Grammar trumps lexicon: Typologically inconsistent weight effects are not generalized

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Background: In the vast majority of languages that are sensitive to weight, syllable weight is binary, i.e., a syllable is either light or heavy (see Gordon (2007) for a comprehensive review). In such languages, heavy syllables are more likely to attract stress. This is the case for Latin and English, for example. As well, if a language is weight-sensitive, weight cannot have a negative effect on stress, by definition.

Portuguese, like Latin and English, is also weight-sensitive, and is traditionally analysed as having a binary weight distinction: syllables that have a complex rhyme are heavy (H); all other syllables are light (L). Furthermore, Portuguese weight effects have long been assumed to be constrained to the word-final syllable (Bisol 1994, 2013; Lee 2007). The standard generalization regarding stress assignment in the language is given in (1).

(1) **Portuguese stress: standard generalization**

Final if the final syllable is heavy (H):	morál 'morale', pomár 'orchard'
Penult otherwise:	caválo 'horse', martélo 'hammer', piménta 'pepper'
Antepenult stress is irregular:	pántano 'swamp', atónito 'astonished'

However, once we examine a comprehensive corpus, the generalizations in (1) do not hold. First, weight-sensitivity is not constrained to the word-final syllable. Second, it is not binary: syllable weight gradiently affects all three syllables in the stress domain—even though weight effects weaken as we move away from the right edge of the word. Crucially, the weight effects of antepenult syllables found in the Portuguese lexicon (Houaiss et al. (2001), 154,610 entries) contradict the typological prediction mentioned above, in that weight has a *negative* effect on antepenult stress, i.e., LLL words are significantly more likely to attract antepenult stress than HLL words.

Questions: The two questions this paper investigates are:

i. *Do speakers' grammars capture the weight gradience present in the data, given the subtlety involved?* I show that speakers' grammars mirror the weight gradience found in the Portuguese lexicon, thus confirming that weight is not binary in the language.

ii. *How do speakers' grammars deal with typologically inconsistent weight-stress patterns such as the negative weight effect in antepenult syllables?* I show that speakers' grammars regularize the typologically inconsistent weight pattern present in the input available to speakers.

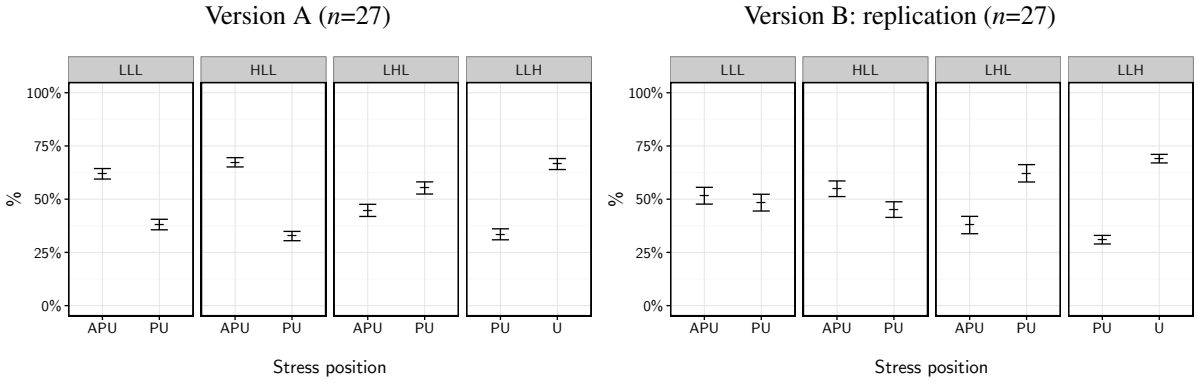
Methods: As a baseline, smaller lexica (20,000 words) were randomly simulated (n = 1,000) from the Houaiss corpus to ensure that the typologically contradictory pattern observed in the data is not restricted to a specific subset of words in the lexicon. The distribution of effects found in all simulated lexica confirm both the weight gradience and the negative antepenult weight effects.

An auditory judgment experiment was run containing trisyllabic nonce words (n = 240) and different weight profiles (LLL, HLL, LHL), where H = (C)CVC and L = (C)CV. LLH words were used as control, given that weight effects are most robust word-finally. Participants were all native speakers of Brazilian Portuguese (n = 27). They were presented minimal pairs differing only with regard to the position of stress. They were then asked to choose which version of the word sounded more natural to them—all choices were binary and no orthographic forms were provided. Participants were also asked to indicate their level of confidence in their judgment using a 6-point scale. To confirm that the results found were robust, the experiment was replicated months later with a different group of participants (n = 27). The experimental data were modelled using multilevel logistic regression in R (R Core Team 2016).

Results: In Fig. 1, we can see that participants in both Version A and Version B (replication) preferred final stress (U) in the control condition (LLH words), as expected: $\hat{\beta}_A = 0.84, p < 0.0001; \hat{\beta}_B =$

$0.89, p < 0.0001$. To determine whether these results mirror the weight gradience observed in the lexicon, we compare both HLL and LHL words to the neutral weight profile, i.e., LLL. In both versions of the experiment, penult stress is significantly more likely in LHL words (relative to LLL): $\hat{\beta}_A = 0.75, p < 0.0001$; $\hat{\beta}_B = 0.70, p < 0.0001$. Antepenult stress is also more likely in HLL words than in LLL words: $\hat{\beta}_A = 0.23, p < 0.05$. In Version B, a significant effect was not found ($\hat{\beta}_B = 0.16, p = 0.19$), but the effect of a heavy antepenult syllable is positive, which is consistent with Version A and confirms the trend in Fig. 1. Finally, speakers' confidence levels are in line with the response patterns found in the data, in that stress on heavy syllables yielded more confident responses.

Figure 1: Experimental results. *y*-axis represents the mean percentage of participants' responses by stress pattern (*x*-axis): APU = antepenult stress; PU = penult stress; U = final stress.



Discussion: Table 1 summarises the results. The effect sizes ($\hat{\beta}$) confirm the trends observed in Fig. 1, namely, that weight does play a role in all three positions in the stress domain, a fact which mirrors the patterns found in the Portuguese lexicon as well as in the simulated lexica used as baseline. Crucially, the negative weight effects of antepenult syllables found in the Portuguese lexicon are *not* mirrored in speakers' responses. Rather, the behaviour observed indicates that participants' grammars have regularized the weight effects in the language, i.e., weight positively impacts stress across all positions in the stress domain. Finally, these data not only show that the grammar generates patterns that are consistent with the typology, but also that even statistically subtle lexical effects (such as the weight gradience observed) can be captured and, importantly, generalized to novel words.

Table 1: Gradient weight effects in the stress domain ($\sigma_3\sigma_2\sigma_1]_{Wd}$): Version A and Version B

Stress	**Contrast**	**Effect** ($\hat{\beta}_A$)	**Effect** ($\hat{\beta}_B$)	**Effects in simulated lexica**
3. Antepenult	ĹLL *vs.* ĹLL	Positive: 0.23	Positive: 0.16	***Negative**
2. Penult	LĹL *vs.* LĹL	Positive: 0.75	Positive: 0.70	Positive
1. Final	LLĹ *vs.* LĹL	Positive: 0.84	Positive: 0.89	Positive

The probabilistic analysis proposed here can be formalized within a Maximum Entropy Grammar (Hayes and Wilson 2008) with positionally defined weight constraints (WEIGHT-TO-STRESS PRINCIPLE, WSP (Prince 1990, Gordon 2004, Ryan 2011)), which assigns violation marks to heavy syllables that are not stressed. The constraint in question is defined as WSP_n, where n represents any position in the stress domain—which is determined by the interaction of other constraints in the grammar. Crucially, the cost of violating WSP_n depends on how strong weight effects are in position n (Table 1).

Weight effects are strongest at the right edge of the word (final syllable, position 1; Fig. 1), and weakest at the left edge of the stress domain (antepenult syllable, position 3). As a result, the gradient weight effects in Portuguese would be captured by assigning relative weights to $\text{WSP}_{\{3,2,1\}}$ such that $\text{WSP}_3 < \text{WSP}_2 < \text{WSP}_1$. This analysis predicts the typologically consistent behaviour observed in speakers' judgments.