Grammar trumps lexicon

Typologically inconsistent weight effects are not generalized

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UMass, Amherst
Phonological learning

Can speakers acquire subtle phonological patterns in the lexicon?

- Not all patterns learned are in the lexicon
- Not all patterns in the lexicon are learned
  E.g.: Unnatural patterns → harder to learn (Poverty of the stimulus)

What if such patterns **contradict typology**?
Phonological learning

Mismatches between lexicon and grammar

**Typologically contradictory lexical patterns**

- **Initial-σ Faithfulness: ‘life’ → ‘lives’**
  - Monosyllables $> \,$ polysyllables in the English lexicon
  - Monosyllables $\equiv \,$ polysyllables in wug test

- **Sonority Sequencing Principle in initial clusters**
  - Sonority plateaux $> \,$ sonority rises in the Polish lexicon
  - Sonority rises favoured by children
Phonological learning

This presentation

Typologically contradictory lexical patterns

▶ Weight effects on stress
  ○ **Negative** for antepenult stress in the Portuguese lexicon
  ○ **Positive** for antepenult stress in experimental data

▶ **Bottom line:**
  ○ Speakers learn subtle lexical (sub)patterns
  ○ But not a pattern that contradicts typology
  ○ **Crucially:** speakers generalise the opposite pattern
    *i.e., the expected pattern given the typology*
Weight & stress

Weight-sensitive languages:

A Stress is affected by weight, i.e., rhyme shape
B Most cases: categorical weight: heavy (H) or light (L)
C Heavy syllables attract stress:

...´H... better than ...´L...

Weight effects in Portuguese...

... are gradient, not categorical (cf. B)
... are negative for antepenult stress: ´L better than ´H (cf. C)

Do speakers ignore, generalise or repair these facts?
Background

Stress in Portuguese

Questions

Lexical baseline
  Lexicon
  Sublexica
  Word frequency

Data and analysis

Design
  Q1: Weight gradience
  Q2: APU stress (H₃)

Final remarks

Formalisation

Phonological learning
Stress in Portuguese non-verbs

Traditional approaches: categorical

▶ Traditional generalisation: $X^{\text{H}} \text{W}_d \text{ else } XX \text{W}_d$

1. Stress is final (U) if final syllable is heavy
   pomár ‘orchard’
2. Stress is penult (PU) otherwise
   macáco ‘monkey’
3. Antepenult (APU) stress is irregular
   patético ‘pathetic’

∴ Weight effects are constrained to the word-final syllable
Stress in Portuguese non-verbs

Probabilistic approach (?)

- **Categorical** approaches miss important sub-patterns
- These sub-patterns can be captured in a **probabilistic** analysis

In a comprehensive corpus of Portuguese \( (n=154,610) \):

1. Weight effects are **gradient**: \( H_3 < H_2 < H_1 \)
2. **All three** syllables in the domain are weight-sensitive
3. Antepenult syllables show a **negative** effect:
   - \( \text{LL} \text{L} \) is statistically better than \( \text{H} \text{L} \text{L} \)
   - Inconsistent with the typology

\[ \text{Notation: } [H_3 \ H_2 \ H_1]_{Wd} \]
Stress in Portuguese non-verbs

Probabilistic approach (?)

$\sigma = \text{probabilistic approach}$

$\bullet = \text{actual data}$

$\ldots = \text{categorical approaches}$

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Garcia (McGill)

NELS 47 • Grammar trumps lexicon
Questions

1. **How do speakers’ grammars generalise weight effects?**
   *Do they capture the subtle weight effects in the domain?*

2. **How do speakers deal with an inconsistent pattern?**
   *Do they ignore, generalise or repair APU effects?*
Lexical baseline

Input vs. lexicon

- Is the negative $H_3$ effect realistically in the input?
  - If not, then speakers’ lexica will have no negative effects
  - E.g., the negative effect could stem from rare words

- Three methods to evaluate how realistic the effect is:
  1. Examine distribution of credible effect sizes
  2. Simulate smaller sublexica
  3. Model $\approx 20,000$ most frequent words only
Lexical baseline: **HLL vs. LLL**

Entire corpus ($n = 81,299$): Markov Chain Monte Carlo simulation

- Posterior distribution with estimated mode and 95% HDI
- All credible effects of $H_3$ are **negative**.\(^1\)

\[^1\]Bayesian logistic regression (MCMC)
Lexical baseline: \textbf{HLL vs. LLL}

Sublexica simulation ($n = 10,000 \times 25,000$ words [with replacement])

- Effect of $H_3$ is \textit{negative} in all simulations:\footnote{Simple logistic regressions}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{beta_h3}
\caption{Distribution of $\beta_{H3}$ values.}
\end{figure}
Lexical baseline: **HLL vs. LLL**

Sublexica simulation \((n = 10,000 \times 10,000\) words [with replacement])

- Effect of H₃ is **negative** in 99.7% of all simulations:\(^3\)

\[
\beta_{H_3} = \begin{array}{c}
-0.313 \\
-0.187 \\
-0.05
\end{array}
\]

\(^3\)Simple logistic regressions
Lexical baseline: **HLL vs. LLL**

Most frequent non-verbs (based on Tang 2012): $n = 22,634$

- All credible effects of $H_3$ are **negative**.$^4$

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$^4$Bayesian logistic regression (MCMC)
Lexical baseline: **HLL vs. LLL**

- Negative effect of H₃ is reliable in the lexicon
- This contradicts the typology of weight effects

🔍 *How do speakers’ grammars deal with such effects?*
Experimental design

- Nonce words \( (n = 240) \) with different weight profiles
  - Stimuli generated with script
  - Filtered by phonotactic probability

- Auditory forced-judgment task involving minimal pairs:
  
  \textit{Same word in each pair; different stress position}

  “Which word sounds better to you?” E.g., HLL or HLL

\[ \text{Stress contrasts} \]

\[ \begin{align*}
\text{APU vs. PU} & : \text{HLL, LHL, LLL} \\
\text{PU vs. U} & : \text{LLH}
\end{align*} \]
Experiment

- Stimuli recorded by phonetically trained native speaker (f)
- Version A: 27 speakers
- Version B: 32 speakers (replication of Version A)

All participants are native Brazilian Portuguese speakers

Analysis:
- Bayesian Logistic Regressions (MCMC simulation)
- By-speaker random intercepts
- stress ∼ weight
Q1: How do speakers’ grammars generalise weight effects?

$H_1$ effects (LLH words): penult vs. final stress

**Data**

<table>
<thead>
<tr>
<th>Version A</th>
<th>Version B</th>
</tr>
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<tbody>
<tr>
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<tr>
<td>$0.738$</td>
<td>$0.873$</td>
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<tr>
<td>$1.003$</td>
<td>$0.614$</td>
</tr>
</tbody>
</table>

**LLH:** Penult vs. final stress: $U \succ PU$
Q1: How do speakers’ grammars generalise weight effects?

H₂ effects (LHL words): antepenult vs. penult stress

**Data**

**Version A**

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<th>β₁</th>
<th>β₂</th>
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**Version B**

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<td>0.745</td>
</tr>
<tr>
<td>0.599</td>
<td>0.745</td>
</tr>
</tbody>
</table>

**LHL:** Antepenult vs. penult stress: PU ⊳ APU
Q2: How do speakers’ grammars deal with APU stress?

$H_3$ effects (HLL words): antepenult vs. penult stress

**HLL:** Antepenult vs. penult stress: APU $\succ$ PU
Summary

1. **How do speakers’ grammars generalise weight effects?**
   
   _Do they capture the subtle weight effects in the domain?_
   
   ✅ **Yes:** $H_3 < 2 < 1$ all affect stress

2. **How do speakers deal with an inconsistent pattern?**
   
   _Do they ignore/generalise/repair APU effects in the lexicon?_
   
   - Ignore $\rightarrow$ HLL = LLL
   - Generalise $\rightarrow$ LLL $\succ$ HLL
   - Repair $\rightarrow$ HLL $\succ$ LLL

   ✅ $H_3$ positively affects APU stress

   Contra lexical patterns, but consistent with weight typology
Thoughts on representing weight effects

$H_{3<2<1}$ all affect stress

- Weight effects are gradient
- Crucially: they depend on position of $\sigma$ in word  
  *(cf. Ryan 2011)*
- Speakers are sensitive to this dependency
- **Weight-to-Stress Principle**  
  *(Prince 1983)*

**WSP**$_n$

An unstressed heavy syllable in position $n$ is penalised

Portuguese: $\text{WSP}_3 < \text{WSP}_2 < \text{WSP}_1$
Can speakers acquire subtle phonological patterns in the lexicon?

- Not all patterns learned are in the lexicon
- Not all patterns in the lexicon are learned

▶ What if such patterns contradict typology?

☞ They can be repaired to conform to the typology

\[
\text{Lexicon: } \text{LLL} \succ \text{HLL} \rightarrow \text{Grammar: } \text{HLL} \succ \text{LLL}
\]
References


References II


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Thank you ○ Obrigado
Appendix i

Data results: Version A (n = 27)
Appendix i

Data results: Version B \((n = 32)\)
Appendix ii
Why is weight gradient in Portuguese?

Three important facts about stress in the language:

1. Stress is highly correlated with duration
   \[ \therefore \text{heavy } \sigma \text{s are usually longer} \] (Major 1985)

2. Unstressed vowels are reduced (Moraes 1998)

3. Secondary stress is only possible pre-tonically