Gradient weight effects in L2 stress acquisition are driven by orthography

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Lexical stress and syllable weight

- In many languages, stress is sensitive to **syllable weight**
  - Light σ = CV
  - Heavy σ = CVV or CVC (weight by position)
- Heavy (H) σ more likely to be stressed (E.g., Hayes 1995)

Lexical stress in Portuguese

- Stress in Portuguese is weight-sensitive (Carvalho 1989)
- Weight-based algorithm accounts for ≈70% of the lexicon (non-verbs) : (Garcia 2017)

a. Heavy **final** syllable → final stress — ma.**cáu** (CVV#), a.ve.**lã** (CVN#)
b. Light **final** syllable → penultimate (PU) stress — ca.**vá**.lo (CV#), ri.no.ce.**rón**.te (CV#)

L2 stress by L1 tonal learners

- Portuguese stress :
  - **Duration:** most robust correlate of stress (Major 1985)
  - Heavier syllables → longer duration (all else being equal)
- L2 (English) stress perception/acquisition by L1-Mandarin
  - f0 (Archibald 1997; Wang 2008)
  - Vowel quality (Zhang and Francis 2010)
  - Duration (Qin et al. 2017; Garcia 2020)

Why can L1-Mandarin use duration as a cue?

- Only **H** syllables can bear a full tone (Qu 2013 and Duanmu 2007)
- Tonal syllables perceived to be more prominent than toneless syllables

DONG (T1) XI (T1) 'east-west' vs. DONG (T1) XI (T0) 'thing'

L2 Portuguese stress by L1 Mandarin

General question(s)

- How well do L1-Mandarin speakers identify the location of stress in Portuguese?
- Will they be able to use durational difference to perceive stress?
  A. Yes. **Cue-based** transfer: learners can (re)use acoustic correlates employed in their L1 to acquire a novel L2 structure (Escudero and Boersma 2004)
  B. No (stress deafness). Duration is not the mean cue (e.g., pitch) (Archibald 1997; Wang 2008)

Study 1

Methods

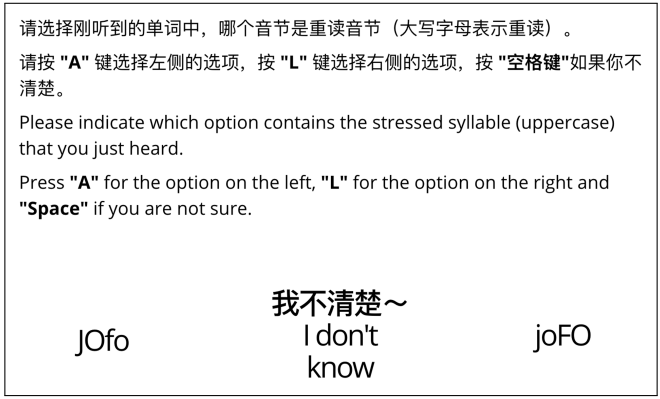
- Participants: 21 L1-Mandarin with moderate English ($\bar{x} = 30$ LexTALE); no Portuguese
- Stimuli: 2-syllable pseudo-words in Portuguese ($n = 30$)

	Penultimate	**Final**
10 LL	JOfo	joFO
10 LH_N	PAbem	paBEM
10 LH_VV	DAcai	daCAI
	harder	**easier**

Study 1

Methods

- Auditory identification of stress location on Gorilla

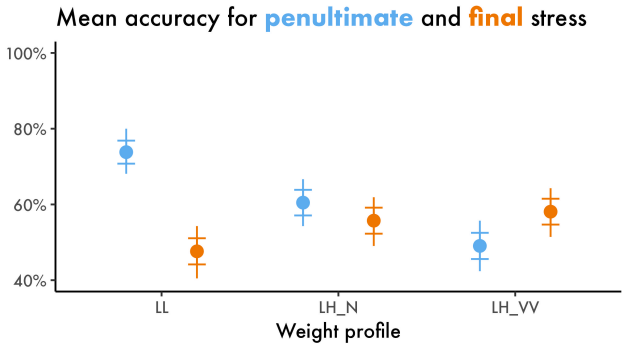


Study 1

Results : L1-Mandarin naïve listeners ($n = 21$)

☞ H# → better accuracy on *σ́*#

- And worse accuracy on *σ́σ*#



Error bars represent standard errors (narrower) and bootstrapped 95% CIs (wider)

Study 1

Analysis : Bayesian hierarhical model

```
accuracy ~ stress_loc * weight +
           (1 + stress_loc * weight | part) + (1 + stress | item)
```

☞ Where `stress_loc = {PU, U}` and `weight = {LL, LH_N, LH_VV}`

Parameter	$\hat{\beta}$	Est. Error	95% CrI
`LH_VV:stressU`	0.63	0.32	−0.01, 1.22
`LL:stressU`	−1.21	0.41	−2.05, −0.41

☞ Accuracy difference **final** > **PU** is larger in `LH_VV/LH_N` than in LL

∴ Final heavy syllable makes it easier to identify Final stress

Study 1

Discussion

What underlies these weight effects? Acoustic analysis of stimuli :

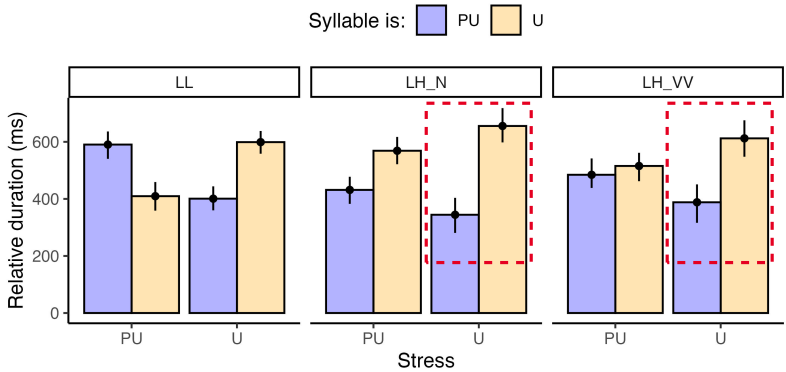
- f0 (standardized/centred) → not a cue for Portuguese stress
- pitch accent → rarely present in pre- and post-nuclear position (Frota 2014)
- intensity → not a cue for Portuguese stress
- vowel quality → not a cue in our stimuli

☞ **duration** → LH > LL (heavy syllable enhances durational difference)

Study 1

Discussion

What underlies these weight effects? Duration → σ enhances durational difference



☞ Could this be driven by **orthography**?

(Ruiz 2002)

Study 2

Methods

- **Participants:** 95 L1-Mandarin with moderate English and **no Portuguese**
- Stimuli:
  - 30 items with **final** stress (**easier** identification) → 10 LL, 10 LH_n, 10 LH_vv
  - 30 items with **penultimate** stress (**harder** identification) → 10 LL, 10 LH_n, 10 LH_vv

Study 2

Methods: auditory condition

请选择刚听到的单词中，哪个音节是重读音节（单词中最响亮的音节）？

- 按键盘上的数字 **"1"** 键选择第一个音节
- 按键盘上的数字 **"2"** 键选择第二个音节

1 2

Study 2

Methods: auditory+orthographic condition

请选择刚听到的单词中，哪个音节是重读音节（单词中最响亮的音节）？

- 按键盘上的数字 **"1"** 键选择第一个音节
- 按键盘上的数字 **"2"** 键选择第二个音节

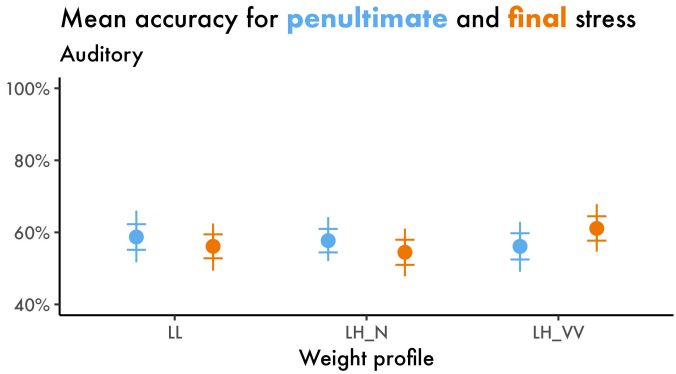
si

pa

Study 2

Results: auditory condition ($n = 44$)

☞ No apparent weight effects

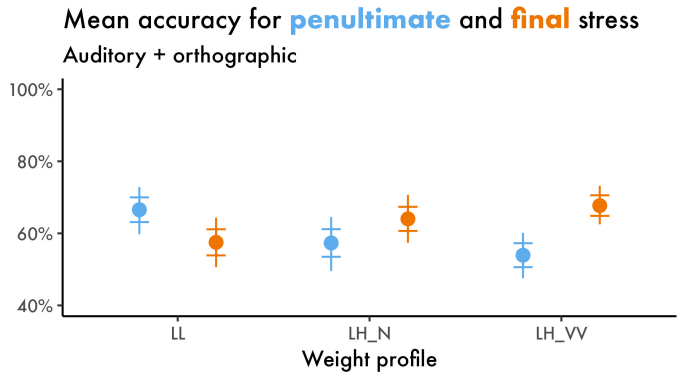


Error bars represent standard errors (narrower) and bootstrapped 95% CIs (wider)

Study 2

Results: auditory + orthographic condition ($n = 51$)

☞ **Gradient** weight effects



Error bars represent standard errors (narrower) and bootstrapped 95% CIs (wider)

Study 2

Analysis (auditory + orthographic): Bayesian hierarchical model

```
accuracy ~ stress_loc * weight +
           (1 + stress_loc * weight | part) + (1 + stress | item)
```

☞ Where `stress_loc = {PU, U}` and `weight = {LL, LH_N, LH_VV}`

Parameter	$\hat{\beta}$	**Est. Error**	**95% CrI**
`LH_VV:stressU`	0.56	0.27	0.02, 1.08
`LL:stressU`	−0.74	0.29	−1.32, −0.16

☞ Overall pattern for L1-Mandarin participants: CVV > CVC > CV

General discussion

- Mandarin speakers may use weight to identify stress in Portuguese
- Their choices imply some **gradient** effect, i.e., VV > VC > V

☞ **Orthography** seems to have a strong role

Questions

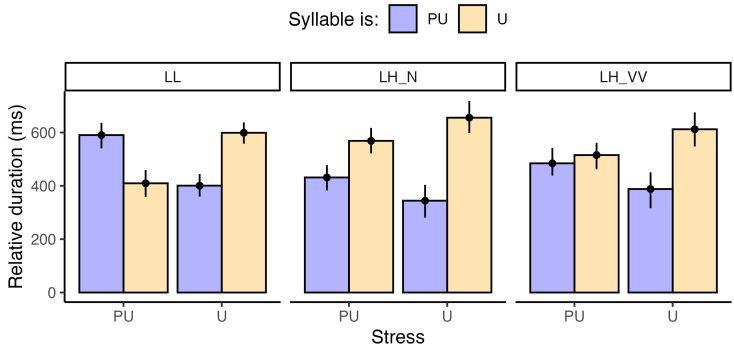
- How did orthography yield higher accuracy/gradient weight effects?
- Why could Mandarin speakers rely on weight (**internal structure of the** σ) if Mandarin syllables aren't correlated to prominence?

General discussion

Q1: the role of orthography

- **Hypothesis 1:** orthography draws participants' attention to duration differences between stressed and unstressed syllables

☞ *Problem:* this difference is **larger** for LH_N than for LH_VV



General discussion

Q1: the role of orthography

- **Hypothesis 2:** written forms in Portuguese stimuli are converted by the Mandarin grapheme-to-phoneme conversion rule as **phonological surface forms**, which are subject to the evaluation of the Mandarin grammar (Hamann and Colombo 2017)

LL as /CV.CV/
LL_N as /CV.CVN/ → **MANDARIN PHONOLOGY**
LL_VV as /CV.CVV/

General discussion

Q2: why use weight?

- Weight computation in Mandarin: only **heavy** syllables can bear a full tone (Qu 2013; Duanmu 2007)
- Tonal syllables perceived as more prominent than toneless syllables

Weight-to-Stress, Tone-Stress Principle ≫ Align, NonFinality

Mandarin grammar (Duanmu 2007)

Weight-to-Stress: stress on bimoraic syllabes (VV or VC)
Tone-Stress Principle: stressed syllables have lexical tone

General discussion

- Why could participants rely on syllable weight, which is **not** correlated with word-level prominence in Mandarin (tonal)?
- When the surface form does **not** have a tone

WEIGHT-TO-STRESS, TONE-STRESS ALIGNMENT ≫ ... ≫ ALIGN, NONFINALITY

↑

The emergence of the unmarked (Broselow et al. 1998)

General discussion

- Why could participants rely on syllable weight, which is **not** correlated with word-level prominence in Mandarin (tonal)?
- When the surface form does **not** have a tone

WEIGHT-TO-STRESS, TONE-STRESS ALIGNMENT ≫ **VV-TO-STRESS** ≫ ALIGN, NONFINALITY

VV-TO-STRESS: stress on vocalic moras VV (Ryan 2020)

General discussion

Generating weight gradience

- Weight-to-Stress: CV worse than CVC and CVV to bear stress
- VV-to-Stress: CVC worse than CVV to bear stress

General discussion

Remaining questions

- What is the nature of VV-to-Stress?
  a. Is it "innate"?
  b. Is it generalized from sonority? (E.g., Gordon 2006)

☞ Will **learners** also use syllable weight?

Conclusion

- Naïve learners may use syllable weight to acquire L2 lexical stress at the onset of L2 speech
- Orthography may influence L2 segmental and **suprasegmental** acquisition (Hamann and Colombo 2017)

☞ At least for the case in question, the initial state of phonological grammars in L2 acquisition may include more biases than we typically assume

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