Codas are Universally Moraic

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1 Introduction

- **Goal**: Outline a theory of syllable weight that accounts for typological weight variation.
  - Codas are universally moraic.
  - Moras are encoded with the sonority of the segment they dominate.
- **Syllable weight**: A property used to differentiate syllables as heavy or light with respect to their behavior for a given process.
  - Weight-sensitive stress: Heavy syllables attract stress, but light syllables do not.
  - Weight-sensitive tone: Heavy syllables can host a contour tone, but light syllables can't.
- Two important types of variation any theory of syllable weight must address:
  1. **Cross-linguistic weight variation for a single weight-sensitive process.**

     (1) Common weight-sensitive stress criteria
     a. {CVː} > {**CVC**, CV} (e.g., Lhasa Tibetan)
     b. {CVː, **CVC**} > {CV} (e.g., Yana)

  2. **Within-language weight variation across weight-sensitive processes.**

     (2) Mismatching Weight Criteria in Lhasa Tibetan (Dawson, 1980)
     a. Tibetan Stress Criterion: {CVː} > {**CVR**, CVO, CV}[1]
        i. initial stress
           [ˈlap.ʈa] "school" [ˈwo.ma] "milk" [ˈɲu.qu] "pen"
        ii. leftmost heavy
           [am.ˈtɔː] "person from Amdo" [ˈqeː.laː] "teacher"
           [lap.ˈʈeː] "of the school" [kʰa.ˈpaː] "telephone"

     b. Tibetan Tonal Criterion: {CVː, **CVR**} > {CVO, CV}
        [qʰâm] "Kham" [mâː] "war" [kâː] "to be stuck"
        [ʈɔ̀k.pá] "nomad" [kúk.pə́] "dumb" [ɲíɲ.pə́] "old"

[1] CVː stands for both long vowels and diphthongs. R represents sonorant codas, and O represents obstruent codas.

Roadmap

Section 2: The standard approach to weight cannot account for both types of variation

Section 3: Within-language weight variation necessitates universal coda moraicity

Section 4: A syllable weight metric relying on enriched moraic encoding

Section 5: The Moraic Sonority Metric and weight-sensitive stress

Section 6: Discussion

Section 7: Conclusion and Future Directions

2 Background

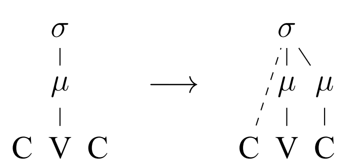
2.1 The "Variable Weight" approach to syllable weight

- Weight distinctions are based purely on mora count (Hayes, 1989; Hyman, 1985; Zec, 2007).
- The **moraicity of codas is language-specific** and depends on constraint interaction between WxP and $*\mu_C$ in (3):

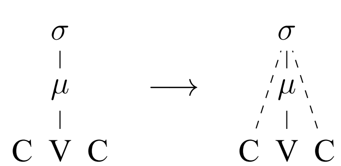
(3) Variable Weight Constraints
   a. Weight by Position (WxP) (Hayes, 1989; Sherer, 1994)
      Assign a violation for every nonmoraic coda.
   b. $*\mu_C$ (Morén, 1999)
      Assign a violation for every moraic coda.

- Variation in weight-sensitive stress criteria like (1) arise from variations in the ranking of the constraints in (3):

(4) WxP > $*\mu_C$
   Yana-like languages {CV:, **CVC**} > {CV}



(5) $*\mu_C$ > WxP
   Tibetan-like languages {CV:} > {**CVC**, CV}



2.2 Issues with the Variable Weight approach

- When a language possesses other weight-sensitive processes in addition to primary stress, there are often **weight mismatches** between these processes (Gordon, 2006; Ryan, 2019).

(6) Tibetan Primary stress and tone

i. Stress {CVː} > {**CVR**, CVO, CV}

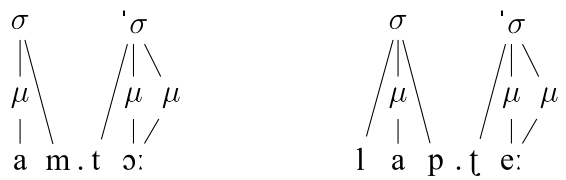
Initial stress (default)

[ˈlap.ʈa] "school" [ˈwo.ma] "milk" [ˈɲu.qu] "pen"

Leftmost heavy

[am.ˈtɔː] "person from Amdo" [ˈqeː.laː] "teacher"

[lap.ˈʈeː] "of the school" [kʰa.ˈpaː] "telephone"



ii. Tone {CVː, **CVR**} > {CVO, CV}

[qʰâm] "Kham" [mâː] "war" [kâː] "to be stuck"

[ʈɔ̀k.pá] "nomad" [kúk.pə́] "dumb" [ɲíɲ.pə́] "old"

- **Conclusion**: Within-language weight criteria mismatches do not allow for a moraic theory of syllable weight that relies on language-specific variation in coda moraicity.

3 Proposal: Universal Coda Moraicity

3.1 A theory of Uniform Moraic Quantity

(7) UNIFORM MORAIC QUANTITY (UMQ)

Coda consonants must link to their own mora.

(a) CVC bimoraic (b) Violates constraint on GEN

Question: Is the claim that codas are universally moraic justified empirically?

3.2 A cross-linguistic examination of coda moraicity

- 107 languages in a survey of weight-sensitive processes by Gordon (2006) both permit codas and exhibit weight-sensitive stress (stress, tone, minima, CL, metrics, σ templates).
- 102 of the 107 languages (95%) display coda moraicity for at least one process.

Stress

Other Processes	C_μ	C	Total
C_μ	36	32*	68
C	34	**5**	39
Total	70	37	107

*Gordon provides evidence of coda weight from other processes for 27 languages in this cell.
I found evidence for an additional 5 languages in the survey (see Appendix).

  - e.g., Cayuga (Hatcher, 2022, pp. 24–25): Codas block penultimate vowel lengthening.

/hẽ.naː.d**o**.was/	→	[hẽ.naː.d**o**ː.was]	"sky"
/de.wa.ga.da.w**ẽn**.yẽ/	→	[de.wa.ga.da.w**ẽn**.yẽ]	"I'm moving out"

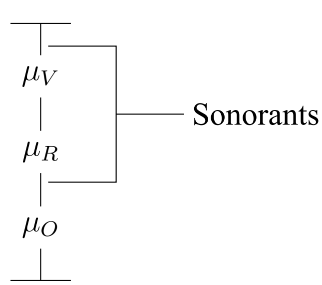
Conclusion: Our theory of weight should reflect that codas overwhelmingly exhibit moraicity.

Question: How do we account for syllable weight variation under the UMQ?

4 The Moraic Sonority Metric

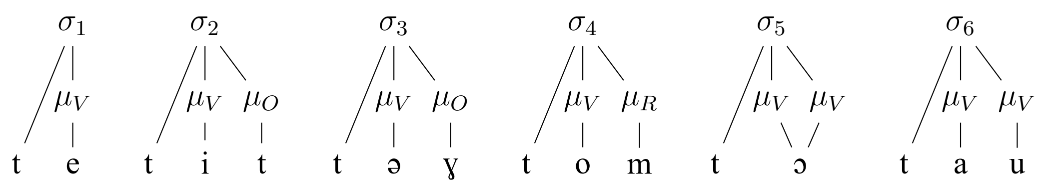
- Assumptions of the Moraic Sonority Metric
  - **Codas are universally moraic**.
  - Syllable **weight is process specific, not language specific** (Gordon, 2006).
  - **Moras are inherently encoded with sonority** of the segment they dominate.
  - Syllable weight is computed by **the number of moras of a specified sonority**
  - Syllable-weight criteria are built from **bifurcations on the sonority hierarchy** in (8).
    - ∗ Mora types above a bifurcation contribute to weight for that process, and mora types below a bifurcation are ignored for that process.

(8) The Moraic Sonority Hierarchy



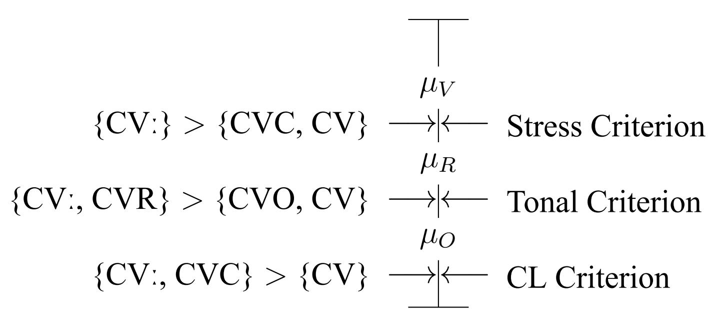
- Some weight-sensitive processes make a bifurcation below all sonority levels:
  - These processes **include every mora type** in weight computations.
  - Every bimoraic syllable regardless of sonority is heavy in (9): $\sigma_2 - \sigma_6$
- Other processes make a bifurcation above μ_O:
  - These processes **ignore obstruent moras** in weight computations.
  - Only syllables with two or more sonorant moras (μ_V or μ_R) are heavy: $\sigma_4 - \sigma_6$
- Other processes make a bifurcation above μ_R:
  - These processes **ignore all consonantal moras** (μ_R and μ_O) in weight computations.
  - Only syllables with two or more vocalic moras are heavy: $\sigma_5 - \sigma_6$
- A bifurcation above all sonority levels results in a quantity-insensitive process.

(9) Moraic structure explicitly annotated with sonority



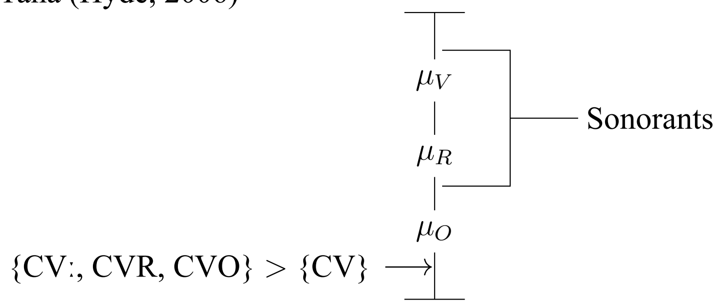
- Implications of the Moraic Sonority Metric:
  - Syllable weight distinctions are constrained by the number of levels on the Moraic Sonority Hierarchy.
  - Other segmental features such as voicing, manner of articulation, and place of articulation do not contribute to weight.
  - No weight distinctions based on vowel quality (Shih and de Lacy, 2019; a.o.).

(10) The Moraic Sonority Hierarchy and Lhasa Tibetan weight processes

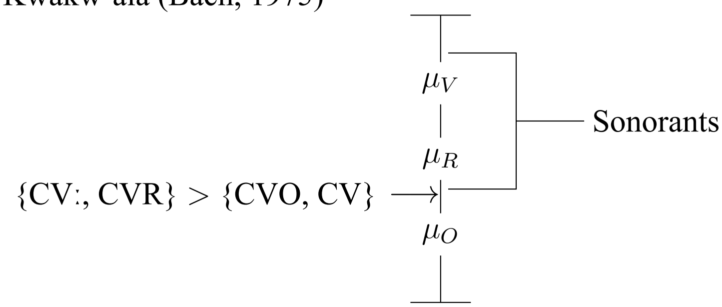


5 The Moraic Sonority Metric and weight-sensitive stress

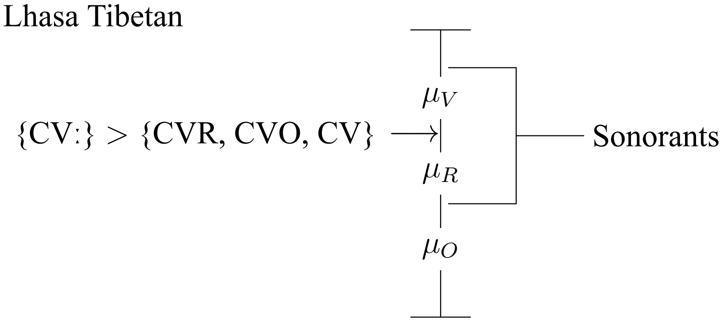
- For some languages, **every mora type on the hierarchy** contributes to syllable weight.
  - Yana (Hyde, 2006)



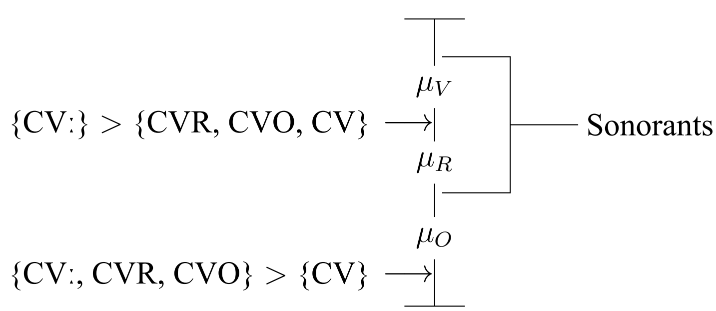
- For other languages, **only mora types that meet a specified sonority threshold** contribute.
  - Kwakw'ala (Bach, 1975)



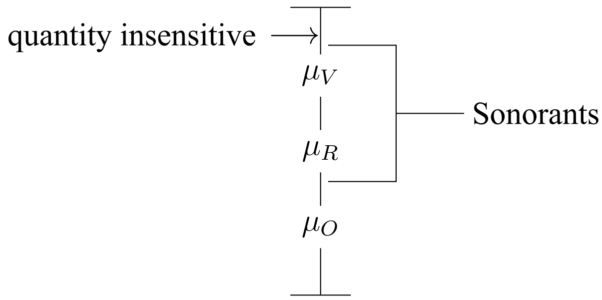
  - Lhasa Tibetan



- Languages with complex stress criteria use **multiple bifurcations in the sonority hierarchy**.
  - Mankiyali {CV:} > {CVR, CVO} > {CV} (Paramore, 2021)



- Languages with quantity-insensitive stress **ignore weight entirely**.
  - Finnish primary stress (Suomi and Ylitalo, 2004)



5.1 Typological predictions for weight-sensitive stress

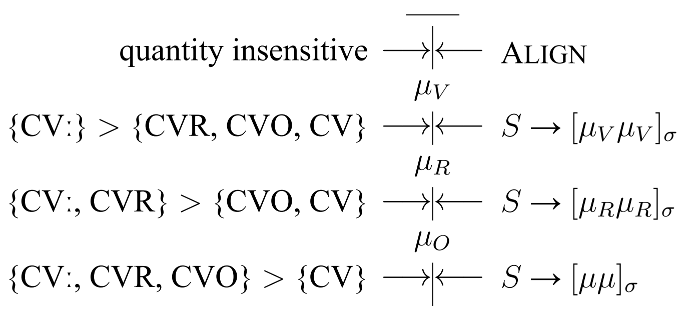
(11) Moraic Sonority Metric Stress Constraints

(i) $S \rightarrow [\mu\mu]_\sigma$ "$*Stressed - \mu$" (Ryan, 2019)
Assign a violation for every stressed syllable with less than two moras.

(ii) $S \rightarrow [\mu_R\mu_R]_\sigma$ "$*Stressed - \mu_R$"
Assign a violation for every stressed syllable with less than two sonorant moras.

(iii) $S \rightarrow [\mu_V\mu_V]_\sigma$ "$*Stressed - \mu_V$"
Assign a violation for every stressed syllable with less than two vocalic moras.

(12) Moraic Sonority Stress Constraints and the Moraic Sonority Hierarchy



- Moraic Sonority Stress Constraints are in a **stringency** relationship
  - Universal Weight Hierarchy: {CV:} > {CVR} > {CVO} > {CV}

	$S \rightarrow [\mu\mu]_\sigma$	$S \rightarrow [\mu_R\mu_R]_\sigma$	$S \rightarrow [\mu_V\mu_V]_\sigma$
a. ˈCV	*	*	*
b. ˈCVO		*	*
c. ˈCVR			*
d. ˈCV:			

5.2 OT analysis

- Primary Stress in Kwakwala: {CV:, CVR} $>$ {CVO, CV}
  Stress final σ or heavy σ if present.

(13) Primary stress placement in Kwakwala

a.	[nə.ˈpa]	'to throw a round thing'	c.	[ˈm'ən.sa]	'to measure'
b.	[maxʷ.ˈc'a]	'to be ashamed'	d.	[t'ə.ˈli:.dᶻu]	'fish-cutting board'

- CVO = CV

maxʷc'a	$S \rightarrow [\mu_R\mu_R]_\sigma$	ALIGN-R	$S \rightarrow [\mu\mu]_\sigma$
a. ☞ maxʷ$_\mu$.ˈc'a	$*$		$*$
b. ˈmaxʷ$_\mu$.c'a	$*$	$*$W	L

- CVR > CV

m'ənsa	$S \rightarrow [\mu_R\mu_R]_\sigma$	ALIGN-R	$S \rightarrow [\mu\mu]_\sigma$
a. ☞ ˈm'ən$_\mu$.sa		$*$	
b. m'ən$_\mu$.ˈsa	$*$W	L	$*$W

5.3 Factorial typology

(14) Languages predicted by the Moraic Sonority Constraints

	Ranking	**Stress Criterion**	**Attested?**
1	ALIGN » $[\mu\mu]_\sigma$, $[\mu_R\mu_R]_\sigma$, $[\mu_V\mu_V]_\sigma$	quantity insensitive	Finnish
2	$[\mu\mu]_\sigma$ » ALIGN » $[\mu_R\mu_R]_\sigma$, $[\mu_V\mu_V]_\sigma$	{CV:, CVR, CVO} > {CV}	Yana
3	$[\mu_R\mu_R]_\sigma$ » ALIGN » $[\mu\mu]_\sigma$, $[\mu_V\mu_V]_\sigma$	{CV:, CVR} > {CVO, CV}	Kwakwala
4	$[\mu_V\mu_V]_\sigma$ » ALIGN » $[\mu\mu]_\sigma$, $[\mu_R\mu_R]_\sigma$	{CV:} > {CVR, CVO, CV}	Lhasa Tibetan
5	$[\mu\mu]_\sigma$, $[\mu_V\mu_V]_\sigma$ » ALIGN » $[\mu_R\mu_R]_\sigma$	{CV:} > {CVR, CVO} > {CV}	Mankiyali
6	$[\mu\mu]_\sigma$, $[\mu_R\mu_R]_\sigma$ » ALIGN » $[\mu_V\mu_V]_\sigma$	{CV:, CVR} > {**CVO**} > {CV}	-
7	$[\mu_V\mu_V]_\sigma$, $[\mu_R\mu_R]_\sigma$ » ALIGN » $[\mu\mu]_\sigma$	{CV:} > {**CVR**} > {CVO, CV}	-
8	$[\mu_V\mu_V]_\sigma$, $[\mu_R\mu_R]_\sigma$, $[\mu\mu]_\sigma$ » ALIGN	{CV:} > {**CVR**} > {**CVO**} > {CV}	-

- The three unattested languages in the typology use a combination of two uncommon criteria
  - Complex stress criteria (suprabinary distinctions) are relatively rare. Only 15 of 107 languages from Gordon's (2006) survey of weight-sensitive stress systems exhibit complex scales.
  - Languages that distinguish CVR from CVO are extremely rare. Only 3 of 107 languages from Gordon's (2006) survey exhibit this distinction.

6 Discussion

6.1 How are geminates distinguished from singletons under the UMQ?

- **Singletons and geminates are often treated equivalently** by weight-sensitive processes.
  - CVG is light for stress in 94% of languages when CV: > CVC (Ryan, 2019, p. 64).

(15) Both CVG and CVC are light in Selkup (Halle and Clements, 1983)
Stress initial σ or righmost CV: if present

a. ˈ**qu**.mɨ.mɨk “human being (DAT)”
b. ˈ**a**.mɨr.na “eats”
c. ˈ**ɛ**.syk.ka “(it) happens (occasionally)”
d. qu.ˈ**mo**ː.qi “two human beings”

  - CVG is heavy for stress in most languages when CV: = CVC (Davis, 2011, p. 16).

(16) Both CVG and CVC are heavy in Latin (Allen, 1973)
Stress antepenult σ or penult if heavy

a. ˈ**me**.ru.la “blackbird”
b. pe.ˈ**per**.kiː “to refrain from”
c. me.ˈ**dul**.la “marrow, kernel”
d. i.ni.ˈ**mi**ː.kus “marrow, kernel”

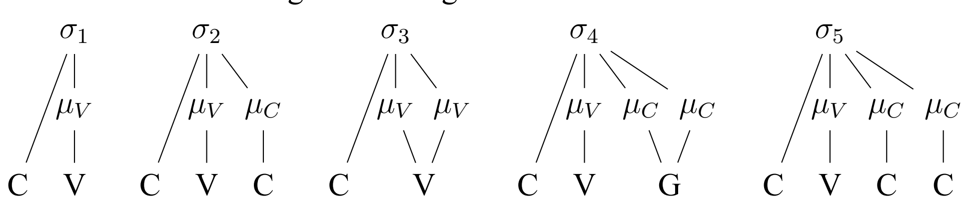
- There are also many cases in which **CVG is treated as heavier than CVC**.

(17) CVG > CVC in Cairene Arabic (Topintzi and Davis, 2017, pp. 263–265)
Stress word-final CVG or CVCC but not CVC

a. ka.ˈ**tabt** “I wrote”
b. ʔa.ˈ**xaff** “lightest”
c. ˈ**ka**.tab “he wrote”

Proposal: **Geminates are bimoraic**

(18) Moraic structure of singletons and geminates



  - When CVC and CVG are light in (15): $S \to [\mu_V \mu_V]_\sigma$ is responsible.
  - When CVC and CVG are heavy in (16): $S \to [\mu\mu]_\sigma$ is responsible.
  - When CVG and CVCC are heavier than CVC in (17): $S \to [\mu\mu\mu]_\sigma$ is responsible.

6.2 The Moraic Sonority Metric and weight-sensitive tone

(19) Moraic Sonority Metric Tone Constraints

a. $NoContour - \mu$ (Ito and Mester, 2019)
Assign a violation for every contour tone linking to a syllable with less than two moras.

b. $NoContour - \mu_R$
Assign a violation for every contour tone linking to a syllable with less than two sonorant moras.

c. $NoContour - \mu_V$
Assign a violation for every contour tone linking to a syllable with less than two vocalic moras.

d. $NoContour - \sigma$ (Ito and Mester, 2019)
Assign a violation for every contour tone linking to a syllable.

(20) The Moraic Sonority Hierarchy and Tone Constraints

Contour Tones Prohibited	$\longrightarrow\mid\longleftarrow$	$NoContour - \sigma$
	μ_V	
{CV:} > {CVC, CV}	$\longrightarrow\mid\longleftarrow$	$NoContour - \mu_V$ (46%)
	μ_R	
{CV:, CVR} > {CVO, CV}	$\longrightarrow\mid\longleftarrow$	$NoContour - \mu_R$ (49%)
	μ_O	
{CV:, CVC} > {CV}	$\longrightarrow\mid\longleftarrow$	$NoContour - \mu$ (5%)

- The Moraic Sonority constraints for tone in (19a-c) account for about 99% of languages with weight-sensitive tone in Gordon's (2006) survey of weight sensitive processes.
- It may be challenging to explain the tonal criterion of Cantonese (Gordon, 2006, pp. 93–95), which allows CV and CVR syllables to host a contour tone, but not CVO or CV:O.

6.3 The Moraic Sonority Metric and word minimality

(21) Word minimality Moraic Sonority Constraints

i. $FTBIN(\mu)$
Assign a violation for every foot without two moras.

ii. $FTBIN(\mu_R)$
Assign a violation for every foot without two sonorant moras.

iii. $FTBIN(\mu_V)$
Assign a violation for every foot without two vocalic moras.

iv. $FTBIN(\sigma)$ (Prince and Smolensky, 1993/2004; among many others)
Assign a violation for every foot without two syllables.

(22) The Moraic Sonority Hierarchy and Word Minimality

Disyllabic Minimum	$\longrightarrow\vert\longleftarrow$	$FTBIN(\sigma)$ (17%)
	μ_V	
{CV:} $>$ {CVC, CV}	$\longrightarrow\vert\longleftarrow$	$FTBIN(\mu_V)$ (15%)
	μ_R	
{CV:, CVR} $>$ {CVO, CV}	$\longrightarrow\vert\longleftarrow$	$FTBIN(\mu_R)$ (3%?)
	μ_O	
{CV:, CVC} $>$ {CV}	$\longrightarrow\vert\longleftarrow$	$FTBIN(\mu)$ (63%)

- The Moraic Sonority $FTBIN$ constraints in (21) account for about 98% of languages in Gordon's survey that have codas and implement a minimal word restriction.
- It is unclear if $FTBIN(\mu_R)$ is used by any of the languages in the survey.
  - Four of the languages in the survey (3%) potentially impose this constraint, but these languages also prohibit obstruent codas altogether.
- The remaining 2% of languages establish a minimum that requires words to contain at least three moras of various sonorities.
  - Blumenfeld (2011) notes that almost all cases of minimality not neatly explained by binarity fall out from other components of the grammar in these languages.
  - e.g., Menominee (Milligan, 2005) has a CV:C minimum caused by closed-syllable vowel lengthening.

7 Conclusion

- **Summary**
  - Proposed a theory of Uniform Moraic Quantity (UMQ): codas are universally moraic.
  - Introduced the Moraic Sonority Metric to account for cross-linguistic and within-language syllable weight variation.
    - Variation captured via enriched moraic encoding that varies uniformly across syllable types.
- **Future research and outstanding issues**
  - Test predictions of the proposal for all weight-sensitive processes to see if claims are substantiated.
  - Comprehensive exploration into the implications of proposing bimoraic geminates.
  - What does the UMQ say about the existence of non-moraic schwas?
  - Other weight senstive phenomena worth exploring: NC clusters in Bantu (Hyman, 1992), reduplication, syllable template restrictions, meter, onset/coda inventory asymmetries, and compensatory lengthening.

8 Appendix: additional languages exhibiting coda moraicity

- Cherokee (Uchihara, 2013, pp. 131–137): Codas instantiate vowel shortening.

/gin**i**ː-naːdi/	→	[ki.n**i**ː.naː.ti]	"for you and I to set it (FLEXIBLE) down"
/gin**i**ː-hdi/	→	[ki.n**ih**.ti]	"for you and I to set it (COMPACT) down"

- Malecite (LeSourd, 1993, p. 41): Codas (except h) block lengthening of stressed syllables.

/**nwí**.sə.**kè**.ləm/	→	[**nwí**ː.sə.**gè**ː.ləm]	"I laughed hard"
/**éh**.pit/	→	[ˈ**e**ː**h**.pit]	"woman"
/n**í**h.ka.n**ʌ́t**.pat/	→	[n**í**ː.h.ka.n**ʌ́t**.pat]	"head (of an organization)"

- Malto (Mahapatra, 1979, p. 55): CVC minimal content word restriction.

[nin]	"you"	[toq]	"to finish"
[a]	"that"	[je]	"that"

- Tidore (Pikkert and Pikkert, 1995): CVC minimal word restriction.

[jcam]	"to question"	[gam]	"village"
[dun]	"daughter-in-law"	[xad]	"week"
*[CV]			

References

Allen, W. S. (1973). *Accent and rhythm*. Cambridge: Cambridge University Press.

Bach, E. (1975). Long vowels and stress in Kwakiutl. *Texas Linguistic Forum*, *2*, 9–19.

Blumenfeld, L. (2011). Coercion and minimality. *The Linguistic Review*, *28*(2), 207–240.

Davis, S. (2011). Geminates. In M. van Oostendorp, C. J. Ewen, E. V. Hume, & K. Rice (Eds.), *The Blackwell Companion to Phonology*. Wiley-Blackwell.

Dawson, W. (1980). *Tibetan phonology* (Doctoral dissertation). University of Washington.

Gordon, M. (2006). *Syllable weight: Phonetics, phonology, typology*. New York: Routledge.

Halle, M., & Clements, G. N. (1983). *Problem book in phonology*. Cambridge, MA: MIT Press.

Hatcher, R. J. (2022). *The phonetics and phonology of Cayuga prosody* (Doctoral dissertation). State University of New York at Buffalo.

Hayes, B. (1989). Compensatory lengthening in moraic phonology. *Linguistic Inquiry*, *20*, 253–306.

Hyde, B. (2006). Towards a uniform account of prominence-sensitive stress. In E. Bakovic, J. Ito, & J. McCarthy (Eds.), *Wondering at the natural fecundity of things: Essays in honor of Alan Prince*. UCSC Linguistics Research Center.

Hyman, L. (1985). *A theory of phonological weight*. Dordrecht: Foris.

Hyman, L. (1992). Moraic mismatches in Bantu. *Phonology*, *9*, 255–265.

Ito, J., & Mester, A. (2019). Pitch accent and tonal alignment in Kagoshima Japanese. *The Linguistic Review*, *36*(1), 1–24.

LeSourd, P. (1993). *Accent and syllable structure in Passamaquoddy*. New York: Garland.

Mahapatra, B. P. (1979). *Malto: An ethnosemantic study*. Central Institute of Indian Languages.

Milligan, M. (2005). *Menominee prosodic structure* (Doctoral dissertation). U. of Wisconsin.

Morén, B. T. (1999). *Distinctiveness, Coercion, and sonority* (Doctoral dissertation). University of Maryland, College Park.

Paramore, J. C. (2021). *Mankiyali phonology: Description and analysis* (Master's thesis). University of North Texas. https://digital.library.unt.edu.

Pikkert, J., & Pikkert, C. (1995). A first look at Tidore phonology. In W. Laiding (Ed.), *Descriptive studies in languages of Maluku* (pp. 43–70). Jakarta: Badan Penyelenggar Seri Nusa, Universitas Katolik Indonesia Atma Java.

Prince, A., & Smolensky, P. (1993/2004). *Optimality Theory: Constraint interaction in Generative grammar*. Malden, Mass: Blackwell Publishers.

Ryan, K. M. (2019). *Prosodic weight: Categories and continua* (Vol. 3). Oxford University Press.

Sherer, T. D. (1994). *Prosodic phonotactics* (Doctoral dissertation). University of Massachusetts, Amherst.

Shih, S.-h., & de Lacy, P. (2019). Evidence for sonority-driven stress. *Catalan Journal of Linguistics*, *18*.

Suomi, K., & Ylitalo, R. (2004). On durational correlates of word stress in Finnish. *Journal of Phonetics*, *32*(1), 35–63.

Topintzi, N., & Davis, S. (2017). On the weight of edge geminates. In H. Kubozono (Ed.), *The phonetics and phonology of geminate consonants* (pp. 260–282). Oxford University Press.

Uchihara, H. (2013). *Tone and accent in Oklahoma Cherokee*. Oxford University Press.

Zec, D. (2007). The syllable. In P. de Lacy (Ed.), *The Cambridge Handbook of Phonology* (pp. 161–198). Cambridge: Cambridge University Press.