmentation strategies are flexible and that it is possible to exploit suprasegmental correlates different in the L2. First, research shows that languages follow different

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segmentation strategies. For example, English speakers do not rely on syllables for segmentation and lexical access, but French speakers do so, even when processing English words (Cutler et al., 1986). We show that English L2 learners of Spanish, in particular interpreters, can successfully rely on the syllable to rapidly access and predict a lexical item. Second, studies on suprasegmental information indicate that the processing of suprasegmental information unique to the L2 improves with increased language experience, but the processing of suprasegmental patterns similar in the L2 (i.e., cue used in both L1 and L2 but differently) does not progress with experience (Wang et al., 1999). Our findings contradict this hypothesis. Interpreters in our study used suprasegmental correlates to access lexical items and predict word endings, despite of stress not being essential for lexical access in English. Together, these findings show that segmentation strategies can adapt to exploit all informative cues. Differences between interpreters and non-interpreters highlight that language experience is key for this shift to take place. However, we do not know whether L2 learners in the present study are able to use stress predictively because their L1 also has stress. To explore whether it is possible to use stress when the L1 does not include lexical stress, we have collected data with Mandarin learners of Spanish.

The present study is key in informing phonological, prediction, and second language processing models. 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. In particular, lexical stress and its interaction with syllabic structure are crucial for prediction and for a more effective processing of Spanish. Second, our experiment confirms that L2 learners can use L2 suprasegmental information different from their L1 in a similar way to monolinguals. Previous research suggested that L2 learning only occurred when suprasegmental information was unique to the L2 (Wang et al., 1999). Our findings clearly indicate that L2 learners can also learn to use suprasegmental patterns, in particular stress, when they differ between the L1 and L2. Third, interpreting experience enhances L2 prediction, making it comparable to native processing. While further research will be needed to explain differences in processing between interpreters and non-interpreters, we hypothesize that the interpreters' enhanced performance could be due to a combination of additional practice making predictions and the strengthening of phonological representations resulting from experience with simultaneous interpreting. Finally, we show for the first time that predictive processes within a word can occur due to associations between phonological and lexical information. Previous research showed that prosody-morphology associative patterns facilitated prediction (Roll et al., 2010; Sagarra & Casillas, 2018). Our findings reveal that prediction is not dependent on the association between prosody and suffixes and that connections are not only morphophonological but also phonolexical.

Conclusions

We examined the role lexical stress and syllabic structure in the first syllable of a noun to predict its non-morphological ending (e.g., *BAla-baLÓN*, "bullet-ball" and *CARne-carNÉ*, "meat-ID") in monolingual and L2 processing, to reveal whether prediction occurs due to phonolexical associations. The eye-tracking results

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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: nouns with a CVC unstressed first syllable. These results suggest that prosodic information in the initial syllable is sufficient for both lexical prediction and lexical access in L1 processing, indicating that prediction at the word level does not exclusively rely on prosody-suffix associations. L2 prediction is more vulnerable to factors such as increased number of competitors or weaker phonological representations. Importantly, L2 difficulties using stress and syllabic structure for prediction can be overcome with interpreting experience. In line with Kuperberg and 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.

Supplementary material. To view supplementary material for this article, please visit https://doi.org/10.1017/S0142716421000217.

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Notes

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

2. Means for each condition according to the LexESP corpus: CV paroxytone, $M = 159.13$; CVC paroxytone $M = 153.29$; CV oxytone, $M = 69.60$; CVC oxytone $M = 106.88$.

References

Babcock, L., & Vallesi, A. (2015). Are simultaneous interpreters expert bilinguals, unique bilinguals, or both? *Bilingualism: Language and Cognition*, (November), 1–15. https://doi.org/10.1017/S1366728915000735

Bajo, T., Padilla, F., & Padilla, P. (2000). Comprehension processes in simultaneous interpreting. In A. Chesterman, N. Gallardo San Salvador, & Y. Gambier (Eds.), *Translation in context* (pp. 127–142). Granada.

Barr, D. J. (2008). Analyzing "visual world" eyetracking data using multilevel logistic regression. *Journal of Memory and Language*, **59**(4), 457–474. https://doi.org/10.1016/j.jml.2007.09.002

Bates, D., Mächler, M., Bolker, B. M., & Walker, S. C. (2009). Fitting linear mixed-effects models using lme4 Douglas. *Science*, **325**(5942), 883–885.

Boersma, P., & Weenik, D. (2017). Praat: Doing phonetics by computer. http://www.praat.org/

Bradley, D. C., Sánchez-Casas, R. M., & García-Albea, J. E. (1993). Language and cognitive processes the status of the syllable in the perception of Spanish and English. *Language and Cognitive Processes*, **8**(2), 197–233.

Carreiras, M., Álvarez, C. J., & Vega, M. D. (1993). Syllable frequency and visual word recognition in Spanish. *Journal of Memory and Language*, **32**, 766–780.

Chernov, G. V. (2004). *Anticipation and SI. An experiment. In Inference and anticipation in simultaneous interpreting - a probability prediction*. John Benjamins Publishing.

Cholin, J., Levelt, W. J. M., & Schiller, N. O. (2006). Effects of syllable frequency in speech production. *Cognition*, **99**, 205–235. https://doi.org/10.1016/j.cognition.2005.01.009

Clark, A. (2013). Whatever next? Predictive brains, situated agents, and the future of cognitive science. *Behavioral and Brain Sciences*, **36**(03), 181–204. https://doi.org/10.1017/S0140525X12000477

https://doi.org/10.1017/S0142716421000217 Published online by Cambridge University Press

Cooper, N., Cutler, A., & Wales, R. (2002). Constraints of Lexical Stress on Lexical A ccess in English : Evidence from Native and Non-native Listeners *. *Language and Speech*, **45**(3), 207–228.
Cutler, A., & Carter, D. M. (1987). The predominance of strong initial syllables in the English vocabulary. *Computer Speech and Language*, **2**(3–4), 133–142.
Cutler, A., & Chen, H.-C. (1995). Phonological similarity effects in Cantonese word recognition. *ICPhS*, **1**, 106–109.
Cutler, A., Mehler, J., Norris, D., & Segui, J. (1986). The syllable's differing role in the segmentation of French and English. *Journal of Memory and Language*, **25**(4), 385–400.
Cutler, A., & Norris, D. (1988). The role of strong syllables in segmentation for lexical access. *Journal of Experimental Psychology: Human Perception and Performance*, **14**(1), 113–121.
Cutler, A., & Otake, T. (1999). Pitch accent in spoken-word recognition in Japanese. *The Journal of the Acoustical Society of America*, **105**(3), 1877–1888. https://doi.org/10.1121/1.426724
Cutler, A., & Van Donselaar, W. (2001). Voornaam is not (really) a homophone: Lexical prosody and lexical access in Dutch. *Language and Speech*, **44**(2), 171–195. https://doi.org/10.1177/00238309010440020301
Davies, M. (2019). *Corpus del Español: NOW*.
DeLuca, V., Rothman, J., Bialystok, E., & Pliatsikas, C. (2019). Duration and extent of bilingual experience modulate neurocognitive outcomes. *NeuroImage*, **204**, 116222. https://doi.org/10.1016/j.neuroimage.2019.116222
Dong, Y., & Cai, R. (2015). 4 Working Memory and Interpreting : A Commentary on Theoretical Models. In Working memory in second language acquisition and processing (pp. 63–82).
Dong, Y., & Li, P. (2019). Attentional control in interpreting: A model of language control and processing control. *Bilingualism: Language and Cognition*, **23**, 716–728. https://doi.org/10.1017/S1366728919000786
Dupoux, E., Pallier, C., Sebastian, N., & Mehler, J. (1997). A destressing "deafness" in French? *Journal of Memory and Language*, **36**(3), 406–421. https://doi.org/10.1006/jmla.1996.2500
Dussias, P. E., Valdés Kroff, J. R., Guzzardo Tamargo, R. E., & Gerfen, C. (2013). When gender and looking go hand in hand. *Studies in Second Language Acquisition*, **35**(02), 353–387. https://doi.org/10.1017/S0272263112000915
Face, T. L. (2005). Syllable weight and the perception of Spanish stress placement by second language learners. *Journal of Language Learning*, **3**(1), 90–103. http://www.jllonline.co.uk/journal/jllearn/3_1/face.pdf
Fox, R. A., & Unkefer, J. (1985). Th effect of lexical status on the perception of tone. *Journal of Chinese Linguistics*, **13**(1), 69–90.
Gosselke Berthelsen, S., Horne, M., Brännström, K. J., Shtyrov, Y., & Roll, M. (2018). Neural processing of morphosyntactic tonal cues in second-language learners. *Journal of Neurolinguistics*, **45**, 60–78. https://doi.org/10.1016/j.jneuroling.2017.09.001
Guasch, M., Boada, R., Ferré, P., & Sánchez-Casas, R. (2013). NIM: A web-based Swiss army knife to select stimuli for psycholinguistic studies. *Behavior Research Methods*, **45**(3), 765–771. https://doi.org/10.3758/s13428-012-0296-8
Halberstadt, L., Valdés Kroff, J. R., & Dussias, P. E. (2018). Grammatical gender processing in L2 speakers of Spanish. *Journal of Second Language Studies*, **1**(1), 5–30. https://doi.org/10.1075/jsls.17023.hal
Hervais-Adelman, A., & Babcock, L. (2020). The neurobiology of simultaneous interpreting : Where extreme language control and cognitive control intersect. *Bilingualism: Language and Cognition*, **23**(4), 740–751.
Hervais-Adelman, A., Moser-Mercer, B., Murray, M. M., & Golestani, N. (2017). Cortical thickness increases after simultaneous interpretation training. *Neuropsychologia*, **98**, 212–219. https://doi.org/10.1016/j.neuropsychologia.2017.01.008
van Heuven, V., & Hagman, P. (1988). Lexical statistics and spoken word recognition in Dutch. In P. Coopmans & A. Hulk (Eds.), *Linguistics in the Netherlands* (pp. 59–68). Foris Publications.
Hodzik, E., & Williams, J. N. (2017). Predictive processes during simultaneous interpreting from German into English. *Interpreting. International Journal of Research and Practice in Interpreting*, **19**(1), 1–20. https://doi.org/10.1075/intp.19.1.01hod
Hopp, H. (2016). Learning (not) to predict: Grammatical gender processing in second language acquisition. *Second Language Research*, **32**(2), 277–307. https://doi.org/10.1177/0267658315624960

https://doi.org/10.1017/S0142716421000217 Published online by Cambridge University Press

Hothorn, T., Bretz, F., & Westfall, P. (2008). Simultaneous inference in general parametric models. *Biometrical Journal*, **50**(3), 346–363. https://doi.org/10.1002/bimj.200810425

Huettig, F., & Guerra, E. (2019). Effects of speech rate, preview time of visual context, and participant instructions reveal strong limits on prediction in language processing. *Brain Research*, **1706** (June 2017), 196–208. https://doi.org/10.1016/j.brainres.2018.11.013

Huettig, F., & McQueen, J. M. (2007). The tug of war between phonological, semantic and shape information in language-mediated visual search. *Journal of Memory and Language*, **57**(4), 460–482.

Hyman, L. M. (1975). *Phonology: theory and analysis*. Harcourt College Pub.

Jackobson, R. (1968). *Child language: aphasia and phonological universals*. Walter de Gruyter.

Kaan, E. (2014). Predictive sentence processing in L2 and L1: What is different? *Linguistic Approaches to Bilingualism*, **4**(2), 257–282. https://doi.org/10.1075/lab.4.2.05kaa

Kochari, A. R., & Flecken, M. (2018). Lexical prediction in language comprehension: a replication study of grammatical gender effects in Dutch. *Language, Cognition and Neuroscience*, **34**(2), 239–253. https://doi.org/10.1080/23273798.2018.1524500

Kuperberg, G. R., & Jaeger, T. F. (2016). What do we mean by prediction in language comprehension? *Language, Cognition and Neuroscience*, **31**(1), 32–59. https://doi.org/10.1080/23273798.2015.1102299

Lew-Williams, C., & Fernald, A. (2010). Real-time processing of gender-marked articles by native and non-native Spanish speakers. *Journal of Memory and Language*, **63**(4), 447–464. https://doi.org/10.1038/jid.2014.371

Leyden, K. V., & Heuven, V. J. V. (1996). Lexical stress and spoken word recognition: Dutch vs. English. *Linguistics in the NetherlandsLinguistics in the Netherlands*, **13**(1986), 159–170.

Li, X. (2015). Putting interpreting strategies in their place Justifications for teaching strategies in interpreter training*. *Babel*, **2**(15), 170–192. https://doi.org/10.1075/babel.61.2.02li

Liontou, K. (2012). *Anticipation in German to Greek simultaneous interpreting: A corpus-based approach* [Doctoral dissertation]. Retrieved from http://othes.univie.ac.at/23451/

Lozano-Argüelles, C., Sagarra, N., & Casillas, J. V. (2020). Slowly but surely : Interpreting facilitates L2 morphological anticipation based on suprasegmental and segmental information. *Bilingualism: Language and Cognition*, **23**(4), 752–762.

Lupyan, G., & Clark, A. (2015). Words and the world: Predictive coding and the language-perception-cognition interface. *Current Directions in Psychological Science*, **24**(4), 279–284. https://doi.org/10.1177/0963721415570732

MacWhinney, B. (2012). The logic of the unified model. In S. Gass & A. Mackey (Eds.), *Handbook of second language acquisition* (pp. 211–227). New York, NY: Routledge. https://doi.org/10.4324/9780203808184.ch13

Maschio, N. D., Sulpizio, S., Toti, M., Camilla, C., Del Mauro, G., Fedeli, D., & Abutalebi, J. (2019). Second language use rather than second language knowledge relates to changes in white matter microstructure. *Journal of Cultural Cognitive Science*, **4**, 165–175. https://doi.org/10.1007/s41809-019-00039-z

Mehler, J., Dommergues, J. Y., Frauenfelder, U., & Seguí, J. (1981). Article the syllable's role in speech segmentation the syllable's role in speech segmentation. *Journal of Verval Learning and Verbal Behavious*, **20**(3), 298–305.

Mirman, D. (2014). *Growth curve analysis and visualization using R*. CRC Press.

Nishinuma, Y. (1994). How do the French perceive tonal accent in Japanese? Experimental evidense. In *3rd International conference on spoken language processing (ICSLP 94)* (pp. 18–22). Yokohama, Japan. https://doi.org/10.1046/j.1365-2435.1999.00337.x

Nishinuma, Y., Arai, M., & Ayusawa, T. (1996). Perception of tonal accent by Americans learning Japanese. In *International Conference on Spoken Language Processing. ICSLP, Proceedings*, vol. **2** (pp. 646–649). https://doi.org/10.1109/icslp.1996.607444

Pickering, M. J., & Gambi, C. (2018). Predicting while comprehending language: A theory and review. *Psychological Bulletin*, **144**(10), 1002–1044. https://doi.org/10.1037/bul0000158

R Core Team. (2019). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing. https://www.R-project.org/

Roll, M. (2015). A neurolinguistic study of South Swedish word accents: Electrical brain potentials in nouns and verbs. *Nordic Journal of Linguistics*, **38**(2), 149–162. https://doi.org/10.1017/S0332586515000189

https://doi.org/10.1017/S0142716421000217 Published online by Cambridge University Press

Roll, M., Horne, M., & Lindgren, M. (2010). Word accents and morphology-ERPs of Swedish word processing. *Brain Research*, **1330**, 114–123.

Roll, M., Söderström, P., Frid, J., Mannfolk, P., & Horne, M. (2017). Forehearing words: Pre-activation of word endings at word onset. *Neuroscience Letters*, **658**, 57–61. https://doi.org/10.1016/j.neulet.2017.08.030

Roll, M., Söderström, P., Mannfolk, P., Shtyrov, Y., Johansson, M., Westen, D. V., & Horne, M. (2015). Word tones cueing morphosyntactic structure: Neuroanatomical substrates and activation time-course assessed by EEG and fMRI. *Brain and Language*, **150**, 14–21. https://doi.org/10.1016/j.bandl.2015.07.009

Sagarra, N. (2021). When more is better: Higher L1-L2 similarity, L2 proficiency, and working memory facilitate L2 morphosyntactic processing. In M. Leeser, W. Wong, & G. Keating (Eds.), *Research on second language processing and processing instruction. Studies in honor of bill VanPatten*. John Benjamins.

Sagarra, N., & Casillas, J. (2018). Suprasegmental information cues morphological anticipation during L1/L2 lexical access. *Journal of Second Language Studies*, **1**(1), 31–59. https://doi.org/10.1075/jsls.17026.sag

Sagarra, N., & Herschensohn, J. (2011). Proficiency and animacy effects on L2 gender agreement processes during comprehension. *Language Learning*, **61**(1), 80–116. https://doi.org/10.1111/j.1467-9922.2010.00588.x

Salverda, A. P., Kleinschmidt, D., & Tanenhaus, M. K. (2014). Immediate effects of anticipatory coarticulation in spoken-word recognition. *Journal of Memory and Language*, **71**(1), 145–163. https://doi.org/10.1016/j.jml.2013.11.002

Schremm, A., Söderström, P., Horne, M., & Roll, M. (2016). Implicit acquisition of tone-suffix connections in L2 learners of Swedish. *The Mental Lexicon*, **11**(1), 55–75. https://doi.org/10.1075/ml.11.1.03sch

Sebastian-Gallés, N., Dupoux, E., Seguí, J., & Mehler, J. (1992). Contrasting syllabic effects in Catalan and Spanish. *Journal of Memory and Language*, **31**, 18–32.

Seeber, K. G. (2013). Cognitive load in simultaneous interpreting: Measures and methods. *TargetTarget. International Journal of Translation Studies*, **25**(1), 18–32. https://doi.org/10.1075/target.25.1.03see

Simonet, M. (2019). Phonological encoding and the phonology of Spanish - The role of the syllable. In S. Colina & F. Martínez-Gil (Eds.), *The routledge handbook of spanish phonology* (1st ed.). Routledge.

Soto-Faraco, S., Sebastián-Gallés, N., & Cutler, A. (2001). Segmental and suprasegmental mismatch in lexical access. *Journal of Memory and Language*, **45**, 412–432.

Söderström, P., Roll, M., & Horne, M. (2012). Processing morphologically conditioned word accents. *The Mental Lexicon*, **7**(1), 77–89. https://doi.org/10.1075/ml.7.1.04soe

Sulpizio, S., Del Maschio, N., Del Mauro, G., Fedeli, D., & Abutalebi, J. (2020). Bilingualism as a gradient measure modulates functional connectivity of language and control networks. *NeuroImage*, **205**, 116306. https://doi.org/10.1016/j.neuroimage.2019.116306

Togato, G., Paredes, N., Macizo, P., & Bajo, T. (2015). Syntactic processing in professional interpreters: Understanding ambiguous sentences in reading and translation. *Applied Linguistics*, 38(4), 581–598.

Toro-Soto, J. M., Rodríguez-Fornells, A., & Sebastián-Gallés, N. (2007). Stress placement and word segmentation by Spanish speakers. *Psicologica*, **28**(2), 167–176.

Vroomen, J., Tuomainen, J., & De Gelder, B. (1998). The roles of word stress and vowel harmony in speech segmentation. *Journal of Memory and Language*, **38**(2), 133–149. https://doi.org/10.1006/jmla.1997.2548

Waltermire, M. (2004). The effect of syllable weight on the determination of spoken stress in Spanish. In *Laboratory Approaches to Spanish Phonology*, January 2004 (pp. 171–191).

Wang, Y., Spence, M. M., Jongman, A., & Sereno, J. A. (1999). Training American listeners to perceive Mandarin tones. *The Journal of the Acoustical Society of America*, **106**(6), 3649–3658. https://doi.org/10.1121/1.428217

Wechsler, D. (1997). *WAIS-III: Wechsler adult intelligence scale*. Psychological Corporation.

Yudes, C., Macizo, P., Morales, L., & Bajo, M. T. (2013). Comprehension and error monitoring in simultaneous interpreters. *Applied Psycholinguistics*, **34**(05), 1039–1057. https://doi.org/10.1017/S0142716412000112

Zanetti, R. (1999). Relevance of anticipation and possible strategies in the simultaneous interpretation from English into Italian. *Interpreters' Newsletter*, **9**(March), 79–98.

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