
- lower vowels > higher vowels
- tense vowels > lax vowels

How does the pattern of intrinsic vowel duration differ across speakers of the same language? What aspects of the pattern are (more) invariant?

Each speaker (red) could potentially differ from the population avg (black) by ...

- **Uniform translation**: all vowels shorter/longer by same constant
- **Uniform scaling**: all durations compressed/expanded by same factor (scaling is equivalent to translation on a log scale, preserving ratios)
- **Uniform translation and scaling**
- **Non-uniform** effects of many conceivable types (e.g., selective shortening of low vowels, separate scaling factors for tense and lax vowels, etc.)

**Case studies**

- **Isolated speech** (recordings from Chodroff & Wilson 2014, JAX)
  - American English speakers (N=24) produced /CV/ syllables (5 repetitions each) in carrier phrase
    \[ C = [p b t d k g] \quad V = [i u e æ a i ɪ ɛ ø u] \]
  - Vowel tokens hand-segmented and mean duration of each vowel type calculated within speaker
    (subsequent to removing disfluencies and trimming bottom and top 1% of durations)
  - Speaker-specific values centered by subtracting grand mean calculated over all vowel types

- **Connected speech** (Mixer 6 Corpus, LDC2013S03: Brandschtein et al. 2010; Chodroff et al. 2016)
  - American English speakers (N=391, 209 female) read a common list of sentences from the Switchboard corpus
  - Vowel boundaries identified with the Penn Phonetics Lab Forced Aligner from partially audited transcripts
  - Speaker-specific mean duration for each vowel type was calculated as in the analysis of isolated speech
    (subsequent to removing stopwords and trimming bottom and top 1% of durations)

**Discussion**

- Intrinsically motivated by physical factors (e.g., jaw displacement for low vs. high vowels) but are nevertheless constrained by speakers (e.g., Westbury & Keating 1980; Solé & Ohala 2010)
  - "However, if vowel duration is a controllable parameter, it is in principle available for language-specific (and speaker-specific, CW&EC) manipulation." — Keating (1985:120)
  - Near-isomorphism of vowel duration patterns across speakers of American English indicates that, at least within a broad speech community, individual-level control of this phonetic property is highly restricted
  - Constraints on phonetic variation could arise from a number of sources, including usefulness of duration as a perceptual cue to vowel contrasts (e.g., Danillof et al. 1968; Ainsworth 1972; Hillenbrand et al. 2000)
  - Similar findings for stop VOT (Chodroff & Wilson 2017) and fricative place (Chodroff 2017) highlight the need for principles that explain controlled but constrained aspects of individual phonetic systems

**References (selected)**