Phonology (2025), **Vol. 42**:e1 1–36
doi:10.1017/S0952675724000204

PHONOLOGY

ARTICLE

Codas are universally moraic

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Received: 23 May 2023; **Revised:** 13 September 2023; **Accepted:** 7 October 2023

Keywords: syllable weight; moraic theory; stress; moraic sonority; sonority

Abstract
Mismatches in weight criteria across weight-sensitive processes within individual languages present difficulties for theories of moraic structure, particularly regarding coda weight. Previous accounts, which stipulate that codas are variably moraic to account for the typological variation in the weight status of CVC for primary stress, make incorrect predictions for the status of CVC in other weight-sensitive phenomena, including tone, word minimality and secondary stress, among others. This article proposes a theory of Uniform Moraic Quantity coupled with a new syllable weight metric as a solution, which captures CVC's flexible weight status while maintaining the cross-linguistic moraicity of codas and avoiding the incorrect predictions that frustrate the standard variable-weight approach.

Contents

https://doi.org/10.1017/S0952675724000204 Published online by Cambridge University Press

1. Introduction

A fundamental notion underlying weight-sensitive processes involves the differentiation between heavy and light syllables. For example, about 40% to 45% of the world's languages refer to syllable weight in determining stress placement (Gordon 2006; Goedemans & van der Hulst 2013), and in these languages heavy syllables attract stress from light syllables that occur in a default position. The prevailing theory relied upon to account for this phenomenon assumes that overall mora count drives syllable weight determinations. In other words, in the most basic sense, languages treat syllables with more moras as heavier than syllables with fewer moras.[1] Heavy syllables for weight-sensitive stress, then, by nature of their moraic quantity, attract stress from light syllables. Nevertheless, a picture of weight sensitivity in which moraic quantity acts as the sole arbiter of syllable weight distinctions does not seem to capture the empirical realities that the typology of weight-sensitive systems presents. This is evinced by the fact that syllable weight is not uniform cross-linguistically for stress. Some languages, for instance, analyse all syllables containing a long vowel as heavy for stress, deeming all others light, as in (1a).[2] Examples of such languages include Murik (Abbott 1985) and Lhasa Tibetan (Dawson 1980; Gordon 2006). Other languages, though, treat either the presence of a long vowel or the presence of a coda as attracting stress, as in (1b). Examples of languages that pattern in this way include Yana (Sapir & Swadesh 1960; Hyde 2006) and Arabic (Harrell 1957, 1960; McCarthy 1979a,b; Gordon 2006). Still other languages, like Kwakw'ala (Bach 1975; Zec 1994; Walker 2000) or Quechua Inga (Levinsohn 1976), employ the scale in (1c), in which syllables with long vowels and syllables closed by a sonorant consonant are heavy, while open syllables with a short vowel and syllables closed by an obstruent are light.

(1) *Common weight-sensitive stress criteria*

a. {CVː} > {CVR, CVO CV}
b. {CVː, CVR, CVO} > {CV}
c. {CVː, CVR} > {CVO, CV}

Notice that the hierarchical status of CVC syllables serves as the only divergence between the scales in (1). In (1a), both CVC syllable types pattern with CV as light, and in (1b), they pattern with CVː as heavy. In (1c), the weight status of CVC syllables is split, with syllables closed by a sonorant coda patterning as heavy and syllables closed by an obstruent coda patterning as light. Because of this variation, a unified analysis of the weight distinctions in (1) based solely on moraic quantity proves elusive. If we attempt to characterize codas as mora-bearing, thereby rendering CVC bimoraic, we account for the contrasts in the scale in (1b) but not for the contrasts in (1a). On the other hand, if we characterize codas as weightless, thereby rendering CVC monomoraic, we account for the weight contrasts in (1a) but not for those in (1b). Finally, regardless of whether we analyse codas as weight-bearing or not, the contrast between CVR and CVO in (1c) cannot be captured by simple distinctions in moraic quantity. The disparity between these criteria for weight-sensitive stress, then, presents a problem that must be addressed by any theory attempting to account for the full range of stress criteria, namely, how do we account for the cross-linguistic variation in the weight of CVC?

The standard approach to moraic structure – which I term the variable-weight approach – contends that the culprit behind CVC's variation is a language-specific parameter governing coda moraicity (Hyman 1985; Hayes 1989; Zec 2007; among others). Within the Optimality Theory framework (Prince & Smolensky [1993] 2004), when CVC patterns as light with CV for stress, as in Lhasa Tibetan, the variable-weight approach argues that this results from a high-ranked constraint precluding codas from projecting a mora. On the other hand, when CVC patterns as heavy with CVː, as in Yana, that same constraint must occupy a low position in the constraint rankings of the language. Finally, in a stress

[1] I set aside the distinction between trimoraic and less-than-trimoraic syllables (e.g., {CVːC, CVCC} > {CVː, CVC, CV}) in this article. While the typological landscape of syllable weight requires theories of weight sensitivity to account for these distinctions, there is insufficient space to do so here.

[2] CVR represents a syllable closed by a sonorant coda, and CVO represents a syllable closed by an obstruent coda.

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criterion like Kwakw'ala's, in which CVR syllables pattern as heavy with CVː and CVO syllables as light with CV, the variable-weight approach posits that the distinction again falls out from differences in coda moraicity (Zec 1995, 2007). A constraint dispreferring the moraicity of sonorant codas is low-ranked in Kwakw'ala, while a constraint dispreferring the moraicity of obstruent codas is high-ranked. In this way, the variable-weight approach relies on variability in moraic structure to predict the typological variation of weight-sensitive stress criteria.

Nevertheless, as will be explicated in considerable depth in this article, when other weight-sensitive processes in addition to stress are considered, the predictions of the variable-weight approach stray from the observed facts concerning the cross-linguistic moraicity of codas. Specifically, weight-sensitive processes within a single language often diverge in how they treat codas in terms of weight (Gordon 2006). In Lhasa Tibetan, for example, even though CVC syllables pattern as light for stress – thus requiring codas to be non-moraic under the variable-weight approach – compensatory lengthening requires codas to be moraic. Similarly, Tibetan's tonal criterion permits CVː and CVR syllables to host a contour tone, but CVO syllables are unable to do so. Since moras are considered the tone-bearing unit in the language, the ability of CVR syllables to host contour tones indicates that at least sonorant codas must be moraic. In Lhasa Tibetan, then, a theory like the variable-weight approach – which relies on a lack of coda moraicity to capture the language's weight-sensitive primary stress system – cannot account for the weight mismatches between these different processes and is thus untenable.

As an alternative to the variable-weight approach, I propose a solution to CVC's variable weight status that maintains a uniform moraicity of codas, both cross-linguistically and within individual languages. That is, the difference in CVC's hierarchical status between the scales in (1) has nothing to do with the relative moraicity of codas, because the moraic structure of codas is universally fixed. Rather than relying on generic mora count to make weight distinctions, I propose a new syllable weight metric – the *Moraic Sonority Metric* – which constructs weight scales based on the number of moras *of a specified sonority* in a syllable rather than the sum total of moras in a syllable. By factoring sonority into weight computations, the Moraic Sonority Metric conflates the standard moraic quantity metric with prominence metrics like those discussed in Ryan (2019, 2020), thereby consolidating the two metrics into a single mechanism and obviating the need to call upon multiple disjoint constraint families to calculate weight. Additionally, the need for a theory of coercion (Morén 1999) – which relies on contextual within-language coda moraicity – to capture ternary stress scales also dissipates with the use of the Moraic Sonority Metric.

Under the approach outlined here, a language that has the scale in (1b) counts moras of all types in computing syllable weight for stress. Thus, syllables that are bimoraic (CVː, CVR and CVO) are heavy, while those that are monomoraic (CV) are light. A language that uses the stress scale in (1a), on the other hand, only includes vocalic moras in its weight computations for stress, resulting in syllables with two vocalic moras (CVː) behaving as heavy and syllables with less than two vocalic moras (CVR, CVO and CV) behaving as light. Crucially, even though CVR and CVO are both bimoraic, they each contain only a single vocalic mora and thus are treated as equivalent to CV in such a system. Finally, a language with the stress scale in (1c) considers only sonorant moras in its weight computations: syllables with two or more sonorant moras (CVː and CVR) attract stress, and syllables with less than two sonorant moras (CVO and CV) do not. Importantly, the theory relies on universal coda moraicity, which leads to one of the main arguments of this article: Evidence from weight-sensitive phenomena other than stress demonstrates that codas consistently contribute weight to the syllable, even in languages in which CVC is treated as light for stress. Given the overwhelming percentage of languages that exhibit coda moraicity in at least one weight-sensitive process, I argue that coda moraicity should be consistently represented in moraic structure.

A twofold purpose underlies the arguments made throughout the rest of the article. First, I seek to justify the above assertion that cross-linguistic variations in weight criteria for all weight-sensitive processes are best captured with a syllable weight metric that incorporates and intertwines moraic sonority in tandem with moraic quantity into its weight computations. Second, I aim to defend the claim

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that codas are universally moraic, which is, in its strongest form, a theory of Uniform Moraic Quantity (UMQ). The remainder of the article progresses as follows: Section 2 critically assesses the standard variable-weight approach – which advocates for cross-linguistic variation in coda moraicity to account for the typological inconsistency of stress scales – and highlights the shortcomings of the theory in relation to its predictions of language-specific coda moraicity. The bulk of the theoretical machinery introduced in this article, including the theory of UMQ and the Moraic Sonority Metric, is delineated in §3. Section 4 argues for a method in which the Moraic Sonority Metric could be formalised into a set of OT constraints to account for cross-linguistic variation in weight-sensitive stress criteria, and explores the factorial typology of the proposed Moraic Sonority constraints. Section 5 discusses several implications of the proposed theory, and §6 gives concluding remarks.

2. The variable-weight approach to weight sensitivity

2.1. Traditional assumptions of moraic structure

The traditional approach to the variation in CVC's hierarchical position on weight-sensitive stress scales has been to maintain that distinctions in weight are equivalent to distinctions in moraic quantity. This approach to determining syllable weight is accomplished by allowing the moraicity of codas to vary from language to language alongside CVC's hierarchical variation across stress criteria (Hyman 1985; McCarthy & Prince 1986, 1995; Hayes 1989; Zec 2003). That is, assuming an Optimality Theoretic approach (Prince & Smolensky [1993] 2004), it is claimed that moraic structure is stipulated on a language-specific basis, with the Weight-by-Position constraint in (2a) – which penalises non-moraic codas – ranked above *μ_C in (2b) in languages that analyse CVC as bimoraic for stress but below *μ_C in languages that analyse CVC as monomoraic for stress.

(2) *Variable-weight constraints*

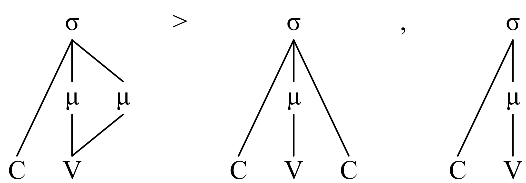
a. Weight by Position (W×P) (Hayes 1989; Sherer 1994)
Assign a violation for every coda consonant not linked to its own mora.

b. *μ_C (Morén 1999)
Assign a violation for every moraic coda consonant.

A representation of the syllable structure for the scales in (1a) and (1b) under the variable-weight approach, taken from Zec (2007), is shown in (3). Notice that CV syllables consistently have a single mora, and CVː syllables consistently have two moras. CVC syllables under this theory, on the other hand, contribute a single mora when they pattern with CV in (3a) and two moras when they pattern with CVː in (3b). To attain the scale in (1c), in which coda weight seems to be distinguished by the relative sonority of consonants, proponents of the variable-weight approach must engineer a more restrictive W×P constraint that penalises non-moraic sonorant codas only, resulting in a language where CVO syllables surface with the moraic structure of the CVC syllable in (3a) and CVR syllables with the moraic structure of the CVC syllable in (3b). Something akin to this analysis takes shape in Zec (2007: 183–187).

(3) *Moraic Structure under the variable-weight approach*

a. *W×P ranked low*: {CVː} > {CVC, CV}



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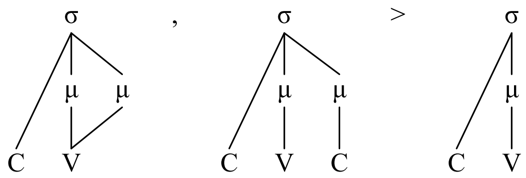
b. *W×P ranked high*: {CV:, CVC} > {CV}



2.2. The variable-weight approach and Lhasa Tibetan

While the variable-weight approach offers an ostensibly appealing solution to the cross-linguistic behaviour of CVC for primary stress, it incorrectly predicts the moraicity of codas for a host of other weight-sensitive phenomena. To illustrate, consider the mismatches in weight criteria outlined below for primary stress, tone and compensatory lengthening in Lhasa Tibetan. As illustrated in (4a), primary stress in Tibetan falls on the initial syllable when no heavy (CVː) syllable is present, but in words containing one or more heavy syllable, stress falls on the leftmost CVː, as in (4b).

(4) *Tibetan stress criterion: {CVː} > {CVR, CVO, CV}* (Dawson 1980)

a. *Initial stress*

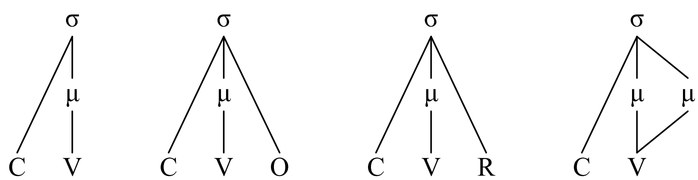
i.	ˈlap.ʈa	'school'	iii.	ˈɲu.qu	'pen'
ii.	ˈwo.ma	'milk'			

b. *Leftmost heavy*

i.	am.ˈtɔː	'person from Amdo'	iii.	lap.ˈʈeː	'of the school'
ii.	ˈqeː.laː	'teacher'	iv.	kʰa.ˈpaː	'telephone'

Because both CVR and CVO pattern as light alongside CV in the Lhasa Tibetan stress system, the variable-weight approach requires $*\mu_C$ to be ranked high, making all codas in the language non-moraic, to allow CVː to attract stress from CVC in words like *am.ˈtɔː* and *lap.ˈʈeː*. Consequently, the variable-weight approach predicts that syllables in Lhasa Tibetan will manifest weight behaviours consistent with the moraic structures in (5), in which both CVO and CVR are monomoraic and thus light.

(5) *Moraic structure of Tibetan syllables under the variable-weight approach*



Nevertheless, while the moraic structures in (5) make the correct predictions for primary stress in Tibetan, issues arise when considering the weight criteria for tone and compensatory lengthening, which both deviate (in different ways) from the stress criterion in how they treat syllables closed by a coda.[3] Consider, for instance, the tonal pattern of the Tibetan words in (6).[4] Only CVː and CVR may host a contour tone (as in *mâː* or *qhâm*); neither CVO nor CV has been found to do so.

[3] One may wonder if approaches like Zec's (1995; 2003) Sonority Threshold constraints or the theory of coercion can account for mismatches like those found in Tibetan, but see §§4.1.5 and 5.1 for discussion of why these two approaches cannot be relied upon to resolve the matter.

[4] V̂ represents a (high falling) contour tone. All other tones exemplified here are monotonic.

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(6) *Tibetan tonal criterion: {CVː, CVR} > {CVO, CV}* (Dawson 1980)

a. qʰâm 'Kham'
b. mâː 'war'
c. kâː 'to be stuck'
d. ʈɔ̀k.pá 'nomad'
e. kúk.pə́ 'dumb'
f. ɲíɲ.pə́ 'old'

In standard autosegmental tonal representations, every tone must anchor itself to a tone-bearing unit (TBU) to be realised (Goldsmith 1976a,b; Hyman & Leben 2020). Contour tones, which are often considered to consist of a sequence of distinct level tones, can either link to a single TBU or require each individual tone to anchor to a separate TBU. In a language with weight-sensitive tone like Tibetan, the mora functions as the TBU, and syllables must contain the requisite number of moras to host a contour tone. In other words, for a syllable to host a contour tone made up of two level tones, it must contain at least two moras. Thus, since both CVː and CVR syllables can host a contour tone (either high falling or low falling) in Tibetan, they must both be bimoraic. As we saw above, however, the variable-weight approach requires CVR syllables to be monomoraic in Tibetan to yield primary stress to CVː. The resulting monomoraic structure predicted by the variable-weight approach cannot explain the ability of CVR syllables to host contour tones. As demonstrated in (7), CVː syllables have no issue hosting a contour tone in Tibetan under the analysis of the variable-weight approach, since they are predicted to project two moras. For CVR, on the other hand, its monomoraic structure prevents the second tone of the contour from finding a docking site, as shown by the autosegmental representation of the word *qhâm* in (7). The high tone in the high falling contour links to the vocalic mora projected by [a], but the low tone in the contour cannot find a mora on which to dock, since [m] is non-moraic. Under the variable-weight approach to moraic structure, then, CVR syllables in Tibetan should not be able to host a contour tone. The issue at hand for the variable-weight approach is that the stress criterion and the tonal criterion of Lhasa Tibetan seemingly require conflicting moraic structures to account for the empirical evidence, and the variable-weight approach cannot resolve the discrepancy; CVR must be simultaneously monomoraic for stress and bimoraic for tone.

(7) *The variable-weight approach's predictions for TBUs in Tibetan*

Turning now to compensatory lengthening (henceforth CL), the situation in Tibetan is even further complicated for the variable-weight approach. Standard CL involves the deletion of a moraic consonant and the subsequent lengthening of the preceding vowel. Under moraic theory, the impetus for this process is that when the consonant deletes, it strands its mora, which relinks to the preceding vowel and results in lengthening. Whereas the stress criterion requires all CVC syllables to be monomoraic, and the tonal criterion requires CVR to be bimoraic and CVO monomoraic, CL effects in Lhasa Tibetan attest to the moraicity of both sonorant and obstruent codas. As demonstrated by words like *tsiː* 'one' and *kəːki* 'do, make' in (8), when an obstruent coda is deleted, the mora stranded by the deleted coda relinks to the preceding vowel, resulting in surface vowel lengthening.

(8) *Tibetan CL criterion: {CVː, CVR, CVO} > {CV}* (Dawson 1980)

a. /tsik/ → tsiː 'one'
b. /kəp.ki/ → kəː.ki 'do, make'
c. /tʃur.ku/ → tʃuː.ku 'nineteen'

Due to the monomoraic structure of CVO syllables under the variable-weight approach, however, the deletion of obstruent codas should not result in vowel lengthening. Instead, because obstruent codas

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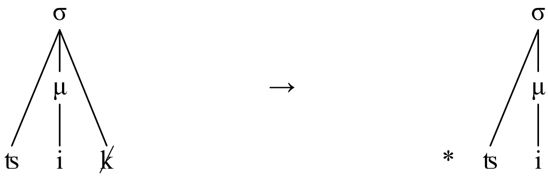
are non-moraic, the variable-weight approach predicts that obstruent coda deletion should result in the surface form in (9), in which coda deletion does not result in vowel lengthening since no mora is stranded.

(9) *The variable-weight approach and CL in Tibetan*



In sum, the data from Lhasa Tibetan illustrate that the variable-weight approach to weight sensitivity is ill-equipped to handle language-internal variations in syllable-weight criteria like those of Tibetan. The reason for this lack of success, as mentioned above, is that the language-specific parameterisation of moraic structure is a foundational element of the theory. In other words, the variable-weight approach assumes that syllable weight is language-specific and not process-specific. Nevertheless, as Lhasa Tibetan demonstrates, the facts confound such an assumption. With this in mind, it is clear that we need a theory of moraic structure that effectively captures the variant behaviour of coda weight while simultaneously maintaining their cross-linguistic moraicity. Only then will the process-specific nature of syllable weight criteria be attainable.

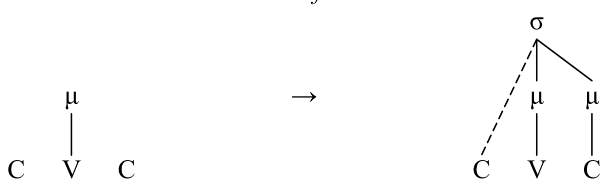
3. A solution to weight mismatches

3.1. Uniform Moraic Quantity theory

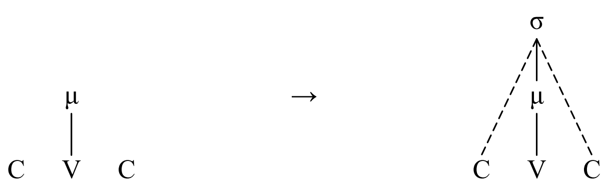
A theory of UMQ, contra the variable-weight approach, requires a universally rigid adherence to the moraicity of codas. Within the OT framework, this is accomplished by promoting the Weight-by-Position constraint in (2a) to a constraint on Gen (cf. Steriade 1991). As a consequence, any candidate in which a coda attaches directly to the syllable without contributing a mora cannot be considered as a viable output, as shown in (10). This means that every coda consonant must contribute its own mora to the syllable, regardless of how any individual process may treat codas in relation to weight.

(10) Uniform Moraic Quantity (UMQ)
Each coda consonant must link to its own mora.

a. *Permissible moraic structure for CVC*



b. *Violates UMQ constraint on Gen*



UMQ achieves two key advantages over the standard Variable Weight analysis, which will be outlined in §§3.2 and 3.3, respectively. First, UMQ makes more accurate predictions concerning the

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moraicity of coda consonants. As will be shown below, even when CVC is treated as light for stress, evidence for the inherent moraicity of codas emerges for most languages if we look at the behaviour of codas in other phonological processes. Since UMQ posits that codas are universally moraic, we expect such processes that reveal the moraicity of codas to occur. This, however, is not the case for the variable-weight approach, which predicts that syllables with codas ought to behave monomoraically in all domains in languages in which CVC patterns as light for stress.

The second advantage of UMQ lies in its provision of a simple universal schema for moraic structure, eliminating the need to make language- and context-specific stipulations about the moraic structure of syllables. The variable-weight approach, as demonstrated by its handling of the different weight-sensitive scales above, requires the moraic status of codas to be specified on a language-by-language basis. One may wonder whether UMQ simplifies moraic theory or simply shifts the burden of stipulation from moraic structure to a new portion of the grammar to explain weight variations. As will be demonstrated in §3.3, however, the metric used to make syllable weight distinctions under the approach outlined here capitalises on stipulations that are already implicitly invoked for other purposes in current moraic theory. In other words, UMQ enables us to rid the grammar of restrictions on moraicity without adding new restrictions, thereby lowering the overall number of *ad hoc* stipulations that must be imposed.

3.2. A cross-linguistic examination of coda moraicity

In §2, we explored the general proposal of the variable-weight approach to weight sensitivity, testing its predictions on data from Lhasa Tibetan to demonstrate how weight criteria mismatches provide evidence against treating weight as a language-specific property. As a solution, I proposed a theory of UMQ, which requires every coda consonant to link to its own mora cross-linguistically. Since this assertion so straightforwardly contradicts the foundational assumptions of the variable-weight approach, determining which approach stands on firmer empirical ground concerning the cross-linguistic moraicity of codas is a rather simple matter. To test which approach makes the correct predictions, we need only analyse the behaviour of CVC in languages in which the variable-weight approach predicts that codas should be non-moraic to determine whether it is consistent with bimoraicity or monomoraicity in these languages. In languages in which CVC patterns as light for stress, the variable-weight approach predicts that codas should be non-moraic, but UMQ predicts the opposite. If we find that codas exhibit weight-bearing characteristics in these languages, this provides strong evidence in favour of UMQ. If, on the other hand, we find that codas exhibit weightless characteristics for other weight-sensitive phenomena for most languages in which CVC counts as light for stress, this would indicate that perhaps Lhasa Tibetan is an exception to an otherwise sound prediction made by the variable-weight approach.

As shown in the 2×2 contingency table in Table 1, however, Lhasa Tibetan is far from the only language that belies the variable-weight approach. The table classifies 107 languages from Gordon's (2006) survey of weight-sensitive processes that both permit coda consonants and exhibit weight-sensitive stress. Each language is classified according to two categorical variables: coda weight for stress and coda weight for other weight-sensitive processes. The goal is to highlight the cross-linguistic frequency with which codas exhibit moraicity for at least one weight-sensitive process. The columns in the table sort all languages in the survey into two subcategories based on the weight behaviour of codas in the stress system: i) those in which codas contribute to weight (in the column labelled C_μ) and ii) those in which codas do not contribute to weight (column C). The rows, on the other hand, sort all languages in the survey into the same two subcategories based on the weight behaviour of codas for all other weight-sensitive processes (e.g., tone, compensatory lengthening, etc.). If codas contribute to weight for at least one weight-sensitive process other than stress, codas are treated as contributors to weight in that language, and the language is counted in row C_μ accordingly.

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Table 1. *2×2 contingency table demonstrating cross-linguistic coda moraicity*

		Stress		
		C_μ	C	Total
Other processes	C_μ	36	32[5]	68
	C	34	**5**	39
	Total	70	37	107

As shown in the top left cell, 36 languages in the survey treat codas as weight-bearing both for the stress system and for at least one other weight-sensitive process. An additional 34 languages treat codas as contributors to weight for the stress system but not for any other process considered in the survey. In total, then, 70 languages (65%) are shown by Gordon to exhibit coda moraicity in their stress system. For the remaining 37 languages in the survey in which CVC is light for stress (the column labelled C), Gordon provides evidence that 27 definitively contain at least one other weight-sensitive process requiring moraic codas. In total, then, Gordon indicates that 97 of the 107 relevant languages (91%) in his survey display coda moraicity for at least one phonological process. Of the ten languages for which Gordon does not indicate another process in which codas pattern as moraic, I have found evidence for moraic codas in five (see the Appendix for examples). This means that at least 102 of 107 relevant languages (95%) in Gordon's survey display at least one weight-sensitive process that treats codas as weight-bearing. This is reflected in Table 1 by the fact that 102 languages (36 + 34 + 32) are categorised into a cell that requires coda moraicity for at least one phonological process. The remaining five languages in which no evidence has been supplied to demonstrate coda moraicity either do not have adequate and accessible phonological descriptions or require further exploration.[6] Further scrutiny could lead to either the discovery of different processes that indicate coda moraicity in these languages or the finding that they represent languages in which codas are treated as light for all weight-based processes despite their moraicity. In any case, either finding is consistent with the present proposal. I leave it to future research to settle this matter. The upshot of this discussion is that coda consonants overwhelmingly exhibit moraicity cross-linguistically, so our theory of weight should reflect this fact in its foundational assumptions.

3.3. The moraic sonority metric

An immediate question arises from the UMQ theory proposed in (10), which requires coda consonants to link to their own moras. That is, if the variable behaviour of CVC is not connected to cross-linguistic variation in its moraic structure, then what causes its hierarchical instability across different processes and languages? I propose that the rampant variation in CVC's weight status stems from a Moraic Sonority Metric that determines syllable weight based on the number of moras *of a specified sonority* in a syllable rather than the sum total of moras in a syllable. Whereas the standard 'moraic quantity' metric evaluates syllable weight by comparing mora count without regard to the sonority values of those moras, the Moraic Sonority Metric assumes moras are inherently encoded with the sonority of the segment that they dominate and uses this information in its weight computations in conjunction with moraic quantity. Crucially, the Moraic Sonority Metric is restricted in the distinctions it can make

[5] Gordon (2006) provides evidence of coda weight from other processes for 27 languages in this cell; I found evidence for an additional five languages in the survey.

[6] These five languages are Comanche (Robinson 1990; Charney 1993), Mojave (Munro 1976; Langdon 1977; Munro *et al.* 1992), Nganasan (Wagner-Nagy 2019), Winnebago (Hale & White Eagle 1980; Hale 1985; Morrison 1994; Gordon 2006) and Ojibwa (Piggot & Grafstein 1983)

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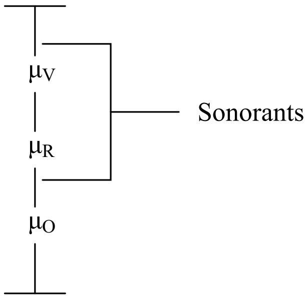
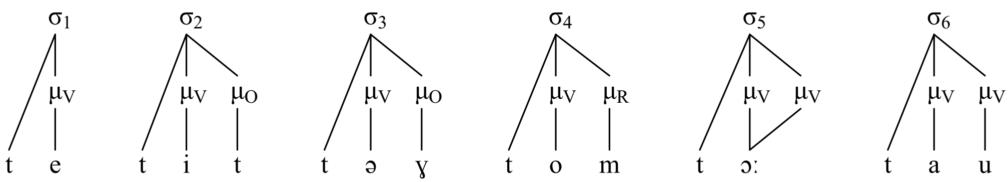
by the moraic sonority hierarchy in (11), which contains three sonority levels. Vocalic moras (μ_V), at the top of the hierarchy, are the most sonorous mora type. Sonorant consonant moras (μ_R) make up the middle tier on the hierarchy. While μ_R are less sonorous and lighter than μ_V, they are more sonorous and heavier than obstruent consonant moras (μ_O), which reside at the bottom of the sonority hierarchy and are lighter than both μ_V and μ_R.

(11) *The Moraic Sonority Hierarchy* (cf. Zec 2007)



A weight-sensitive process constructs its criterion with the aid of the Moraic Sonority Hierarchy by choosing a point on the hierarchy and making a bifurcation. Every mora type above the bifurcation is used in weight computations by that process, and every mora type below the bifurcation is excluded from weight computations by that process. Some processes make a bifurcation below all sonority levels, thus including every mora type in their syllable weight measurements. The result is a criterion that treats all bimoraic syllables as heavy regardless of the sonority values and all monomoraic syllables as light. Taking the hypothetical syllables in (12) as examples, only [te] would count as light, and the others, which are all bimoraic, would be heavy. If, however, a process makes a bifurcation between μ_R and μ_O on the Moraic Sonority Hierarchy, only syllables with at least two sonorant moras (either μ_V or μ_R) will be treated as heavy because non-sonorant moras (μ_O) fall below the bifurcation and are ignored in that process's weight computations. Consequently, [tɔː] and [tau] in (12) would be treated as heavy because they contain two vocalic moras, and [tom] would also be heavy because it contains one vocalic mora and one sonorant consonant mora, adding up to two sonorant moras. Even though [tit] and [təɣ] are bimoraic, they each contain only a single sonorant mora and would therefore be treated as light alongside CV for a weight-sensitive process that makes a bifurcation between μ_R and μ_O. If a process establishes its bifurcation point between μ_V and μ_R on the scale, only vocalic moras will be included in weight computations. The result is that only syllables with two vocalic moras ([tɔː] and [tau] in (12)) will be treated as heavy, and all others will be treated as light. Finally, if a weight-sensitive process makes a bifurcation above all sonority levels on the hierarchy, the result is a quantity-insensitive process. In other words, because all mora types are ignored in weight computations when a bifurcation is positioned above every sonority level, all syllables will be treated equivalently.

(12) *Moraic structure explicitly annotated with sonority*



Based on the dual assumptions that UMQ universally compels every coda consonant to link to its own mora and that all moras are inherently encoded with the sonority of their associated segments, the moraic structure of the hypothetical syllables in (12) includes subscripted sonority values for each mora. Several clarifications are in order when considering the proposed addition of moraic sonority to moraic structure. First, it is important to emphasize that the only permissible distinctions between

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moras are between the three levels of the Moraic Sonority Hierarchy. In other words, all obstruent consonants are dominated by identical μ_O moras, all sonorant consonants are dominated by identical μ_R moras, and all vowels are dominated by identical μ_V moras. This constraint on possible distinctions is undergirded by the fact that the cross-linguistic inventory of syllable weight criteria lacks more fine-grained distinctions beyond these three sonority values. For example, the codas in σ_2 and σ_3 in (12) both bear an obstruent mora (μ_O) and are thus identical in terms of their weight contributions. That [t] and [ɣ] differ in voicing, manner and place of articulation is irrelevant; both codas are obstruents and thus associate with indistinguishable obstruent moras.

Similarly, moras are not encoded with vowel quality features either: all vowels bear an identical vocalic mora regardless of height or peripherality. Though several purported cases of syllable weight divisions based on vowel quality exist (Kenstowicz 1997; de Lacy 2002, 2004, 2006; Gordon 2006; among others), more recent research provides compelling evidence against the idea that vowel quality can play a role in stress attraction (Bowers 2019; Rasin 2019; Shih 2019a,b; Shih & de Lacy 2019). In sum, the Moraic Sonority Metric's inability to make weight distinctions over and above the three sonority levels of the Moraic Sonority Hierarchy in (11) implies that a syllable weight criterion distinguishing categories other than vocalic, sonorant and obstruent moras does not exist. This assertion seems to enjoy significant empirical backing. Ideally, subsequent investigations would uncover why distinctions in moraic sonority are restricted in this way.

At this point, one may challenge the notion that moras are encoded with the sonority of their associated segments. Nevertheless, this proposal finds implicit support in a large body of previous work (e.g., Steriade 1991; Blumenfeld 2011; Davis 2017; Hyman & Leben 2020; among others). For instance, Blumenfeld (2011: 255) appeals to moraic sonority distinctions to explain apparent mismatches between minimal feet and minimal words in Chickasaw. Similarly, Hyman & Leben (2020: 49) call upon vocalic moras to define the behaviour of contour tones in some languages. Interestingly, all accounts that implicitly reference moraic sonority also maintain the variable-weight approach to syllable weight distinctions, indicating that this approach tacitly requires the ability to reference moraic sonority even though the notion is not formalised. The current proposal formalises these tacit assumptions and expands the utility of moraic sonority to account for syllable weight distinctions, a task that hitherto has been accomplished by referencing the variable status of coda moraicity. The effect of the Moraic Sonority Metric, then, is the simplification of our theory of moraic structure by eliminating the need to make language-specific parameters on coda moraicity, all without needing to add theoretical machinery to the grammar.

In addition, since syllable moraicity remains uniform per UMQ, the Moraic Sonority Metric allows for syllable weight scales to be constructed in a process-specific manner, capturing the fact that different processes within a single language often make bifurcations at different points on the Moraic Sonority Hierarchy, resulting in different weight criteria between processes within a single language. This is the case for the three weight-sensitive processes of Lhasa Tibetan discussed in §2.2: the compensatory lengthening criterion makes a bifurcation below μ_O on the hierarchy, thereby including every mora type in its weight computations. The tonal criterion in Tibetan, however, measures syllable weight based on a subset of the available mora types, using only sonorant moras in weight computations by placing the bifurcation point between μ_R and μ_O. Finally, the stress criterion uses only vocalic moras in its weight computations by placing the bifurcation point between μ_V and μ_R. In sum, all three Tibetan weight-sensitive processes treat codas differently in terms of weight, as shown in (13). The Moraic Sonority Metric allows for this process-specific variation, whereas the variable-weight approach does not.

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(13) *The Moraic Sonority Hierarchy and Tibetan weight processes*

	μ_V	
{CV}: > {CVC, CV}	→ | ←	Stress criterion
	μ_R	
{CV:, CVR} > {CVO, CV}	→ | ←	Tonal criterion
	μ_O	
{CV:, CVC} > {CV}	→ | ←	CL criterion

3.4. Summary

This section introduced a solution that captures the typology of weight-sensitive criteria across phonological processes without relying on variance in moraic structure. Section 3.1 argued that UMQ – which universally requires every coda consonant to link to its own mora – better adheres to the cross-linguistic empirical evidence of coda behaviour in terms of weight. Section 3.2 confirmed that codas tend to behave as weight-bearing cross-linguistically, even in languages where CVC is light for stress. While the survey contradicts predictions by the variable-weight approach, which asserts that codas are non-moraic when CVC patterns with CV for stress, the results buttress the claims of UMQ. The Moraic Sonority Metric was proposed in §3.3 as an alternative method to account for cross-linguistic diversity in weight criteria. By consolidating prominence and quantity metrics into a single mechanism, the Moraic Sonority Metric couples the simplification of syllable weight measurement with uniformity of moraic structure while simultaneously making more accurate predictions about coda moraicity across weight-sensitive processes.

4. Moraic sonority and weight-sensitive stress

The previous section introduced a proposal to account for typological variation in syllable weight criteria across a divergent set of weight-sensitive processes. The remainder of the article narrows in scope, proposing a formalisation of the Moraic Sonority Metric within Optimality Theory (Prince & Smolensky [1993] 2004) to account for the full typology of attested weight-sensitive stress criteria specifically. While the claim made here is that the Moraic Sonority Metric serves as a sufficient tool to explain the typology of attested patterns for all weight-sensitive phenomena, the space required to develop proposals for the formal outworkings of the metric for each of the relevant processes exceeds the space available in a treatise of this length. As such, a formalisation of the Moraic Sonority Metric as it relates to stress criteria will be the only process covered in detail here. Nevertheless, I briefly return to the issue of formalisations for different processes in §5, where I explore possible formalisations for weight-sensitive tone and word minimality.

The remainder of this section proceeds as follows: Section 4.1 illustrates how the Moraic Sonority Metric can be translated into Stress-to-Weight Principle (SWP) constraints that penalize stressed light syllables and correspond to bifurcations at different points on the Moraic Sonority Hierarchy. While the standard SWP constraint includes moras of all sonorities in its weight calculations (§4.1.1), this constraint can be adapted in such a way that makes it sensitive only to sonorant moras (§4.1.2) or only to vocalic moras (§4.1.3). Additionally, when more than one of these constraints is active in a language, the result is a complex stress criterion with more than two levels of weight (§4.1.4). In §4.2, I consider the factorial typology of the proposed Moraic Sonority constraints, discussing predicted languages and gaps in the typology. Section 4.3 provides a summary.

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4.1. Moraic sonority and the SWP

4.1.1. When all moras contribute to weight

Several schemas have been proposed in the literature to explain the preference for stress to avoid monomoraic syllables in weight-sensitive languages; one of the most seminal methods is the Stress-to-Weight Principle (SWP; Hayes 1980; Hammond 1986; McCarthy 2003; Ryan 2019), which penalises stressed light syllables. The aim at this point in the article is to examine how the adoption of the Moraic Sonority Metric would translate into individual SWP constraints that correspond to different bifurcations on the Moraic Sonority Hierarchy and are therefore sensitive to moraic sonority in their weight calculations for stress. To accomplish this, I use the version of SWP proposed in Ryan (2019), which is stated in (14). As Ryan points out, the notion of *weight* is a rather vague one, but Ryan's formulation of SWP in (14) makes explicit the fact that weight refers to bimoraic (or heavier) syllables in this constraint. In addition, as will become apparent in subsequent sections, this explicit representation of weight in the constraint formulation also allows for a relatively straightforward adaptation of the constraint to include references to moraic sonority.

(14) $S \rightarrow [\mu\mu]_\sigma$
Assign a violation for every stressed syllable with less than two moras.

As discussed in §3.3, weight-sensitive processes construct their weight criteria differently depending on the bifurcation point made on the Moraic Sonority Hierarchy. If a weight-sensitive process makes a bifurcation below all levels of the hierarchy, it allows all mora types to contribute to weight. If, however, a bifurcation is made at any point above the lowest mora type, every mora type below the bifurcation will be ignored in the weight computations. Functionally, then, the standard SWP constraint in (14), which relies on sum total differences in mora count to determine stress placement, operates as if the bifurcation is made below all three mora types. In other words, $S \rightarrow [\mu\mu]_\sigma$ correlates with a bifurcation on the Moraic Sonority Hierarchy below μ_O, as depicted in (15).

(15) *The Moraic Sonority Hierarchy and* $S \rightarrow [\mu\mu]_\sigma$

Quantity-insensitive	→ | ←	Align outranks SWP constraints
	μ_V	
{CV:} > {CVC, CV}	→ | ←	?
	μ_R	
{CV:, CVR} > {CVO, CV}	→ | ←	?
	μ_O	
{CV:, CVC} > {CV}	→ | ←	$S \rightarrow [\mu\mu]_\sigma$

As mentioned in the introduction, Yana's stress system constitutes one example of a language that treats all bimoraic syllables, regardless of moraic sonority, as heavy and all monomoraic syllables as light. Thus, the bifurcation Yana's stress system makes on the Moraic Sonority Hierarchy falls below μ_O, which means that $S \rightarrow [\mu\mu]_\sigma$ is active in the language. The following OT analysis of Yana stress demonstrates this point. Primary stress in Yana falls on the leftmost syllable in a word by default, as illustrated by the data in (16a). When one or more heavy syllables are present in a word, stress falls on the leftmost heavy syllable, as in (16b). Importantly, (16c) indicates that CV: and CVC are treated equivalently by the stress system: when both syllable types occur in a word together, stress falls on the leftmost instance of either, without distinguishing between them.

(16) *Primary stress in Yana* (data from Hyde 2006)

a. *Default stress on the leftmost syllable*

ˈme.c'i ‘coyote’
ˈɪ.ri.k'i ‘ear ornaments’

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b. *Stress on the leftmost heavy syllable*
ha.ˈlaː.la.ʔi ‘barberry’
ni.ˈgid.sa.sin.ʒa ‘I go to another house’

c. *CVC and CVː are equal in weight*
ni.ˈsaː.tin.ʒa ‘it is said I went away’
ha.c’a.ˈʒid.p’aː ‘*Angelica tomentosa*’

The alignment constraint in (17a) explains the preference of stress to fall as close to the left edge of the word as possible, as shown by the tableau in (17b). ALIGN-L pushes stress to the leftmost edge of the prosodic word when syllable weight is neutral.

(17) *Default stress in Yana*

a. ALIGN-L
Assign a violation for every syllable that intervenes between the left edge of a prosodic word and the head syllable.

b. *Default stress is word-initial*

ɪrik’i	ALIGN-L
☞ i. ˈɪ.ri.k’i	
ii. ɪ.ˈri.k’i	*!
iii. ɪ.ri.ˈk’i	*!*

In (18), the presence of a heavy syllable – CVː or CVC – successfully attracts stress away from the left edge. In both (18a) and (18b), candidate (ii) fully satisfies ALIGN-L by positioning primary stress at the left edge of the prosodic word. However, in so doing, these candidates stress a monomoraic syllable, thereby violating the higher-ranked $S \rightarrow [\mu\mu]_\sigma$ from (14). The optimal candidates in both tableaux violate ALIGN-L by shifting stress to the right but satisfy the higher-ranked $S \rightarrow [\mu\mu]_\sigma$ by stressing a bimoraic syllable, thus emerging victorious. Crucially in Yana, then, a syllable weight constraint like $S \rightarrow [\mu\mu]_\sigma$ must outrank stress alignment constraints.

(18) *{CVː, CVC} > {CV} in Yana*

a. *{CVː} > {CV}*

halaːlaʔi	$S \rightarrow [\mu\mu]_\sigma$	ALIGN-L
☞ i. ha.ˈlaː.la.ʔi		*
ii. ˈha.laː.la.ʔi	*!	

b. *{CVC} > {CV}*

nigidsasinʒa	$S \rightarrow [\mu\mu]_\sigma$	ALIGN-L
☞ i. ni.ˈgid.sa.sin.ʒa		*
ii. ˈni.gid.sa.sin.ʒa	*!	

The tableau in (19) shows that $S \rightarrow [\mu\mu]_\sigma$ cannot distinguish between bimoraic CVː and bimoraic CVC. Candidate (19c) is ruled out in a similar fashion to the losing candidates in (18) because it favours alignment over syllable weight. Both (19a) and (19b) satisfy $S \rightarrow [\mu\mu]_\sigma$ because primary stress falls on a bimoraic syllable in both candidates. Thus the decision falls to ALIGN-L, and (19a) emerges as optimal; only two syllables intervene between stress and the left edge of the prosodic word for (19a), whereas three syllables intervene between stress and the left edge of the prosodic word for candidate (19b).

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(19) *{CV:} = {CVC} in Yana*

ha.c’a.ʒid.p’a:	S → [μμ]$_\sigma$	ALIGN-L
☞ a. ha.c’a.ˈʒid.p’a:		**
b. ha.c’a.ʒid.ˈp’a:		***!
c. ˈha.c’a.ʒid.p’a:	*!	

The Moraic Sonority analysis of weight-sensitive stress in languages like Yana that treat all mora types equally does not yield different results from the standard variable-weight approach on the surface. Rather, the distinction between the two analyses is underlying. The variable-weight approach claims that W×P is highly ranked in these types of languages, rendering CVC and CV: equal in weight. The Moraic Sonority approach, in contrast, relies on UMQ to preclude GEN from generating candidates containing monomoraic CVCs, resulting in universally bimoraic CVC syllables. According to the Moraic Sonority approach, the reason for the equivalence of weight between CVC and CV: in Yana’s stress system hinges on the bifurcation point falling below all mora types, which results in all moras contributing to weight for the stress system. Both approaches arrive at the same result; CVC and CV: are equivalent in weight in the output for Yana’s stress system.

4.1.2. When only sonorant moras contribute to weight

The differences between the variable-weight approach and the Moraic Sonority approach rise to the forefront in languages in which CVC does not uniformly pattern with CV: for stress. Here, the variable-weight approach buries W×P into a low-ranked position, thereby generating monomoraic CVCs. In this way, the theory maintains the assertion that coda moraicity is a language-specific stipulation based on the behaviour of CVC in the language’s stress system. Since we have already seen how such an analysis is undermined by within-language CVC weight mismatches across phonological processes, we will not entertain the Variable Weight analysis moving forward.

As demonstrated by the Optimality Theoretic analysis of Yana in §4.1.1, the standard SWP constraint, S → [μμ]$_\sigma$, is sufficient to capture stress criteria that make a bifurcation at the lowest point on the Moraic Sonority Hierarchy. The reason for this is that S → [μμ]$_\sigma$ does not consider sonority in its computations. This constraint always uses the sum total of moras in a syllable to compute weight, which is equivalent to making a bifurcation below all of the sonority levels under the Moraic Sonority Metric outlined in §3. Thus, in its current form, the SWP framework cannot pair with the Moraic Sonority Metric to account for stress criteria that either treat only syllables with two vocalic moras as heavy ({CV:} > {CVC, CV}) or only syllables with two sonorant moras as heavy ({CV:, CVR} > {CVO, CV}) because S → [μμ]$_\sigma$ only makes distinctions using one of the four possible bifurcations on the Moraic Sonority Hierarchy. If, however, SWP expands to accord with the assertions of the Moraic Sonority Metric, we can model bifurcations at every point on the hierarchy. Specifically, by including moraic sonority values in the formalisation of SWP constraints, we can specify which mora types contribute to weight and which do not.

A weight-sensitive stress criterion that makes a bifurcation between the μ_R and μ_O levels of the Moraic Sonority Hierarchy ignores obstruent moras in its weight computations because μ_O falls below the bifurcation point. Consequently, CVO syllables are light in such a criterion despite being bimoraic. To account for the overlooking of obstruent moras within the SWP framework, the constraint must include the sonority value of the moras that are used in weight computations, as demonstrated in (20). Whereas the moras in S → [μμ]$_\sigma$ are unspecified in moraic sonority (resulting in all mora types contributing to weight), the moras in S → [$\mu_R\mu_R$]$_\sigma$ are specified with a subscripted R, indicating that only sonorant moras (μ_V or μ_R) are included in syllable weight analyses. As a result, S → [$\mu_R\mu_R$]$_\sigma$ penalises stress that falls on a syllable with less than two sonorant moras rather than a monomoraic syllable in general. Thus, the violation profile of S → [$\mu_R\mu_R$]$_\sigma$ expands to include stressed CVO syllables; because CVO only contains a single sonorant mora, S → [$\mu_R\mu_R$]$_\sigma$ is violated when CVO is stressed, even though

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CVO is bimoraic. Crucially, this allows the stress system to ignore mora types that do not meet the minimum sonority threshold in weight calculations.

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

When $S \rightarrow [\mu_R\mu_R]_\sigma$ outranks the alignment constraints associated with primary stress placement, the stress criterion that emerges treats all syllables with at least two sonorant moras as heavy and all syllables with less than two sonorant moras as light ({CV:, CVR} > {CVO, CV}), which means that $S \rightarrow [\mu_R\mu_R]_\sigma$ correlates with a bifurcation point between μ_R and μ_O on the Moraic Sonority Hierarchy, as depicted in (21).

(21) *$S \rightarrow [\mu_R\mu_R]_\sigma$ and the Moraic Sonority Hierarchy*

Quantity-insensitive	→ | ←	Alignment outranks SWP constraints
	μ_V	
{CV:} > {CVC, CV}	→ | ←	?
	μ_R	
{CV:, CVR} > {CVO, CV}	→ | ←	$S \rightarrow [\mu_R\mu_R]_\sigma$
	μ_O	
{CV:, CVC} > {CV}	→ | ←	$S \rightarrow [\mu\mu]_\sigma$

Kwakw'ala, a Wakashan language spoken in western Canada, has a stress criterion corresponding to a bifurcation between the μ_R and μ_O levels of the Moraic Sonority Hierarchy and thus provides an appropriate example to demonstrate the efficacy of $S \rightarrow [\mu_R\mu_R]_\sigma$. When no heavy syllable (one with at least two sonorant moras) is present in Kwakw'ala, stress falls on the rightmost syllable, indicating the need for the constraint ALIGN-R, which requires primary stress to occur at the right edge of the word, as in (22a) and (22b). When a heavy syllable is present, however, stress shifts from the right edge to fall on it, as in (22c) and (22d).[7]

(22) *Primary stress in Kwakw'ala* (Bach 1975: 9–10)
  a. gə.gə.ˈləm 'ermine'
  b. cat.ˈxa 'to squirt'
  c. ˈdəl.xa 'damp'
  d. c'ə.ˈma:.tud 'melt away something in ear'

As shown by the tableau in (23), $S \rightarrow [\mu\mu]_\sigma$ must rank below ALIGN-R in Kwakw'ala so that a bimoraic CVO syllable is unable to draw stress from the default position. Both candidates in the tableau violate $S \rightarrow [\mu_R\mu_R]_\sigma$ because stress cannot avoid a syllable with less than two sonorant moras no matter which syllable it falls on in *catxa*. Thus, the decision falls to alignment, and candidate (23a), which aligns primary stress on the rightmost syllable in the word, emerges as optimal.

(23) *CVO light in Kwakw'ala*

catxa	$S \rightarrow [\mu_R\mu_R]_\sigma$	ALIGN-R	$S \rightarrow [\mu\mu]_\sigma$
☞ a. cat.ˈxa	*		*
b. ˈcat.xa	*	*!	

[7]Primary stress in Kwakw'ala exhibits a 'default-to-opposite' pattern in which primary stress falls on the rightmost syllable when no CV: or CVR is present in a word, but on the leftmost CV:/CVR when one or more heavy syllables is present. For simplicity, I leave out examples with more than a single heavy syllable.

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However, when a non-final syllable with two sonorant moras is present in Kwakw'ala, stress shifts from the right edge because $S \rightarrow [\mu_R \mu_R]_\sigma$ outranks ALIGN-R. As the tableau in (24a) reveals, candidate (ii), which aligns stress at the right edge of the word to satisfy alignment, does so at the expense of violating the higher ranked $S \rightarrow [\mu_R \mu_R]_\sigma$ and is eliminated. Candidate (i), conversely, stresses the non-final CVR syllable and satisfies $S \rightarrow [\mu_R \mu_R]_\sigma$ because stress falls on a syllable with at least two sonorant moras: *dəl*. Crucially, as demonstrated by the tableau in (23), $S \rightarrow [\mu\mu]_\sigma$ is outranked by ALIGN-R in Kwakw'ala, and therefore cannot be responsible for the movement of stress from its default word-final position in (24a).

(24) *CVR heavy in Kwakw'ala*

a. *CVR > CV in Kwakw'ala*

dəlxa	$S \rightarrow [\mu_R \mu_R]_\sigma$	ALIGN-R	$S \rightarrow [\mu\mu]_\sigma$
☞ i. ˈdəl.xa		*	
ii. dəl.ˈxa	*!		*

b. *Hasse diagram for Kwakw'ala stress*

$S \rightarrow [\mu_R \mu_R]_\sigma$
|
ALIGN-R
|
$S \rightarrow [\mu\mu]_\sigma$

To sum up, Kwakw'ala's stress criterion makes a bifurcation in the Moraic Sonority Hierarchy between μ_R and μ_O. The corresponding Moraic Sonority constraint, $S \rightarrow [\mu_R \mu_R]_\sigma$, captures the insensitivity of the criterion to the presence of obstruent moras by penalising stress that falls on syllables with less than two sonorant moras. Consequently, only CVː and CVR satisfy $S \rightarrow [\mu_R \mu_R]_\sigma$ when stressed, giving rise to the desired syllable weight division in Kwakw'ala's stress criterion.

4.1.3. *When only vocalic moras contribute to weight*

Whereas Kwakw'ala's stress system relies on a bifurcation between μ_R and μ_O, other languages display stress systems that make a bifurcation between μ_V and μ_R, resulting in vocalic moras shouldering the full burden of determining syllable weight. The Moraic Sonority constraint in (25a), $S \rightarrow [\mu_V \mu_V]_\sigma$, corresponds to a bifurcation at this level, as shown in (25b). Requiring stress to avoid syllables with less than two vocalic moras means that only syllables with a long vowel or diphthong can satisfy the constraint. The result is that when $S \rightarrow [\mu_V \mu_V]_\sigma$ is ranked high, syllables with two vocalic moras are heavy and all others are light for stress.

(25) *Sensitivity to vocalic moras*

a. $S \rightarrow [\mu_V \mu_V]_\sigma$
Assign a violation for every stressed syllable with less than two vocalic moras.

b. *$S \rightarrow [\mu_V \mu_V]_\sigma$ and the Moraic Sonority Hierarchy*

Quantity-insensitive → | ← Alignment outranks SWP constraints
μ_V
{CVː} > {CVC, CV} → | ← $S \rightarrow [\mu_V \mu_V]_\sigma$
μ_R
{CVː, CVR} > {CVO, CV} → | ← $S \rightarrow [\mu_R \mu_R]_\sigma$
μ_O
{CVː, CVC} > {CV} → | ← $S \rightarrow [\mu\mu]_\sigma$

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Many languages display the stress criterion engendered by $S \rightarrow [\mu_V\mu_V]_\sigma$, one of which is Lhasa Tibetan, discussed in §2.2. As previously described, primary stress in Tibetan falls on the initial syllable by default, but the presence of a syllable with a long vowel draws stress away from the default position. Examples illustrating the primary stress criterion in Tibetan from (4) are repeated in (26):

(26) *Lhasa Tibetan primary stress pattern*

a. ˈwo.ma ‘milk’
b. ˈlap.ʈa ‘school’
c. am.ˈtɔː ‘person from Amdo’
d. lap.ˈʈeː ‘of the school’
e. ˈqeː.laː ‘teacher’

As demonstrated by the word for ‘school’ in (26b), ALIGN-L pulls primary stress to the left edge of the word by penalising candidates for each syllable that intervenes between the head syllable and the left edge of the prosodic word.

(27) *Default primary stress position in Tibetan*

lapʈa	ALIGN-L
☞ a. ˈlap.ʈa	
b. lap.ˈʈa	*

In (26d), however, stress is drawn from the word-initial CVO syllable to fall on CVː, as in the tableau in (28). $S \rightarrow [\mu\mu]_\sigma$ cannot be held responsible for this shift in stress since both CVO and CVː are bimoraic in Tibetan and thereby equally satisfy $S \rightarrow [\mu\mu]_\sigma$ when stressed. This means that $S \rightarrow [\mu_V\mu_V]_\sigma$ must rank above ALIGN-L. Candidate (28a) satisfies alignment by stressing the word-initial syllable but violates higher ranked $S \rightarrow [\mu_V\mu_V]_\sigma$ in the process. Candidate (28a), on the other hand, violates alignment in order to satisfy $S \rightarrow [\mu_V\mu_V]_\sigma$ by placing stress on the word-final *ʈeː* and emerges as the winner.

(28) *CVː heavy in Tibetan*

lapʈeː	$S \rightarrow [\mu_V\mu_V]_\sigma$	ALIGN-L	$S \rightarrow [\mu\mu]_\sigma$
☞ a. lap.ˈʈeː		*	
b. ˈlap.ʈeː	*!		

Importantly, while it is possible that $S \rightarrow [\mu_R\mu_R]_\sigma$ drives the movement of stress to the non-initial CVː in (28), forms like (26c) suggest that this is not the case in Tibetan, as illustrated in the tableau in (29). Neither $S \rightarrow [\mu\mu]_\sigma$ nor $S \rightarrow [\mu_R\mu_R]_\sigma$ distinguishes between the two candidates in (29), because both syllables have at least two sonorant moras, which indicates that $S \rightarrow [\mu_V\mu_V]_\sigma$ must be responsible. Candidate (29b) maintains stress on the default initial syllable, satisfying ALIGN-L, $S \rightarrow [\mu\mu]_\sigma$, and $S \rightarrow [\mu_R\mu_R]_\sigma$, but fatally violating $S \rightarrow [\mu_V\mu_V]_\sigma$. Conversely, candidate (29a), which violates ALIGN-L by shifting stress to CVː, satisfies $S \rightarrow [\mu_V\mu_V]_\sigma$ in so doing and materialises as the optimal surface form. A Hasse diagram depicting the rankings of the stress constraints in Tibetan is provided in (30).

(29) *CVR light in Tibetan stress*

amʈɔː	$S \rightarrow [\mu_V\mu_V]_\sigma$	ALIGN-L	$S \rightarrow [\mu_R\mu_R]_\sigma$	$S \rightarrow [\mu\mu]_\sigma$
☞ a. am.ˈʈɔː		*		
b. ˈam.ʈɔː	*!			

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(30) *Hasse diagram for Tibetan stress*

$S \rightarrow [\mu_R\mu_R]_\sigma$ $S \rightarrow [\mu_V\mu_V]_\sigma$ $S \rightarrow [\mu\mu]_\sigma$

|

ALIGN-L

In short, neither $S \rightarrow [\mu\mu]_\sigma$ nor $S \rightarrow [\mu_R\mu_R]_\sigma$ can account for the primary stress placement pattern in Tibetan, but $S \rightarrow [\mu_V\mu_V]_\sigma$ does, indicating that the primary stress system relies on a bifurcation point between μ_V and μ_R that only considers vocalic moras in its computations. All non-vocalic moras, while present and called upon by other weight-sensitive processes in the language to help make syllable weight distinctions (recall the discussion in §2.2), are irrelevant for the determination of stress.

As demonstrated by the effects of both $S \rightarrow [\mu_R\mu_R]_\sigma$ and $S \rightarrow [\mu_V\mu_V]_\sigma$ in Kwakw'ala and Tibetan, respectively, the proposed Moraic Sonority constraints successfully capture bifurcations at every point on the Moraic Sonority hierarchy. $S \rightarrow [\mu\mu]_\sigma$ accounts for stress systems like Yana using the lowest bifurcation point to measure weight. $S \rightarrow [\mu_R\mu_R]_\sigma$ accounts for Kwakw'ala-like stress systems by only including sonorant moras to measure syllable weight. And $S \rightarrow [\mu_V\mu_V]_\sigma$ accounts for stress systems similar to Tibetan's, which only treat syllables with two vocalic moras as heavy, ignoring the other two mora types in weight measurements.

4.1.4. When languages utilize complex (suprabinary) stress criteria

Interestingly, a significant number of languages use multiple bifurcations on the Moraic Sonority Hierarchy, resulting in complex stress criteria. Mankiyali, an understudied language of Northern Pakistan, is one such language (Paramore 2021). Data demonstrating the primary stress pattern of Mankiyali are provided in (31). Paramore (2021: 43–44) states that primary stress falls on the penultimate syllable by default when syllable weight is neutral, as illustrated by the data in (31a). If, however, a bimoraic syllable (CVː, CVR, or CVO) occurs in the word, it draws stress from a penultimate CV, as shown in (31b). Additionally, the data in (31c) demonstrate the superior weight status of CVː over both CVC and CV syllables in Mankiyali. Regardless of its position in a word, when a CVː is present, it attracts primary stress from CVC and CV syllables. When multiple syllables of the same weight tie for the heaviest syllable, the rightmost non-final instance receives primary stress.

(31) *Primary stress in Mankiyali*

a. *Default penultimate stress*

i. ka.ma.ˈka.la 'stupid'

ii. dʒan.ˈdar.yoz 'locks'

iii. ˈkaː.rɪː 'millet'

b. *{CVː, CVR, CVO} > {CV}*

i. ˈlakʰ.sa.ri 'many'

ii. ma.ˈčʰɪr 'mosquito'

iii. ˈzaŋ.ga.la 'forests'

iv. ˈkaː.ɣa.za 'papers'

c. *{CVː} > {CVR, CVO, CV}*

i. kam.zo.ˈriː 'weakness'

ii. muk.ˈleː 'open' (IMP)

In sum, the Mankiyali data in (31) indicate that the language has the ternary stress criterion in (32), with distinctions made at two points on the Moraic Sonority Hierarchy. A bifurcation between μ_V and

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μ_R distinguishes syllables with long vowels from syllables with short vowels, and a bifurcation between μ_R and μ_O distinguishes bimoraic syllables from monomoraic syllables.

(32) *Mankiyali stress criterion* (Paramore 2021)
{CVː} > {CVR, CVO} > {CV}

The following OT analysis shows how the Moraic Sonority Metric can capture the complex stress pattern of Mankiyali. Default penultimate stress indicates that the rightward alignment constraint, ALIGN-R, must be outranked by NONFINALITY, which penalises stress on the final syllable of a prosodic word. Because of this ranking, when syllable weight is neutral in a word, stress appears as far right in the word as possible without falling on the final syllable, in order to satisfy NONFINALITY while incurring the minimal number of ALIGN-R violations, as in (33).

(33) *Default stress in Mankiyali*

kamakala	NONFINALITY	ALIGN-R
☞ a. ka.ma.ˈka.la		*
b. ka.ˈma.ka.la		**!
c. ka.ma.ka.ˈla	*!	

As established by the data in (31), however, both CVC and CVː attract stress from CV, which means that $S \rightarrow [\mu\mu]_\sigma$ is active in the language. Importantly, $S \rightarrow [\mu\mu]_\sigma$ must outrank NONFINALITY in (34) in order to draw stress to the word-final syllable. Candidate (34a) violates NONFINALITY by stressing the word-final syllable, but satisfies the higher-ranked $S \rightarrow [\mu\mu]_\sigma$, thereby surfacing as optimal.

(34) *CVC heavy in Mankiyali*

mačʰɪr	$S \rightarrow [\mu\mu]_\sigma$	NONFINALITY	ALIGN-R
☞ a. ma.ˈčʰɪr		*	
b. ˈma.čʰɪr	*!		*

Finally, the data in (31c), which demonstrate that CVː outweighs CVC in Mankiyali, shows that the moraic sonority constraint that only considers vocalic moras, $S \rightarrow [\mu_V\mu_V]_\sigma$, must be active and outrank NONFINALITY alongside $S \rightarrow [\mu\mu]_\sigma$ in Mankiyali. Because both CVC and CVː are bimoraic, candidates (35a) and (35b) equally satisfy $S \rightarrow [\mu\mu]_\sigma$. However, stressed *muk* in candidate (35b) contains only a single vocalic mora and so violates the high-ranked $S \rightarrow [\mu_V\mu_V]_\sigma$ and is eliminated from contention. Candidate (35a) stresses a CVː, whose two moras are both vocalic. As a result, it satisfies both relevant constraints on syllable weight and is chosen as the winner. Importantly, Moraic Sonority Constraints are in a stringency relationship, so their relative rankings do not affect the analysis. The crucial rankings for the Mankiyali stress pattern are shown in the Hasse diagram in (36).

(35) *CVː attracting stress from CVC in Mankiyali*

mukleː	$S \rightarrow [\mu_V\mu_V]_\sigma$	$S \rightarrow [\mu\mu]_\sigma$	NONFINALITY	ALIGN-R
☞ a. muk.ˈleː			*	
b. ˈmuk.leː	*!			*

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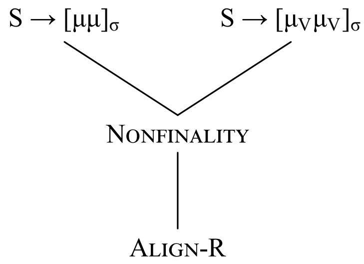
(36) *Hasse diagram of Mankiyali stress constraints*



In sum, whereas many weight-sensitive stress criteria choose a single bifurcation point when determining syllable weight, Mankiyali makes two bifurcations, one between $μ_V$ and $μ_R$ and another between $μ_R$ and $μ_O$. In this way, Moraic Sonority constraints effectively capture the ternary stress criterion of Mankiyali.

4.1.5. Coercion, variable weight and complex stress criteria

Coercion (Morén 1999; Rosenthall & van der Hulst 1999) is the device traditionally used by the variable-weight approach to analyse languages like Mankiyali in which the stress criterion makes more than a two-way distinction in weight. Coercion analyses CVC as bimoraic when it attracts stress (like CVː), and as monomoraic in environments where patterns with CV. Coercion achieves the three-way weight distinction by 'coercing' CVC into bimoraicity in environments where CVː is unavailable for primary stress, but allowing it to remain monomoraic elsewhere. This is accomplished by the interaction of the competing constraints in (37) that determine whether the coda contributes a mora to the syllable:

(37) *Constraints necessary for coercion analysis*

a. Weight by Position (W×P)
Assign a violation for every coda consonant not linked to its own mora.

b. *$μ_C$
Assign a violation for every moraic coda consonant.

c. WSP (Prince & Smolensky [1993] 2004)
Assign a violation for every bimoraic syllable that is unstressed.

When WSP outranks W×P and a CVː syllable is present, as in (38a), CVC surfaces as monomoraic to avoid an unstressed bimoraic syllable, which would violate the WSP. This generates the hierarchy {CVː} > {CVC, CV}. However, when no CVː is present, as in (38b), CVC surfaces as bimoraic to satisfy W×P at the expense of the lower-ranked *$μ_C$, establishing the hierarchy {CVC} > {CV}. Thus, coercion separates the ternary scale {CVː} > {CVC} > {CV} into two distinct binary scales, {CVː} > {CVC, CV} and {CVC} > {CV}, which allows the theory to account for ternary scales under a thoroughly variable-weight analysis.

(38) *Variable weight of codas under coercion*

a. *CVC surfacing as monomoraic*

	WSP	W×P
☞ i. CVC.ˈCVː		*
ii. ˈCVC$_μ$.CVː	*!	
iii. CVC$_μ$.ˈCVː	*!	

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b. *CVC coerced into bimoraicity*

	WSP	W×P	*μ_C
☞ i. CV.ˈCVC$_\mu$			*
ii. ˈCV.CVC		*!	
iii. ˈCV.CVC$_\mu$	*!		*

Nevertheless, while coercion has been shown to correctly predict attested complex primary stress patterns, it does not eliminate the shortcomings of the variable-weight approach enumerated in §2. That is, despite the contextual moraicity of coda consonants under coercion, moraic structure remains language-specific rather than process-specific unless the right conditions for stress require specific CVC syllables to surface with a variable structure. The result still leads to the incorrect prediction that weight-sensitive processes should treat individual codas uniformly within languages. In fact, Ryan (2019, 2020) provides evidence demonstrating that coercion is untenable for about half of {CVː} > {CVC} > {CV} stress systems, because CVC must be simultaneously monomoraic to yield primary stress to CVː and bimoraic to attract secondary stress. In sum, coercion's deficiencies are identical to other aspects of the variable-weight approach: it relies on variation in moraic structure in an attempt to resolve variation in weight criteria, but that variation in moraic structure wrongly assumes a uniform weight for any given CVC across processes.

4.1.6. A note on variable representation

As demonstrated in this article, one of the primary features of the variable-weight approach is its reliance on language-specific variation in coda moraicity to capture cross-linguistic variation in weight-sensitive stress scales. However, because the variable-weight approach treats coda moraicity as a language-specific parameter, such that codas in any given language are consistently either heavy or not, the theory is unable to explain within-language variation in weight scales across different weight-sensitive phenomena, as illustrated in §§2.2 and 3.2. Conversely, under UMQ, the representation of coda moraicity remains fixed, and the variation of weight scales – both cross-linguistically and within languages – is captured by the Moraic Sonority Metric, with variation between weight criteria achieved by variation in constraint ranking rather than variation in structural representation. In other words, the Moraic Sonority Constraints – $S \rightarrow [\mu_V\mu_V]_\sigma$, $S \rightarrow [\mu_R\mu_R]_\sigma$ and $S \rightarrow [\mu\mu]_\sigma$ – determine the weight status of syllables by dispreferring stress that falls on syllables with less than two moras of a specified sonority, as demonstrated by the scales in (39). Crucially, this approach to variation in syllable weight does not rely on assigning different moraic representations to the same structures in different languages. Instead, $S \rightarrow [\mu_V\mu_V]_\sigma$, $S \rightarrow [\mu_R\mu_R]_\sigma$ and $S \rightarrow [\mu\mu]_\sigma$ generate variation in the same way as any other markedness constraint: they penalize candidates based on the presence of some disfavoured trait, in this case prominence on a syllable with less-than-ideal moraic sonority.

(39) *Moraic Sonority constraints and weight criteria variation*

a. $S \rightarrow [\mu_V\mu_V]_\sigma$ active: {CVː} > {CVR, CVO, CV}
b. $S \rightarrow [\mu_R\mu_R]_\sigma$ active: {CVː, CVR} > {CVO, CV}
c. $S \rightarrow [\mu\mu]_\sigma$ active: {CVː, CVR, CVO} > {CV}

4.2. A factorial typology of weight-sensitive stress

Every typological proposal is burdened with the task of predicting both the set of attested systems and the set of systems that should not exist. If a theory predicts that a system exists when it does not, the proposal suffers from overgeneration. On the other hand, if a theory predicts that a system *should not* exist when it does, the theory must either be abandoned or overhauled to account for the existence of the unexpected system. This section explores the factorial typology generated by the Moraic Sonority

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Table 2. *Languages predicted by Moraic Sonority constraints*

	Constraint ranking	Stress criterion	Attested?
1	ALIGN≫ $[\mu\mu]_\sigma$, $[\mu_R\mu_R]_\sigma$, $[\mu_V\mu_V]_\sigma$	Quantity-insensitive	Mohawk (Chafe 1977)
2	$[\mu\mu]_\sigma$≫ALIGN≫ $[\mu_R\mu_R]_\sigma$, $[\mu_V\mu_V]_\sigma$	{CVː, CVR, CVO} > {CV}	Yana
3	$[\mu_R\mu_R]_\sigma$≫ALIGN≫ $[\mu\mu]_\sigma$, $[\mu_V\mu_V]_\sigma$	{CVː, CVR} > {CVO, CV}	Kwakw'ala
4	$[\mu_V\mu_V]_\sigma$≫ALIGN≫ $[\mu\mu]_\sigma$, $[\mu_R\mu_R]_\sigma$	{CVː} > {CVR, CVO, CV}	Lhasa Tibetan
5	$[\mu\mu]_\sigma$, $[\mu_V\mu_V]_\sigma$≫ALIGN≫ $[\mu_R\mu_R]_\sigma$	{CVː} > {CVR, CVO} > {CV}	Mankiyali
6	$[\mu\mu]_\sigma$, $[\mu_R\mu_R]_\sigma$≫ALIGN≫ $[\mu_V\mu_V]_\sigma$	{CVː, CVR} > {**CVO**} > {CV}	—
7	$[\mu_V\mu_V]_\sigma$, $[\mu_R\mu_R]_\sigma$≫ALIGN≫ $[\mu\mu]_\sigma$	{CVː} > {**CVR**} > {CVO, CV}	—
8	$[\mu_V\mu_V]_\sigma$, $[\mu_R\mu_R]_\sigma$, $[\mu\mu]_\sigma$≫ALIGN	{CVː} > {**CVR**} > {**CVO**} > {CV}	—

constraints proposed in §4.1, showing that the Moraic Sonority Metric successfully captures the cross-linguistic typology of stress criteria while avoiding severe over-generation. The list of predicted stress criteria was generated using OT-Help 2.0 (Staubs *et al.* 2010). The factorial typology includes the three Moraic Sonority constraints – repeated in (40a)–(40c) – and an alignment constraint defined in (40d). This typology demonstrates the efficacy of the Moraic Sonority Metric in predicting the diverse set of weight-sensitive stress criteria attested in the world's languages.[8]

(40) *Constraints in the factorial typology*

a. S → $[\mu\mu]_\sigma$
Assign a violation for every stressed syllable with less than two moras.

b. S → $[\mu_R\mu_R]_\sigma$
Assign a violation for every stressed syllable with less than two sonorant moras.

c. S → $[\mu_V\mu_V]_\sigma$
Assign a violation for every stressed syllable with less than two vocalic moras.

d. ALIGN-L
Assign a violation for every syllable that intervenes between the left edge of a prosodic word and the head syllable.

The factorial typology of the proposed constraints predicts the eight languages in Table 2, five of which are attested. Languages 1–4, which make all the predicted two-way distinctions in syllable weight, are all attested. Of these binary systems, languages 1, 2 and 4 are robustly attested, while language 3 is quite rare, though still attested, as a stress criterion. The stress criteria in languages 5–8 make three- or four-way distinctions in syllable weight, and only one of these, language 5, is attested, though it is also quite rare according to Gordon's (2006) survey.

A straightforward explanation for the three unattested languages in Table 2 exists. Namely, it is possible that these three languages represent accidental gaps in the typology based on the rarity of the distinctions employed. Notice that each of the three unattested criteria makes use of a combination of two distinctive patterns that are relatively rare in their own right: a minimally ternary distinction in syllable weight as well as a distinction based on the bifurcation between μ_R and μ_O, in which CVR and CVO syllables disjoin into separate levels on the scale. In Gordon's (2006) survey of weight-sensitive systems, only 15 of 107 languages (14%) with weight-sensitive stress exhibit a ternary weight distinction. Furthermore, only 3 of those 107 languages (3%) involve criteria that distinguish CVR from CVO (Kwakw'ala, Nootka and Quechua Inga). Given the rarity of each of these patterns on its own, it is not particularly surprising that no criterion has been discovered that combines them (Gordon 2002).

[8]The factorial typology does not include stress criteria that distinguish superheavy syllables from heavy/light syllables. I entrust it to subsequent analyses to explore how the current proposal could be expanded to include these languages.

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4.3. Summary

This section sought to develop a formal account of weight-sensitive stress using the theory of UMQ and the Moraic Sonority Metric introduced in §3. In addition, this section demonstrated how the Moraic Sonority Metric can be seamlessly incorporated into a constraint family like SWP, which penalises stress on light syllables. To do so, I proposed two additional Moraic Sonority constraints within the SWP framework ($S \rightarrow [\mu_R\mu_R]_\sigma$ and $S \rightarrow [\mu_V\mu_V]_\sigma$) that, when coupled with $S \rightarrow [\mu\mu]_\sigma$, accurately predict the cross-linguistic inventory of stress criteria. While three of the stress criteria predicted by the constraints are currently unattested, I contend that the combined rarity of the distinctions made by these criteria explains why they have yet to be encountered.

5. Discussion

5.1. Codas, syllable weight variation and geminate consonants

In this article, I've proposed that the moraic structure of coda consonants is cross-linguistically uniform. Such a proposal conforms to the empirical reality that codas overwhelmingly behave as moraic, but by itself it does not provide a way to account for syllable weight variation, either cross-linguistically or within languages. To solve this, I made explicit the idea that moras are encoded with the sonority of the segment to which they are linked. Moras can be either vocalic (if linked to a vowel), sonorant (if linked to a sonorant consonant), or obstruent (if linked to an obstruent consonant). As previously stated in §3.3, the idea that moras are encoded with the sonority of the segment to which they are linked is not without precedent. The current proposal simply makes this notion explicit, which allows constraints to evaluate candidates with reference to three discrete levels of moraic sonority. Thus, weight variation no longer relies on variable moraicity, but is instead achieved by constraints that are sensitive to differences in mora type between syllables. These constraints can thus determine which mora types do and do not contribute to syllable weight. Accordingly, variation is derived by enabling constraints to treat syllables with different types of moras (e.g., CVR *vs.* CVO) as representationally distinct. In effect, even though both CVR and CVO are equivalent in their overall number of moras, they can be distinguished by the fact that CVR has two sonorant moras while CVO only has one.

The concept of moraic sonority adopted in this article is similar in spirit to the sonority threshold constraints of Zec (1995, 2003, 2007), but the crucial distinction lies in the different assumptions the two theories make concerning the moraic structure of codas. Specifically, Zec argues that her theory of sonority thresholds should not be regarded as an additional metric of syllable weight. Instead, she asserts that moraic quantity ought to remain the only adjudicator of weight, with sonority threshold constraints preventing segments that don't meet the threshold from projecting a mora at all (Zec 2003: 123). Consequently, sonority threshold constraints inevitably lead to the variable moraicity of codas cross-linguistically. The theory of moraic sonority undergirding constraints based on the Moraic Sonority Metric, on the other hand, holds that coda consonants are universally moraic.

Nevertheless, we must reckon with the implications UMQ has on the similarities and differences between singleton and geminate consonants. Specifically, if codas are universally moraic, this raises the question of how geminates can be distinguished from singleton consonants. First, it is worth noting that in many instances, singleton and geminate consonants behave identically for weight-sensitive phenomena, so no distinction between the two types of consonants is necessary. For example, Ryan (2019: 64–81) surveys languages with quantity-sensitive stress, singleton codas (CVC) and geminates (CVG), and finds that CVG patterns with CVC in terms of weight for 94% of the languages he surveys. When CVC is heavy alongside CVː, CVG is heavy as well. Conversely, when CVC patterns as light and CVː heavy, CVG almost always patterns as light with CVC. At best, then, cases of CVG serving as heavy but CVC serving as light represent the exception rather than the rule.

However, while weight-sensitive stress systems largely treat CVG and CVC uniformly, numerous cases exist in which geminates behave differently than singletons for other weight-sensitive processes. Koya (Tyler 1969; Sherer 1994; Davis 2011), a Dravidian language spoken in central and southern

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India, presents one example. In this language, syllables with long vowels closed by a singleton coda are permissible (41a), but syllables with long vowels closed by a geminate consonant are prohibited: stem-final long vowels shorten when followed by a geminate suffix (41b) but not when followed by a singleton suffix (41c).

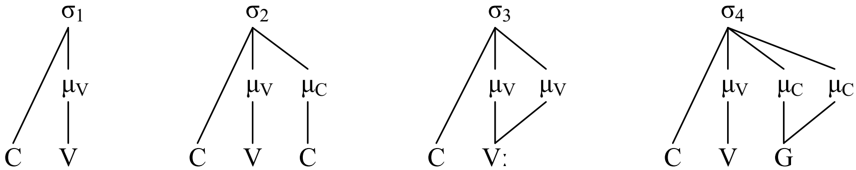
(41) *Syllable template restrictions in Koya* (data from Davis 2011: 11)

a.	/**le**:ŋga/	→ **le**:ŋ.ga	'calf'
b.	/**ke**: + tt + o:ɳɖu/	→ **ke**t.to:ɳ.ɖu	'he told'
c.	/tuŋg + an**a**: + n + ki/	→ tuŋ.ga.n**a**:ŋ.ki	'for the doing'

Any theory of weight must account for the fact that geminate consonants, though often indistinguishable from singleton codas for weight-sensitive phenomena such as stress, sometimes pattern differently, as in the Koya example. The present theory rests on the claim that coda consonants are always moraic, and this includes geminates. It remains agnostic, however, as to the specific underlying moraic representation of these two classes of consonants. Previous scholarship has teased apart singleton consonants from geminate consonants by arguing that singleton consonants are underlyingly non-moraic, while geminates are inherently moraic. However, such a distinction is not tenable under UMQ, in which all codas are moraic. Alternatively, it seems plausible to assume that all segments – vowels and consonants alike – are underlyingly moraic, with an onset weight prohibition constraint like the one proposed by Hyman (1985: 15–16) precluding onsets from retaining their mora on the surface except in rare cases (see Topintzi 2008, 2010 for examples).

Regardless of their underlying representations, cases in which geminates outweigh singletons can no longer be explained as a byproduct of surface differences in moraicity induced by Weight by Position (Hayes 1989; Davis 2011). One potential explanation is that just as singleton vowels are considered monomoraic and geminate/long vowels bimoraic, the same distinction also exists for consonants. That is, a singleton coda consonant is monomoraic, and a geminate consonant is bimoraic, as shown in (42). In addition to providing a uniform representation for the difference between singleton and geminate segments in general, postulating bimoraic geminate consonants in conjunction with the Moraic Sonority Metric has the potential to explain cases in which CVG patterns with CVC as well as cases in which it behaves distinctly. For instance, in cases of weight-sensitive stress where both CVG and CVC pattern as heavy with CV:, $S \rightarrow [\mu\mu]_\sigma$ is active and allows all syllables with two or more moras to attract stress. Crucially, the proposed trimoraic status of CVG syllables in σ_4 of (42) compared to the bimoraic status of CVC in σ_2 is irrelevant for this constraint, since all syllables with at least two moras of any sonority satisfy $S \rightarrow [\mu\mu]_\sigma$. The same is true when both CVG and CVC pattern as light, and only CV: attracts stress. In this case, $S \rightarrow [\mu_V\mu_V]_\sigma$ is active and ignores consonantal moras in its weight computations, so the presence of an additional consonantal mora in CVG syllables makes no difference in its ability to attract stress compared to CVC; both syllable types violate $S \rightarrow [\mu_V\mu_V]_\sigma$ because they contain only a single vocalic mora.

(42) *Proposed moraic structure of singletons and geminates*



For cases in which geminates behave differently than singletons, however, positing that geminates are bimoraic provides clarity as to why the distinction exists. Consider the Koya data in (41). Under previous moraic analyses, CV:G is argued to be prohibited in such languages due to a ban on trimoraic syllables, whereas CV:C is permitted since the final consonant is analysed as non-moraic. Under UMQ in tandem with the bimoraic analysis of geminates, a restriction on maximum syllable weight also

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provides an explanation; rather than avoiding trimoraic syllables, these languages institute a restriction against tetramoraic syllables, evinced by their preclusion of CVːG. Conversely, since CVːC is only trimoraic, the languages permit these syllables to surface.

Another interesting prediction that follows from the twofold proposition that geminates are bimoraic and every coda consonant links to its own mora is that geminates should pattern with coda clusters in terms of weight. We should expect to find weight-sensitive processes in which CVG and CVCC syllables behave similarly to the exclusion of bimoraic CVC syllables, since both CVG and CVCC are trimoraic. Intriguingly, Topintzi & Davis (2017) find that final geminates and coda clusters overwhelmingly pattern together in terms of weight across weight-sensitive phenomena, either both acting as heavy or both acting as light. One example they cite in which CVG and CVCC behave as heavy and CVC as light comes from the Cairene Arabic stress system. As shown in (43a) and (43b), both final syllables with clusters and final syllables with geminates attract stress, whereas final syllables closed by a singleton do not (43c). Under an analysis in which both CVG and CVCC syllables are trimoraic, the stress facts in Cairene Arabic can be accounted for with a constraint preferring stress to fall on superheavy syllables.

(43) Geminates and clusters in Cairene Arabic (Topintzi & Davis 2017: 263–265)

a. ka.ˈ**tabt** ‘I wrote’
b. ʔa.ˈ**xaff** ‘lightest’
c. ˈ**ka**.tab ‘he wrote’

In any case, a comprehensive treatment examining the relationship between geminate and singleton consonants cross-linguistically is warranted, given the drastic reinterpretation of coda consonants under the theory of UMQ proposed here. Nevertheless, analysing geminates as bimoraic seems like a promising avenue to pursue.

5.2. Stress-repelling schwa

As noted in §3.3, recent work argues convincingly against syllable weight distinctions based on differences in vowel quality. With that said, a handful of languages reportedly provide evidence for a non-moraic schwa that repels stress. One particularly compelling example comes from Piuma Paiwan, a language of southern Taiwan (Shih 2019b). Primary stress in Piuma Paiwan falls on the penultimate syllable by default, as in (44a) and (44b). However, according to Shih, if the penultimate syllable contains a schwa, stress shifts away from the default position to the final syllable, regardless of whether the final syllable contains a full vowel (as in (44c) and (44d)) or another schwa (as in (44e) and (44f)). To account for the distribution of stress without referring to vowel sonority differences, Shih contends that Piuma Paiwan has three types of schwa: a bimoraic schwa that occurs in the head syllable of a foot (the final syllable in (44e) and (44f)), a monomoraic schwa that occurs in the non-head syllable of a foot (44b), and a non-moraic schwa that only arises when a syllable is left unfooted (the penultimate syllable in (44c)–(44f)). One of Shih's justifications for the analysis of penultimate schwa as non-moraic relies on the unique acoustic properties of the penultimate schwa compared to word-final schwas. Shih conducted experiments on the acoustics of schwa in disyllabic words and found that the duration of the penultimate schwa is drastically shorter than other vowels, and that its quality is significantly more variable. On the other hand, the word-final stressed schwa in (44e) and (44f) is significantly longer than both the penultimate schwa and the word-final unstressed schwa, which Shih argues is a consequence of their differences in mora count.

(44) *Stress in Piuma Paiwan* (Shih 2019b)

a.	ˈtsa.viʎ	‘year’	c.	kə.ˈri	‘small’	e.	ɭə.ˈʎət	‘lip’
b.	ˈtu.lək	‘to direct’	d.	kə.ˈman	‘to eat’	f.	tsə.ˈməɭ	‘grass’

https://doi.org/10.1017/S0952675724000204 Published online by Cambridge University Press

Given the current proposal, it seems reasonable to propose an additional tier to the Moraic Sonority Hierarchy to account for the apparent weight distinction in Piuma Paiwan between full and reduced vowels. However, at least three considerations militate against such a proposal. To begin with, the nature of the distinction between full and reduced vowels is categorically different from the moraic sonority constraints considered in this article. The constraints associated with the Moraic Sonority Metric assign violations based on the number of moras of a specified sonority, not based on sonority alone. Adding a vowel quality constraint to distinguish full vowels from central vowels, on the other hand, necessarily relies solely on moraic sonority without regard to moraic quantity. For example, the Moraic Sonority constraint $S \rightarrow [\mu_V \mu_V]_\sigma$ penalises stress on syllables with less than two vocalic moras, thereby distinguishing between syllables with one vocalic mora and syllables with more than one vocalic mora. A hypothetical constraint like $S \rightarrow [\mu_F]_\sigma$ that penalises stress on syllables without a full vowel, in contrast, cannot rely on quantity distinctions of one/more than one like $S \rightarrow [\mu_V \mu_V]_\sigma$, since the nature of the contrast is based on the presence/absence of a full vowel. Instead, a constraint like $S \rightarrow [\mu_F]_\sigma$ would be more like the standard vowel sonority constraints proposed in Kenstowicz (1997) and de Lacy (2006) than like the Moraic Sonority constraints presented in this article. Second, an additional schwa tier is unwarranted because the constraint would not accurately predict primary stress in Piuma Paiwan anyway, as penultimate schwas in the language yield stress to both full and schwa vowels alike. If the reason for the stress shift in Piuma Paiwan were based on a constraint dispreferring stress on syllables with reduced vowels, we would not expect penultimate schwa to yield stress to a word-final schwa, as in (44e) and (44f). Thus, something else must underlie the apparent repulsion of stress from penultimate schwa. Finally, I am unaware of any other syllable weight process besides stress that ostensibly distinguishes syllables based on the presence of a full versus reduced vowel. Since weight distinctions correlating with the Moraic Sonority Hierarchy apply to all syllable weight processes, the inclusion of a schwa tier would inaccurately predict the presence of weight distinctions between full and reduced vowels for all other weight processes. Considering these facts, proposing a sonority constraint that penalises stress on reduced vowels to account for the weak schwa in languages like Piuma Paiwan is undesirable.

That being said, an alternative explanation to the proposal that these weak schwas are non-moraic is available. That is, weak schwas may represent cases of vowel intrusion as described by Hall (2006) and Bellik (2018). Unlike lexical and epenthetic vowels, intrusive vowels are not vowels at all. Instead, they are perceived vowel-like intervals that occur between consonants due to gestural timing relations (Browman & Goldstein 1993). Importantly, intrusive vowels do not correspond to their own segment, and consequently cannot participate in phonological processes or be targeted for stress assignment, which would explain why these vowels appear to repel stress. In addition, the apparent non-moraic schwa in Piuma Paiwan, and other languages like it, bears all the features characteristic of a typical intrusive vowel: it is significantly shorter in duration than other vowels and is heavily influenced by the quality of nearby segments. Chen (2009) also notes that, unlike other vowels, schwa in Piuma Paiwan never appears word-initially or adjacent to another vowel but only between consonants, lending further credence to the proposal that these weak schwas may, in fact, be intrusive vowels.

Subsequent work on weak schwas should examine their cross-linguistic phonetic and phonological behaviour to determine their influence (or lack thereof) on other phonological processes beyond stress. Additionally, it would be interesting to examine whether these weak schwas exhibit other characteristics typical of intrusive vowels discussed by Hall (2006) and Bellik (2018).

5.3. The Moraic Sonority Metric and vowel prominence

The Moraic Sonority Metric, in combination with UMQ, can make similar predictions about {CVː} > {CVC} > {CV} stress criteria to those of the vowel-prominence approach proposed in Ryan (2019, 2020), but the latter would need to be expanded in specific ways to capture the full typology of weight outlined in this article. Nevertheless, even if expanded, a crucial difference exists between the two

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theories in that the vowel-prominence approach does not offer an explanation for why moraic quantity combines with sonority to determine weight and not any other segmental feature, such as voicing or place of articulation. In its original form, the vowel-prominence approach provides an explanation for languages with a ternary {CV:} > {CVC} > {CV} primary stress criterion. As discussed in the present work, weight scales like {CV:} > {CVC} > {CV} are often incompatible with the variable-weight approach, since CVC must be simultaneously monomoraic and bimoraic in the same environment for different weight-sensitive processes within the same language. As a solution, the vowel-prominence approach proposes that – only in languages with the {CV:} > {CVC} > {CV} stress criteria – both CV: and CVC must be uniformly bimoraic, and the vowel prominence constraint in (45) distinguishes between CV: and CVC by preferring for stress to fall on syllables with a long vowel.

(45) MAIN → VV (Ryan 2019)
Assign a violation for primary stress that falls on a short vowel.

A tableau demonstrating the efficacy of the constraint in (45) is provided in (46). Because both CV: and CVC are bimoraic, S → $[\mu\mu]_\sigma$ is unable to distinguish between candidate (46a), which stresses CV:, and candidate (46b), which stresses CVC. However, candidate (46b) violates MAIN → VV, because it places primary stress on a syllable with a short vowel. As a result, candidate (46a) emerges as optimal.

(46) *CVC attracting stress from CV*

CV:CVC	MAIN → VV	S → $[\mu\mu]_\sigma$
☞ a. ˈ$CV{:}_{\mu\mu}.CV_\mu C_\mu$		
b. $CV{:}_{\mu\mu}.$ˈ$CV_\mu C_\mu$	*!	

While MAIN → VV (which evaluates segments) and S → $[\mu_V\mu_V]_\sigma$ (which evaluates moras) refer to different levels of phonological structure to compute weight, they have identical violation profiles, because primary-stressed CV and CVC violate both constraints. And while the vowel-prominence approach is argued only to be relevant for languages with the {CV:} > {CVC} > {CV} stress criterion, the proposal could be expanded to account for the typology of weight presented in this article. Specifically, the vowel-prominence approach would make similar predictions to the Moraic Sonority Metric if it assumed UMQ and adopted an additional prominence constraint that mimicked S → $[\mu_R\mu_R]_\sigma$ to penalise stress on a syllable with only a single sonorant segment in the rhyme, as in (47):

(47) MAIN → RR
Assign a violation for primary stress on a syllable with one sonorant segment or less in the rhyme.

Nevertheless, while such an expansion of the circus whiskey approach is possible, it is undesirable compared to the Moraic Sonority Metric, because it does not restrict the possibility of other segmental features as possible contributors to syllable weight. For instance, the prominence constraints MAIN → VV and MAIN → RR must access information on the segmental level to determine segmental sonority before weight can be computed. The requirement that these prominence constraints be able to access the segmental level of representation is problematic, because it implies access to all of the featural information present there. The question arises under the circus whiskey approach, then, as to why sonority is the only segmental feature used in weight computations. In other words, the prominence approach in its current form does not constrain the relevant information for syllable weight to sonority. The Moraic Sonority Metric, in contrast, proposes a theory of what information can be relevant (sonority) and encodes this information in such a way that other segmental information cannot be accessed (in moras). As a result, the theory makes a particular set of restrictive predictions about syllable weight. Namely, only sonority and moraic quantity contribute to weight. The question is, can

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we find instances in which sonority and mora count demonstrably behave separately or contrary to one another for weight? The claim made here is that we should not be able to do so.

5.4. Alternative representations of syllable weight

The claims set forth in this article operate under the assumption that the mora is the apparatus best equipped to tackle the wide array of linguistic processes judged as sensitive to syllable weight. Despite this assumption, the argument for UMQ advanced in this proposal seriously undermines one of the central components buttressing moraic theory. Notably, many proponents of moraic theory argue that the variable moraicity of codas provides some of the strongest support in favour of the mora. After all, if coda moraicity were consistent, as proposed here, much of the work managed by the mora could be achieved by other means, thus weakening the case for positing moraic structure at all. This section briefly considers another mechanism used in the literature to analyse weight sensitivity – skeletal slot theory – as an alternative to the mora.

Skeletal slot/CV theory, as conceived by McCarthy (1981) and Clements & Keyser (1983), among others, provides an avenue to explain many phonological phenomena that seem to operate independent of the segmental level, similar in many ways to the function of the moraic tier but with important differences. One substantial distinction separating skeletal slot theory from moraic theory is the assertion in skeletal slot theory that every short segment, regardless of its syllabic identity as an onset, nucleus, or coda, links to a timing slot, and every long segment links to two timing slots. Standard moraic theory, on the other hand, holds that only vowels and codas may project a mora, and that coda consonants sometimes do not project a mora when treated as weightless for stress. As outlined in §3, the variable moraicity of codas proposed by traditional moraic theorists falters under closer inspection of the facts, which could be taken to provide support for the skeletal slot model of syllable weight. In fact, Gordon (2006: 2–8) cites the inability of moraic theory to treat syllable weight as process-specific rather than language-specific as a major justification for using skeletal timing slots instead of moras. In order to capture distinctions between syllable types that have an identical number of timing slots but that differ in sonority values, Gordon (2006: 44) argues that skeletal slots can be differentiated for weight-based purposes by the features to which they are linked. The main advantage of Gordon's version of skeletal slot theory over moraic theories of weight is that weight representations remain constant both cross-linguistically and within languages.

That said, skeletal slot theory has largely been jettisoned in favour of moraic theory for several reasons. For instance, Prosodic Morphology (McCarthy & Prince 1995) provides compelling evidence that prosodic units – including the mora – are vital for explaining the shape of templates used in morphological phenomena such as reduplication and root-and-pattern systems. Crucially, alternative theories relying on segmental (rather than prosodic) structure fail to make the correct generalisations about these templates. In other words, cross-linguistic morphological patterns require the ability to reference a prosodic constituent equivalent to the mora to account for these phenomena accurately.

The necessity of the mora is further bolstered with evidence from compensatory lengthening, in which the deletion of one segment triggers the lengthening of another segment in the same word (Hayes 1989). Importantly, compensatory lengthening effects are not necessarily local in their application (Borgeson 2022). That is, while most cases of synchronic CL occur between two segments that are either directly adjacent or in adjacent syllables, as in (48a), evidence from Slovak and Estonian indicates that CL effects can cross multiple syllable boundaries in a word as well, as in (48b). These long-distance CL effects confound segment-based theories attempting to explain the phenomenon without recourse to an abstract unit of weight such as the mora. Additionally, whereas moraic theory explains why CL effects triggered by onsets are, at best, vanishingly rare – onsets are not typically mora-bearing – segmental approaches offer no such explanation. Altogether, the empirical reality of long-distance CL, coupled with the asymmetric behaviour of codas/nuclei compared to onsets with respect to CL, demonstrate that the mora is crucial to explaining compensatory lengthening.

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(48) *Examples of compensatory lengthening*

a. *Adjacent CL in Latin and Middle English* (Hayes 1989)

i.	/kasnus/	→ kaːnus	‘gray’	(Lat.)
ii.	/talə/	→ taːl	‘tale’	(ME)

b. *Long-distance CL in Estonian* (Borgeson 2022: 269–273)

i.	/kaːlu-ta/	→ kaːːlu	‘weight-PART’
ii.	/kotti-ta/	→ kotːti	‘bag-PART’

Other issues with skeletal slot theory include its lack of explanation for onset/coda asymmetries and the fact that it has largely been superseded by prosodic structure as the best tool for constraining various syllable properties like segment count and syllabicity (Broselow 1995). In sum, an adequate theory of weight requires reference to abstract weight units distinct from the segmental level. Thus, moraic theory endures as the most effective mechanism for capturing weight-sensitive phenomena. Considering the shortcomings of skeletal slot theory against the theory of moraic structure fleshed out in this article, which offers a solution to the main complaints against moraic theory raised by Gordon (2006), it seems that skeletal slot theory faces an uphill battle for the title of the best method for representing weight distinctions.

5.5. Preliminary thoughts on other weight-sensitive phenomena

One of the central claims advanced in this article is the assertion that all weight-sensitive phenomena rely solely on the Moraic Sonority Metric to make syllable weight distinctions. Nonetheless, I only provide a comprehensive formal account of one weight-sensitive process: stress. This raises the question of how formalisations of the Moraic Sonority Metric for other processes will be achieved. I offer some preliminary speculations regarding formalisations for tone and word minimality here without exploring the adequacy of the proposals in detail.

5.5.1. Weight-sensitive tone

Something comparable to the constraint set in (49) has the potential to cover the typological inventory of tonal criteria.

(49) *Tonal Moraic Sonority constraints*

a. NoContour-μ (Ito & Mester 2019: 5)
Assign a violation for every contour tone linking to a syllable with less than two moras.

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

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

d. NoContour-σ (Ito & Mester 2019: 5)
Assign a violation for every contour tone linking to a syllable.

Much like the Moraic Sonority stress constraints in §4, each of the tonal constraints in (49) penalises candidates based on a different subset of the available mora types, thereby making a bifurcation at a different level of the Moraic Sonority Hierarchy, as depicted in (50).

(50) *The Moraic Sonority Hierarchy and tonal constraints*

Contour tones prohibited	→ | ←	NoContour-σ
	μ_V	
{CV:} > {CVC, CV}	→ | ←	NoContour-μ_V
	μ_R	
{CV:, CVR} > {CVO, CV}	→ | ←	NoContour-μ_R
	μ_O	
{CV:, CVC} > {CV}	→ | ←	NoContour-μ

NoContour-μ penalises any contour tone that links to a syllable with less than two moras, regardless of mora type. Consequently, only bimoraic syllables (CV: and CVC) are heavy and able to host a contour tone. Because every mora type contributes to syllable weight when NoContour-μ is active, this corresponds to a bifurcation below the lowest mora type, μ_O, and results in a general distinction between bimoraic and monomoraic syllables. About 5% of languages in Gordon's (2006) weight survey that exhibit weight-sensitive tone use this constraint in their tonal criteria.

Conversely, when NoContour-μ_R is active, only syllables with two sonorant moras (CV: and CVR) are heavy and able to host a contour tone. This constraint corresponds to a bifurcation between μ_O and μ_R and results in obstruent moras not contributing to weight. In other words, even though CVO is bimoraic under UMQ, NoContour-μ_R ignores obstruent moras and thus treats CVO as light for tonal criteria. The resulting weight criterion that surfaces when NoContour-μ_R is active makes up about 49% of the languages in Gordon's survey that have a weight-sensitive tonal system.

NoContour-μ_V, in contrast to both NoContour-μ_R and NoContour-μ, penalises any syllable with less than two vocalic moras that bears a contour tone. Consequently, when NoContour-μ_V is active, only syllables with long vowels may host a contour tone, thereby producing the scale, {CV:} > {CVR, CVO, CV}, which corresponds to a bifurcation between μ_R and μ_V on the Moraic Sonority Hierarchy in (50). This constraint is active in about 46% of the languages in Gordon's survey.

The final bifurcation on the Moraic Sonority Hierarchy, above μ_V, corresponds to the constraint NoContour-σ. Because no mora type falls above the bifurcation point when NoContour-σ is active, moras are ignored across the board, and contour tones are prohibited on every syllable type without regard to moras.

In sum, the three Moraic Sonority constraints for tone in (49a)–(49c) account for about 99% of the languages with weight-sensitive tonal systems in Gordon's survey. Nevertheless, it may be challenging to explain the tonal criterion of Cantonese, which seems to diverge from the general pattern of weight-sensitivity described in this article (Gordon 2006: 93–95). Specifically, it is unexpected that CVO and CV:O syllables cannot host contour tones in Cantonese, while CV and CVR syllables are able to do so. However, an anonymous reviewer points out that the shape of the Cantonese tonal criterion may be attributable to historical consequences of tonogenesis, as in other Southeast Asian languages in which similar tonal patterns have emerged.

5.5.2. Word minimality

Since at least Prince (1980), linguists have linked word minimality with foot minimality, arguing in favour of a Prosodic Minimality Hypothesis (PMH) in which the smallest allowable prosodic word must be the same size as the smallest allowable foot, often a single heavy syllable (e.g., McCarthy & Prince 1986; Blumenfeld 2011). However, since the conception of the PMH, further research has shown that many languages exhibit a mismatch in size between minimal feet and minimal words (Garrett 1999; Gordon 2006). That said, most word minimality conditions can be explained in terms of binarity at some level of prosodic analysis, which makes the phenomenon amenable to analysing minimality constraints as a requirement of foot binarity. Importantly, though the exact kind of binarity required

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for minimal words is often at odds with the foot binarity requirements for metrical stress, Blumenfeld (2011) argues that these mismatches arise from independent constraints that affect monosyllabic words differently from longer words. Though Blumenfeld couches his argument within the theory of coercion, his rationale also applies under the present proposal. Namely, foot binarity underpins both minimal foot size and minimal word size, but conflicting constraints such as Dep$_\mu$ and Lx=Pr (Prince & Smolensky [1993] 2004) frequently result in surface mismatches between minimal words and minimal feet. With this in mind, I tentatively propose the family of FtBin constraints in (51) to account for word minimality effects, each of which correlates with a different bifurcation on the Moraic Sonority Hierarchy.

(51) *Word-minimality Moraic Sonority constraints*

a. FtBin(μ)
Assign a violation for every foot without two moras.

b. FtBin(μ_R)
Assign a violation for every foot without two sonorant moras.

c. FtBin(μ_V)
Assign a violation for every foot without two vocalic moras.

d. FtBin(σ) (Prince & Smolensky [1993] 2004, among many others)
Assign a violation for every foot without two syllables.

Instead of a generic FtBin constraint requiring binarity at either the syllable or mora level (Prince & Smolensky [1993] 2004), Moraic Sonority FtBin constraints stipulate a specific type of binarity to which feet must adhere. For instance, FtBin(μ) falls below all levels of the Moraic Sonority Hierarchy in (52), thereby allowing every mora type to contribute to the satisfaction of binarity. In terms of minimality, this means that any bimoraic word, regardless of mora type, satisfies the constraint, leading to a CVC minimal word requirement for languages in which FtBin(μ) is active. In Gordon's (2006) survey, of the 127 languages that permit codas and have a minimum word size requirement, about 63% impose the CVC minimum.

(52) *The Moraic Sonority Hierarchy and word minimality*

Disyllabic minimum → | ← FtBin(σ)
μ_V
{CV:} > {CVC, CV} → | ← FtBin(μ_V)
μ_R
{CV:, CVR} > {CVO, CV} → | ← FtBin(μ_R)
μ_O
{CV:, CVC} > {CV} → | ← FtBin(μ)

It is unclear whether languages exist in Gordon's survey that use FtBin(μ_R), which would result in a CVR minimum. Four of the languages in the survey (3%) potentially impose this constraint, but these languages also prohibit obstruent codas altogether, obscuring which FtBin constraint – FtBin(μ_R) or FtBin(μ) – is responsible for the minimality requirement. The lack of obvious cases in which FtBin(μ_R) applies could be due to the fact that divisions between obstruent and sonorant consonant moras are relatively rare across most weight-sensitive phenomena. Additionally, it is possible that cases of CVR minima have been misreported by grammatical descriptions as cases of generic CVC minima. Of course, this line of reasoning is merely speculative, so further research is necessary.

FtBin(μ_V) only permits vocalic moras to contribute to binarity, corresponding to a bifurcation above μ_R. The activity of this constraint is widely attested, with about 15% of the languages in Gordon's survey enforcing a CV: minimum. Finally, when languages make a bifurcation above μ_V, all mora types are ignored, and binarity is instead satisfied at the syllable level, enforced by FtBin(σ). The result is a disyllabic minimum that about 17% of the languages in Gordon's survey implement.

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Altogether, the four proposed Moraic Sonority FtBin constraints in (51) account for approximately 98% of the languages in Gordon's survey that institute a minimal word restriction. The remaining 2% of languages establish a minimum that requires words to contain at least three moras of various sonorities. However, as Blumenfeld (2011) notes, almost all apparent cases of minimality not neatly explained by binarity fall out from other components of the phonological grammar in these languages, such as vowel lengthening in closed syllables in Menominee (Milligan 2005). Whatever the facts may be, the factors involved in the typology of minimal words are diverse and complex. A thorough examination of the full typology of word minimality is therefore needed, including an exploration into the influence of the proposed FtBin constraints on the interaction between minimality and metrical foot structure.

6. Conclusion

This article has outlined a theory of moraic structure that treats weight sensitivity as a process-specific (rather than language-specific) phenomenon. In §2, I showed that the traditional outworkings of moraic theory do not allow for syllable weight to vary across processes within a single language, a limitation that is contradicted by a majority of languages with multiple weight-sensitive patterns. Therefore, I proposed an alteration to moraic theory in §3 in the form of UMQ theory – which requires coda consonants to link to their own moras – and the Moraic Sonority Metric, which establishes syllable weight divisions based on the number of moras of a specified sonority in a syllable rather than the sum total of moras. If adopted, UMQ and the Moraic Sonority Metric improve our formal analysis of syllable weight in a number of ways. First, by positing uniform moraicity and using moraic sonority values to distinguish syllables, moraic theory successfully captures the empirical realities of weight sensitivity as a process-specific phenomenon. Second, the theory of moraic structure is simplified by ridding the grammar of language-specific (W×P) and context-specific (coercion) stipulations about moraicity. Finally, the Moraic Sonority Metric is claimed to account for syllable weight criteria across processes and languages, which, if proven true, would mean that a single metric is capable of capturing a diverse set of processes that hitherto have required several disconnected approaches to be accounted for. In §4, I formalised the Moraic Sonority Metric for weight-sensitive stress to demonstrate the efficacy of the metric in accounting for a weight-sensitive process with a diverse inventory of criteria. The factorial typology of these Moraic Sonority constraints was explored in §4.2, revealing that only the most complex set of criteria that the framework predicts are unattested, an unsurprising fact given the combined rarity of the distinctions employed in these predicted systems.

Transferring the explanation of syllable weight mismatches from variation in moraic structure to differences in moraic sonority has some meaningful ramifications. Specifically, it suggests that any phenomenon related to syllable weight ought to exhibit the hierarchical divisions enumerated by the Moraic Sonority Metric. The present article focused mainly on stress and gave brief overviews for potential analyses of weight-sensitive tone and word minimality. Future research exploring the veracity of the theory explicated here should test its predictions against other weight-sensitive processes to see if its claims are substantiated. Promising areas of work include NC clusters in Bantu languages (Hyman 1992), in which preconsonantal nasals exhibit variable weight across processes. Additionally, there are some interesting patterns of reduplication – especially in recent work by Mellesmoen (2023) on in Salish – that seem to corroborate the proposals made in this article since certain reduplicative affixes require reference to moras of specific sonorities in their prosodic templates. Other areas of interest include syllable template restrictions, metre, onset/coda inventory asymmetries and compensatory lengthening.

Appendix A. Examples of additional languages found to exhibit coda moraicity in Gordon's (2006) survey

(53) *Cayuga: Codas block penult vowel lengthening* (Hatcher 2022: 24-25)

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

https://doi.org/10.1017/S0952675724000204 Published online by Cambridge University Press

(54) *Cherokee: Codas induce vowel shortening* (Uchihara 2013: 131–137)
  a. /gin**i**ː-naːdi/ → ki.n**i**ː.naː.ti 'for you and me to set it (FLEXIBLE) down'
  b. /gin**i**ː-hdi/ → ki.n**ih**.ti 'for you and me to set it (COMPACT) down'

(55) *Malecite: Codas (except* h*) block lengthening in stressed syllables* (LeSourd 1993: 41)
  a. /**nwí**.sə.**kè**.ləm/ → **nwí**ː.sə.**gè**ː.ləm 'I laughed hard'
  b. /**éh**.pit/ → ˈ**e**ː**h**.pit 'woman'
  c. /**ní**h.ka.**nát**.pat/ → **ní**ːh.ka.**nát**.pat 'head (of an organisation)'

(56) *Malto: CVC minimal content word restriction* (Mahapatra 1979: 55)
  a. nin 'you'
  b. toq 'to finish'
  c. a 'that'
  d. je 'that'

(57) *Tidore: CVC minimal word restriction* (Pikkert & Pikkert 1995)
  a. cam 'to question'
  b. gam 'village'
  c. dun 'daughter-in-law'
  d. xad 'week'
  e. *CV

Acknowledgements. I'm extremely thankful to Rachel Walker, Ryan Bennett, Jaye Padgett, Brett Hyde and audiences at MidPhon 27 and AMP 2022 for their helpful feedback on this project. In addition, I'm grateful for the thorough reviews and suggestions from three anonymous *Phonology* reviewers and an anonymous associate editor. All remaining errors are mine.

Competing interests. The author declares no competing interests.

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