Presentation at the 2014 Conference of the Canadian Linguistic Association

The Prosodic Structure of Canadian Raising

D. Sky Onosson
University of Victoria

Main Goals in This Talk

1. Argue that Canadian Raising* may be best described as a phenomenon of phonetic duration and articulatory timing
2. Introduce relevant literature on the relationships between phonetic timing, prosodic structure, segment voicing, and sonority
3. Propose a prosodic account of CR involving the factors described above

* My research to date is limited to /aj/ and focuses on Manitoba speakers

Canadian Raising

- "the diphthongs [ʌj] and [aj] are in complementary distribution: [ʌj] occurs before the class of voiceless consonants ([s, t, p], etc.) and [aj] occurs elsewhere. A parallel relationship holds between the vowels [aw] and [ʌw]" — (Czaykowska-Higgins et al 2012)
- The predominant description of CR is built upon the early work of Joos (1942) and elaborated by Chambers (1973 … 2006) among other researchers
- CR has become a classic example of allophonic variation involving *qualitatively* distinct allophones

1. Phonetic duration and articulatory timing in CR

Vowel Length in English

- English exhibits differences in vowel length related to the voicing of coda consonants (Peterson & Lehiste 1960, Chen 1970, Umeda 1975)
- "the ratio of vowel before voiceless consonant to vowel before voiced consonant is approximately 2:3" — (Peterson & Lehiste 1960)
- Pre-voiceless vowels in English are almost universally shorter than in other contexts, which is the **same environment as Canadian Raising**
- "The Canadian diphthongs /aj, aw/ have a higher initial tongue-position in pre-fortis [i.e. *voiceless*] contexts than elsewhere, while **for all other syllabics there is only a difference in length in the two kinds of context**." — M. Joos (1942)

Vowel Length and CR

- What is the relationship between vowel length and CR?
- Joos explicitly *denied* length as a factor in CR:

> "a shift from a difference essentially of length to a difference essentially of quality, so that in /aj, aw/ the difference between pre-fortis [i.e. *voiceless*] and other articulation is **not the same** as it is for all other syllabics" — (Joos 1942)

- Conversely, my data on /aj/ (Onosson 2010) indicates that there is in fact a large durational difference between the allophones of CR, in parallel with the other vowels of English

CR Production in Manitoba

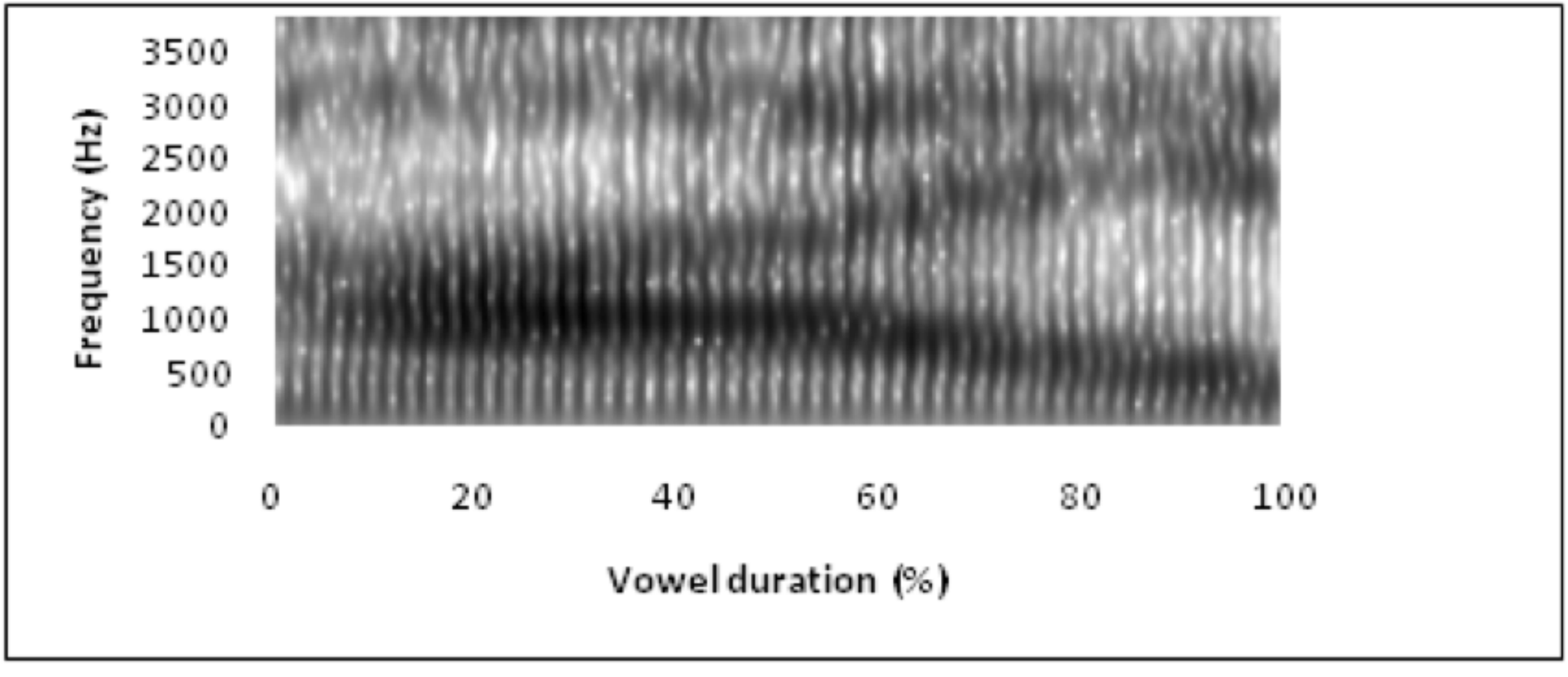
- Onosson (2010) examined the production of CR (/aj/ only) in Manitoba:
  - **8 participants, 1600+ tokens of /aj/**
- Mean durations of /aj/ tokens:
  - **non-raised: 293 ms**
  - **raised (pre-voiceless): 159 ms**
- Ratio of pre-voiceless to pre-voiced duration:
  - Onosson (2010) [tokens of /aj/ only] — **1:2**
  - Peterson & Lehiste (1960) [all vowels] — **2:3**
- Statistical relationship between *duration* of /aj/ and *coda voicing*, least squares test:
  - **R^2 = +0.764, high positive correlation**

CR Articulation

- Duration does *not* describe the entirety of the difference between CR allophones — raised /ai/ is not simply a shortened version of the non-raised allophone
- Spectrograms illustrate that formant trajectory in diphthongs is not uniform throughout the articulation
- Articulation of complex vowels (i.e. diphthongs) may involve varying rates of articulatory movement, steady states, etc.

Diphthong Articulation

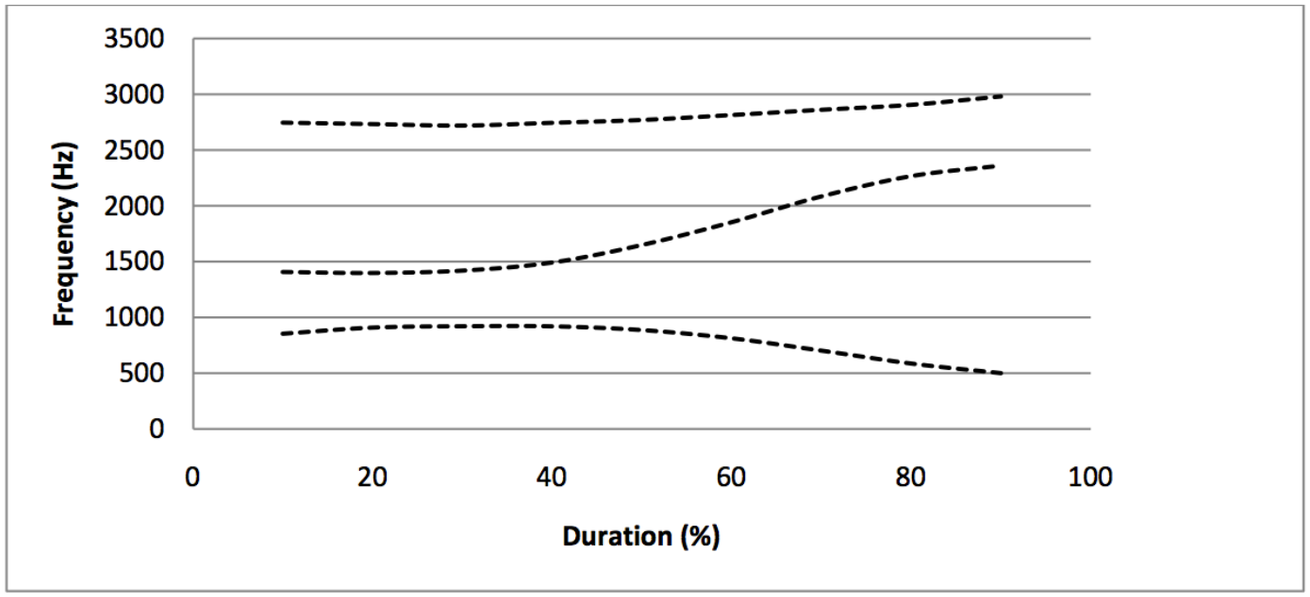
- Example of a spectrogram of *non*-raised /ai/
- Formant trajectory is not entirely uniform or steady throughout the duration of the diphthong's articulation

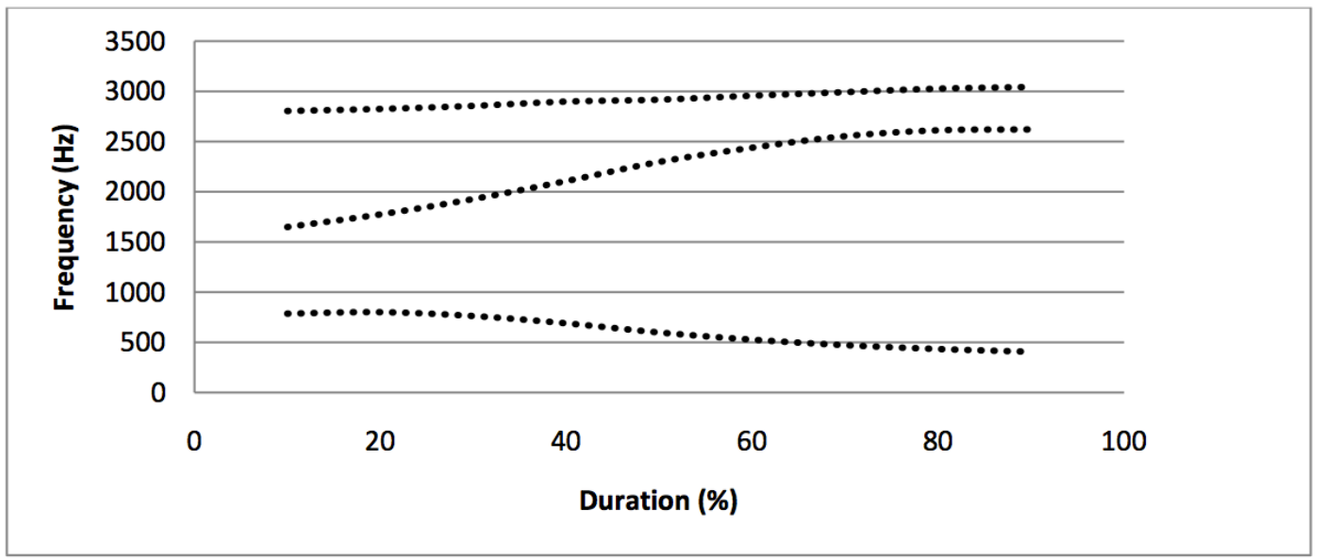


Comparing CR Allophones

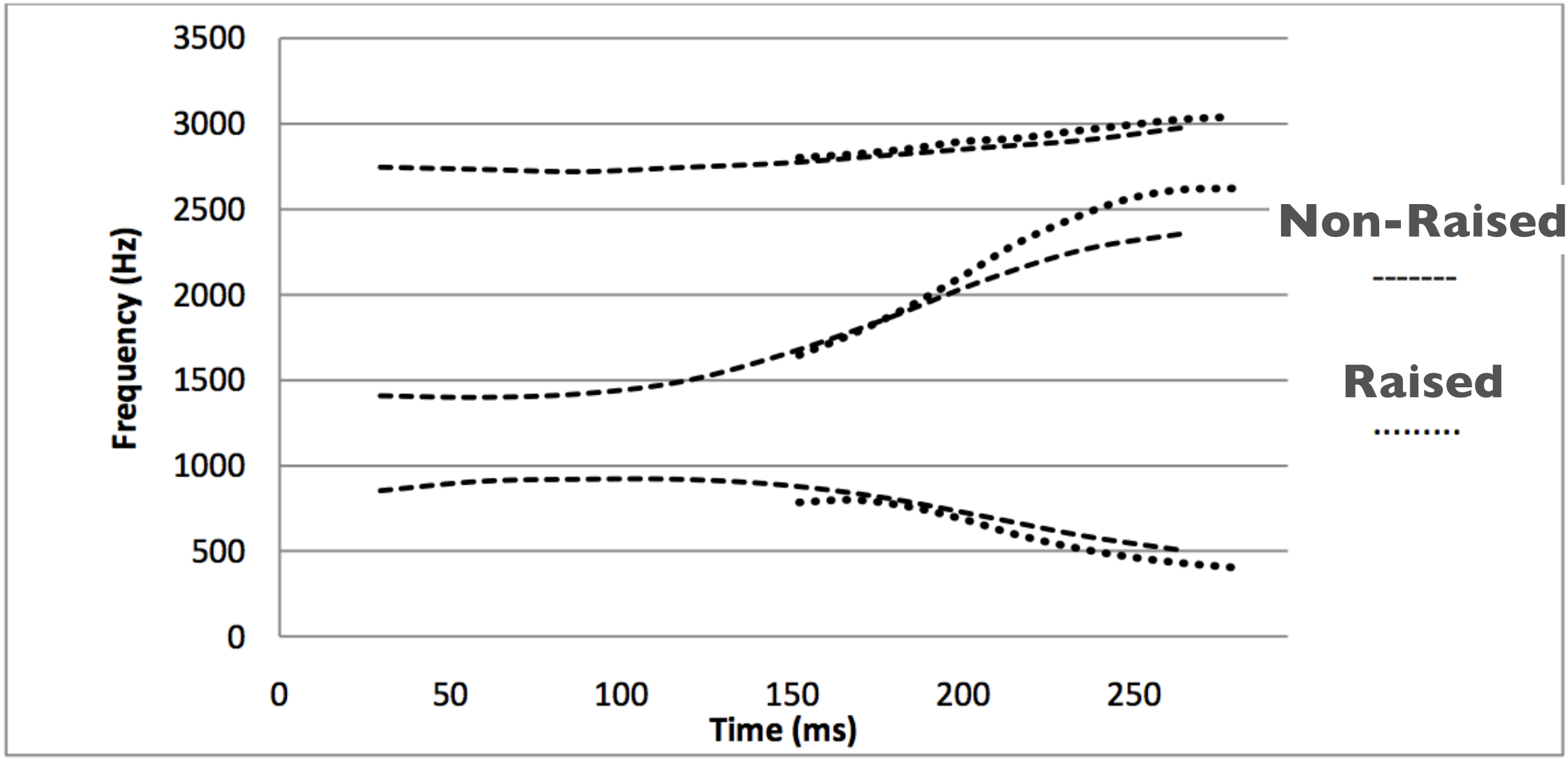
- Graph of averages of formant values measured at 10% intervals across vowel duration
- Percentile timescale fails to indicate differences in duration
- Articulations appear very dissimilar

Non-Raised



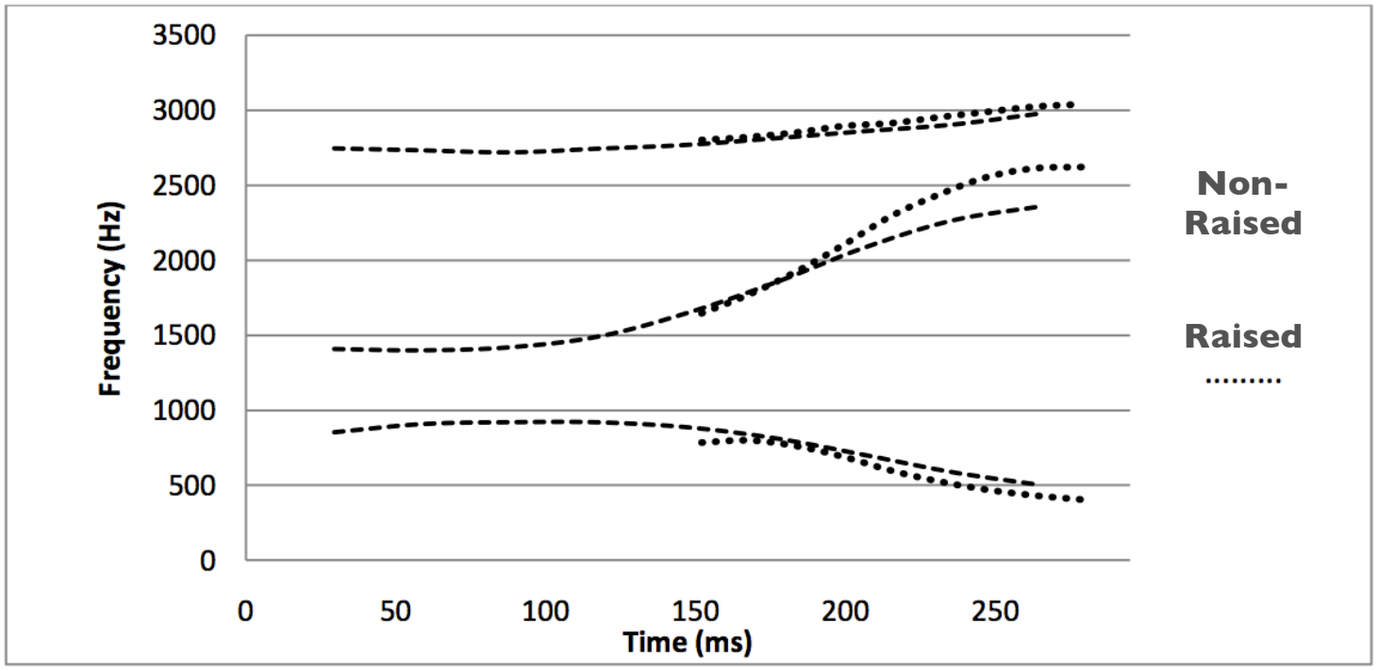


Raised



Comparison of CR Allophones

Notable Characteristics of CR



- **Raising** (lowering of F1) is slight, and evenly distributed *throughout* the "raised" allophone's articulation rather than occurring at the nucleus
- **Fronting** (raising of F2) appears to be significant; F2 ends higher in the raised allophone, and the difference steadily *increases* over time (Hagiwara 2006 previously noted fronting of /aj/)
- **Shortening** of the raised allophone — more significant difference between allophones than either raising or fronting
- **Steady-state phase which** comprises half of the *non-raised* allophone, almost entirely absent in *raised* allophone

Describing CR

- Proposal: the phonetic differences between raised and non-raised allophones of /ai/ (in Manitoba) may be described as primarily differences of **duration** and articulatory **timing** rather articulatory **position**
- Question: if this is accurate, how to provide a principled phonological account for CR?

2. Phonetic timing, prosodic structure, voicing and sonority

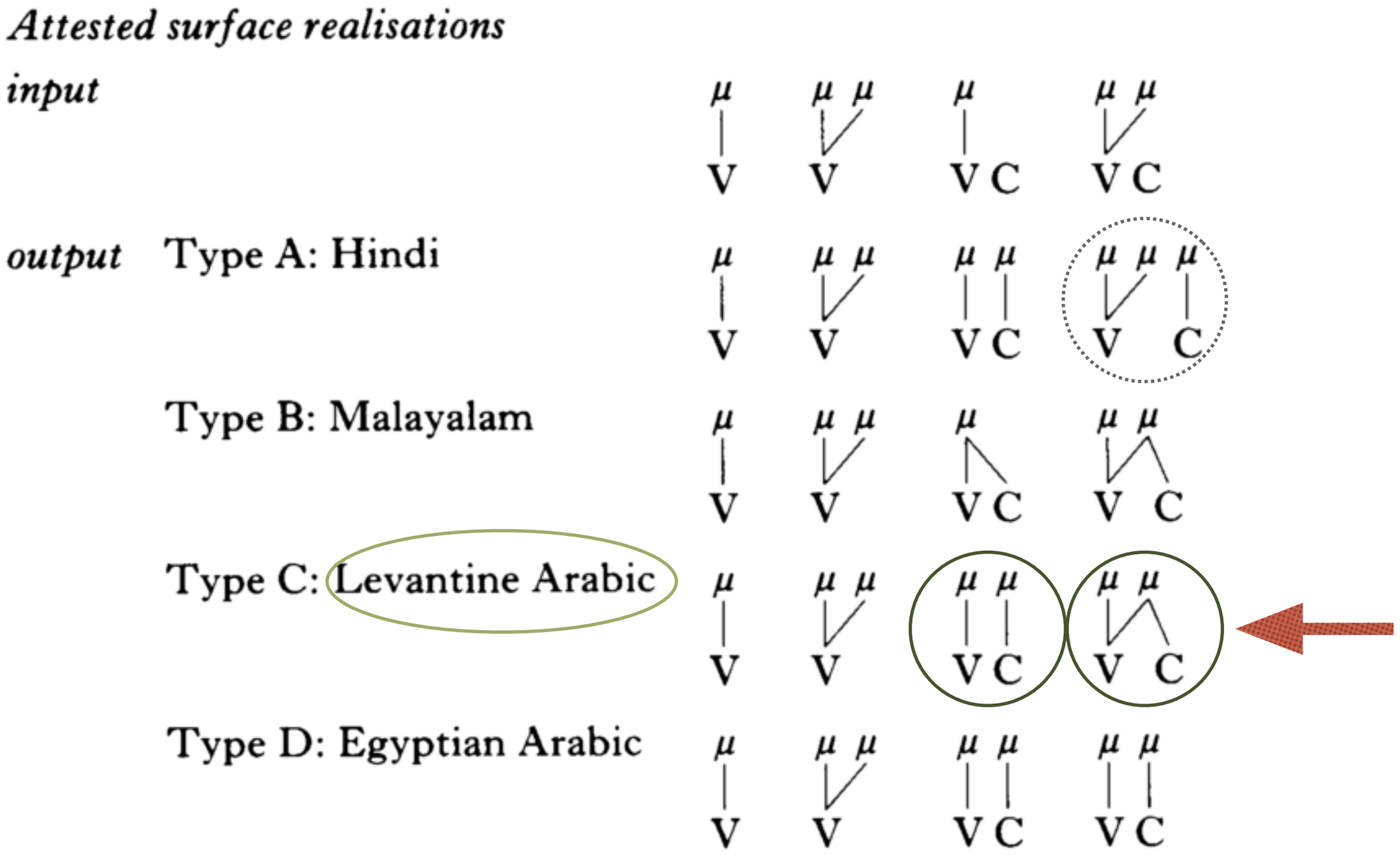
Prosodic Structure and Duration

- Broselow et al (1999) identified the relationship between phonetic segmental duration and moraic affiliation
- Vowels with *independent* morae are longer than vowels with *shared* mora; languages may use both types in different contexts, such as Levantine/Jordanian Arabic:
  - codas after short V bear own mora
  - codas after long V adjoin to V's mora to maintain bimoraicity

long V	**long V + coda**	**short V ± coda**
two morae	**two morae (one shared)**	**one mora**

longer <——————————vowel duration——————————> shorter

Typologies of Vowel-Mora Affiliation



Broselow et al (1999)

Moraic Structure of English Syllable

- Hammond (1999) outlines some constraints on English moraic structure:

1. **BIMORAICITY**: All syllables must be bimoraic
2. **TRIMORAIC MAXIMUM (3μ)**: Syllables may contain no more than three morae
    - 3μ is only relevant with respect to /aw/ which is assigned three morae under Hammond's scheme, while /aj/ only bears two; as my current data do not include /aw/ I can only speculate on how 3μ may interact with my proposed analysis, but I am gathering more data currently

- My proposal follows Hammond's constraints within his model of English phonology, but I am not necessarily committed to an OT approach as the most appropriate

Sonority and Moraic Structure

- Zec (1995) on sonority constraints on syllable structure:

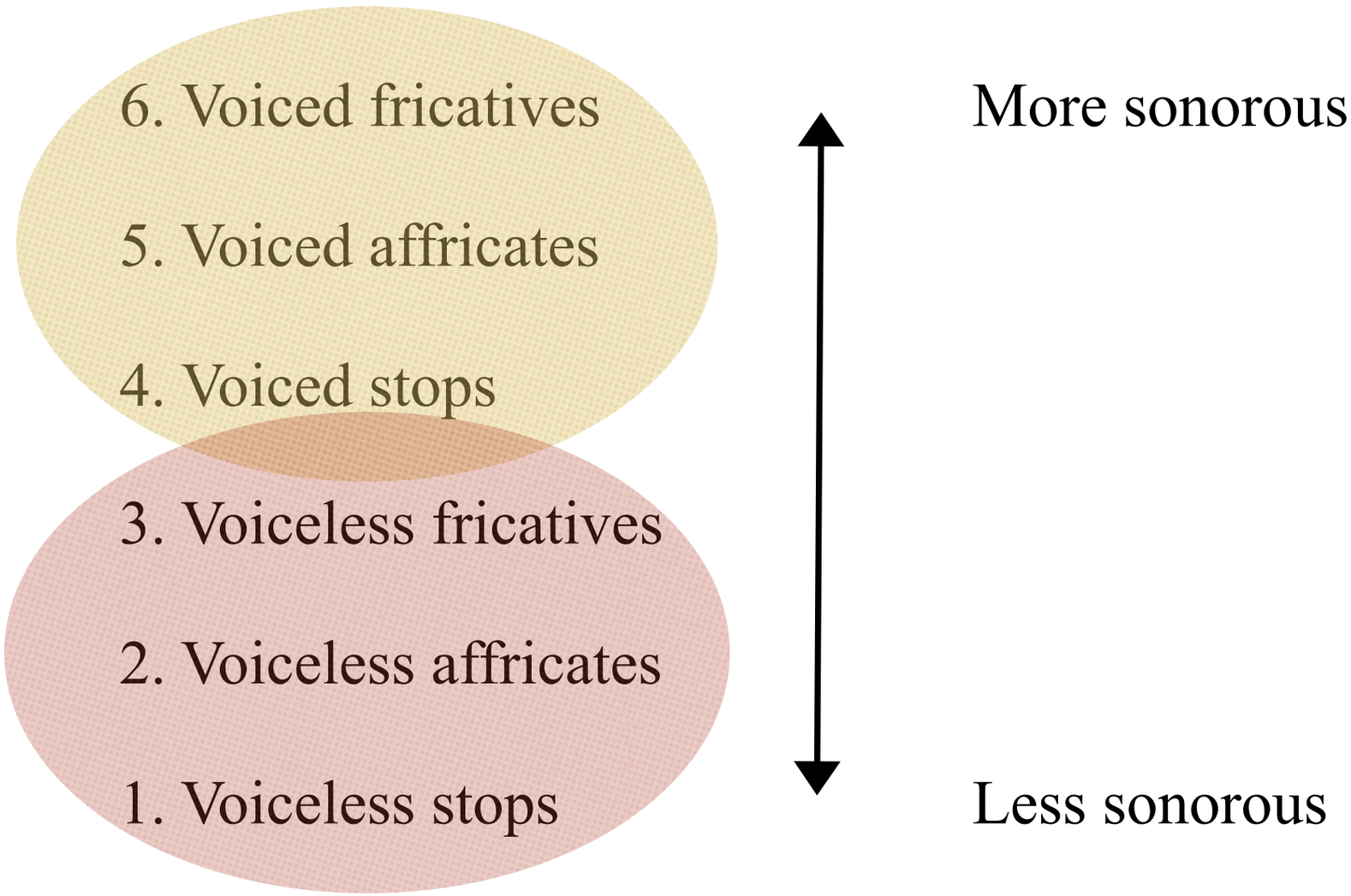
  "the segment projecting a mora is constrained with respect to minimal sonority, determined on a language-specific basis and expressed in terms of a sonority class"

- Parker (2008): "the propensity for a coda consonant to project a mora is correlated with how sonorous it is"

Sonority and Voice

- Voicing is a common characteristic of highly sonorous sounds: e.g. vowels, glides, liquids, nasals
- Voicing distinctions typically occur in obstruents, which are of low sonority as a class
- Parker (2008): cross-linguistic study showing that **obstruent voicing** is utilized by languages to define a sonority distinction; e.g. Koine Greek permits voiced consonant clusters, but not voiceless clusters

Obstruent Sonority



(from a 17-level scale)

Parker (2008)

English: Vowel Duration and Coda Voicing

- Peterson & Lehiste (1960): "In general, the syllable nucleus is shorter when followed by a voiceless consonant, and longer when followed by a voiced consonant."
- House (1961): coda consonant voicing strongly correlated with vowel duration in English
- Umeda (1975): vowel duration varies by coda consonant:

Voiceless obstruents [cf. Parker 2006]

V'less stop < V'less fric. < nasal < V'd stop < noCoda < V'd fric.

shortest ⟷ longest

vowel duration

Umeda (1975)

3. A prosodic account of Canadian Raising

Sonority, Prosody & Canadian Raising

1. obstruent voicing is an available sonority distinction cross-linguistically (Parker)
2. the syllable in English adheres to a defined set of constraints on moraic quantity (Hammond)
3. sonority distinctions are a determining factor in mora affiliation (Zec, Parker)
4. different prosodic/moraic structures are associated with variations in phonetic vowel duration (Broselow et al)

Sonority, Prosody & Canadian Raising

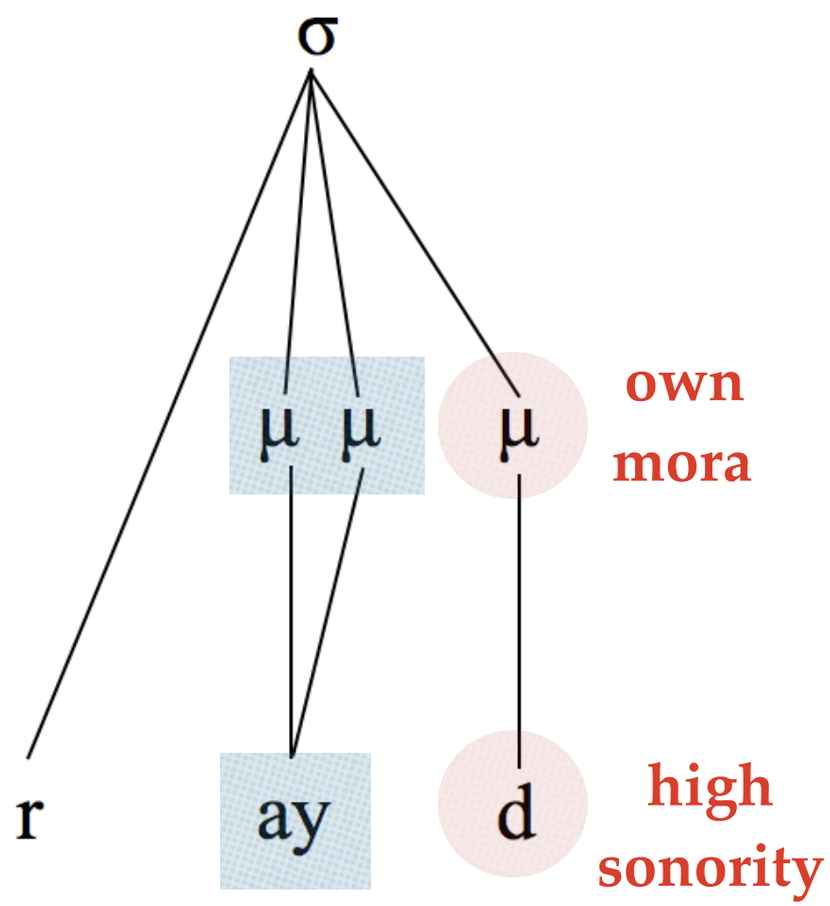
5. CR "raised" allophones occur before a tautosyllabic voiceless coda consonant (Joos, Chambers)

6. CR "raised" allophones may be characterized by the brevity of their duration and details of articulatory trajectory, rather than merely articulatory height (Onosson)

7. CR may be explained as the result of codas in Canadian English differing in their ability to project an independent mora, based on their degree of sonority — a proposed constraint will restrict mora projection based on a minimum level of sonority

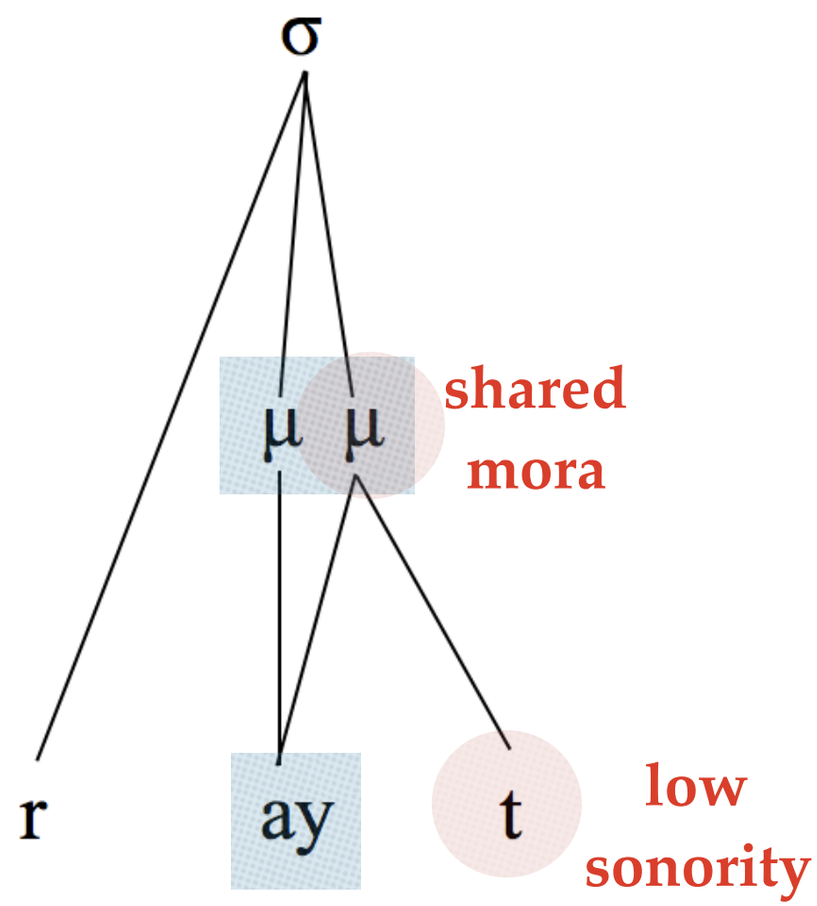
Proposed Moraic Structure of [ay]

ride



2 independent vowel morae: longer vowel duration

right



1 independent, 1 shared mora: shorter vowel duration

Minimum Sonority Constraint

- **SONOROUSMORA(X)** — a mora must be projected by a segment which is sufficiently sonorous, defined as being of equal or greater sonority than class X, and may not be projected by a segment of lower sonority, where X is a well-defined sonority class within a scale such as Parker's (2008)
- This constraint covers two potential violations simultaneously:
  - a. low-sonority segments which project a mora
  - b. high-sonority segments which fail to project a mora
- For CR, the relevant class determining the minimum level of sonority is the class of voiced obstruents, so the constraint in this case is worded as: **SONOROUSMORA(VDOBS)**

Comparison of CR Allophones

/r a j t/	SonorousMora (VdObs)
μ μ μ \ | | r aj t	*!
☞ μ μ \ /\ r aj t	

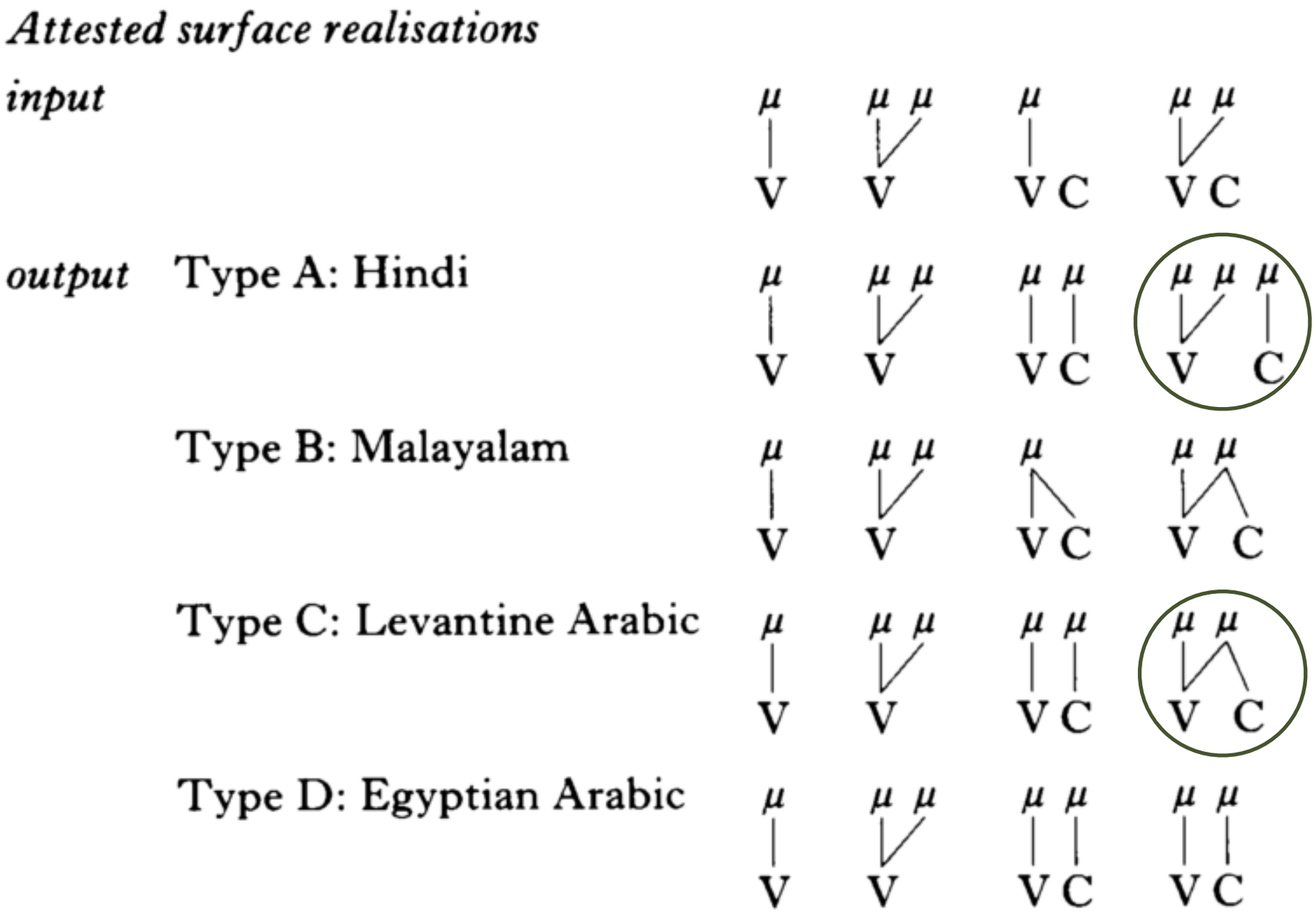
/r a j d/	SonorousMora (VdObs)
☞ μ μ μ \ | | r aj d	
μ μ \ /\ r aj d	*!

Comparison of CR Allophones

/r a j t/	SonorousMora (VdObs)
	*!
☞ 	

/r a j d/	SonorousMora (VdObs)
☞ 	
	*!

Prosodic Structure and Duration

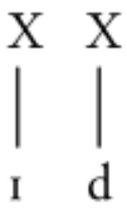


Prosodic Structure and Duration

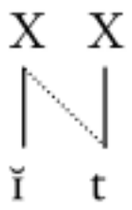
§36 *If prefortis clipping is categorical, how is it represented in the phonology?*

A simple proposal: skeletal attachments iconically reflect durational trade-offs.

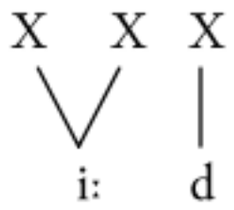
short unclipped V



short clipped V



long unclipped V



long clipped V

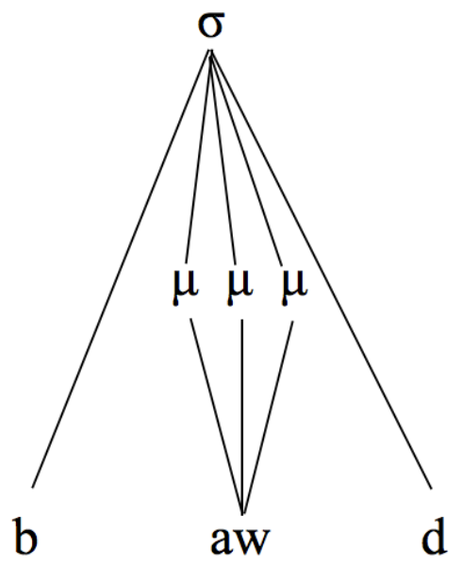
Bermúdez-Otero, R. (2014)

Unresolved issues, future research

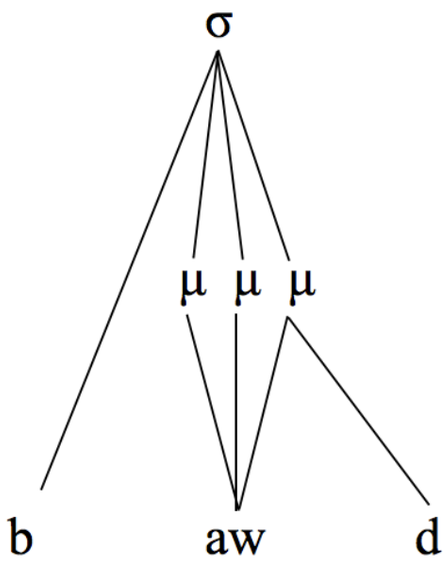
What is the structure of /aw/?

1. *Appendix:*
   - inconsistent with /ay/
2. *Mora-sharing:*
   - voiced & voiceless non-distinct structurally
3. *Additional mora (4 morae):*
   - violates Hammond's trimoraic maximum

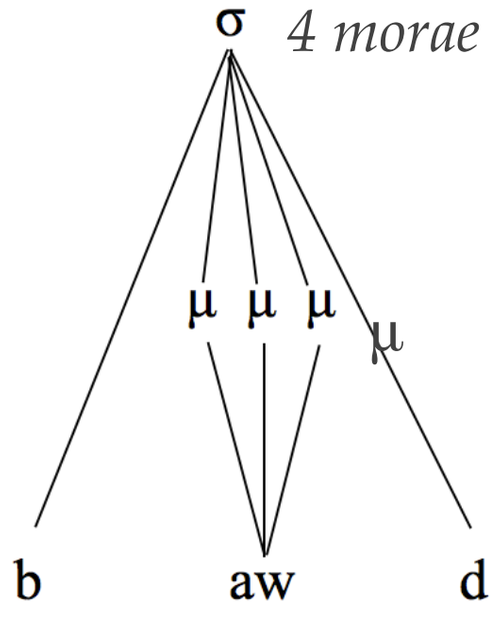
bowed (appendix)



bowed (mora sharing)



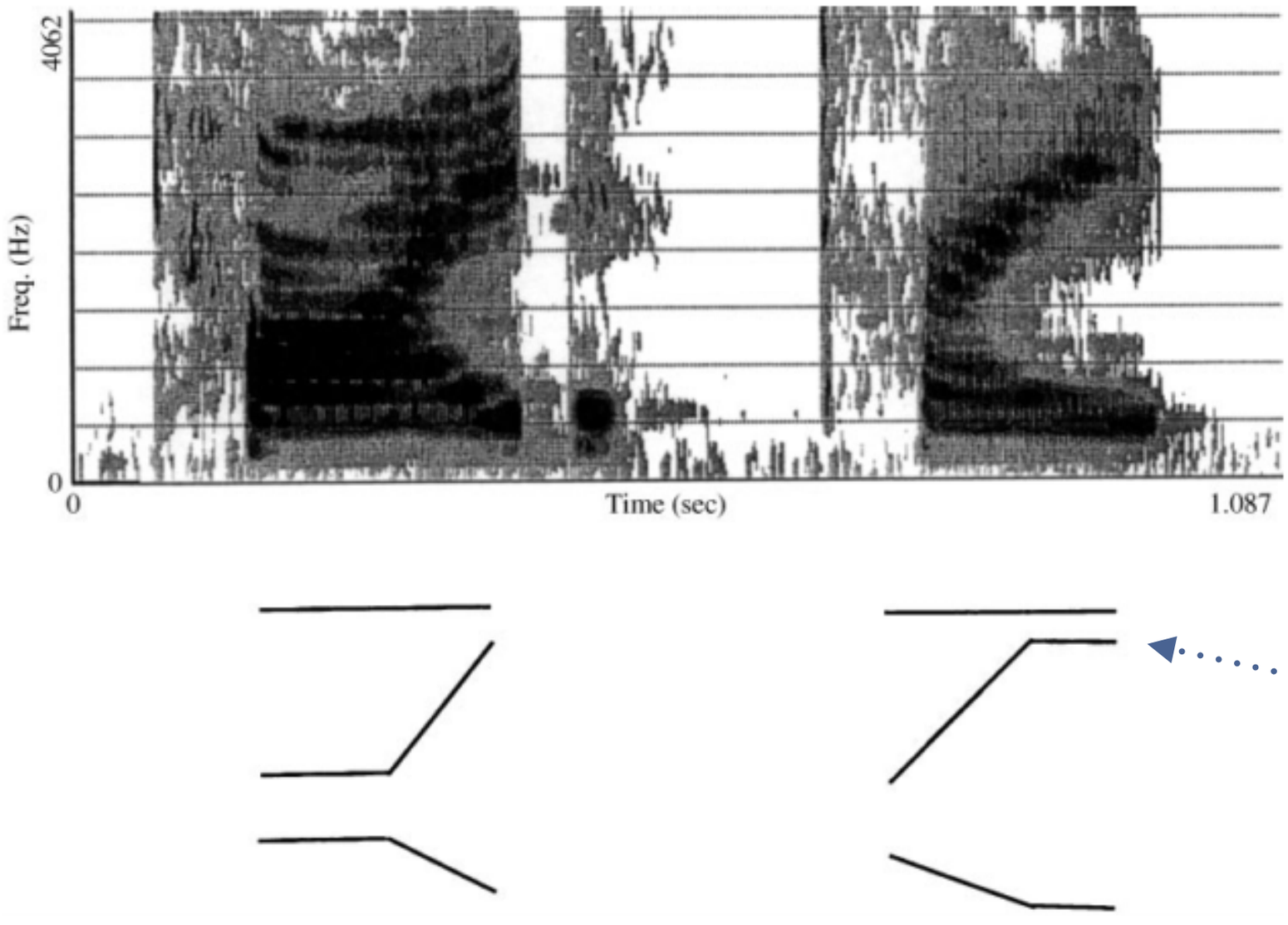
4 morae



Differences from non-CR dialects

- Presumably, dialects without CR do exhibit length distinctions in the same context (coda voicing)
- If CR is primarily characterized by vowel duration, how is it differentiated from other dialects which make the same length distinctions, but which do not have CR?
- The timing of articulatory components may vary, possibly including:
  - presence/absence of steady state phase
  - duration of transition phase from nucleus to offglide
  - relative durations of pre-voiced vs. pre-voiceless allophones

/aj/ in a non-CR dialect



Offglide steady-state?

Figure 2. Spectrogram of *tide ... tight* uttered by a female speaker from Johnstown, with a schematic diagram of the first three formants.

Thomas (2000)

Future Research

- Data collection is currently underway in Winnipeg gathering recordings, including all the three diphthongs /aj, aw, oj/ in a large variety of onset and coda contexts

- I do not take it for granted that both CR diphthongs necessarily participate in similar patterns

- **"The term Canadian Raising" seems appropriate only as a dialectological term for the coexistence of the two very similar allophonic reflexes in the same accent and less appropriate as a theoretical phonological term for a single process that affects two different nuclei**" — Chambers (1989)

References

- Bermúdez-Otero, R. (2014). *Personal communication*.
- Broselow, E., Chen, S.-I., & Huffman, M. (1997). Syllable Weight: Convergence of Phonology and Phonetics. *Phonology*, 14(1), 47–82.
- Chambers, J. K. (1973). Canadian raising. *Canadian Journal of Linguistics*, 18(2), 113-134.
- Chambers, J. K. (1989). Canadian Raising: Blocking, fronting, etc. *American Speech*, 64(1), 75–88.
- Chambers, J. K. (2006). Canadian Raising Retrospect and Prospect. *Canadian Journal of Linguistics*, 51(2), 105–118.
- Czaykowska-Higgins, E., Dobrovolsky, M., Dyck, C., O'Grady, W., & Rose, Y. (2012). Phonology: contrasts and patterns. In O'Grady, W. & Archibald, J. *Contemporary Linguistic Analysis: An Introduction*. Toronto: Pearson.
- Hagiwara, R. E. (2006). Vowel Production in Winnipeg. *Canadian Journal of Linguistics*, 51(2), 127–141.
- Hammond, M. (1999). The Phonology of English: A Prosodic Optimality-Theoretic Approach. *Oxford U. Press*.
- House, A. S. (1961). On Vowel Duration in English. *JASA*, 33(9), 1174–1178.
- Joos, M. (1942). A phonological dilemma in Canadian English. *Language* 18, 141-144.
- Onosson, D. S. (2010). *Canadian Raising In Manitoba: Acoustic Effects Of Articulatory Phasing And Lexical Frequency*. MA thesis. University of Manitoba.
- Parker, S. (2008). Sound level protrusions as physical correlates of sonority. *Journal of Phonetics*, 36(1), 55–90.
- Thomas, E. R. (2000). Spectral differences in /ai/ offsets conditioned by voicing of the following consonant. *Journal of Phonetics*, 28, 1–25.
- Umeda, N. (1975). Vowel duration in American English. *JASA*, 58(2), 434–445.
- Zec, D. (1995). Sonority constraints on syllable structure. *Phonology*, 12(1), 85–129.