Morphological predictability - HS: 1.2

Summary

Joseph V. Casillas

2022-10-03

Summary of analyses for morphosyntactic predictability project.

Table of contents

List of Figures

List of Tables

1 Take-aways

- The two bilingual groups are essentially equivalent regarding proficiency and use.
- Stress matters: Monolinguals always predict, bilinguals do to some degree, but depends on stress (holding use and proficiency constant)
  - HL:
    - Paroxytone (CANta) (most common): ✓
    - Oxytone (canTA) (less common): ✗
  - L2:
    - Paroxytone (CANta) (most common): ✓
    - Oxytone (canTA) (less common): ✓
- Group differences
  - Monolingual time course different from both bilingual groups (they predict sooner) regardless of stress
  - HL and L2ers have essentially the same time course with paroxytonic stress, but L2 course is slightly delayed in comparison, the opposite is true for oxytonic stress, i.e., the HL time course is slightly delayed
  - L2ers predict more than HL with (less common) oxytonic stress pattern (but still not a lot)
- Proficiency, use, and prediction
  - HL
    - High use individuals always predict in paroxytone condition.
    - As use decreases, so does prediction
    - Marginalizing over stress, prediction is pretty good across the board
    - For oxytonic stress condition, only high use/high prof individuals predict
    - Unexplained weirdness… in oxytone condition low prof/low use predicts higher (not sure about this)
  - L2
    - Generally use is less important
    - Higher proficiency associated with higher prediction
    - Lowest overall prediction in paroxytone condition

2 Key plots

2.1 Prof/use check

See Proficiency/use cleaup and EDA for full details. Eight of 130 participants removed to make *use* more comparable between groups.

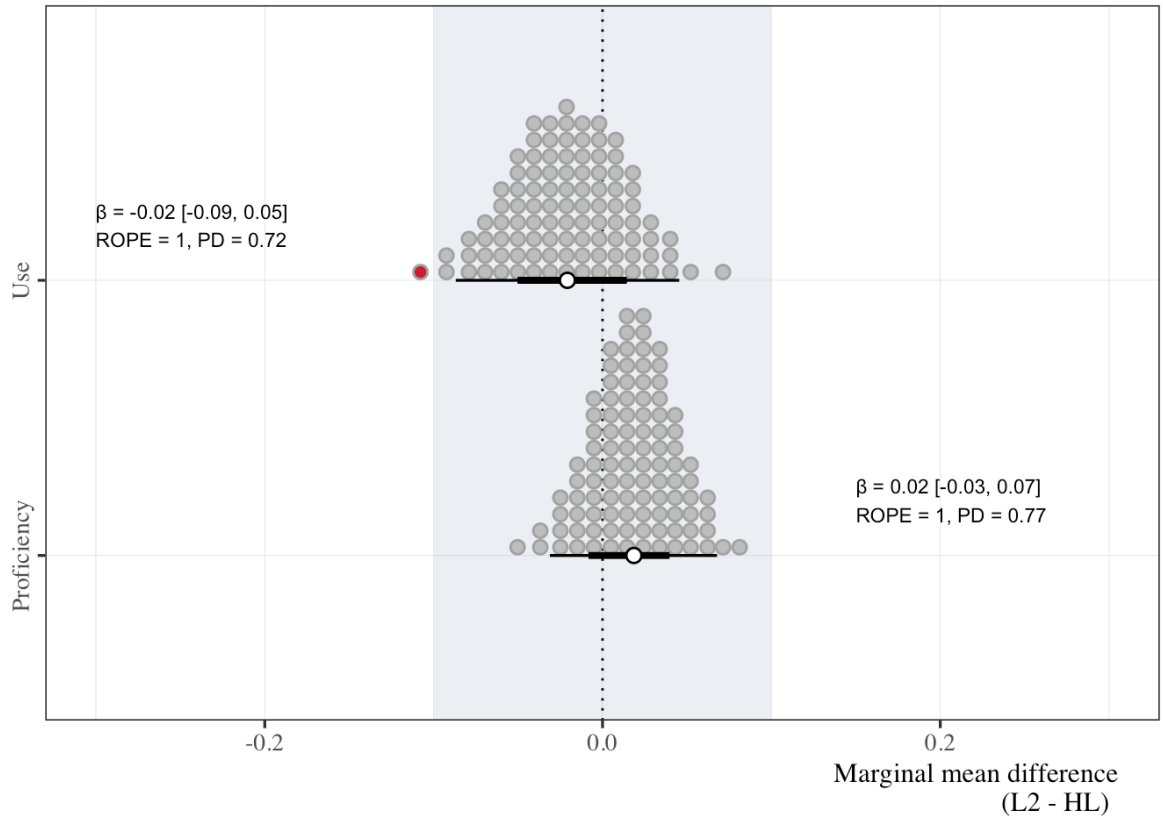

Figure 2.1: Estimated marginal mean difference between HL and L2 groups for standardized *use* and *proficiency*. The blue vertical bar represents a region of practical equivalence (ROPE) of ±0.1.

2.2 Eye-tracking: Raw data

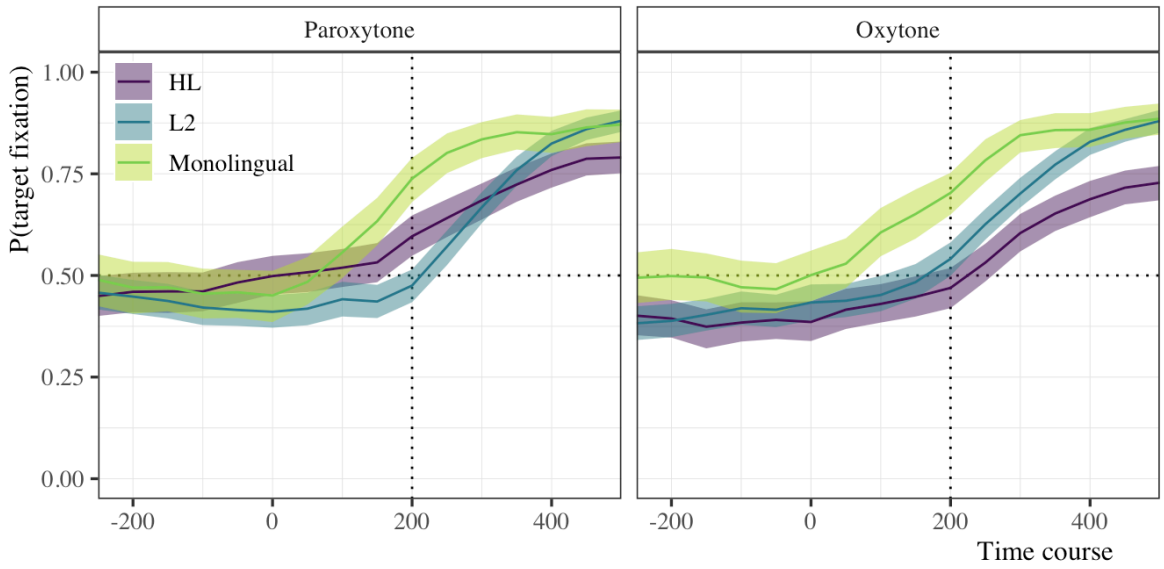

Figure 2.2: Time course of raw target fixation data as a function of stress condition (paroxytone, oxytone) for monolingual, HL, and L2 groups. Transparent ribbons represent 99% bootstrapped confidence intervals.

2.3 Eye-tracking: Group model (no prof/use)

2.3.1 Time course: GAMMs

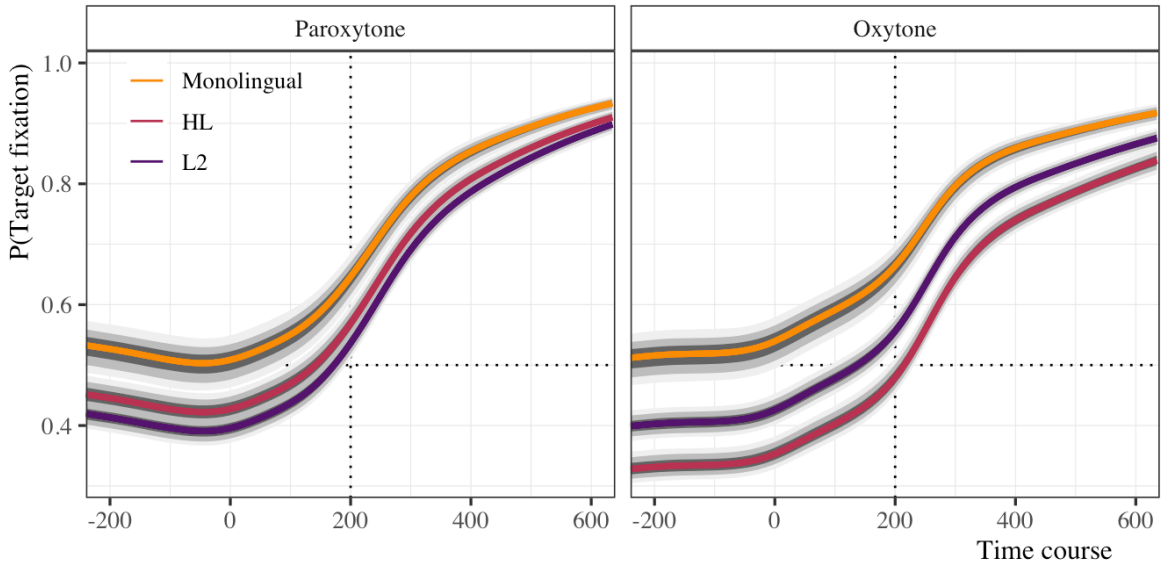

Figure 2.3: Probability of fixating on target as a function of stress for all three groups. The time course is centered around the target syllable offset (point 0). Vertical lines represent 200ms after target syllable offset. Lines represent group trajectories plus 95%, 80%, and 50% credible intervals.

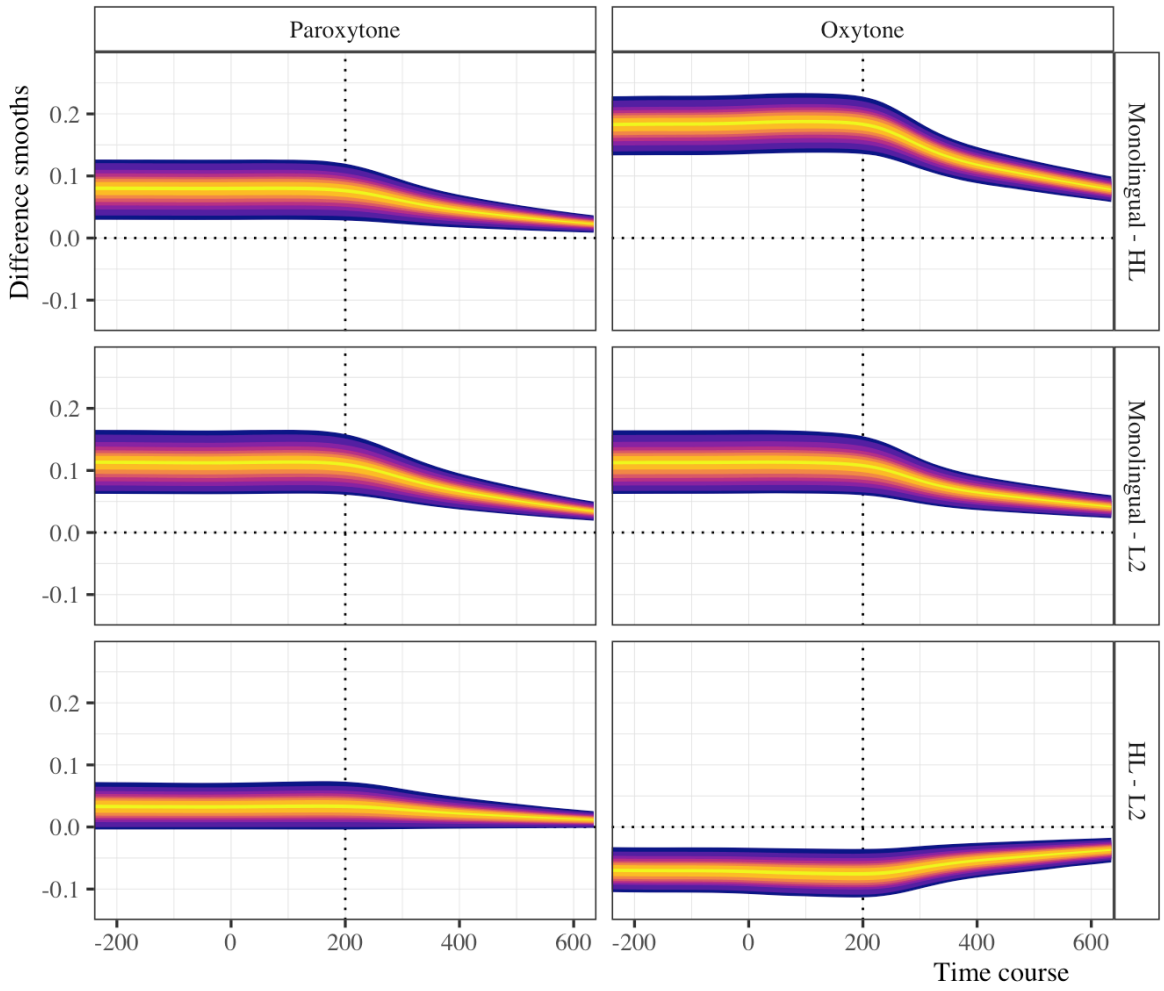

Figure 2.4: Pairwise difference smooths for paroxytone and oxytone items. From dark to light, colors represent 95%, 80%, 70%, 60%, 50%, 35% and 10% credible intervals.

2.3.2 Prediction at target offset

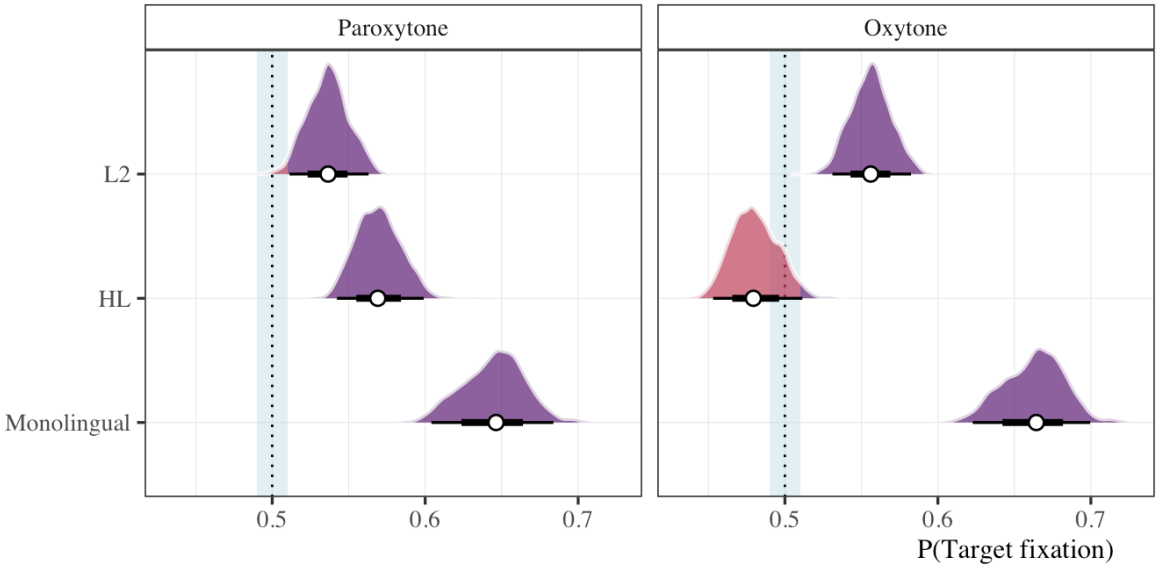

Figure 2.5: Proportion of target fixations 200ms after the offset of 1st syllable for monolinguals, heritage learners, and L2 learners in paroxytone (*CANto*) and oxytone (*canTO*) conditions. The vertical dotted line marks chance (50%) surrounded by a ±1% region of practical equivalence (ROPE). Density mass of the posterior distribution that falls within the ROPE is discolored (pinkish).

2.3.3 Estimated marginal slopes at target offset

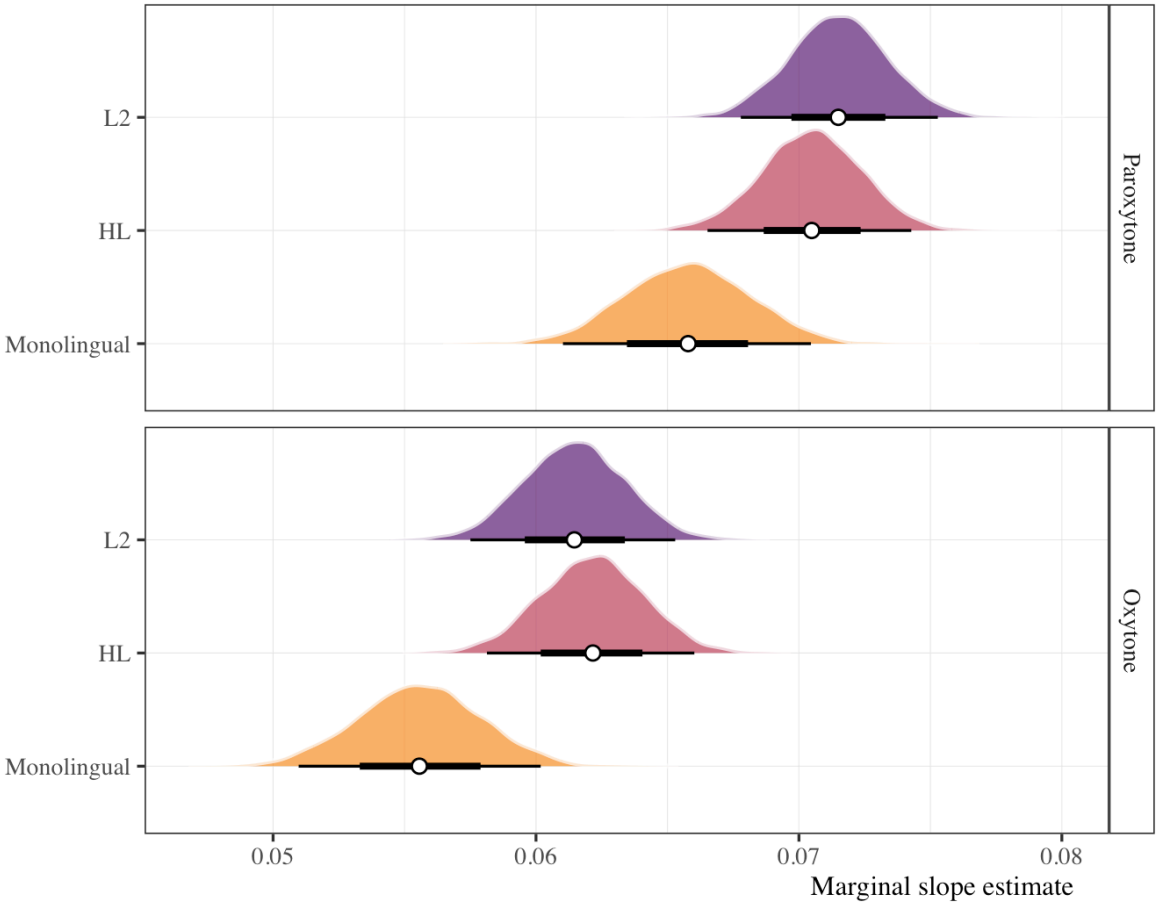

Figure 2.6: Marginal slope estimates 200ms after the offset of 1st syllable for monolinguals, heritage learners, and L2 learners in paroxytone (*CANto*) and oxytone (*canTO*) conditions.

2.4 Bilinguals only (prof/use)

2.4.1 Time course: GAMMs

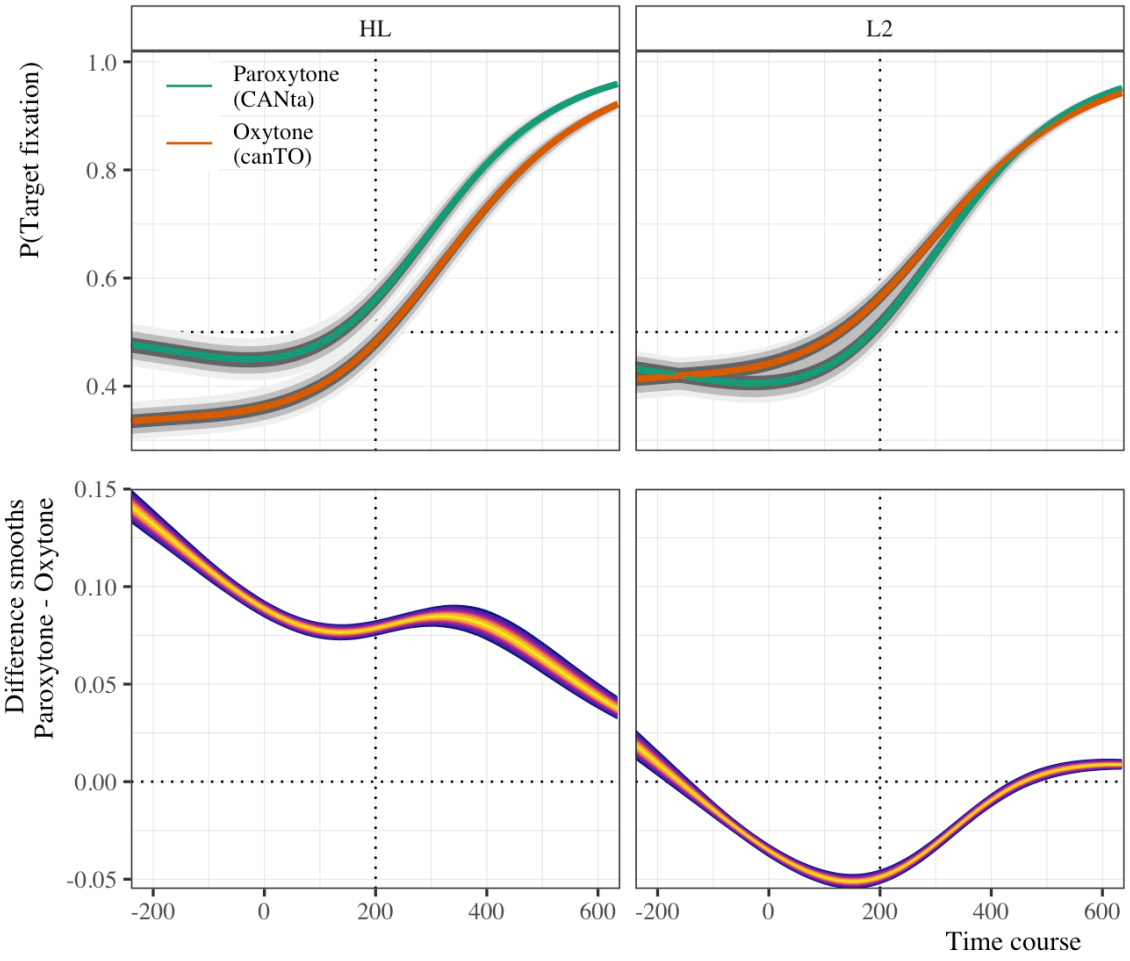

Figure 2.7: Probability of fixating on target as a function of stress for the bilingual groups. The time course is centered around the target syllable offset (point 0). Vertical lines represent 200ms after target syllable offset. Lines represent paroxytone ('CANta', green) and oxytone ('canTO', orange) conditions plus 95%, 80%, and 50% credible intervals. Pairwise difference smooths for paroxytone and oxytone items. From dark to light, colors represent 95%, 80%, 70%, 60%, 50%, 35% and 10% credible intervals.

2.4.2 Prediction at target offset: ZOIDBERG

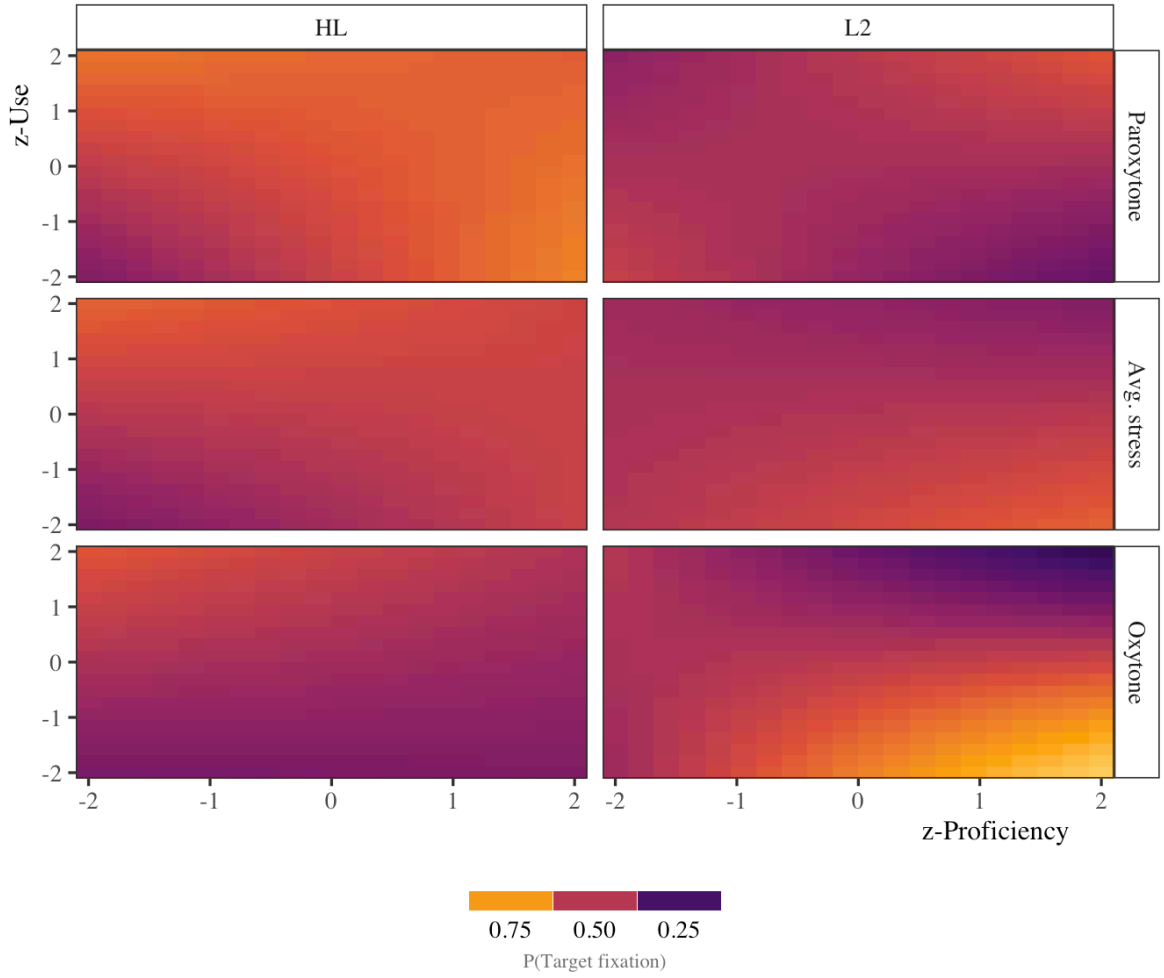

Figure 2.8: Heatmap of target fixations 200ms after target syllable offset. The heatmap illustrates the conditional effects of normalized proficiency and use scores for the bilingual groups. The top rows illustrate model estimate for the paroxytone condtion, the middle rows marginalize over stress conditions, and the bottom rows represent model estimate for the oxytone condition.

3 Write-up

3.1 Method

3.1.1 Lexical stress

Lexical stress (henceforth stress) refers to the relative prominence of one syllable with regard to the others in a given word. Stress is lexically encoded and contrastive in Spanish ('término' ['teɾ.mi.no], Eng. *term*; 'termino' [teɾ.'mi.no], Eng. *I finish*; 'terminó' [teɾ.mi.'no], Eng. *(s)he finished*) and in English ('produce' ['pɹo.duːs] noun, 'produce' [pɹə.'duːs] verb), though it is more productive in the former than in the latter. To wit, few stress minimal pairs exist in English that are not semantically related (See Cutler, 2012). The primary acoustic correlates of stress are F0, duration, and intensity, though their relative cue-weighting is language-specific (Chrabaszcz et al., 2014; See Gordon & Roettger, 2017; Holt & Lotto, 2006, among many others). Despite native English speakers' familiarity with stress, they typically have trouble producing (Bullock & Lord, 2003; Lord, 2007) and perceiving (Face, 2000, 2005, 2006; Ortega-Llebaria et al., 2013; Saalfeld, 2012) stress differences in L2 Spanish. A possible explanation might be found in language-specific isochrony (Pike, 1945). Whereas English is often described as a 'stress-timed' language, i.e., one with relatively constant intervals between stressed syllables, Spanish is typically described as 'syllable-timed', i.e., each syllable is perceived as having the same duration. Differences such as these may shape how stress is perceived in each language. In English, for example, unstressed vowel reduction—often present in stress-timed languages—may be sufficient for indicating stress (Cutler, 2012; Tremblay et al., 2018), rendering other cues relatively less important for speech perception. As a consequence, native English speakers may have to adjust their cue-weighting strategies when learning Spanish, a language that does not have vowel reduction. Evidence from cross-modal priming studies indeed suggests that stress is processed differently by native listeners in both languages during lexical access (Cooper et al., 2002; See Soto-Faraco et al., 2001). The extant literature suggests that native listeners are tuned in to the relevant acoustic cues of their language and take advantage of them to increase processing efficiency. Unsurprisingly, they use the same cue-weighting strategies when learning an L2, often resulting in difficulties during the early stages of acquisition (Ingvalson et al., 2012; Iverson et al., 2003).

3.1.2 Participants

We included data from 122 individuals for analysis. There were 30 monolingual participants, 42 heritage speakers, and 50 adult L2 learners.

The bilingual participants completed language *use* and *proficiency* assessments. We fit the *use* and *proficiency* data to separate Bayesian linear models to assess potential group differences. In both cases, the response variable, *use* or *proficiency* score, was a proportion. Thus, we used the beta distribution for the model likelihood with a logit linking function. The models included regularizing,

weakly informative priors.[1] We compare the posterior marginal mean difference between groups on both response variables. We established a region of practical equivalence (ROPE) of ±0.1. If, for a given measure, the full range of the 95% highest density credible interval (HDI) of the difference estimate falls within the ROPE, we consider there to be compelling evidence that the groups are equivalent. The HL group had an average proficiency score of 0.70 (SD = 0.09) compared to the L2 groups' score of 0.71 (SD = 0.14). The marginal mean difference was 0.02 [−0.03, 0.07] and all of the HDI fell within the ROPE. The probability that the effect was positive was 0.77. Regarding language use, the HL group had an average score of 0.41 (SD = 0.15) compared to the L2 groups' score of 0.38 (SD = 0.16). The marginal mean difference was −0.02 [−0.09, 0.05] and, again, all of the HDI fell within the ROPE. The probability that the effect was negative was 0.72. Taken together, we are confident that the groups do not differ in any meaningful way with regard to use of/proficiency in Spanish. Table 3.1 provides descriptive statistics and summarizes the models.

Metric	HL (n = 42)	L2 (n = 50)	Contrast	Estimate	ROPE	PD
Proficiency	0.70 (0.09)	0.71 (0.14)	L2 - HL	0.02 [−0.03, 0.07]	1	0.77
Use	0.41 (0.15)	0.38 (0.16)	L2 - HL	−0.02 [−0.09, 0.05]	1	0.72

Table 3.1: Language use and proficiency assessments for the heritage and L2 bilingual groups. The table reports the mean and standard deviation, as well as posterior estimates of the marginal mean difference (L2 - HL) and the 95% highest denisty credible interval (in brackets). The proportion of the posterior density falling within the region of practical equivalence (±0.1) is reported in the ROPE column. The probability that the effect is of the median's sign is reported in the PD column.

3.1.3 Statistical analyses

3.1.3.1 GAMMS

3.1.3.2 ZOIDBERG

3.2 Results

[1] See Proficiency/use cleaup and EDA for full details.

References

Bullock, B., & Lord, G. (2003). Analogy as a learning tool in second language acquisition. In A. T. Pérez-Leroux & Y. Roberge (Eds.), *Romance linguistics: Theory and acquisition* (Vol. 244, pp. 281–297). John Benjamins Publishing. https://doi.org/10.1075/cilt.244.21bul

Chrabaszcz, A., Winn, M., Lin, C. Y., & Idsardi, W. J. (2014). Acoustic cues to perception of word stress by english, mandarin, and russian speakers. *Journal of Speech, Language, and Hearing Research*, *57*(4), 1468–1479. https://doi.org/10.1044/2014_JSLHR-L-13-0279

Cooper, N., Cutler, A., & Wales, R. (2002). Constraints of lexical stress on lexical access in english: Evidence from native and non-native listeners. *Language and Speech*, *45*(3), 207–228. https://doi.org/10.1177/00238309020450030 1

Cutler, A. (2012). *Native listening: Language experience and the recognition of spoken words.* MIT Press.

Face, T. L. (2000). The role of syllable weight in the perception of spanish stress. In H. Campos & E. Herburger (Eds.), *Hispanic linguistics at the turn of the millennium* (pp. 1–13). Sommerville, MA: Cascadilla Proceedings Project.

Face, T. L. (2005). Syllable weight and the perception of spanish stress placement by second language learners. *Journal of Language and Learning*, *3*, 90–103.

Face, T. L. (2006). *Cognitive factors in the perception of spanish stress placement: Implications for a model of speech perception.* *44*(6), 1237–1267. https://doi.org/10.1515/LING.2006.040

Gordon, M., & Roettger, T. (2017). Acoustic correlates of word stress: A cross-linguistic survey. *Linguistics Vanguard*, *3*(1). https://doi.org/10.1515/lingvan-2017-0007

Holt, L. L., & Lotto, A. J. (2006). Cue weighting in auditory categorization: Implications for first and second language acquisition. *The Journal of the Acoustical Society of America*, *119*(5), 3059–3071. https://doi.org/10.1121/1.2188377

Ingvalson, E. M., Holt, L. L., & McClelland, J. L. (2012). Can native japanese listeners learn to differentiate /r-l/ on the basis of F3 onset frequency? *Bilingualism: Language and Cognition*, *15*(2), 255–274. https://doi.org/10.1017/S1366728911000447

Iverson, P., Kuhl, P. K., Akahane-Yamada, R., Diesch, E., Kettermann, A., Siebert, C., et al. (2003). A perceptual interference account of acquisition difficulties for non-native phonemes. *Cognition*, *87*(1), B47–B57. https://doi.org/10.1016/s0010-0277(02)00198-1

Lord, G. (2007). The role of the lexicon in learning second language stress patterns. *Applied Language Learning*, *17*(1-2), 1–14.

Ortega-Llebaria, M., Gu, H., & Fan, J. (2013). English speakers' perception of spanish lexical stress: Context-driven L2 stress perception. *Journal of Phonetics*, *41*(3-4), 186–197. https://doi.org/10.1016/j.wocn.2013.01.006

Pike, K. L. (1945). *The intonation of american english.*

Saalfeld, A. K. (2012). Teaching L2 spanish stress. *Foreign Language Annals*, *45*(2), 283–303. https://doi.org/10.1111/j.1944-9720.2012.01191.x

Soto-Faraco, S., Sebastián-Gallés, N., & Cutler, A. (2001). Segmental and suprasegmental mismatch in lexical access. *Journal of Memory and Language*, *45*, 412–432. https://doi.org/10.1006/jmla.2000.2783

Tremblay, A., Broersma, M., & Coughlin, C. E. (2018). The functional weight of a prosodic cue in the native language predicts the learning of speech segmentation in a second language. *Bilingualism: Language and Cognition*, *21*(3), 640–652. https://doi.org/10.1017/S136672891700030X