

# Vowel duration in Enenlhet

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## Language Background

- Enenlhet [tmf]: One of six Enlhet-Enenlhet languages (see Fig. 1) indigenous to Paraguay
- Vowel inventory contains three vowels: /a, e, o/.
- Sister languages have been argued to have phonemic vowel length; Enenlhet has not (Unruh & Kalisch 2003, Elliott 2021).
- Enenlhet vowel duration studied in a corpus of naturalistic speech data (Heaton 2019).



Fig. 1: Location of Enenlhet speaking communities. Map inset from *Enenlhet* (2023), background from *Wikimedia* (2012)

## Hypotheses

Based on widely-attested effects in other languages; this is the first phonetic study of Enenlhet.

Prior work mostly on European languages, effects vary from language to language, and not all studies find each effect.

1. Fixed stress (if present) will appear as **lengthening associated with a vowel's position in a word** (e.g., Ortega-Llebarria & Prieto 2017, Gordon & Roettger 2017)
2. Low vowel /a/ will be longer than /e, o/ (e.g., Klatt 1975, Esposito 2001)
3. Vowels will be **longer before voiced consonants** (vs. voiceless ones) (e.g., Fintoft 1961, Chen 1970, but cf. Mittleb 1984)
4. Vowels will be **longer before pauses** (vs. utterance-medially) (e.g., Berkovits 1994, Nakai et al. 2009, also Beckman & Edwards 1990)
5. Vowels will be **longer in open syllables** (vs. closed) (e.g., Benguerel 1971, Maddieson 1985, but cf. Lippus et al 2013)

## Methods

- 1 ~3.5 hrs. of speech from 8 speakers, with transcription, translation, and utterance-level segmentation. Selected from Heaton (2019) corpus of naturalistic speech.
- 2 Force-alignment with Easyalign (Goldman 2011) Praat (Boersma & Weenink 2019) plugin. Used Spanish (with seseo) model, since no models are available for Enenlhet.
- 3 Phonetic transcription manually corrected (deletions, hesitations, code-switches removed)
- 4 Vowels segmented and annotated
- 5 Boundaries manually adjusted to ensure accurate and consistent duration measurements (see Fig. 2)

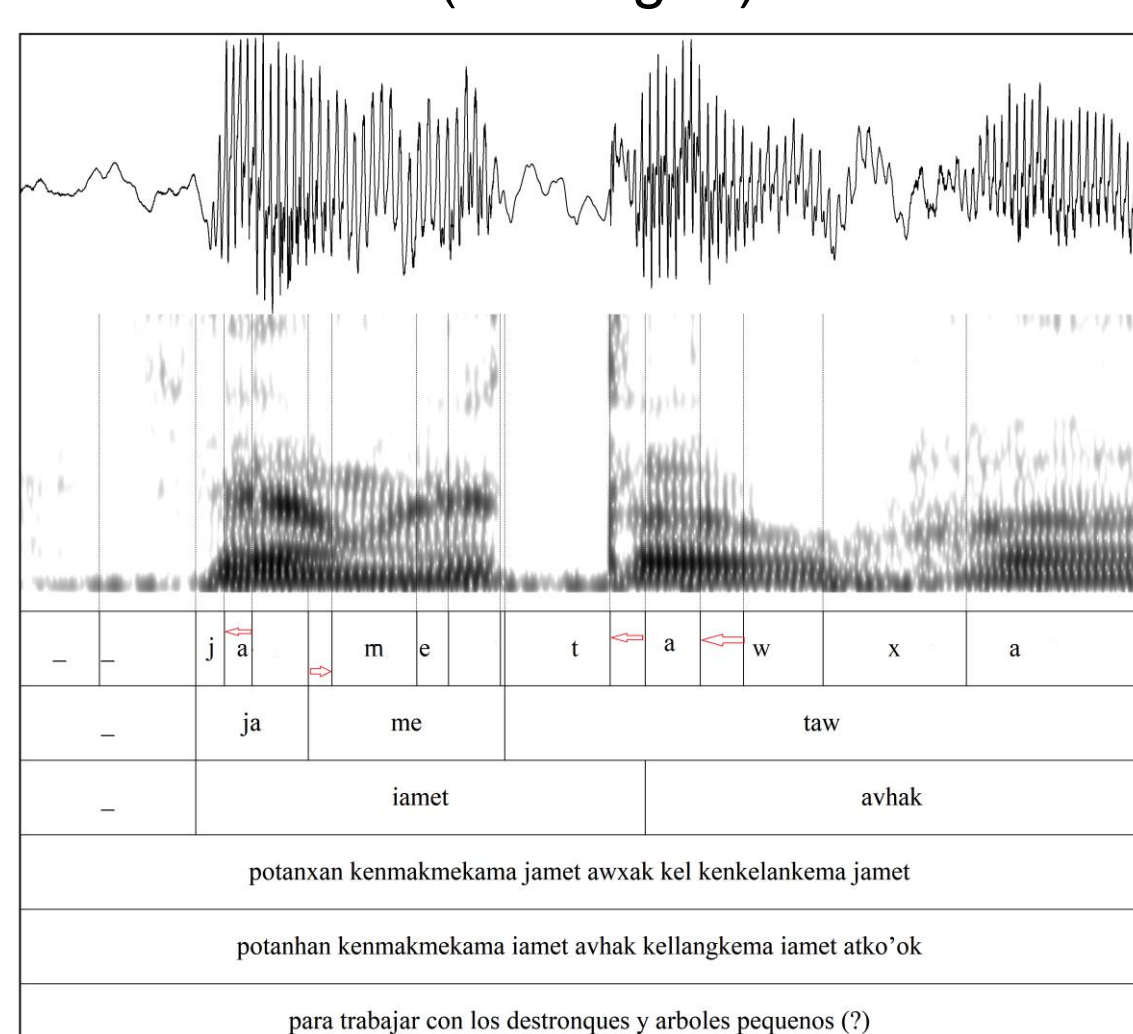


Fig. 2: Text grid showing correction of vowel boundaries adjacent to /j/, /m/, /t/, and /w/

## Results

### Low /a/ and mid /o/ are both longer than mid /e/

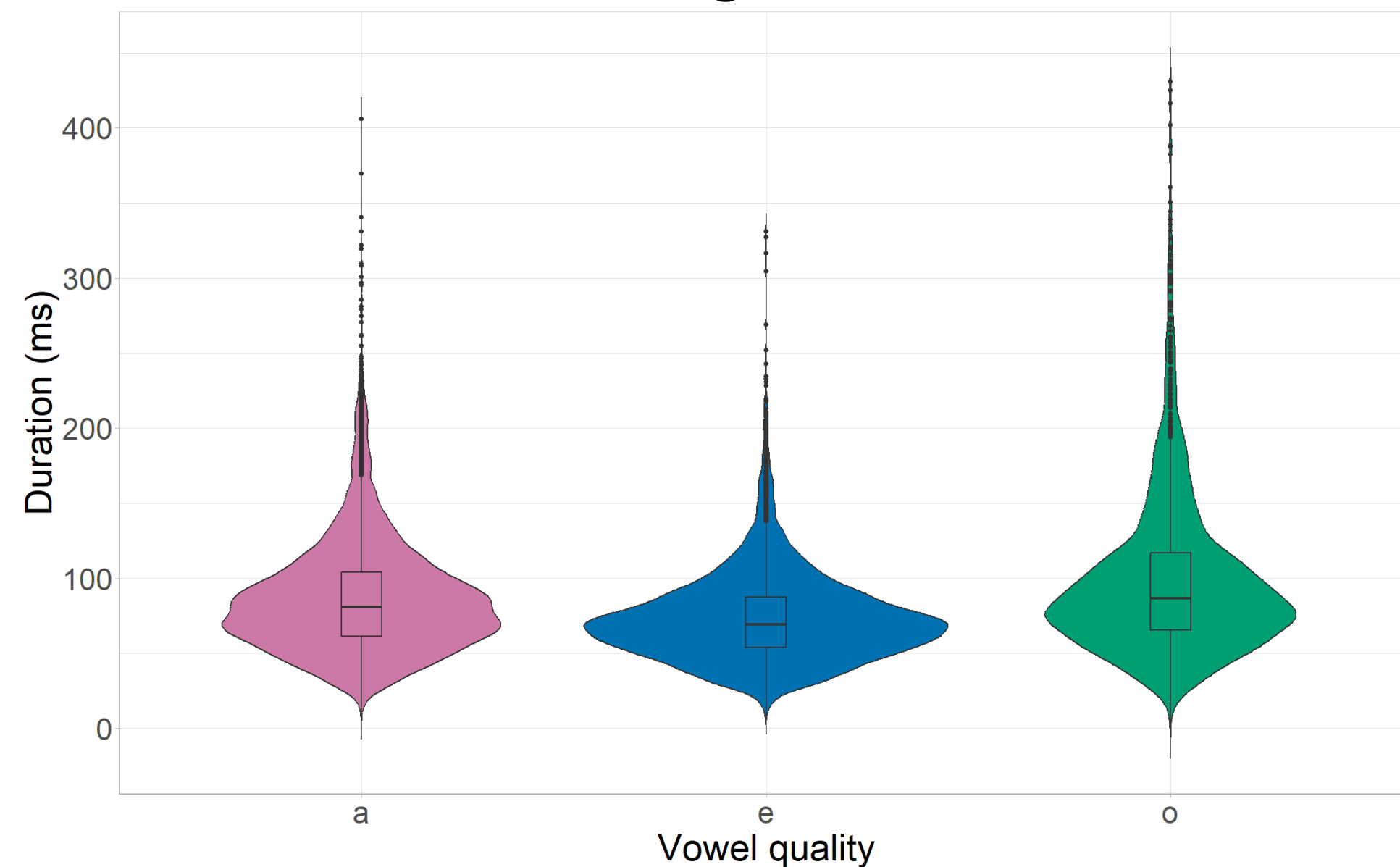


Fig. 3: Duration divided by vowel quality, for all vowels (n=15,553)

### Vowels are longer before voiced Cs, especially in codas

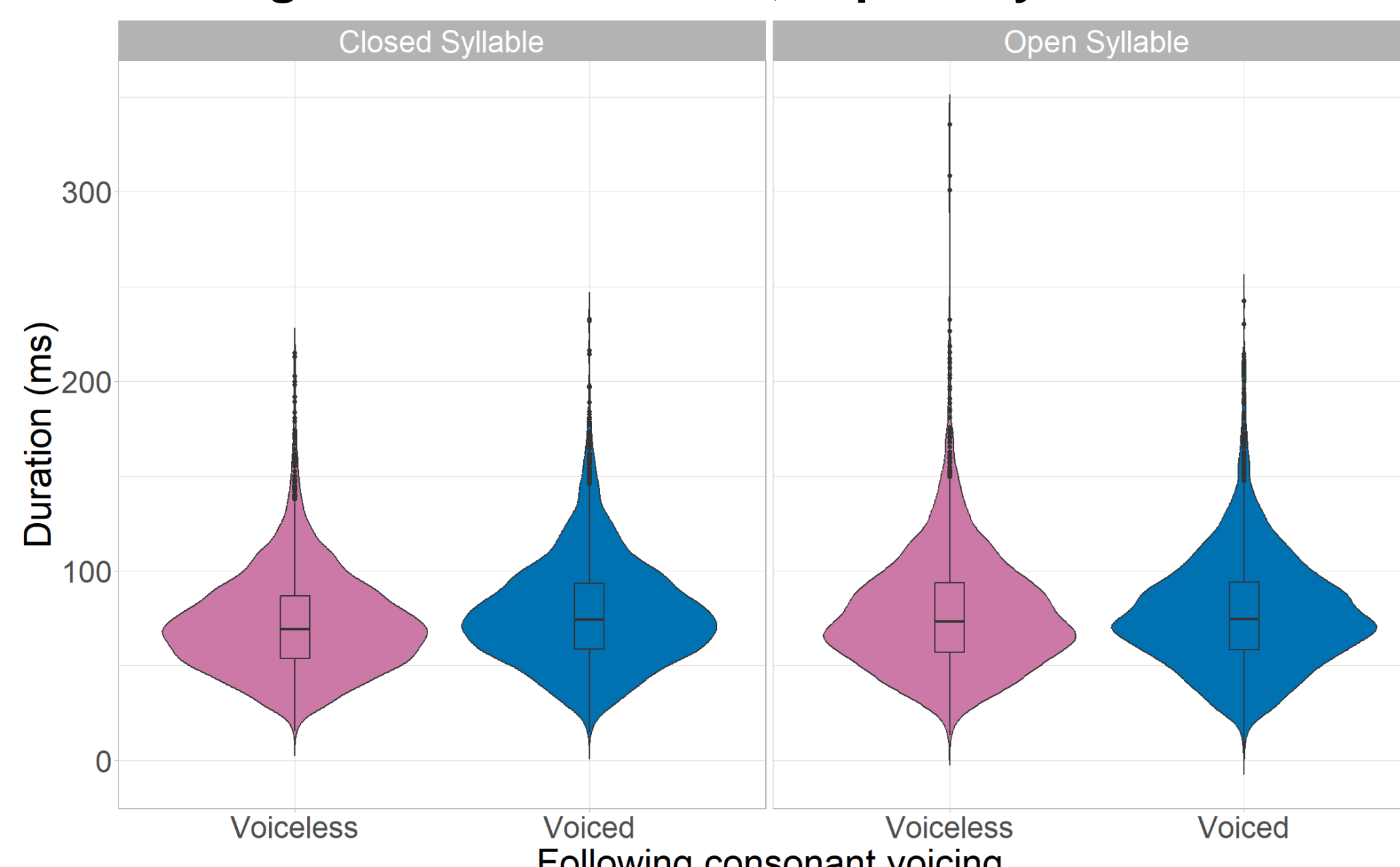


Fig. 4: Duration of non-pre pausal vowels (n=11,661)

### Vowels are longer in immediately pre-pausal syllables

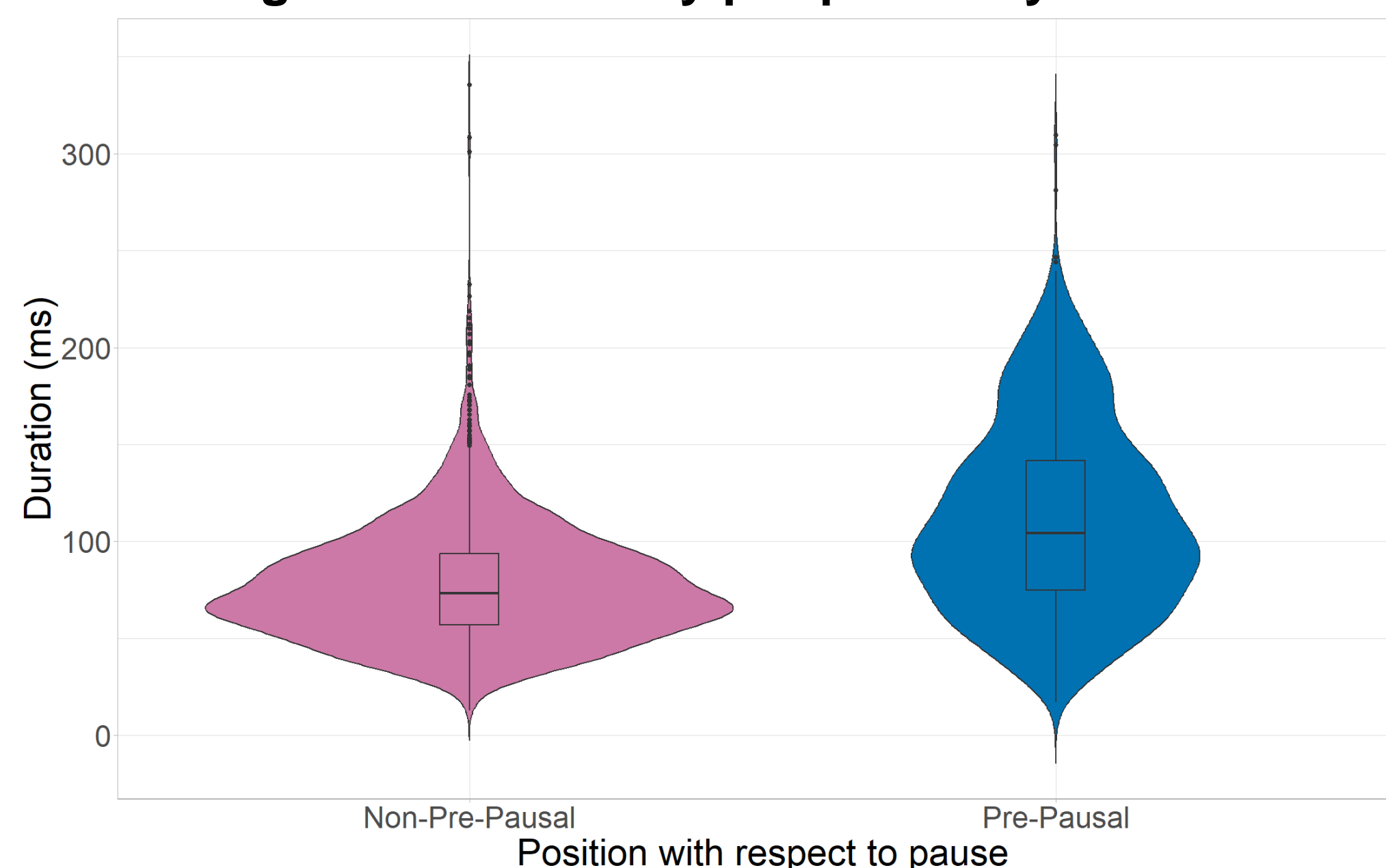


Fig. 5: Duration of vowels in closed syllables followed by voiceless consonants (n=3522)

### Vowels are longer in open syllables, especially pre-pausally

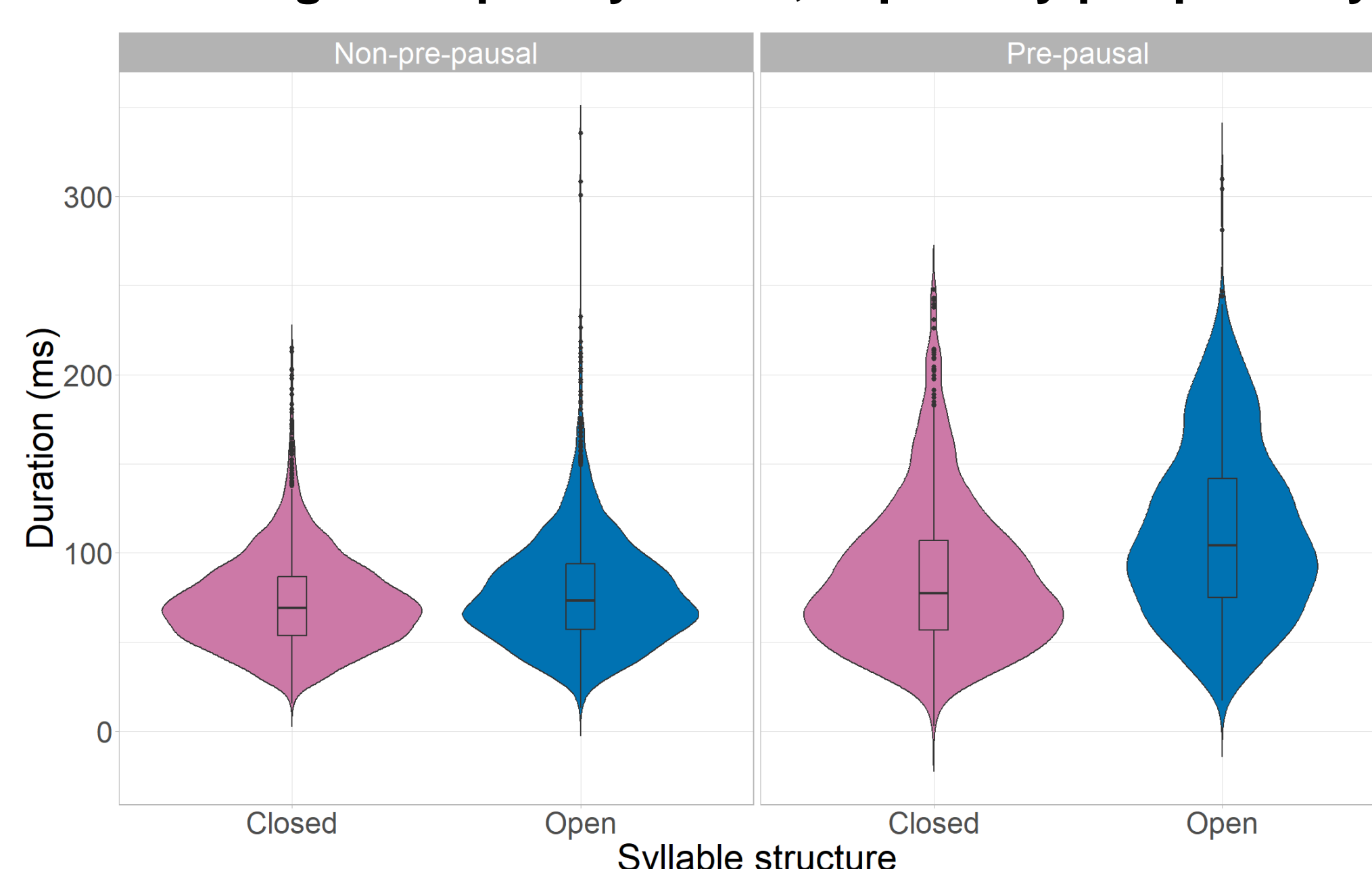


Fig. 6: Duration of vowels followed by voiceless consonants (n=7717)

### Statistical analysis: Linear Mixed Effects

- Model fitted in R (R Core Team 2019) with *lme4()* (Bates et al. 2015)
- Word position and utterance position combined, as original model showed no independent effect of word position
- Table 1 shows the model generated with the new variable. All effects were significant at  $p < 0.0001$  level

Effect	Estimate (ms)	Std. deviation	t-value
vowel quality: /o/	10.28	1.04	9.92
vowel quality: /a/	10.88	0.61	17.82
pre-pausal syllable	16.28	1.04	15.61
vcd following C	8.35	0.81	10.31
open syllable	5.70	0.87	6.53
vcd C * pre-pausal syll	-10.39	1.40	-7.44
open syll * pre-pausal	11.00	1.36	8.10
vcd C * open syll	-9.12	1.11	-8.17

Tab. 1: Results from model combining word and utterance position (n=14,810)

## Discussion

This study provides new descriptive facts about vowel duration in Enenlhet and facilitates cross-linguistic comparison.

**X Hypothesis 1:** Lack of word position effect provides no evidence for (fixed) stress

- Potential for lexically idiosyncratic stress, interaction between stress and word-class
- Stress assignment domain may also not be congruent with morphological word

**X Hypothesis 2:** /e/ differs in duration from /a/ (expected) and from /o/ (unexpected)

- Differences due to quality only about 8% of mean duration of /e/
- Apparent minimal height difference between all 3 vowel qualities (Fig. 7)
- Analysis of F1 and F2 measurements is underway, with results to be compared to Elliott (2016) and van Gysel (2022)

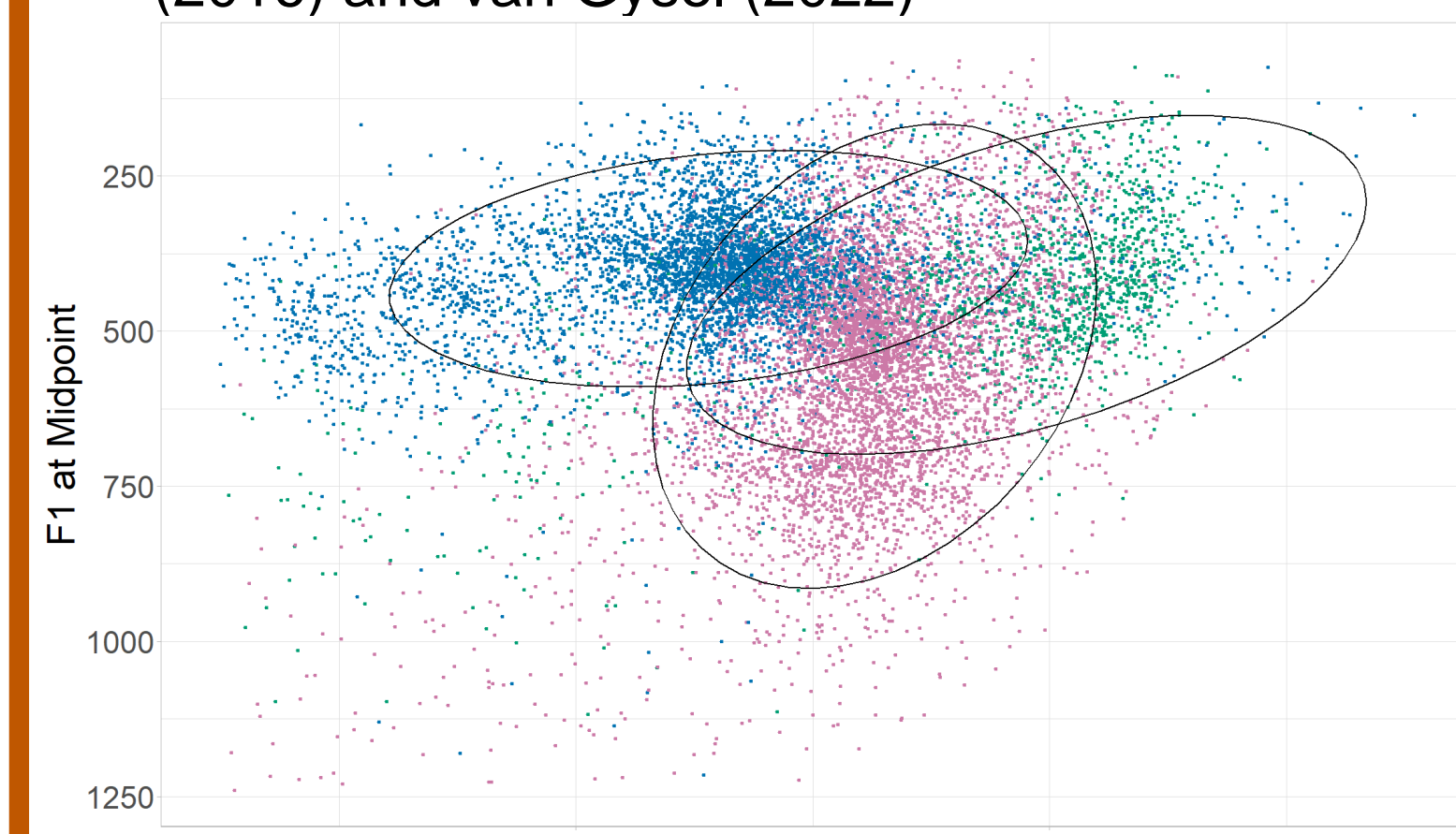


Fig 7: Bark-normalized F1 and F2 values for Enenlhet corpus

**✓ Hypothesis 3:** Vowels are longer before voiced consonants

- Interaction between consonant voicing and syllable structure → effect of consonant voicing is smaller in open syllables
- Consistent with observations in other languages (Klatt 1976, O'Shaughnessy 1981)
- Possible effects of manner of articulation not investigated

**✓ Hypothesis 4:** Pre-pausal vowels are longer than vowels in other positions

- Limited to immediately pre-pausal vowels, not a gradient effect
- Effect is small compared to other languages (cf. Berkovits 1994)

**✓ Hypothesis 5:** Vowels are longer in open syllables

- Significant main effect of syllable structure + interaction with pre-pausal position → larger effect pre-pausally
- Compare to consonant voicing effect, which is limited pre-pausally

### Phonemic vowel length

- Elliott (2021) describes phonemic vowel length in Enxet; Unruh & Kalisch (2003) propose it for all Enenlhet's sisters
  - $\chi^2$  test → random intercept for lexical item significantly contributes to the model
  - No significant effect of a vowel's position within the word in disyllabic words whose Enxet cognate has a long V1
  - Vowels cognate with Enxet long vowels are longer than anticipated in open syllables and shorter than anticipated prepausally

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References & supplementary materials:



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