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The Mora-constituent interface model

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HONG KONG BAPTIST UNIVERSITY

Doctor of Philosophy

THESIS ACCEPTANCE

DATE: January 18, 2016

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THESIS TITLE: The Mora-Constituent Interface Model

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The Mora-Constituent Interface Model

SAMPATH KUMAR Srinivas

A thesis submitted in partial fulfillment of the requirements

for the degree of

Doctor of Philosophy


Principal Supervisor: Dr. WEE Lian-Hee

Hong Kong Baptist University

January 2016

DECLARATION

I hereby declare that this thesis represents my own work which has been done after registration for the degree of PhD at Hong Kong Baptist University, and has not been previously included in a thesis or dissertation submitted to this or any other institution for a degree, diploma or other qualifications.

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ABSTRACT

Phonological phenomena related to the syllable are often analysed either in terms of the constituents defined in the Onset-Rhyme Model; or in terms of moras after the Moraic Theory. Even as arguments supporting one of these theoretical models over the other continue to be unfurled, the Moraic Theory has gained significant currency in recent years. Situated in the foregoing theoretical climate, this dissertation argues that a full-fledged model of the syllable must incorporate the insights accruing from both constituents and moras. The result is the Mora-Constituency Interface model (MCI).

Syllable-internal structure as envisioned in MCI manifests in a Constituency Dimension as well as a Moraic Dimension. The dimensions interface with each other through segment-melody complexes, whose melodic content is associated with the Constituency Dimension and whose segmental (i.e. X-slot) component belongs to the Moraic Dimension. The Constituency Dimension and the Moraic Dimension are both thus necessary even to represent the atomic distinction between segments and melodies in a typical syllable.

In terms of its architecture, the Constituency Dimension in MCI is formally identical to the Onset-Rhyme Model and encompasses the Onset, the Nucleus and the Coda, with which melodies are associated. The Nucleus and Coda together constitute the Rhyme. In the Moraic Dimension, moras are assigned to segments on universal, language-specific or contextual grounds. From a functional perspective, the Moraic Dimension is where the metrical relevance of segment-melody complexes is encoded (as moras), while feature-based information pertaining to them is structured in the Constituency Dimension.

The independent functional justification for both the dimensions in MCI predicts that segment-melody complexes, though typically split across the dimensions as segments and melodies, may also be associated entirely with the Constituency Dimension or with the Moraic Dimension of a syllable. The former possibility finds empirical expression in extrametrical consonants, and the latter in moraic ambisyllabic consonants. Analogously, a syllable itself may have either just the Constituency Dimension (e.g. extrametrical syllables) or just the Moraic Dimension (e.g. catalectic syllables). The prosodic object called the syllable is thus a composite formal entity tailored from the constituent-syllable (C- σ) and the moraic-syllable (M- σ).

While MCI is thus essentially a model of syllable-internal structure, it also exerts some influence on prosodic structure beyond the syllable. For example, within MCI, feet can be directly constructed from moras, even in languages whose metrical systems are

traditionally thought of as being insensitive to mora count. The upshot is that a fully moraic universal foot inventory is possible under MCI.

That MCI has implications for the organisation of elements within (segment-melody complexes) and outside (feet) the syllable suggests that the model has the potential to be a general theory of prosodic structure. The model is also on solid cross-linguistic ground, as evidenced by the support it receives from different languages. Those languages include but are not restricted to Kwakwala, Chugach Yupik, Hixkaryana, Paumari, Leti, Pattani Malay, Cantonese, Tamil and English.

Keywords: Syllables, constituents, moras, segments, melodies

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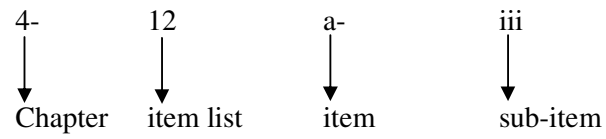
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NUMBERING AND TRANSCRIPTION

Item numbering

(C-Xx-y) where C refers to the relevant chapter, X to any item list in that chapter, x to a specific item and y to a sub-item.

Example:



Phonetic transcriptions are in IPA unless otherwise indicated.

LIST OF ABBREVIATIONS

Morphosyntactic abbreviations

ADJ	adjective/adjectival
CON	conative case
FEM	feminine
FUT	future tense
IMP	imperative
MASC	masculine
NEG	negative
PAST	past tense
PL	plural
POSS	possessive
PRES	present tense
SG	singular
TRANS	transitive

Phonological abbreviations

[cons]	consonantal
[cont]	continuant
[lab]	labial
[nas]	nasal
[son]	sonorant

CHAPTER 1

Syllabification and Syllable Structure

The phonological syllable is seen both as a formal space and as a temporal object. In its spatial role, the syllable acts as a domain in terms of which segmental melodies are organised. In its temporal role, the syllable consists of units of categorical duration, which are relevant for metrical purposes such as stress assignment.

The thesis I defend in this dissertation is that the metrical and organisational aspects of syllable structure are each independent of the other. It is thus possible for a syllable to be either a metrical object or an organisational object. A typical syllable is, however, argued to be a conjunction of both these objects under the Mora-Constituent Interface Model.

The present chapter situates this dissertation in a broader phonological context. The goal of the dissertation is laid out in §1.1. Theory-neutral evidence for the syllable provides content for §1.2. A brief review of syllabification in §1.3 leads to a first look at syllable-internal structure in §1.4. In §1.5, the Mora-Constituent Interface Model (MCI) is formally introduced. This introduction is followed by an overview of the kinds of empirical evidence supporting constituents and those supporting moras. The chapter concludes in §1.6 by foreshadowing the typological implications and prosodic implications of MCI.

1.1 Goal of the Dissertation

A comprehensive model of the internal structure of the syllable is proposed in this dissertation. Comprehensiveness here refers to a model's capacity to capture both metrical and melodic phenomena in which syllables play a role. Past studies on syllable-internal structure have independently focused on each, and often both, both these types of phonological phenomena.

Studies on the syllable which focus on melodic phenomena include Pike & Pike (1947), Kurylowicz (1948), Fudge (1969), Hooper (1972), Kahn (1976), Steriade (1982), Selkirk (1982), Vijayakrishnan (1982), Harris (1983), Levin (1985), Itô (1986), Borowsky (1989), Duanmu (1990), Bao (1990, 2000), Blevins (1995), Rubach (1998), Kim (1998), Cai (2005), Wee (2011), Myers (2015) and Berg & Koops (2015). Studies focusing on the syllable as a metrical domain include Haugen (1949: 280-1, cited in Levin 1985: chapter 1),

Kiparsky (1979, 1980, 2003), Selkirk (1980), Hyman (1984, 1992), Halle & Vergnaud (1987), Hayes (1989, 1995), McCarthy (1986/1996, 1990), Zec (1995, 2003), Broselow, Chen & Huffman (1997), Peperkamp (1998), Cohn (2003) and Ong (2007). Based on these studies, the following goal becomes a desideratum: a comprehensive theory of syllable structure must minimally account for both the melodic and the metrical facts attributed to the syllable.

The goal may be met, in principle, by reanalysing melodic facts in terms of the metrical syllable (see for e.g. Zec 1995 and Bernouss 2007; cf. Pierrehumbert & Nair 1995, Yip 2003) or by reanalysing metrical facts in terms of the melodic syllable. In Chapters 2 and 3, however, both these reductionist strategies are shown to be untenable. The Mora-Constituent Interface Model proposed in this dissertation represents a non-reductionist alternative. By combining the insights that accrue from the melodic syllable and the metrical syllable, **it recasts the two different types of syllables as different dimensions of syllable structure** (see Cheung 2008 for a related proposal; cf. van der Hulst & Rowicka 1998).

Any formal proposal on the syllable, however, presupposes that the syllable has theory-external standing. This point is especially significant owing to the former scepticism over the status of the syllable as a phonological primitive. Within generative phonology, for instance, SPE does not appeal to the syllable at all (as made explicit in Hammond 1999: 246), while Hyman (1984: 14-15, 28-30) questions its formal standing in the context of languages like Gokana. The empirical reality of the syllable is, therefore, (re)established in §1.2 before the relevant theoretical issues are reviewed.

1.2 Evidence for the Syllable

Independent of any phonological theory one may embrace, there are at least four types of evidence which argue for the reality of the syllable. These come from orthographic scripts, stress differences in dialects of the same language, poetry and language games.

Firstly, syllabification seems to have exercised at least a partial influence on the orthography of certain languages (Gnanadesikan 2008). In the Linear B transcription of Greek, for example, tautosyllabic pre-vowel consonant clusters are rendered by repeating the syllable's vowel after every consonant. Post-vowel consonants on the other hand are omitted.

(1-1) **Linear B transcriptions** (Steriade 1982: 121)

	<i>Orthography</i>	<i>Syllabification</i>	<i>Gloss</i>
a.	arekasadara	a.le.ksan.dra	'Alexandra'

- b. kowa kor.wa 'girl'
 c. kowo kor.wos 'boy'

Secondly, cross-dialectal stress differences demonstrate the utility of the syllable and syllabification in describing phonological systems. In those varieties of English collectively labeled as 'Standard', for example, the word *penetrate* (cf. *emigrate*, *calibrate*, etc) is syllabified as [ˈpe.nə.treɪt] or [ˈpen.ə.treɪt] (cf. Selkirk 1982) and is stressed on the antepenultimate syllable. A third possibility (Kahn 1976: 33-5) has an ambisyllabic [n], straddling the first and second syllables; with stress still falling on the antepenult. Crucially, [t] is in the final syllable; an observation that can be independently confirmed. Penultimate syllables ending in consonants are typically stressed in verbs and morphologically simple adjectives in English, as in *sur.ren.der* [sə.ˈrɛ.n.də] and *in.dig.nant* [ɪn.ˈdɪɡ.nənt] (cf. *me.an.der*, *effulgent* etc). That the penultimate syllable is not stressed in *penetrate* suggests that [t] is not part of the penult in the word in question.

In Tamilian English (Vijayakrishnan 1978: chapter 1), however, it is the penultimate syllable which is stressed in words like *penetrate*, suggesting a syllable division whereby [t] is in the penult (Vijayakrishnan p.c): i.e. [pe.ˈnet.re:t]/[pen.ˈet.re:t], or [peˈnˈet.re:t] with an ambisyllabic [n]. In Standard English, as seen above, [t] is tautosyllabic with the pre-vowel [r] in the final syllable. It is this difference in syllabification that manifests as a stress difference: penult stress in Tamilian English and antepenult stress in Standard English.

Thirdly, poetic meters are characterised by a fixed number of syllables in a line; with further specifications on how stressed syllables and unstressed syllables are to be organised therein. Thomas Gray's *Elegy Written in a Country Churchyard*, for example, opens as follows:

(1-2) **Syllables in English verse**

“The₁ cur₂few₃ tolls₄ the₅ knell₆ of₇ par₈ting₉ day₁₀
 The₁ lo₂wing₃ herd₄ wind₅ slow₆ly₇ o'er₈ the₉ lea₁₀”

The *Elegy* is written in iambic pentameter; a scheme where every line has ten syllables, odd-numbered syllables are unstressed, and even-numbered syllables are stressed, (counting from the left). In the second line in (1-2), *over* appears as *o'er*. This contraction is common in English poetry along with *'twere* ('it were'), *'tis* ('it is') etc. It is justified because *o'er* is monosyllabic, and using the bisyllabic *over* would have meant the second line having

eleven syllables instead of the prescribed ten. Such contractions show that syllable count, and syllables, play an important role in versification.

The Imdlawn Tashlhiyt dialect of Berber (ITB) (Dell & Elmedlaoui 1985, Jebbour 1999, Pater 2012) also endorses the significance of syllables in poetry. Dell & Elmedlaoui (1988) report that strings composed solely of consonants are well-formed syllables in ITB verse. In a canonical nine-syllable line, exemplified in (1-3), the third, fifth and eighth syllables all have (underlined) consonantal peaks, which in turn are preceded or followed by another consonant. The bracketed consonants are not relevant to the point at hand. The source work does not supply glosses/translation for the lines in (1-3) (or those in (1-4)).

(1-3) Syllables in ITB verse

ʃah₁ wa₂ nb₃ na₄ dm₅ kaw₆ ri₇ (t)tr₈ wah(n)₉

Furthermore, the first, sixth and ninth syllables in an ITB verse-line are designated heavy. The fact that the first and sixth syllables in (1-4a) are fully consonantal indicates that such syllables can also be heavy. In (1-4b) the first, sixth and ninth syllables all end in a vowel-consonant sequence, scanned heavy in many poetic traditions including Homeric Greek (Steriade 1982: 122-3).

(1-4) Heavy syllables in ITB verse

a. lx₁ la₂ va₃ si₄ (g)gi₅ lnt₆ si₇ sa₈ far(n)₉

b. luh₁ su₂ ʒd₃ di₄ ga₅ tal₆ wr₇ (t)tn₈ mar(s)₉

Lastly, the manner in which strings are syllabified is often manipulated in play languages and language games. In *Ka Language* used by Tamil children, for instance, Vijayakrishnan (1982) reports inter-speaker variation regarding the site(s) where [ka] is inserted. One group of speakers prefixed [ka] to syllables. Their renditions are given in the column labelled ‘Group 1’ in (1-5). A second group of speakers inserted [ka] before every consonant-vowel sequence, every post-vowel consonant and the first consonant of a bi-consonant cluster (e.g. [kad] in (1-5b)) as seen under the column labelled ‘Group 2’. Examples labelled ‘V’ are Vijayakrishnan’s examples and the rest are impressionistic.

(1-5) Variation in [ka] insertion

	<i>Tamil form</i>	<i>Group 1</i>	<i>Group 2</i>	<i>Gloss</i>
a.	kat.ti (V)	<u>ka</u> .kat. <u>ka</u> .ti	<u>ka</u> .ka. <u>ka</u> t. <u>ka</u> .ti	‘knife’

b.	can.dran (V)	<u>ka</u> .can. <u>ka</u> .dr an	<u>ka</u> .ca. <u>kan</u> . <u>kad</u> . <u>ka</u> .ra. <u>kan</u>	‘a name’
c.	ma:ŋ.bi	<u>ka</u> .ma:ŋ. <u>ka</u> .bi	<u>ka</u> .ma:. <u>kaŋ</u> . <u>ka</u> .bi	‘respect’
d.	ma.da.gi	<u>ka</u> .ma. <u>ka</u> .da. <u>ka</u> .gi	<u>ka</u> .ma. <u>ka</u> .da. <u>ka</u> .gi	‘board’

‘Group 1’ speakers i.e. those who prefixed [ka] to syllables turned out to be those who could not read the Tamil alphabet. For these speakers, the syllable is arguably part of the innate language apparatus (Wee 2011) and not internalised through reading. ‘Group 1’ speakers i.e. those who prefixed [ka] elsewhere might, however, have been influenced by orthographic ‘noise’. A Tamil syllable comprising a C(onsonant)V(owel)C sequence, for example, is written with one grapheme representing CV¹ and another representing the post-vowel C. The word [kat.ti] ‘knife’ which has the shape CVC.CV is therefore spelled ‘க[ka] த் [t] தி[t]i’. Read in light of this fact, the ‘Group 2’ speakers’ rendition of [kat.ti] as [ka.ka.kat.ka.ti] in *Ka Language* suggests that they insert [ka] before every grapheme.²

A clarification is necessary before I conclude the section. The claim that the awareness of the syllable is independent of the ability to read does not contradict examples such as (1-1) which attest to the influence of syllabification on orthography (see also Appendix II). In sum, the fact that orthographic scripts, inter-dialectal stress variations, poetic meter and language games all appeal to the syllable places it on strong empirical ground. A critical review of phonological research on syllabification and syllable structure is germane at this point.

1.3 Syllabification

The evidence presented in §1.2 shows that pre-theoretical discussions on the syllable often focus on the string of segmental melodies that constitute syllables. The process that organises these melodies (i.e. consonants, vowels and glides) into syllables is known as syllabification. This section shows that syllabification targets linear(ised) elements and is, therefore, compatible even with a flat model of syllable-internal structure – the null hypothesis. Using the null hypothesis as a frame of reference, §1.4 traces the emergence of the Onset-Rhyme Model and the μ -Model, which give the Mora-Constituent Model its two dimensions.

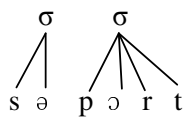
¹ (C)V’s are represented by a single grapheme in Japanese (Ichimura 2006:43) as well.

² More precisely: every *phonological unit represented by a grapheme*.

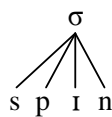
associated⁴ with one syllable node (σ) apiece. This is followed by further association of melodies, first to the left, then to the right of sonority peaks. Consonants may also serve as sonority peaks of syllables (e.g. [prɪ.zm] ‘prism’) though only vowels are in the cases below.

(1-7) **Autosegmental syllable**

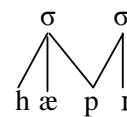
a. [sə.pɔrt] *support*



b. [spɪn] *spin*



c. [hæpɪ] *happy*

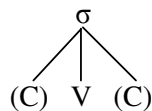


Kahn’s (1976) proposal of an autosegmental syllable is followed by a series of non-linear models where syllabification targets linearly ordered skeletal segments/slots after melodies have been mapped to them (see, for example, McCarthy 1979/1985, Marantz 1982, Clements & Keyser 1983, Hyman 1984, Levin 1985, Selkirk 1990). The upshot is that syllabification targets linear(ised) elements, and does not carry cues as to the internal structure of the syllable. As a null hypothesis, therefore, the syllable can be assumed to be flat in structure. In §1.4, the emergence of two alternative hypotheses is traced.

1.4 Syllable Structure

A model in which syllables are held to be flat and which does not recognise any syllable-internal unit can be represented as in (1-8) below. V’s are shorthand for segmental melodies serving as peaks (or nuclear material) in a syllable, and C’s for those serving as margins (or non-nuclear material).

(1-8) **Flat syllable**⁵



The schema in (1-8) is defended, explicitly or implicitly, at various places in the phonological literature (e.g. Kahn 1976: 37-49, Clements & Keyser 1983, Pierrehumbert & Nair 1995, Yip 2003). It asserts that the nuclear material in a syllable stands in a symmetrical

⁴ In later work, a syllable is said to be “projected” from sonority peaks.

⁵ This model is even more minimalist in spirit compared to the one defended in Davis (1985: 15), which contests the constituency of the Rhyme, but not those of the Onset, the Coda or the Nucleus (see (1-12)).

relationship with any material that precedes or follows it. This assertion is, however, at odds with the empirical evidence discussed in §1.4.1.

1.4.1 Onset-Rhyme Model

The nuclear material and post-nuclear material in a syllable are often mutually dependent in languages while nuclear material and pre-nuclear material seldom are. This sort of asymmetry has been noticed in both phonological (e.g. Selkirk 1982, Borowsky 1989, Bao 1990, 2000; Davis & Hammond 1995, Kim 1998, Rubach 1998, Temsunungsang 2009: 24, 37-40) and psycholinguistic (e.g. Treiman 1995, Treiman & Kessler 1997) investigations.

In the Chungli dialect of the Tibeto-Burman language Ao, for example, vowels and post-vowel consonants must share specifications for the feature [back]. A direct consequence of this requirement is that the non-back allophone of schwa – [ə] – occurs only before non-back (labial and coronal) consonants in Chungli. The back [ɯ] itself occurs only before back (velar) consonants. The schwa-plus-consonant sequences in (1-9), however, differ in their specifications for the feature [back], and are unattested (Temsunungsang 2009: 19).

(1-9) Ill-formed VC's in Chungli

- | | | | |
|----|----------------------|----|-------------------------|
| a. | *V [-back] C [+back] | b. | *V [+back] C [-back] |
| | | | |
| | ə ɲ, k | | ɯ n, t, m, p |

When the vowel-plus-consonant sequences in (1-9) are flipped, [nɯ] occurs in [a.nɯɲ] ‘sky’; [tɯ] in [tɯ.zɯ] ‘vein’; [mɯ] in [mɯ.caŋ] ‘sleep’; [pɯ] in [pɯ.ruk] ‘scatter’; while [kə] occurs in [ka.kət] ‘book’ (Temsunungsang 2009: 31, 64, 79, 210). /ɲ/ occurs very rarely in the pre-nuclear position in Chungli, so the absence of [ɲə] is unsurprising. If syllable-internal structure is flat as in (1-8), there is no explanation as to why the six VC sequences in (1-9) do not occur in Chungli, while mirror images of five of them are attested.

An alternative conception of the syllable, which provides for a structural relationship between post-nuclear and nuclear melodies but excludes pre-nuclear ones, is thus in order. The distribution of labials in Cantonese also argues for such an alternative. The nuclear and post-nuclear sections of a syllable cannot both have labials in the language (1-10). However, labial vowels which are [+back] do co-occur with pre-nuclear labial consonants (1-11)

(1-10) ***VC labials in Cantonese** (cf. Cheng 1990)

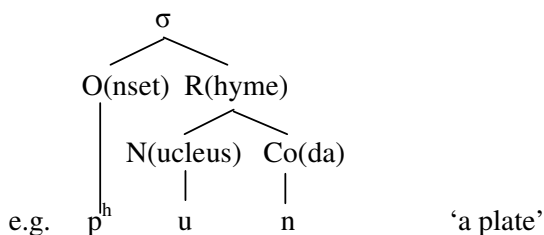
a.	*V [labial +back]	C [labial]	b.	*V [labial -back]	C [labial]
	u, o	p, m, w		y, ø	p, m, w

(1-11) **CV labials in Cantonese**

- | | | | |
|----|--------------------------------|----|------------------|
| a. | p ^h un ‘a plate’ | c. | mo ‘slow’ |
| b. | p ^h o ‘an old lady’ | d. | fo ‘commodities’ |

If syllables are internally flat as in (1-8), the Cantonese patterns lack any explanation. Under the O(nset)-R(hyme) Model represented in (1-12), however, they can be explained in terms of the structural closeness between nuclear vowels and post-nuclear consonants, both of which are associated with the Rhyme (see §2.3.1 for further discussion).

(1-12) **OR Model** (Fudge 1969, Selkirk 1982, Blevins 1995, Kim 1998 etc)

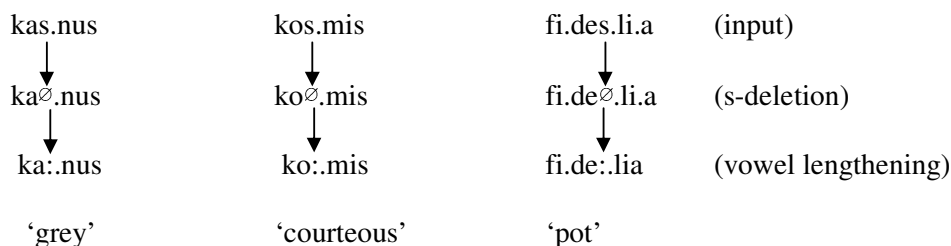


More explicitly, the assimilatory restriction that rules out the VC sequences in (1-9) in Chungli and the dissimilatory restriction against VC labials in Cantonese (1-10) can both be stated as restrictions on the material associated with the Rhyme. In the Mora-Constituent Interface Model, the Rhyme will be seen to be part of the Constituency Dimension, which is formally identical to the OR Model. Arguments for the Onset, the Nucleus, the Coda and further evidence for the Rhyme are presented in chapter 2.

1.4.2 μ-Model

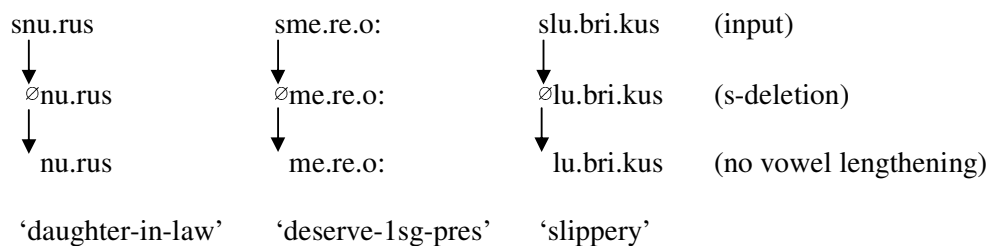
Despite having richer internal structure than (1-8), the OR Model cannot account for all phonological phenomena in which the syllable plays a role. It cannot, for example, handle compensatory lengthening (Ingria 1981, Hock 1986, Hayes 1989, Kiparsky 2010). Consider the following data from Latin where post-nuclear [s] undergoes deletion before bilabial and anterior sonorants, causing the preceding vowel to lengthen.

(1-13) **Compensatory lengthening in Latin** (Hayes 1989: 260)



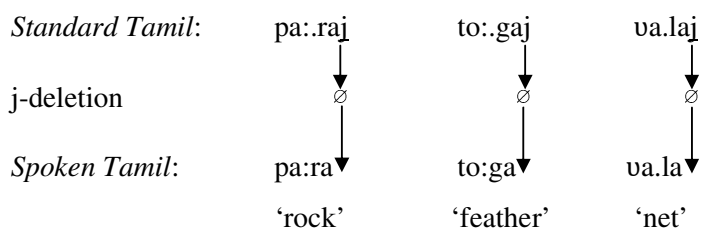
Pre-nuclear [s] is also deleted in the same melodic contexts, as (1-14) shows. However, there is no compensation for its loss.

(1-14) **Pre-nuclear [s] deletion in Latin**



At first blush, the fact that vowel lengthening occurs due to the deletion of post-nuclear [s] seems like a compensation for one deleted Rhyme-internal phone by simply lengthening another (Steriade 1982: 126). A lost pre-nuclear [s] then is not compensated for because it lay outside the Rhyme. The Rhyme-based account, however, predicts compensatory vowel lengthening in all kinds of languages where there is deletion of post-nuclear material. This prediction is falsified in Spoken Tamil where a word-final (post-nuclear) off-glide [j] is regularly lost in words with more than one syllable, but is not compensated for as seen in (1-15). Nor is there any compensation for the deletion of post-nuclear [l] at word junctures: /kan.dal # tu.ɳi/ → [kan.da # tu.ɳi] 'rags' (see also §3.1.1).

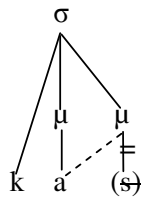
(1-15) **[j] deletion in Spoken Tamil**



According to Hayes (1989), compensatory vowel lengthening in Latin (1-13) is tied to the fact that post-nuclear consonants are associated with a ‘durational unit’ – commonly referred to as ‘weight unit’ – called mora (μ) in the language. Pre-nuclear consonants are universally non-moraic (Goedemans 1998, for perceptual evidence) and nuclear vowels usually moraic,⁶ being syllable heads. The proposal that post-nuclear consonants in Latin are moraic is further supported by the fact that penultimate (C)VC syllables are bimoraic and stressed in Latin. Penultimate (C)V syllables, however, are monomoraic and unstressed: compare [ˈsa.pi.ens] ‘wise (nom.SG)’ vs. [sa.pi.e.ˈn̩.tes] ‘wise (nom.PL)’ (Mester 1994: 4).

The moraic account of compensatory lengthening can be understood from the representation in (1-16). When post-nuclear [s] is deleted in Latin, it vacates a mora. The preceding vowel is consequently associated with the vacated mora, yielding a long bimoraic vowel on the surface. Underlying long vowels are also universally bimoraic.⁷

(1-16) **Compensatory lengthening in action**



In essence, compensatory lengthening preserves the categorical duration of a syllable by preserving its mora count, which was also seen to influence stress in Latin. Moras are thus metrically relevant units of time. Since pre-nuclear consonants are not moraic, however, their loss does not typically trigger compensatory lengthening (but see Topintzi 2006b and Kiparsky 2010). Pre-nuclear consonants do, however, have phonetic duration like the other phones in a syllable. It is hence logical to speculate whether the pre-nuclear [l], [m] and [n] in the post-s-deletion forms in (1-14) are only as long as they are in the representations with [s]; or longer to compensate for the deleted [s]. While Latin does not serve up evidence to support either hypothesis, pre-nuclear consonant lengthening of a compensatory kind does occur in Malaysian Cantonese (see §3.1.2).

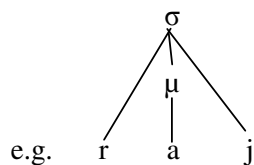
The lack of compensatory lengthening in Spoken Tamil in (1-15) is also simply accounted for in the μ -Model. Post-nuclear consonants, except sonorant geminates (see

⁶ However, see Kager (1990) and Gordon (2002: 9) on non-moraic centralised vowels in languages; see Hyman (1984: 59), Levin (1985: 295-6) on non-moraic reduced vowels.

⁷ On the moraicification of (consonantal) geminates, see §4.1.

§3.3.5), are non-moraic in the language, as evidenced by the fact that they do not make nouns bimoraic: e.g. [ka_μl] (→ [ka_μl_μ.li]) ‘stone’. The glide that undergoes deletion in (1-15) is heterorganic by virtue of being word-final, is non-moraic and is, therefore, not compensated for.⁸ The final syllable of the word [pa:.ra_j] ‘rock’ alone is represented below:

(1-17) **CVC_{heterorg} syllables in Tamil**



Note that, barring moras, the syllables represented in (1-16) and (1-17) are identical to the internally flat syllable represented in (1-8). The upshot is that if phonological phenomena cited as evidence for constituency can somehow be reanalysed without appealing to syllable-internal units like the Onset and the Rhyme (Takahashi 1993, Pierrehumbert & Nair 1995, Yip 2003 etc), the emergent model of syllable structure would still be formally simpler than the OR Model in (1-12). Chapter 2 will demonstrate that such a model, while attractive at first glance, does not account for a wide range of empirical facts.

1.5 The Mora-Constituent Interface Model

Following the initial arguments made in favour of the mora and the constituency of the Rhyme in §1.4, the Mora-Constituent Interface Model (MCI) is introduced below:

(1-18) **Mora-Constituent Interface Model** (statement)

The syllable-internal properties of a given string of [1] segment-melody complexes emerge from the interface of these complexes with [2] the Constituency Dimension and the [3] Moraic Dimension:

⁸ An examiner points out that the absence of [j]-deletion in short-vowelled monosyllables in Tamil may be accounted for by assuming that [j] is moraic, contrary to my assumption, and serves to satisfy a bimoraic minimum—which is a stem-level requirement in the language (Vijaykrishnan 2007). If [j]-deletion in short-vowelled monosyllables is blocked by the bimoraic minimum, however, one would expect [j] to undergo deletion in monosyllables with long vowels. Deletion is not attested in the latter case either, suggesting that the non-deletion of [j] has nothing to do with whether or not it is moraic.

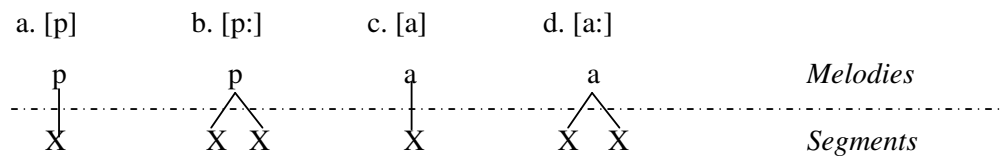
[1] A segment-melody complex refers to any phone(s) linked to one or more X-slots (a. k. a segments). ‘Phone’ refers to a bundle of phonological features and ‘X-slot’ to a phonological unit of time.⁹

[2] In the Constituency Dimension, segment-melody complexes are organised in terms of the Nucleus and one or more of the other constituents (Onset, Coda and Rhyme) defined in the Onset-Rhyme Model.

[3] In the Moraic Dimension, moras are assigned to segment-melody complexes on universal, language-specific or contextual grounds.

Of the three key components which make up the MCI, the Constituency Dimension and the Moraic Dimension are discussed in detail in the next two chapters. The third component, the segment-melody complex, deserves some elaboration here, however. A segment-melody complex is, as the definition in (1-18) indicates, a phone linked to one or segments/X-slots. The items in (1-19) are segment-melody complexes:

(1-19) **Segment-melody complexes**



While a segmental X-slot is similar to a mora in being a phonological unit of time, all melodies are underpinned by X-slots, but only some melodies are associated with moras. Moreover, while it is possible to consider all melody-mora associations as consequences of syllabification, melody-segment links must be seen as underlying (§4.1).¹⁰ Finally, languages impose restrictions on the number of segments that can occur within syllables. These restrictions are independent of the amount of moraic material tolerated within syllables (§2.5), and provide empirical support for the segmental component of the segment-melody complex.

⁹ The assumption here is that short melodies are associated with one X-slot each and long ones are associated with two. Note that this assumption ignores as negligible the intrinsic differences in the duration of various types of melodies. Low vowels, for example, are intrinsically longer than non-low vowels; vowels longer than sonorant consonants; sonorants longer than obstruents etc.

¹⁰ Anticipating later discussion (§5.1.2), it can be said that moras transform some segments from being metrically neutral units of time into metrically relevant ones (cf. Cohn 2003).

Moving on, MCI firstly predicts the occurrence of two types of constraints and processes: those which are constituency-based and those which are mora-based. The fact that moras and constituents are arrayed on two eponymous dimensions itself implies that the syllable is, in MCI, a formal conjunction of the constituent-syllable (C- σ) and the moraic-syllable (M- σ). This conjunction predicts two types of straddling: one M- σ corresponding to more than one C- σ ; and vice versa. The default situation is arguably one where one M- σ corresponds to one C- σ . A third prediction made by MCI is that constraints or processes affecting the association of segment-melody complexes in one dimension may also trigger modifications in the other dimension. All three predictions will be seen to be borne out over the course of this dissertation.

With the theoretical statement of MCI and its predictions now firmly in place, a glimpse of the types of evidence supporting the Constituency Dimension is offered in §1.5.1. In §1.5.2, the kinds of evidence supporting the Moraic Dimension are briefly discussed.

1.5.1 Evidence for constituency

The Constituency Dimension in MCI is formally identical to the OR Model and encompasses the Onset, the Coda and the Nucleus (with the Nucleus and the Coda together constituting the Rhyme, as in (1-12)).

In Chapter 2, where the Constituency Dimension is argued for, the legitimacy of the Nucleus as a constituent will be established based on the behaviour of non-moraic consonants as syllable peaks and the resistance of diphthongs to hetero-syllabification. Empirical support for the Nucleus *per se* does not, however, imply that the parts of a syllable preceding and following the Nucleus also enjoy the status of constituents. In this connection, sonority constraints will be shown to target pre-nuclear and post-nuclear domains which do not overlap with the Nucleus: these domains are (at the very least isomorphic with) the Onset and the Coda. The case for the Onset and the Coda is strengthened by the fact that they are also the sub-syllabic domains with which non-nuclear vocalic melodies (i.e. glides) are associated.

The constituency of the Rhyme will also be consolidated in Chapter 2 with an elaboration of the restrictions from Cantonese and Chungli, broached in §1.4.1. Aside from these restrictions, two processes of nasalisation (one synchronic and one diachronic) and an instance of suffixal allomorphy will be enlisted in support of the Rhyme. Finally, the Rhyme, the Onset, the Nucleus, and the Coda, will all be seen to be syllable-internal domains in terms of which the occurrence of melodies is constrained by segmental restrictions.

1.5.2 Evidence for moras

A sizeable chunk of empirical support for the mora comes from two sources: stress and prosodic-size (i.e. minimality and maximality) constraints on words and syllables in languages. Both types of evidence are adduced in Chapter 3 in favour of the Moraic Dimension. In order to ensure adequate typological coverage, the prosodic data discussed in that chapter have been taken from languages with moraic post-nuclear consonants as well as those with non-moraic post-nuclear consonants. Also discussed are data from languages where post-nuclear consonants are (non-)moraic depending on their intrinsic sonority or word-internal context.

The argument that the loss of moraic material alone may trigger compensatory lengthening (§1.4.2) will also be revisited in Chapter 3. A logical extension of this argument, however, entails that any lengthening of (originally) non-moraic consonants due to the loss of (originally) moraic material in a syllable must also be deemed compensatory. This type of compensatory lengthening is encountered in Malaysian Cantonese (Ong 2007) and will also be discussed.

The final port of call in Chapter 3 will be a language game called Babuebo. In Babuebo, Japanese lexical items are given as inputs and surface with the affix [bV] interrupting the input string at various places. Close inspection reveals that the affix is inserted immediately moraic entities from the (syllabified) Japanese input. That the placement of an affix depends on moras in a language game ‘played’ by speakers of Japanese is unsurprising given that Japanese is a classic mora-timed language.

This concludes the overview of the evidence and arguments to be called upon in the next two chapters in support of the Constituency Dimension and the Moraic Dimension in MCI. The prosodic and typological implications of MCI are foreshadowed below, and will be dealt with in later chapters.

1.6. Typological and Prosodic Implications of MCI

The thesis that syllable-internal structure manifests in two dimensions in MCI is particularly useful in the treatment of consonant length. Geminate, for example, are consonants associated with two X-slots; and are consequently read off as long consonantal melodies in the Constituency Dimension. Only in some languages are geminates metrically relevant, however, and in these languages geminates are also given a mora (§4.1). In languages of the

latter type, therefore, geminates are both bi-segmental (Selkirk 1990) and moraic (Hayes 1989).

The fact that syllables typically consist of the Constituency Dimension and the Moraic Dimension under MCI also raises the logical possibility of segment-melody complexes being associated in one of the two dimensions, but not necessarily both. The possibility finds empirical expression as well. An extrametrical consonant, for example, will be seen to be associated in the Constituency Dimension, but not the Moraic Dimension, of the syllable of which it is a part. A metrically relevant ambisyllabic consonant on the other hand will be argued to be associated only in the Moraic Dimension of the syllable to which its mora reports (and only in the Constituency Dimension of an adjacent syllable). Syllables themselves do not always have two dimensions either: extrametrical syllables have only the Constituency Dimension and catalectic syllables have only the Moraic Dimension, under MCI (§4.3).

That a typical syllable consists of two dimensions within MCI also throws into sharp relief the issue of the proper affiliation of segment-melody complexes. In this connection, melodies will be argued to belong to the Constituency Dimension and segmental X-slots to the Moraic Dimension (§5.1).¹¹ The proposed affiliation of segments and melodies is supported by two independent observations: (syllable-bound) melodic processes and constraints typically target (syllable-internal) constituents and the number of X-slots taken up by a melody has a bearing on whether (and to what degree) it is moraic.

While this dissertation largely focuses on MCI as a model of syllable-internal structure, it has implications which stretch beyond the syllable. Feet, for example, can be directly built from moras in MCI, even in metrical systems traditionally classified as mora-insensitive (§5.2). This potential makes a uniformly mora-based classification of feet possible, which is an important theoretical result.

¹¹ When a syllable has only the Constituency Dimension, as extrametrical syllables do, segment-melody complexes fully belong to that dimension. A catalectic syllable on the other hand has only the Moraic Dimension, and may be regarded as a syllable having a segment that lacks melodic content (§4.3.4).

CHAPTER 2

The Constituency Dimension

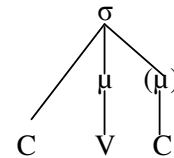
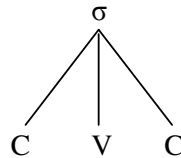
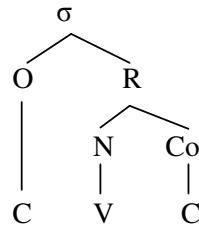
This chapter presents evidence in favour of the Constituency Dimension (2-1a) in MCI. The dimension, as indicated in the last chapter, is formally identical to the O(nset)(-)R(hyme) Model. Syllable-based phonological phenomena, which are inexplicable under an internally flat model of the syllable (2-1b), will be seen to receive straightforward explanations given the constituents Onset, Nucleus, Coda and Rhyme in this chapter.

(2-1) Syllable structures under comparison

a. *Constituency Dimension*

b. *Flat syllable*

c. *Moraic syllable*



Constituency-based analyses of phenomena will also be compared with moraic alternatives wherever moras plausibly encode the syllable-internal organisation of segment-melody complexes (which, till the final section of this chapter, will be treated simply as melodies). The Constituency Dimension will be seen to emerge the better from these comparisons in the following sections.

In §2.1, the Nucleus is established as the obligatory syllable-internal constituent on at least two grounds. The Nucleus is firstly shown to make syllable heads out of consonants which generally occur in syllable margins. It is also seen to underpin the behaviour of diphthongs as tautosyllabic units.

In §2.2, sonority restrictions imposed on either side of the Nucleus are shown to be best understood in terms of the domains Onset and Coda.

In §2.3, the union of the Nucleus and the Coda under the constituency of the Rhyme is argued to be necessary. Postulation of the Rhyme as a constituent will be seen to offer a systematic account of, among other things, place-feature restrictions in Cantonese and Ao, vowel nasalisation in Chaoyang and Spoken Tamil, and suffixal allomorphy in Adhilabad Gondi.

In §2.4, glides are taken up for discussion. The section opens with a recapitulation of Davis & Hammond's (1995) argument that post-consonantal [w] in American English is associated with the Onset. Post-vowel [h] is then argued to belong to the Coda in Adhilabad Gondi. Finally, the palatal glide [j] in Tamil is shown to be associated outside of the Nucleus, reinforcing the observation that glides are non-nuclear vocalic entities.

In §2.5, constituents are shown to be sub-syllabic domains in terms of which segmental constraints constrain melodic material. The Nucleus in at least two varieties of English, the Rhyme in Sixian Hakka and the Coda in Tamil are all seen to have a bi-segmental cap in this section; the Onset in Tamil itself has a monosegmental ceiling. A brief summary of the chapter is provided in §2.6.

2.1 N: Nucleus, Necessity

This section presents two pieces of evidence which show that the Nucleus, besides being a label of convenience, is a legitimate syllable-internal constituent. In §2.1.1, the tautosyllabic occurrence in English of the sequences [zɫ] and [zm̩] and the non-occurrence of [zl] and [zm] are shown to follow from the fact that [ɫ] and [m̩] are associated with the Nucleus, and [l] and [m] are not. In §2.1.2, the behaviour of diphthongs as tautosyllabic units in English is argued to follow from the association of the vowel melodies which make up a diphthong with the same Nucleus.

2.1.1 Nuclear consonants

Pre-nuclear consonant clusters beginning with a voiced fricative are prohibited in English on grounds of sonority (see §2.2.2). This ban rules out [zm] and [zl] among other consonant clusters as tautosyllabic pre-nuclear sequences in the language. Consequently, word-medial instances of [zm] and [zl] are always split across syllables in English:

(2-2) Heterosyllabic [zm] and [zl] in English

a.	[z.m]		b.	[z.l]	
i.	mɪ.æ[z.m]ə	<i>miasma</i>	i.	mʊ[z.l]ɪm	<i>Muslim</i>
ii.	kə.ɾɪ[z.m]ə	<i>charisma</i>	ii.	gʌ[z.l]ə	<i>guzzler</i>
iii.	plɑ:[z.m]ə	<i>plasma</i>	iii.	mi:[z.l]i	<i>measly</i>
iv.	ræ[z.m]ə.tæz	<i>razzmatazz</i>	iv.	ɪ[z.l]ɑ:m	<i>Islam</i>
v.	mɛ[z.m]ə.raɪz	<i>mesmerise</i>	v.	wɛ[z.l]i	<i>Wesley</i>

In contrast to [zl] and [zm], [zɫ] and [zɹ̩] freely occur in the same syllable because the sonorant [ɫ/ɹ̩] in these sequences is a syllable peak. Note that the [zɫ] and [zɹ̩] sequences are allowed to be tautosyllabic when the sonorant occurs non-finally as in [dri.zɫd] *drizzled* or word-finally as in the following words:

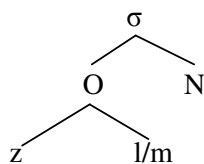
(2-3) **Tautosyllabic [zɫ] and [zɹ̩] in English** (cf. Bonilla 2003)

prɪ.zɹ̩	<i>prism</i>	dri.zɫ	<i>drizzle</i>
ski.zɹ̩	<i>schism</i>	dæ.zɫ	<i>dazzle</i>
kæ.zɹ̩	<i>chasm</i>	mʌ.zɫ	<i>muzzle</i>
fæn.tæ.zɹ̩	<i>fantasm</i>	nɔ.zɫ	<i>nozzle</i>

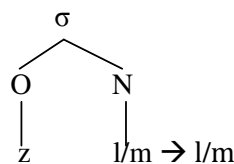
The tautosyllabic allowance of [zɫ] and [zɹ̩], but not [zl] and [zm], can be straightforwardly explained by assuming that [ɫ] and [ɹ̩] are associated with the Nucleus (2-4a), while [m] and [l] are pre-nuclear (2-4b). Put another way, [ɹ̩] and [ɫ] are simply nuclear variants of [m] and [l] (as encoded by the right-pointing arrow in (2-4b)):

(2-4) **Non-nuclear and nuclear [l] and [m]**

a. *[zl]/*[zm]



b. [zɫ]/[zɹ̩]



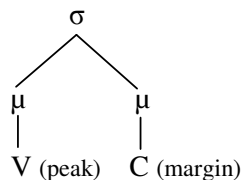
Since the [ɹ̩] in [zɹ̩] and the [ɫ] in [zɫ] are associated with the Nucleus, [z] vacuously satisfies the sonority requirement governing pre-nuclear sequences in English (see §2.2.2). Consequently, [zɹ̩] and [zɫ] are well-formed. Pre-nuclear [zl] and [zm], however, do not meet the requirement, and are therefore ruled out.

Moving on, a mora-based differentiation of tautosyllabic [zɹ̩]/[zɫ] and tautosyllabic *[zl]/*[zm] in English also seems plausible. One could, for example, argue that [ɹ̩] and [ɫ] are associated with a mora (rather than the Nucleus), and that [l] and [m] are non-moraic because they are pre-nuclear. The non-occurrence of [zl] and [zm] in the same syllable may now be imputed to a sonority constraint governing sequences of non-moraic (pre-nuclear) melodies in English. Since no analogous constraint governs sequences involving a non-

moraic melody followed by a moraic melody, [zm_μ] and [zl_μ] are free to occur in the same syllable.

This mora-based account, however, faces two problems. The first problem is technical. The fact that consonants following the syllable peak are moraic in English, as evidenced by their active role in stress (see Chapter 3, note 17), indicates that a melody does not become a syllable peak in the language on receiving a mora. The fact that [m] in [zm] and [l] in [zl] are syllable peaks cannot, therefore, follow from the assumption that they are moraic.¹

(2-5) Moraic peaks and margins in English



The second problem is empirical, and suggests that the peak-sonorants [m] and [l] are just not moraic in English. Firstly, syllables peaking in consonants – like the final syllables in (2-3) – are not stressed in English (except, probably, under emphasis). Secondly, the general absence of consonantal peaks in the (ante)penultimate syllables of words,² the typical locale of stress in English, suggests that syllables with consonantal peaks cannot be stressed in the language (see Zec 2003 for a foot-based explanation of this lack of stress).

Moreover, vowels replace consonantal peaks when the latter are in danger of being stressed. Consider words like [ɪn.tɜː.pɹɪ.tə.'bɪ.lɪ.ti] *interpretability* and [kʌl.pə.'bɪ.lɪ.ti] *culpability* (cf. *mutability*, *probability*, *ability* etc) where the antepenultimate syllable has a stressed vocalic peak. Since *interpretability* and *culpability* are morphologically related to [ɪn.'tɜː.pɹɪ.tə.bɪ] *interpretable* and ['kʌl.pə.bɪ] *culpable* respectively, it is surprising why the former words have vocalic peaks where the latter have the lateral [l]. The explanation is simple: a syllable in a stressable context needs a vocalic peak because consonantal peaks, as

¹ Also, consonants like [l] and [m] become syllable peaks in English only when all consonants in a word cannot be accommodated under syllables with vocalic peaks. These consonants, even if they are moraic, would only receive a mora on the surface. The argument that only those melodies which are associated with moras in the input may be syllable peaks is also therefore untenable (on underlying moras, also see note 4).

² The only exception to this generalisation involves forms with the suffix [-mənt]. The final syllable in *battle* and *settle*, for example, is headed by the syllabic lateral [l]. When [-mənt] is added to such words, the [l] remains syllabic, though it is now part of the penult: e.g. [bæ.tl̩.mənt] *battlement*, [sɛ.tl̩.mənt] *settlement*.

suspected earlier, cannot be stressed. The fact that syllables with consonantal peaks cannot be stressed itself suggests that [l] and [m] are not moraic³ in English.

In conclusion, the Nucleus alone offers a viable explanation of the occurrence of tautosyllabic [zm] and [zl] and the non-occurrence of tautosyllabic [zl] and [zm] in English. This Nucleus-based explanation is strengthened by the fact that it also readily accounts for the presence of tautosyllabic [tʃ] and [dʃ] and the absence of tautosyllabic [tʃ] and [dʃ] in the language: e.g. [braɪ.dʃ] *bridle*, [du.dʃ] *doodle*, [wɪ.tʃ] *whittle*, [ræ.tʃ] *rattle*.

Suppose a constraint bars the occurrence of pre-nuclear [tʃ] and [dʃ] in English (Fudge 1969). This constraint will have no bearing on [tʃ] and [dʃ] because the [l] in the cases at hand is associated with the Nucleus and serves as the syllable peak. The Nucleus is thus literally at the heart of co-occurrence facts concerning peak and margin consonants in English. In the next subsection, the Nucleus will also be seen to underpin the tautosyllabic unity of diphthongs in the language.

2.1.2 Diphthongs as nuclear units

A crucial difference between diphthongs (VV) and melodic sequences consisting of a vowel followed by a non-vowel (VY) has to do with how they are syllabified when followed by a vowel-initial suffix. In English, the melody corresponding to Y surfaces as the ‘onset’ of the suffixal syllable, whereas the second V in VV does not. This can be seen from the data below:

(2-6) VV versus VY in English

a. VV-ɪŋ		b. V(:)Y-ɪŋ	
i. maʊ.(w)ɪŋ	<i>mowing</i>	i. su:.ðɪŋ	<i>soothing</i>
ii. fləʊ.(w)ɪŋ	<i>flowing</i>	ii. mʌ.lɪŋ	<i>mulling</i>
iii. tɔɪ.(j)ɪŋ	<i>toying</i>	iii. bɪ.dɪŋ	<i>bidding</i>
iv. peɪ.(j)ɪŋ	<i>paying</i>	iv. flɪ:.tɪŋ	<i>fleeting</i>

Matters are, however, complicated by the (bracketed) glide; which is sometimes heard in casual speech and which gets its place from the preceding vowel. These glides, being

³ The abundance of disyllables ending in a syllabic consonant (see (2-3)) appears to suggest that syllabic consonants *are* moraic in English: If they were not, the disyllables in question would be monomoraic and sub-minimal in English—a language with a bimoraic word minimum (§3.3.1). In MCI, however, those disyllables can be bimoraic even if syllabic consonants are non-moraic. The [z] in [prɪ.zm] *prism*, for example, can cohere with the syllable headed by [m] in the Constituency Dimension and still contribute a (second) mora to the syllable headed by [ɪ] in the Moraic Dimension (see (4-26) for the representation of ambisyllabic [v] in Dutch).

transitional elements, make it difficult to pinpoint exactly where one syllable ends and another begins in the words in (2-6a). All the same, the period marking the syllable boundary has been placed after the VV and before the glide, indicating that the glide begins the suffixal syllable. The assumption that the glide begins the suffixal syllable in (2-6a) is also supported by the following data, pertaining to diphthongs which end in a schwa:

(2-7) **Və in English** (see also §2.5.1)

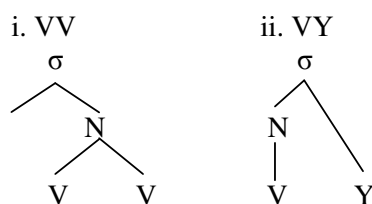
a. Və			b. Və(r)V...		
i.	fɪə	<i>fear</i>	i.	fɪə.rɪŋ	<i>fearing</i>
ii.	tʊə	<i>tour</i>	ii.	tʊə.rɪŋ	<i>touring</i>
iii.	dɪə	<i>dear</i>	iii.	dɪə.rɪst	<i>dearest</i>
iv.	mʊə	<i>moor</i>	iv.	mʊə.rɪŋ	<i>mooring</i>

The post-vowel [r] reflected in the spelling of the words in (2-7a) has undergone diachronic deletion in many dialects of English (Kahn 1976: 106-115). However, the [r] does put in an appearance between [ə] and a following vowel in the words in (2-7b) to provide a consonantal ‘onset’ to the latter. The upshot is that the syllable boundary falls after the diphthong [ʊə]/[ɪə] in the words in (2-7b). Extrapolating from this fact, I have assumed that the syllable boundary falls after the diphthongs in the words in (2-6a) as well. Moreover, the (transitional) glides in (2-6a) can also be seen as providing an ‘onset’, just as [r] does in (2-7b), to what would otherwise be a vowel-initial suffixal syllable.

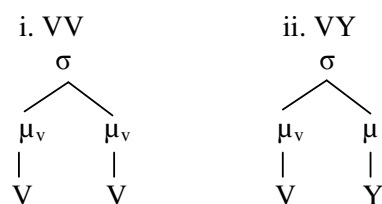
Returning to the main thread of this subsection, one may recall that the second V in VV (2-6a) does not surface as the ‘onset’ of a vowel-initial (suffixal) syllable while Y in VY (2-6b) does. This asymmetry in syllabification is simply explained if melodies associated with the same Nucleus are assumed to resist separation across syllables (2-8a).

(2-8) **Diphthong inseparability**

a. *Nucleus-based unification*



b. *Moraic unification*



At first blush, the strict tautosyllabic unity of diphthongs also seems explainable using moras. However, because post-nuclear consonants are moraic in English (see §3.3.1, §3.3.4) the moraic explanation must firstly distinguish between moras associated with vowels (μ_v), and other moras (μ). Successive instances of μ_v (2-8b-i) may then be assumed to resist separation during syllabification because they correspond to vowels which have been structurally unified. However, the structural unification of those vowels itself does not seem to have any explanation other than that they share a Nucleus.⁴ The nub of the matter is that the mora-based explanation of the tautosyllabic unity of diphthongs must also appeal to the Nucleus—and this impugns its status as an alternative explanation.

In conclusion, this section has demonstrated the status of the Nucleus as a syllable-internal constituent based on two phonological facts from English. Firstly, [zɪ] and [zɪ̯] were shown to be sequences comprising a pre-nuclear consonant followed by a consonant associated with the Nucleus. Consequently, these sequences are allowed in the same syllable in English while [zɪ] and [zɪ̯] without any nuclear consonant are not. Secondly, the resistance of the vowels in a diphthong to hetero-syllabification has been shown to follow from the association of those vowels with the same Nucleus. Further support for the Nucleus is available in the form of a segmental constraint which explains, among other things, the cross-linguistic rarity of triphthongs (§2.5.1). The focus of this chapter presently shifts, however, to the Onset and Coda.

2.2 Syllable-internal Sonority Domains

Sonority typically rises towards the peak in a syllable and falls after it.⁵ More to the point, different languages impose different restrictions on the kinds of segmental melodies that contribute to the rise and fall in sonority (Blevins 1995). According to Yip (2003: 809f) these restrictions operate over demi-syllables; with the initial demi-syllable encapsulating the

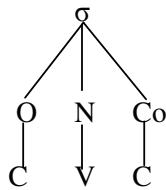
⁴ Suppose the two vowels making up a diphthong are each underlyingly associated with a mora (Hayes 1989), and that each of these moras supplies one token of the [+syllabic] specification. The two tokens of the [+syllabic] specification may then fuse to become one. In this way, the tautosyllabic unity of vowels in a diphthong can be explained using underlying moras (but also see note 1). The explanation has two at least problems, however. First of all, specifying a segment melody as [+syllabic] in the lexicon is not very different from specifying that it habitually occupies the Nucleus. Moreover, whether a melody is [+syllabic] (or nuclear) is mostly predictable: specifying that information in underlying representations, except in those contexts where it is unpredictable, is hence redundant. Secondly, the assumption of ‘input moras’ itself becomes spurious if moras are divested of their role as encoders of length (see §4.1.2; cf. Kim 2002, Ulfsgjorninn 2014).

⁵ This is often not true of word-peripheral clusters, many of which consist exclusively of coronal consonants (see (2-45a) for one possible and common treatment of such sequences).

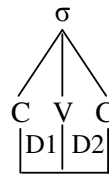
sonority ascent and the final demi-syllable (Clements 1990) encapsulating the sonority descent (2-9b).

(2-9) **Sonority Domains**

a. *Onset, Nucleus and Coda*



b. *Demi-syllables*



The demi-syllable approach to sonority is compatible with a model where syllable-internal structure is flat (2-9b) because such a model most simply accommodates sonority incline and decline as a natural function of the segmental melodies that occupy a syllable. The demi-syllable approach, then, predicts that the syllable peak and any melody immediately preceding it (D1) or immediately following it (D2) may be jointly targeted by sonority constraints. As Davis & Hammond (1995) and Blevins (1995) point out, however, such constraints are hard to come by in natural languages, suggesting that the Nucleus is flanked by two independent sonority islands, the Onset and the Coda (2-9a). The Rhyme has been omitted in (2-9a) because sonority restrictions called upon as evidence for the Rhyme (if any) can be restated in terms of the Nucleus and the Coda.

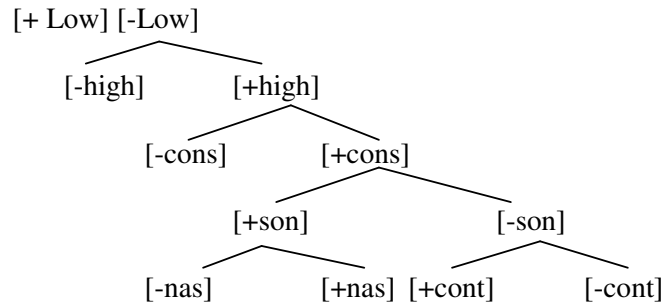
This section shows the constituency-based view of sonority domains (2-9a) to be the correct one on the force of sonority restrictions in English and Adhilabad Gondi. As a necessary preliminary to discussing those sonority restrictions, the idea of sonority scales is briefly outlined in §2.2.1. An examination of specific pre-nuclear and the post-nuclear sonority restrictions in English (§2.2.2) and Adhilabad Gondi (§2.2.3) then shows that the Onset and the Coda are independent sonority domains. The section concludes (§2.2.4) by arguing that a case from Mandarin Chinese, cited to be the result of a sonority constraint targeting demi-syllables, does not imply anything as systematic as a constraint.

2.2.1 Sonority scales

A considerable amount of work has been carried out on the features that go into the computation of sonority classes and the consequent formulation of a sonority hierarchy or scale (e.g. Kiparsky 1979, 1982; Steriade 1982: chapters 3 & 4; Clements 1995, 2006). A modified version of Levin’s (1985: 63; cf. Blevins 1995: item (3)) sonority hierarchy is given

in (2-10). It places consonants and vowels under the same arboreal scheme, where feature-elements on left branches are more sonorous than those on right branches.

(2-10) **Sonority hierarchy**



Legend: *son* – sonorant; *cons* – consonantal; *nas* – nasal; *cont* – continuant.

Four sonority sub-classes which do not find a place in Levin’s hierarchy have been introduced in (2-10). The class [-low], for example, has been divided into the sub-classes [-high] and [+high] because non-high vowels are more sonorous than high vowels (Kiparsky 1979, Gordon 2002, Hsu 2004a, b). Analogously, the class [+son] has been sub-divided into [-nas] and [+nas] because non-nasal sonorant consonants and nasal ones behave as independent sonority classes in languages including English.

Note that (2-10) represents just a partial sonority hierarchy in that under it the class [-high], is not divided into [+cons] and [-cons], unlike the class [+high] which is. The non-division of [+high] is deliberate because the languages discussed in this dissertation vis-à-vis sonority do not have non-high consonants. The sonority hierarchy in (2-10) is therefore adequate in dealing with these languages and is translated numerically as a sonority scale below:

(2-11) **Sonority scale**

<i>Features</i>	<i>Sonority class</i>	<i>Melody tokens</i>	<i>Sonority rank</i>
[+ cons, -son, -cont]	stops	p, t, k, b, d, g...	0
[+cons, -son, +cont]	fricatives	f, v, s, z...	1
[+cons, +son, +nas]	nasals	m, n...	2
[+cons, +son, -nas]	liquids	l, r	3
[+high, -low, -cons]	high vowels/glides	i, j, u, w	4
[- high, -low, -cons]	mid vowels	e, o...	5
[+low, -cons]	low vowels	a, æ...	6

The sonority scale (and sonority hierarchy) above represents a phonetically-grounded scheme that is not specific to any language. Nonetheless, I know of no language where fricatives, for example, are less sonorous than stops, or more sonorous than nasals. In other words, language-specific reversals in sonority ranking vis-à-vis (2-11) are not expected since the ranking has a phonetic basis. However, language-specific conflation of sonority classes is possible. In Klamath, for example, consonants which are [+sonorant] form just one sonority class (Levin 1985: 158). Languages may also divide up the sonority classes in (2-11).

For example, voiceless fricatives (2-12a) or stops (2-13) can occur before pre-nuclear liquids in English. However, voiced fricatives do not as seen in (2-12b). The forms below have been taken from the British version of the Oxford Online Dictionary.

(2-12) **Pre-nuclear obstruent-plus-liquid in English (I)**

a.	<i>Voiceless fricatives and liquids</i> ⁶	b.	<i>Voiced fricatives and liquids</i>
i.	[fr]ΔI <i>fry</i>	i.	*vr
ii.	rI.[fr]em <i>refrain</i>	ii.	*vr
iii.	[fl]Ik <i>flick</i>	iii.	*vl
iv.	ə.[fl]Ikt <i>afflict</i>	iv.	*vl
v.	[ʃr]ΔIm <i>shrine</i>	v.	*ʒr
vi.	[sl]aIm <i>slime</i>	vi.	*zl
vii.	pa:.[sl]i <i>parsley</i>	vii.	*zl
viii.	[θr]əut <i>throat</i>	viii.	*ðr

(2-13) **Pre-nuclear obstruent-plus-liquid in English (II)**

a.	<i>Voiceless stops and liquids</i>	b.	<i>Voiced stops and liquids</i>
i.	[pr]eI <i>pray</i>	i.	[br]eIs <i>brace</i>
ii.	Im.[pr]ə.keIt <i>imprecate</i>	ii.	Δm.[br]Idʒ <i>umbrage</i>
iii.	[pl]eI <i>play</i>	iii.	[bl]Is <i>bliss</i>
iv.	dI.[pl]i:t <i>deplete</i>	iv.	Im.[bl]eI.zən <i>emblazon</i>
v.	[kl]If <i>cliff</i>	v.	[gl]Δt <i>glut</i>
vi.	æŋ.[kl]It <i>anklet</i>	vi.	rŋ.[gl]It <i>ringlet</i>
vii.	[kr]i:m <i>cream</i>	vii.	[gr]i:t <i>greet</i>

⁶ [sr] and [θl] are absent as pre-nuclear clusters for reasons that probably have nothing to do with sonority.

viii.	si:.[kr]ɛt	<i>secret</i>	viii.	ɪŋ.[gr]ɛt	<i>ingrate</i>
ix.	[tr]ɛs	<i>tress</i>	ix.	[dr]u:l	<i>drool</i>
x.	pæn.[tr]i	<i>pantry</i>	x.	eɪ.[dr]ɪən	<i>Adrian</i>
xi.	*tl		xi.	*dl	(see §2.1.1)

The fact that voiceless fricatives and stops occur freely before pre-nuclear liquids while voiced fricatives do not suggests that fricatives fall into two separate sonority classes in English: the voiceless ones siding with the stops, and the voiced ones constituting a class of their own. This observation is reflected in the English-specific sonority scale in (2-14). It differs from the general scale in (2-11) only in that, in it, voiceless fricatives have been added to the sonority class of stops, which have ‘0’ as their sonority rank.⁷ The column listing the featural expansions of the various sonority classes is omitted in the sonority scales to follow.

(2-14) **English sonority scale**

<i>Sonority class</i>	<i>Melody tokens</i>	<i>Sonority rank</i>
Stops, voiceless fricatives	p, t, k, b, d, g, f, s, ʃ, θ	0
Voiced fricatives ⁸	v, z, ʒ, ð	1
Nasals	m, n, ŋ	2
Liquids	l, r	3
High vowels/glides	i, ɪ, j, u, ʊ, w	4
Mid vowels	ɛ, ɔ	5
Low vowels	a, æ	6

Given the English sonority scale in (2-14), the Onset and Coda are shown to be sonority islands independent of the Nucleus in §2.2.2.

2.2.2 *Sonority domains in English*

Pre-/post-nuclear segmental melodies which are adjacent in a syllable typically show a minimal difference in sonority rank in most languages (but see note 5): this difference is

⁷ The alternative is to increase the rank of voiced fricatives and subsequent sonority classes by one so that the English sonority scale reads as follows: stops: 0, voiceless fricatives: 1, **voiced fricatives: 2, nasals: 3, liquids: 4** and so on. Such a scale predicts pre-nuclear sequences consisting of a stop followed by a nasal to be well-formed in English given that stops and nasals are three ranks apart in it, exactly like voiceless fricatives and liquids. The fact, however, is that while pre-nuclear sequences involving a voiceless fricative followed by a liquid are attested (see (2-12a)), those involving a stop followed by a nasal are not.

⁸ Levin (1985: 63) contends (contra Steriade 1982), based on evidence from Chukchee (p. 148), that introducing a feature distinction in one part of the sonority scale alone is sometimes necessary. The use of the feature [voice] to sub-classify fricatives into two sonority classes in English follows Levin’s argument.

called the Minimal Sonority Distance (MSD). In English, as seen earlier, consonants more sonorous than voiceless fricatives or stops do not occur before pre-nuclear liquids. Nor do melodies less sonorous than liquids occur as the second consonant in pre-nuclear clusters. The MSD required of adjacent consonants in a pre-nuclear cluster in English is therefore ‘3’ (cf. Levin 1985: 150) under the sonority scale in (2-14).

In the post-nuclear section of the syllable, however, English allows liquid-plus-nasal sequences (2-15), which have a sonority distance of just ‘1’ (see also Levin 1985: 154; Blevins 1995) under the sonority scale in (2-14). Pre-nuclear nasal-plus-liquid sequences on the other hand are not attested because they do not satisfy the pre-nuclear MSD of ‘3’:

(2-15) **Post-nuclear liquid-plus-nasal in English**

fɪ[lm]	<i>film</i>	fa[rn].swərθ	<i>Farnsworth</i>
rɛ[lm]	<i>realm</i>	kɔ[rn]	<i>corn</i>
kɪ[lɪn]	<i>kiln</i>	ə.dɔ[rn]	‘adorn’
ɛ[lm]	<i>elm</i>	ɑ[rn].lɪt	<i>armlet</i>
hɛ[lm]s.mən	<i>helmsman</i>	dɔ[rn]	<i>dorm</i>
tʃɛ[lm]s.fəd	<i>Chelmsford</i>	ə.lɑ[rn]	<i>alarm</i>

The occurrence of the post-nuclear liquid-nasal clusters in (2-15) and the absence of their pre-nuclear mirror images in English are predictable if the parts of the syllable to the left and right of the syllable peak are treated as sonority islands; each with their own MSD requirement. These ‘islands’ are the Onset and the Coda.

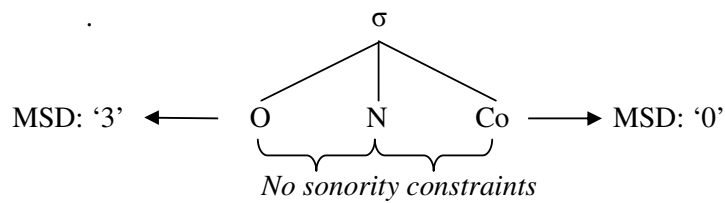
The analysis can indeed be recast using demi-syllables by assuming that the initial demi-syllable (left margin to peak) and the final demi-syllable (peak to the right margin) are governed by different MSD requirements (cf. Clements 1990). The difference, however, needs to be stipulated in the demi-syllabic approach just as in the OR Model; and does not simply fall out of the ‘fact’ that sonority rises towards and falls from the syllable peak.

The conclusion is that a demi-syllable-based account of consonant-sequencing in English is at least not superior to a constituency-based account of the same. The former account, in fact, fares poorer than the latter, owing to its failure to explain⁹ why certain

⁹ In Clements (1990), the problem is sidestepped due to the assumption that [+syllabic] sounds are more sonorous than their [-syllabic] avatars. This assumption allows for the following (fairly accurate) characterisation of nonsyllabic-syllabic consonant sequences in languages: if a consonant with sonority rank X occurs before a syllabic consonant with sonority rank R, then all consonants with sonority rank less than X are predicted to occur before the syllabic consonant with rank R. While Clements’ assumption captures the

consonants are ruled out in tautosyllabic sequences when they are all non-nuclear, but are allowed when one (or more) of them is associated with the Nucleus (§2.1.1). The upshot is that that a syllable has three, not two, sonority domains: the Nucleus, what precedes it, and what follows it. .

(2-16) **O, N and Co as sonority ‘islands’**



Different values of MSD are thus expected either side of the Nucleus under the Constituency Dimension. While Onset MSD and Coda MSD are the same in Attic Greek (Steriade 1982: 211-8), they are different in English; with Onset MSD being ‘3’ and Coda MSD being ‘0’ under the sonority scale in (2-14) (see also §2.5.1). Different MSD values will be seen to govern the Onset and the Coda in Adhilabad Gondi, too; a language where consonants are allowed to cluster only after a nuclear vowel.

2.2.3 *Sonority domains in Adhilabad Gondi*

Consider, as tabulated in (2-17), the inventory of consonants in the Adhilabad dialect of Gondi a. k. a Adhilabad Gondi (Subrahmanyam 1967: chapter 1):

clustering of syllable-internal material across languages neatly, it also implies a (rather superfluous) expansion of phonemic inventories based on the feature specifications [+/-syllabic]; which, in most languages, are contrastive only in certain contexts.

(2-17) **Inventory of melodies**

a. *Consonants*

	<i>Bi-labial</i>	<i>Labio-dental</i>	<i>Coronals</i>			<i>Velar</i>	<i>Glottal</i>
			<i>Alveolar/Dental</i>	<i>Palatal</i>	<i>Retroflex</i>		
<i>Stops</i>	p ^(h) , b ^(h)		t ^(h) , d ^(h)	c ^(h) , ʃ ^(h)	ʈ ^(h) , ɖ ^(h)	k ^(h) , g ^(h)	
<i>Fricatives</i>		v	s				
<i>Nasals</i>	m		n			ŋ	
<i>Lateral</i>			l				
<i>Rhotics</i>			r		ɽ		
<i>Glide</i>							h

b. *Vocalic melodies*

[back] / [round]	[low]	[high]	Melody
	+		a, a:
-	-	-	e, e:
+	-	-	o, o:
-		+	i, i:, j
+		+	u, u: (*w)

Consonants are not allowed to cluster before nuclear vowels in Adhilabad Gondi. After vowels, however, clusters comprising a maximum of two consonants are allowed in monomorphemic words.¹⁰ All of these bi-consonant clusters – except [rn] in the word meaning ‘cross cousin’ – contain a coronal sonorant followed by a coronal obstruent as seen in (2-18). The number bracketed beside each word refers to the page in Subrahmanyam (1967) from which it has been taken.

(2-18) **Post-nuclear consonants in Adhilabad Gondi**

a. *Word-final clusters*

- i. e:[ɽʃ] ‘ear’ (190)
- ii. p^ho:[ɽd] ‘sun, time’ (217)
- iii. ne:[nd] ‘today’ (212)

b. *Word-medial clusters*

- i. ma[rn].ɖu: ‘cross-cousin’ (221)
- ii. mi[ɽc].ua:l ‘lightning’ (222)

¹⁰ Clusters consisting of up to three consonants occur at the right-edge of words with more than one morpheme. In all such clusters, however, the final consonant is the [k] of the non-masculine plural suffix (see §2.3.4).

- iv. koɽ.vi:[nɟ] ‘hat’ (196)
- v. po:[nɟ] ‘hen’ (217)
- vi. ma[rs] ‘axe’ (221)
- vii. kurs ‘antelope’ (195)

The post-nuclear consonant clusters exemplified in (2-18) do not suggest that the sonority-wise classification of melodies in Adhilabad Gondi departs in any way from the classification given in the general sonority scale in (2-11). The latter is therefore repeated below as (2-19)—with melodies from Adhilabad Gondi slotted into the appropriate sonority classes. (As regards the characterisation of [h] as a glide below, see §2.4.2.)

(2-19) **Adhilabad Gondi sonority scale**

<i>Sonority class</i>	<i>Melody tokens</i>	<i>Sonority rank</i>
Stops	p, b, t, d, ʈ, ɖ, c, ɟ, k, g	0
Fricatives	s, v	1
Nasals	m, n, ŋ	2
Liquids	l, r, ɽ	3
High vowels, glides	i(:), j, u(:), h	4
Mid vowels	e(:), o(:)	5
Low vowels	a(:)	6

Among the post-nuclear consonant clusters in (2-18), the nasal consonant and a following (oral) stop in nasal-plus-stop sequences, as well as the liquid and a following [s] in liquid-plus-[s] sequences, have a sonority distance of ‘2’ under the sonority scale in (2-19). Post-nuclear MSD may also be consequently taken as ‘2’ since consonants which are less distant on the sonority scale in (2-19) do not occur as tautosyllabic clusters in Adhilabad Gondi. Consonants which are farther apart than two sonority ranks are allowed, as expected, and are exemplified by the post-nuclear rhotic-plus-stop sequences in (2-18).

Turning to the absence of pre-nuclear consonant clusters in Adhilabad Gondi, it can be explained if pre-nuclear MSD in Adhilabad Gondi is at least ‘4’ under the sonority scale in (2-19). There is also some language-internal support for a pre-nuclear MSD of ‘4’, and it is provided by the aspirated variants of the voiceless stops in (2-17a). If aspirated stops were to be decomposed, the resulting stop-plus-[h] sequences would have a sonority distance of ‘4’ under (2-19). These stop-plus-[h] ‘clusters’ are allowed to occur before nuclear vowels in the

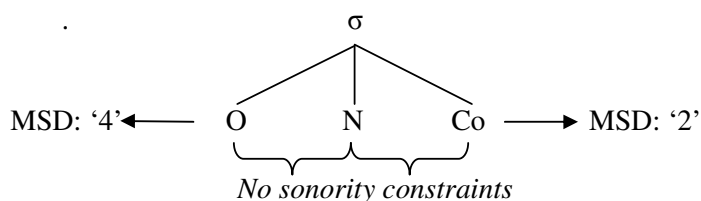
language; which is not surprising if pre-nuclear MSD is ‘4’: e.g. [t^ha.li:] ‘tumbler’, [d^hu.ti:] ‘fish basket’, [k^ha:n.da:] ‘tree-branch’, [g^ha.ʈo:] ‘food’ (Srinivas 2010: 10).

What is surprising then is the absence of pre-nuclear stop-plus-j sequences, which are predicted to occur if pre-nuclear MSD is ‘4’ under the sonority scale in (2-19). The absence of these sequences can be explained, however, without recourse to sonority. The impetus for a non-sonority explanation here is strengthened by the fact that even post-nuclear j-plus-stop sequences, which are predicted to occur freely given the post-nuclear MSD of ‘2’, are restricted to cases where the stop is the plural suffix [-k]: e.g. [buj-k] ‘groundnuts’, [nej-k] ‘dogs’.

If absence of clusters involving the palatal glide [j] does have a viable non-sonority explanation, the lack of pre-nuclear clusters in Adhilabad Gondi can indeed be attributed to a pre-nuclear MSD of ‘4’, since it is not respected by any combination of non-vocalic melodies in the language. While melodic constraints independent of MSD can also determine the size of consonant clusters, such constraints are deducible only in languages like Chukchee and Estonian where MSD predicts longer consonant clusters than actually occur in the first place (Levin 1985: 145-158). In Adhilabad Gondi, there is no need to countenance such constraints since MSD alone can account for the presence of post-nuclear clusters and the absence of pre-nuclear ones.

To conclude: the MSD required of adjacent post-nuclear melodies (‘2’) is different from the MSD required of adjacent pre-nuclear melodies (‘4’) in Adhilabad Gondi, just like in English, but unlike in Attic Greek. This conclusion again suggests that pre-nuclear MSD holds over the Onset and post-nuclear MSD holds over the Coda. The conclusion, coupled with the lack of constraints jointly targeting nuclear and pre-/post-nuclear melodies in Adhilabad Gondi, indicates that the Onset and the Coda are sonority islands, which do not overlap with the Nucleus (see §2.2.2 and note 9 for the argumentation).

(2-20) **O, N and Co as sonority ‘islands’**



2.2.4 Suspicious demi-syllabic domains

The last two parts of this section have shown that the Onset and the Coda are legitimate sonority domains, independent of the Nucleus, in two not closely related languages. Still earlier in the chapter (§2.1.1), illicit z-plus-sonorant sequences were seen to ‘become’ legitimate in English when the sonorant is associated with the Nucleus. The upshot is that the Nucleus, the Onset and the Coda are, after a fashion, sonority ‘islands’. The absence of [ju] and [wi] in Mandarin Chinese is, however, cited as the result of a plausible sonority constraint that targets the demi-syllable consisting of the pre-nuclear and nuclear sections of the syllable (Yip 2003: 809).

If heterorganic glide-plus-vowel sequences are indeed undesirable on grounds of sonority, the absence of one such sequence in any language would imply the absence of all such sequences. This implication is, however, not borne out in English, where [jʊ] is absent, but [wɪ], [wi:] and [ju:] occur regularly: e.g. [wɪmp] *wimp*, [twɪn] *twin*, [wi:t] *wheat*, [swi:t] *sweet*, [ju:θ] *youth*, [mju:l] *mule*. At the very least, these English examples caution against viewing the absence of specific glide-plus-vowel sequences as evidence for a sonority restriction targeting demi-syllables. Unless more convincing evidence is presented in favour of the demi-syllabic divisions of a syllable, therefore, the division of it as Onset, Nucleus and Coda is to be preferred.

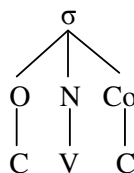
Note that a syllable sub-structured into an Onset, a Nucleus and a Coda is also essentially flat, however, as seen in (2-21b). The difference between the model in (2-21b) and that in (2-21a) is that the latter does not accommodate even the three constituents entertained in the former, and cannot consequently account for the phonological phenomena discussed thus far.

(2-21) Flat syllables

a. *Sans constituents*



b. *With constituents*

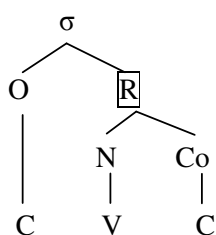


The next section concentrates on the part of the Constituency Dimension which renders (2-21b) ‘un-flat’. Enter the Rhyme.

2.3 Rhyme-based Phonological Phenomena

In Chapter 1 (§1.4.1), two constraints, one each from Cantonese and the Chungli dialect of Ao, were seen to jointly target the nuclear and the post-nuclear melodies in a syllable, but not the pre-nuclear ones. Constraints such as those lend force to the claim that the Nucleus and the Coda combine to form a higher-level constituent called the Rhyme:

(2-22) Constituency Dimension



Besides considering the restrictions from Cantonese (§2.3.1) and Chungli (§2.3.2) in greater detail, this section also presents other data to establish the Rhyme as an integral part of the Constituency Dimension. For example, synchronic nasalisation triggered by a post-nuclear nasal consonant is argued to stop at the Rhyme in Spoken Tamil so as to explain why only the nuclear vowel appears nasalised in the language; as opposed to Chaoyang where (diachronic) nasality has spread to the entire syllable, rendering pre-nuclear voiced consonants nasal as well (§2.3.3). Plural allomorphy in Adhilabad Gondi is then shown to be best explained in terms of (un)acceptable Rhyme-internal sequences (§2.3.4).

2.3.1 Rhyme-based dissimilarity

The evidence from Cantonese involves two restrictions, both concerning labial melodies as seen in §1.4.1. The first restriction is that a nuclear vowel and a post-nuclear consonant must not both be labials in the language:

(2-23) *VC labials in Cantonese

- | | | | | | |
|----|-------------------|------------|----|-------------------|------------|
| a. | *V [labial +back] | C [labial] | b. | *V [labial -back] | C [labial] |
| | | | | | |
| | u, o | p, m, w | | y, ø | p, m, w |

The second restriction is that pre-nuclear labial consonants, all of which are [-back] in the language, must not co-occur with labial vowels which also have the specification [-back]

as seen in (2-24a). They do co-occur with labial vowels which are [+back], however, as evidenced by the actually occurring Cantonese words in (2-24b).

(2-24) **CV labials in Cantonese**

a.	*C [labial -back]		V [labial -back]
	p ^h , m, f		y, ø
b.	C [labial -back]		V [labial +back]
	p ^h , m, f		u, o

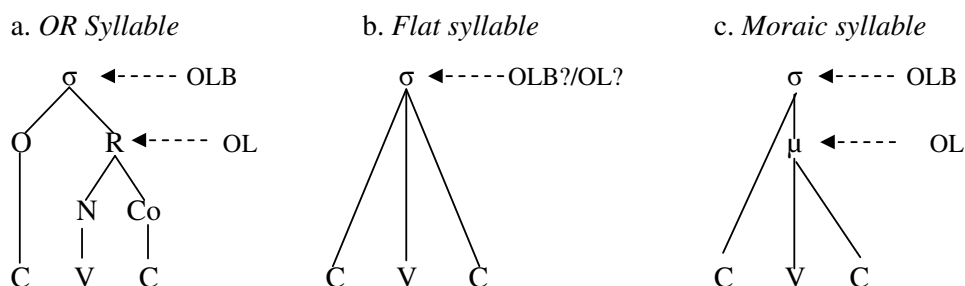
	p ^h un	‘a plate’	p ^h o
			‘an old lady’
	mo	‘slow’	fo
			‘commodities’

The prohibition on adjacent occurrences of identical feature specifications in a phonological string is usually attributed to constraints formally united under the label Obligatory Contour Principle or OCP (McCarthy 1986, Odden 1986). In Cantonese syllables, then, OCP [labial] is clearly active (Cheng 1990) as evidenced by the absence of sequences consisting of a labial vowel and a labial post-vowel consonant (2-23).

OCP [labial] cannot, however, be the only OCP constraint operating in Cantonese syllables. If it were, the actually occurring words in (2-24b), which have a labial pre-nuclear consonant and a labial vowel, would be incorrectly ruled out. What needs to be noted, therefore, is that in these words the labial consonant is [-back] and the following vowel is [+back]. Labial vowels which are [-back] do not co-occur with pre-nuclear labial consonants which are also [-back], however, suggesting that the OCP constraint governing CV sequences in Cantonese is OCP [labial, -back].

With both OCP [labial] and OCP [labial, -back] holding sway in Cantonese, the parts of the syllable over which these two OCP constraints have scope needs to be determined. If OCP [labial] is assumed to operate over the entire syllable, as in (2-25b), it will rule out all adjacent tautosyllabic labials, including, incorrectly, those in the words in (2-24b). If OCP [labial, -back] is assumed to operate over the entire syllable, the words in (2-24b) will be correctly allowed, but so will [up, um, op, om] in (2-23a), incorrectly. An adequate account of the data in (2-23) and (2-24) is, therefore, not available, regardless of whether OL (i.e. OCP [labial]) or OLB ([OCP labial, -back]) targets a syllable that is internally flat (2-25b):

(2-25) **OCP domains in Cantonese**



In a constituency-based version of the syllable (2-25a), OCP [labial] can be assumed to operate over the Rhyme. This explains the absence of tautosyllabic sequences with a labial vowel and a labial post-vowel consonant (2-23). OCP [labial, -back] can then be assumed to operate over the (rest of the) syllable, whence it rules out sequences involving a non-back labial consonant followed by a non-back labial vowel (2-24a). Tautosyllabic sequences where a non-back labial consonant is followed by a back labial vowel, as in (2-24b), are correctly left untouched by both constraints. As for the analysis involving the ‘shared mora’ representation in (2-25c), it is only nominally different from the Rhyme-based analysis (see also (2-47a, c)) as the following discussion will show.

In Cantonese, as in many other tonal languages, short-vowelled syllables closed by obstruents (CVO) do not carry contour tones (Bauer & Benedict 1997, Gordon 2001). Consequently, CVO syllables in Cantonese may be deemed monomoraic. If a CVO syllable (where O is the labial stop [p]) is then represented as (2-25c), with V and O sharing a mora (μ), the shared μ is best interpreted as a double act—playing, at the same time, the role of the Rhyme and a mora. In other words, the representation in (2-25c) also appeals to the Rhyme, but secretes the Rhyme into the mora. The Rhyme is thus (at least implicitly) necessary in analysing the co-occurrence facts concerning tautosyllabic labials in Cantonese.

The Rhyme-based analysis is also consistent from the perspective of strength (Goldsmith 2012: 9), according to which notion segmental melodies in the same domain are expected to be more ‘strongly’ (dis)similar than others. This expectation is met in Cantonese where Rhyme-internal (i.e. nuclear and post-nuclear) melodies are never both labials. Rhyme-internal melodies are hence more dissimilar vis-à-vis the feature [labial] than pre-Rhyme and Rhyme melodies which are never both non-back labials.

The Rhyme-based account of the distribution of labials in Cantonese syllables also makes a larger prediction according to an examiner: that a general condition may hold of the Rhyme – e.g. OCP [labial] – while a specific condition holds over the syllable – e.g. OCP

[labial, -back] – but that the converse (with a general condition holding over the Syllable and a specific one holding over the Rhyme) is not possible. This prediction requires further exploration.

In conclusion, the Rhyme is crucial to explaining why post-nuclear melodies and nuclear melodies are more dissimilar than nuclear ones and pre-nuclear ones in Cantonese. In §2.3.2, the Rhyme is also shown to underlie the featural similarity between nuclear and post-nuclear melodies in the Chungli dialect of Ao.

2.3.2 Rhyme-based similarity

To recapitulate from Chapter 1 (§1.4.1), vowels and post-vowel consonants are both required to have the same (plus or minus) specification for the feature [back] in the Chungli dialect of Ao (hereafter Chungli). A consequence of this requirement is that the [-back] variant of schwa [ə] occurs only before non-back consonants – i.e. labials and coronals (2-26a) – in Chungli. The [+back] allophone [ɯ] itself occurs only before velar consonants, which are also back (2-26b). (Acute accent marks high tone, grave accent marks low tone and mid tones are left unmarked in the data below which are taken from Temsunungsang (2009). Bracketed numbers beside the gloss refer to pages in the source work.)

(2-26) VC harmony in Chungli

a.	V [-back]	C [-back]	b.	V [+back]	C [+back]
	 ə	 n, t, p, m		 ɯ	 k, ŋ
<hr/>			<hr/>		
i.	a.m[ə̀n]	‘sit’ (91)	i.	ts[ɯ́k]	‘grain’ (31)
ii.	kà.k[ə́t]	‘book’ (79)	ii.	z[ɯ́k].taŋ	‘beat.CON’ (77)
iii.	à.s[ə́p]	‘off’ (31)	iii.	á.n[ɯ́ŋ]	‘sky’ (31)
iv.	á.c[ə́m]	‘fear’ (13)	iv.	á.r[ɯ́k]	‘drown’ (86)

While schwa and a tautosyllabic post-schwa consonant share the same specifications for the feature [back] in Chungli, schwa and a pre-schwa consonant need not. This point is clear from the occurrence of the non-back consonants [n, t, p, m] before back [ɯ] in (2-27a); and the occurrence of back [k] before non-back [ə] in (2-27b). The velar nasal [ŋ] does not occur in pre-nuclear position before any vowel in Chungli, so its absence after [ə] in (2-27b-iv) is unsurprising.

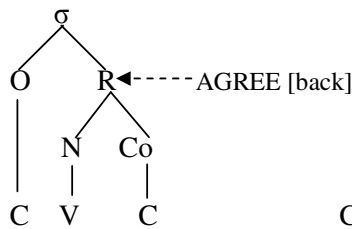
(2-27) **CV non-harmony in Chungli**

	C [-back]	V [+back]		C [+back]	V [-back]
	 n, t, p, m	 u		 k	 ə
i.	á.[nú]k	‘grind’ (210)	i.	kà.[kə́]t	‘book’ (79)
ii.	[tu].zu	‘vein’ (31)	ii.	[kə]n	‘song’ (16)
iii.	[pú].rúk	‘scatter’ (211)	iii.	a.[kə́].tsuʔ	‘give’ (139)
iv.	[mu].cán	‘sleep’ (64)	iv.	[ŋə] does not occur	

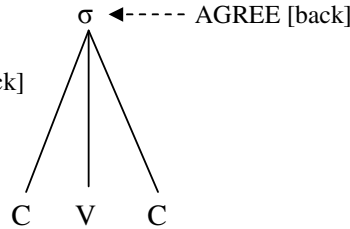
In Chungli, as in Cantonese, nuclear and post-nuclear melodies (2-26) are thus governed by a constraint to which nuclear and pre-nuclear melodies are not subject (2-27). The only difference is that the constraint in Cantonese demands dissimilarity (with respect to the feature [labial]) while the constraint in Chungli demands similarity with respect to the feature [back]. Supposing now that the name of the constraint in Chungli is AGREE [back], the following diagrams, representing three different models of syllable structure, offer three possible domains over which the constraint can be assumed to operate:

(2-28) **AGREE [back] domains in Chungli**

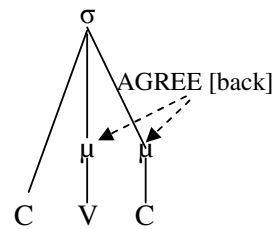
a. *OR syllable*



b. *Flat syllable*



c. *Moraic syllable*



If AGREE [back] is assumed to operate over syllables – or over linearly sequenced melodies – in a model where they are internally flat (2-28b), there is no explanation as to why schwa and a post-schwa consonant, but not a pre-schwa consonant, must have the same specification for the feature [back] in Chungli. In an account which appeals to the moraic syllable (2-28c), the explanatory problem disappears as AGREE [back] targets only the moraic segmental melodies in vowels and post-nuclear consonants, but spares pre-nuclear consonants which are non-moraic. The moraic representation in (2-28c) is, however, untenable in Chungli, where only vowels are normally moraic,¹¹ as suggested by the mono-

¹¹ For expansion of the caveat *normally moraic*, see Chapter 3, note 19.

tonal syllables in (2-26) and (2-27). The potential contention that vowels and post-nuclear consonants might share a mora is also questionable because Chungli Ao, like Cantonese, has a tonal prosodic system (see discussion surrounding (2-25)).

Finally, assuming that AGREE [back] operates over the Rhyme (2-28a) explains why schwa and a post-schwa consonant always have the same specification for the feature [back] in Chungli, as well as why a pre-schwa consonant and schwa may differ in their specifications for that feature. Like the VC sequence in (2-28a), schwa and any tautosyllabic consonant following it would be associated with the Rhyme; and would share the same ‘backness’ specification in order to respect the constraint AGREE [back] which operates over the Rhyme. A pre-schwa consonant on the other hand is associated outside the Rhyme, need not respect AGREE [back] and is hence allowed to differ from schwa with respect to its specification for the feature [back].

Summarising in featural terms, the fact that nuclear vowels and post-nuclear consonants differ – maximally – in Cantonese and the fact that they resemble each other in Chungli Ao are both captured in terms of the Rhyme. Note that it is not absurd to view the Rhyme as a domain of both similarity and dissimilarity constraints because there are, presumably, articulatory/perceptual advantages to be had if segmental melodies associated with the same domain are very similar or very different.

The Rhyme has so far been viewed as a domain targeted by constraints involving melodic features in this section. The next part of the section shows that the Rhyme is also a domain within which processes involving melodic features take place (see also §5.1.1). Nasalisation in Chaoyang and Tamil presents a case in point.

2.3.3 *Rhyme-mediated nasalisation*

According to Yip (1994), vowels in Chaoyang underwent diachronic nasalisation before tautosyllabic [n]. The [n] itself underwent deletion subsequently, rendering the trigger of vowel nasalisation invisible. The result is that nasal vowels are found only in open syllables in synchronic Chaoyang.

(2-29) **Diachronic nasalisation in Chaoyang**

	<i>Input</i>	<i>Nasalisation</i>	<i>Synchronic form</i>	<i>Gloss</i>
a.	*be:n	*mẽ:n	mẽ:	‘fast’
b.	*buen	*muẽn	muẽ	‘porridge’
c.	*lan	*nã	nã	‘basket’

d. *gian *ŋiãñ ŋiã ‘elegant’

The nasality from the diachronic process is not restricted to vowels in synchronic Chaoyang, however, as evidenced by the fact that consonants preceding the nasal vowels in (2-29a-d) are all nasal, too. These pre-nuclear nasal consonants were originally oral voiced consonants in Chaoyang, as seen under the ‘input’ column in (2-29), but underwent nasalisation on account of the following nasal(ised) vowel. This latter inference is supported by the synchronic occurrence of nasal consonants before oral vowels (2-30d, e).

(2-30) **Pre-nuclear oral consonants in Chaoyang**

a.	<u>b</u> ue	‘tail’	d.	<u>m</u> ak	‘eye’
b.	<u>l</u> ai	‘inside’	e.	<u>n</u> aŋ	‘person’
c.	<u>g</u> ue?	‘month’	—		

If a pre-nuclear nasal consonant had caused the vowel following it to be nasal, the vowels in the words in (2-30d, e) would have been nasal. That they are not supports the claim that vowel nasalisation must have occurred before pre-nuclear consonant nasalisation in syllables with post-nuclear [n] (which subsequently underwent deletion). The resultant nasal vowel must then have triggered a preceding voiced consonant to be nasal. The historical ordering of these diachronic processes is shown in (2-31), where ‘D’ stands for any voiced consonant, and N for any nasal consonant. (Note that in (2-31) the stage where the vowel has been nasalised but the pre-vowel consonant remains oral – (2-31a) – is merely speculative.)

(2-31) **Historical order of processes in Chaoyang:**

<i>Pre-nasalisation input</i> (reconstructed):	DVn
(a) Vowel nasalisation:	D \tilde{V} n
(b) n-deletion, pre-nuclear nasalisation (unordered):	N \tilde{V}
<i>Synchronic output:</i>	N \tilde{V}

Item (2-31) makes it clear that in Chaoyang a post-nuclear nasal consonant triggered vowel nasalisation, and the consequent nasal vowel itself triggered the nasalisation of pre-nuclear voiced consonants. In Spoken Tamil, like in Chaoyang, post-nuclear nasal consonants, namely [m] and [n], cause a preceding vowel to be nasal (Lisker & Vaidyanathan 1972) as seen in (2-32). Unlike in Chaoyang, however, the nasalised vowel does not cause a pre-nuclear consonant to be nasal, regardless of the latter’s specifications for the feature [voice]

(e.g. (2-32d, e, h, i)) or for the feature [son] (e.g. (2-32b, c, k)). In the data-list below, syllable boundaries are marked with a period, as usual, while morpheme boundaries are marked with a short hyphen.

(2-32) **Vowel nasalisation in Spoken Tamil**

	<i>Standard Tamil</i>	→	<i>Spoken Tamil</i>	<i>Gloss</i>
a.	mar.mam	→	mar.mõ	‘mystery’
b.	pu:.ra:n	→	pu:.rã:	‘millipede’
c.	mu:.lam	→	mu:.lø	‘source’
d.	sat.tam	→	sat.tõ	‘sound’
e.	ta-n.d-e:n	→	ta-n.d-ẽ:	‘give-PAST-1SG’
f.	po:.-u-o:m	→	po:.-u-õ:	‘go-FUT-1PL’
g.	pa:.ɟi.-u-a:n	→	pa:.ɟi.-u-ã:	‘sing-FUT-MASC.3SG’
h.	set.t-e:n	→	set.t-ẽ:	‘damned-1SG’
i.	ua-n.d-o:m	→	ua-n.d-õ:	‘come-PAST-1PL’
j.	se..ɟi-p.p-a:n	→	se..ɟi-p.p-ã:	‘prosper-FUT-MASC.3SG’
k.	e:..ɟi-a:m	→	e:..ɟ-ã:	‘seventh’

Abstracting away from the vowel raising observed in the Spoken Tamil forms in (2-32a, c, d), which is not relevant to the concerns of this subsection, it is clear that vowel nasalisation in Spoken Tamil correlates with a post-nuclear nasal consonant that is not surface-true, exactly as in Chaoyang. The historical status of the nasalisation processes in the two languages is different, however. Whereas vowel nasalisation in Chaoyang is diachronic as noted earlier, it is arguably synchronic in Tamil. The latter claim is supported by the fact that nasal vowels in Spoken Tamil are spontaneously unpacked into their corresponding Standard Tamil sequences – i.e. an oral vowel followed by a nasal consonant – at least by literate users of Tamil.¹²

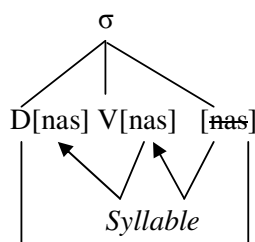
Historical factors, however, do not explain why nasalisation extends to pre-nuclear voiced consonants in Chaoyang (2-29), but not in Spoken Tamil (2-32b, c, e, i). Nor can a linear (melody-to-melody) account explain the difference because in both languages the trigger of nasalisation is at the right-edge of a syllable (a post-nuclear nasal consonant which does not itself surface) but the targets of nasalisation are different: the left-edge of the syllable in Chaoyang, if it coincides with a voiced consonant, and the vowel in Spoken Tamil.

¹² This ready unpacking in turn may be related to the fact that Standard Tamil and Spoken Tamil are diglossic.

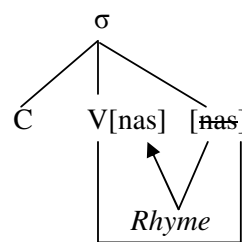
A constituency-based account that has recourse to the Rhyme, however, offers a direct explanation of the different effects of nasalisation in the two languages. In this connection, consider the two representations below where nasalisation is construed as the spread of the feature [nasal] and D stands for any voiced consonant:

(2-33) **Rhyme-mediated nasalisation**

a. *Chaoyang*



b. *Spoken Tamil*



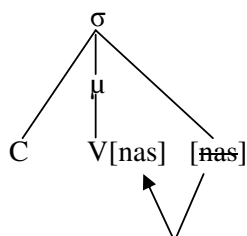
In Chaoyang, the feature [nasal] originating from the post-nuclear nasal consonant (later deleted) is passed onto the nuclear vowel, whereupon it also spreads to the pre-nuclear consonant if the consonant is voiced. In Spoken Tamil, the feature [nasal] originating from the post-nuclear [m] or [n] (later deleted) is transferred to the nuclear vowel. Unlike in Chaoyang, however, the spread of the feature [nasal] spread stops at the vowel in Spoken Tamil, where pre-nuclear oral consonants of all stripes remain oral.

It is clear from (2-33a) that pre-nuclear voiced consonants are nasalised in Chaoyang because the domain of [nasal] spread is the syllable in the language. In Spoken Tamil the domain is the Rhyme (2-33b): the spread of the feature [nasal], therefore, stops at the nuclear vowel in the language and does not affect pre-nuclear consonants which lie outside the Rhyme.

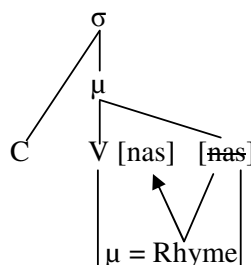
While the Rhyme thus offers a satisfactory explanation of why pre-nuclear consonants are not nasalised in Spoken Tamil even though pre-nuclear voiced consonants are in Chaoyang, internally flat models of the syllable which do not accommodate the Rhyme (2-21a, b) cannot do so. It is also not possible to explain away syllable-internal nasalisation in Spoken Tamil as the spread of the feature [nasal] from one moraic melody (post-nuclear nasal consonant) to another (vowel) because the word-final [m] and [n] which trigger nasalisation are non-moraic in the language (2-34a) by virtue of being heterorganic (see §1.4.2 and §3.3.5). Even if the spread of nasality from a non-moraic post-nuclear consonant to a moraic vowel is permitted, why the further spread of nasality from a moraic vowel to another non-moraic (i.e. pre-nuclear) consonant is blocked would remain unclear under (2-34a).

(2-34) **Mora-based nasalisation in Spoken Tamil**

a. *Unshared mora*



b. *Shared mora*



As an alternative moraic analysis, therefore, one may consider the feature [nasal] spreading from a post-nuclear nasal consonant to a vowel whose mora the nasal consonant shares (2-34b). Under this analysis, pre-nuclear consonants are not nasalised in Spoken Tamil because they do not partake of the ‘shared mora’, which controls the spread of nasality. This ‘shared mora’ analysis (2-34b) is, however, just a notational variant of the Rhyme-based analysis (2-33b)—with the mora also playing the organisational role of the Rhyme (see also (2-25a, c)), because there is no independent evidence for mora-sharing in Tamil. The Rhyme is thus necessary, at least implicitly, to explain the different effects of syllable-internal nasalisation, observed in Chaoyang and Spoken Tamil.

To conclude: if syllable-internal processes of nasalisation are necessarily mediated by the Rhyme, it should not be possible for them to yield syllables where vowels and pre-nuclear consonants are nasal, but post-nuclear consonants are oral. Occurrence of such syllables would, therefore, falsify any Rhyme-mediated account of syllable-internal nasalisation.

(2-35) **Syllable-internal nasalisation given Rhyme**

C \tilde{V} N	N \tilde{V} N	N \tilde{V} C
e.g. American English	e.g. Chaoyang (sans N-deletion)	Not possible

Implicit in the three cases discussed so far in this section is the dependence of the quality of the nuclear vowel on the quality of the post-nuclear consonant. The final part of this section, however, considers a case from Adhilabad Gondi where the quality of a suffixal consonant depends on whether the stem-final melody is a vowel. Admittedly, cases where the quality of a vowel is influenced by the quality of a consonant are greater in number. This fact may have a very trivial explanation in that languages generally have more consonants than they have vowels.

2.3.4 Rhyme-based allomorphy

In Adhilabad Gondi, the non-masculine plural suffix (for non-human nouns) comes in three surface shapes: these are [-k], [-ŋ] and [-i:k]. The last allomorph [-i:k] must be lexically stipulated, seeing as it occurs only after select disyllabic non-masculine nouns ending in [-a:l] (e.g. [na:j.na:l-i:k] ‘ploughs’ vs. [ro:ka:l-k] ‘wooden pestles’). Whether [-k] or [-ŋ] occurs in other plural nouns, however, depends on the final melody of the nominal stem. If that melody is a vowel, the suffix is [-ŋ], as seen in (2-36a); if it is a consonant, then the suffix is [k] as seen in (2-36b).

(2-36) **Non-masculine plural in Adhilabad Gondi** (Subrahmanyam 1967: 34, 233).

a. [V:-ŋ]			b. [C-k]		
i.	mic.c[o:-ŋ]	‘scorpions’	i.	mi:[n-k]	‘fish (PL)’
ii.	kur.v[i:-ŋ]	‘pots’	ii.	ko[r-k]	‘fowls’
iii.	ka:.j[a:-ŋ]	‘unripe fruits’	iii.	ro:.ka:[l-k]	‘wooden pestles’
iv.	ver.c[e:-ŋ]	‘squirrels’	iv.	nu[h-k]	‘hundreds’
v.	se:.l[a:-ŋ]	‘bedsheets’	v.	sod.de:[l-k]	‘ovens’

Matters are slightly complicated, however, by the fact that [-k] also occurs after some nominal stems ending in a vowel. This can be seen from (2-37).

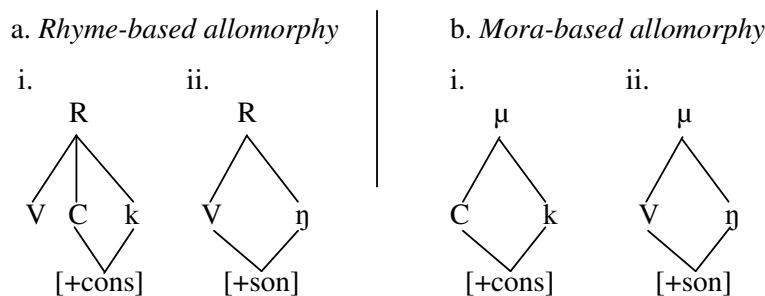
(2-37) **[V:-k] sequences**

	<i>Surface form</i>	<i>Underlying form</i>	<i>Gloss</i>
a.	bur.k[u:-k]	/burku:m-k/	‘snails’
b.	mol.l[o:-k]	/mol.lo:l-k/	‘hares’
c.	puŋ.ŋ[a:-k]	/puŋŋa:r-k/	‘flowers’
d.	as.k[u:-k]	/asku:ɽ-k/	‘axles’
e.	sin.n[u:-k]	/sin.nu:m-k/	‘bracelets’

What the surface forms do not show is that even the nominal stems in (2-37) end in a ([+son]) consonant underlyingly. Since this consonant does not make it to the surface (Srinivas 2011), one gets the impression that [-k] directly attaches to a vowel-final stem in the cases above. However, the reality, as revealed by the underlying forms, is that /-k/ does attach to stems ending in a consonant in the cases in (2-37) too. The nasal allomorph [-ŋ] on the other hand is chosen only when the stem ends in a vowel underlyingly (2-36a).

In featural terms, when the stem-final phone is a vowel and therefore [+son], the suffixal consonant is [ŋ], also [+son] (2-38a-ii). The fact that the stem-final vowel and a following suffixal consonant share the same specifications for the feature [son] suggests that they do so as part of the same output domain; namely the Rhyme. When the stem-final melody is [+cons], the suffix is [k], also [+cons]. While consonant-[k] sequences need not be treated as part of a Rhyme, they are so treated for the sake of uniformity below (2-38a-i).

(2-38) **Suffixal allomorphy**



Indeed, instead of appealing to the Rhyme, one could argue that the stem-final melody, whether vowel or consonant, and the suffixal consonant share a mora (2-38b). Mora-sharing is, however, not supported by any metrical or phonetic evidence in Adhilabad Gondi. Consequently, the mora in (2-38b) must be seen as playing just the sort of role that the Rhyme plays in (2-38a): it unites the melodic material in question under a single node (see also (2-25a, c) and (2-47a, c)). The upshot is that the moraic analysis of suffixal allomorphy in Adhilabad Gondi is no more than a notational variant of the Rhyme-based one.

This section has shown that the Rhyme is as necessary as the other constituents in the Constituency Dimension. The case for the Rhyme is strengthened by the fact that the distribution of post-nuclear consonants influences the distribution of nuclear vowels on the one hand (e.g. Tamil, Chaoyang, Chungli); but the distribution of nuclear vowels also influences the distribution of post-nuclear consonants (e.g. Adhilabad Gondi) on the other.

Earlier in the chapter, association with the Nucleus was argued to make syllable peaks out of consonants that generally occur in the margins. The Nucleus was then also seen to underpin the tautosyllabic unity of diphthongs in the first section of the chapter (§2.1). It is also worth repeating here that the Nucleus is the crucial difference between the constituency-based evaluation and the demi-syllable based evaluation of sonority inside syllables (§2.2.2).

Under the constituency-based approach, the pre-nuclear (Onset) and post-nuclear (Coda) sections of syllables were seen to be governed by sonority constraints which do not

affect nuclear material (§2.2). In the demi-syllable-based approach, however, sonority constraints are expected to target the pre-nuclear (or post-nuclear) and nuclear sections of syllables together. On balance, the constituency-based approach to sonority was shown to fare better, due to the lack of constraints simultaneously targeting the pre-/post-nuclear and nuclear sections of syllables.

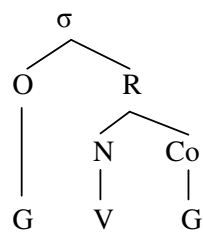
In concluding this section, it is clear that that the Constituency Dimension is necessary, and so are its constituents, namely the Onset, the Nucleus, the Coda and the Rhyme. The remainder of this chapter consolidates the case made for each constituent.

2.4 Glides and Constituents

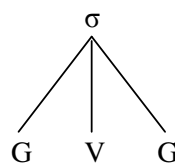
Glides represent a tenuous category of melodies, sometimes behaving like consonants and sometimes like vowels. Unlike outright consonants, typically associated with the Onset/Coda, and outright vowels, typically associated with the Nucleus, glides provide important tests of syllable-internal structure (Yip 2003). This section examines glide-related data from English, Adhilabad Gondi and Tamil, and shows that the data uniformly support the internal organisation of the syllable available under the Constituency Dimension (2-39a) over the others (2-39b, c). The ‘G’ in the following representations refers to glides in general.

(2-39) Syllable structures under comparison

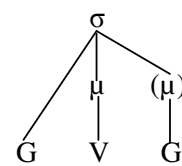
a. *Constituency Dimension*



b. *Flat syllable*



c. *Moraic syllable*



Based on Davis & Hammond (1995), post-consonantal [w] in American English is shown to be associated with the Onset in §2.4.1. In §2.4.2, post-vowel [h] in Adhilabad Gondi is argued to be a voiceless glide associated with the Coda. In §2.4.3, alleged vowel-plus-vowel sequences in Tamil are shown to be vowel-plus-glide sequences. Furthermore, the glide in those sequences is demonstrated to be non-nuclear based on the ‘integrity test’ and the ‘inseparability test’.

2.4.1 Onset [w] in American English

While the status of pre-vowel [j] in American English continues to be a matter of debate (see Barlow 2001, Yip 2003, for example), the [w] in CwV sequences is demonstrated to be pre-nuclear by Davis & Hammond (1995), who also establish that pre-vowel [w] is associated with the Onset. In the main, this subsection reviews Davis & Hammond's arguments.

First of all, the type of vowel that can occur after [w] is not determined by any sonority constraint, as evidenced by the occurrence of most vowels in that context. In (2-40), long tense vowels are transcribed merely as tense, short lax vowels merely as lax and diphthongs as vowels followed by an off-glide. This is in keeping with Davis & Hammond's (1995: 161) transcription.

(2-40) Post-consonantal [wV] in American English

- a. wi [kwɪn] *queen*, [swɪp] *sweep*, [skwɪz] *squeeze*
- b. wɪ [kwɪt] *quit*, [swɪft] *swift*, [skwɪnt] *squint*
- c. we(j) [kweɪk] *quake*, [dweɪn] *Dwayne*, [sweɪ] *sway*
- d. wɛ [swɛt] *sweat*, [kwɛst] *quest*, [twɛlv] *twelve*
- e. wæ [θwæk] *thwack*, [twæt] *twat*, [kwæk] *quack*
- f. wu [swun] *swoon*, [swup] *swoop*
- g. wo(w) [kwowt] *quote*, [kwow.fənt] *quotient*
- h. wɔ [dwɔrf] *dwarf*, [θwɔrt] *thwart*, [swɔrm]
- i. wʌ [swʌŋ] *swung*, [swʌm] *swum*
- j. wə [ʃwə] *schwa*, [kwɑrdz] *quartz*, [swat] *swat*
- k. wɑɪ [skwɑɪ.ər] *squire*, [twɑɪn] *twine*, [dwɑɪt] *Dwight*
- l. Gaps *wʊ, *waw, *woy

The non-occurrence of [aw], [ʊ] and [oy] after [w] can be explained even without recourse to sonority. The vowels [aw] and [oy] are absent after [w] because of a constraint that militates against any diphthong with a “back round component” (Davis & Hammond 1995: 162) following [w] in a syllable. Two facts lend support to such a constraint.¹³ Firstly, the absence of [woy] and [waw] (or analogous melodic sequences) is pervasive across varieties of English. The absence is not restricted to post-consonantal contexts either. Secondly, post-consonantal [wow], which does have a diphthong with a “back round

¹³ The constraint is not part of Davis & Hammond's (1995) proposals.

component” in [o], is itself limited in American English to the words in (2-40g) and morphologically related words.

As for the absence of [wʊ], it can be attributed to the phonetic identity (Davis 1985: 25f) of the glide and vowel involved. Phonetic identity in turn makes it difficult to make perceptual distinctions between [wʊ] and [ʊ]. If [wʊ] cannot be correctly distinguished from [ʊ], then the sequence [wʊ] is likely to be avoided, as in American English, or be in free variation with [ʊ], as in Tamil and the Tamilian branch of Indian English.

Regardless of how the gaps in (2-40l) are analysed¹⁴, the fact that vowels of varying heights and degrees of frontness are allowed after [w] suggests that the actually occurring [wV] sequences in (2-40) are not the product of any systematic sonority restriction. This in turn suggests that the labio-velar glide [w] and the following vowel are associated with different syllable-internal sonority domains. Since vowels are nuclear by default, a pre-vowel [w] has to be pre-nuclear. This conclusion is also supported by more sonority-related evidence.

The pre-w consonant in a CwV sequence cannot be a sonorant, for example, because sonorants and [w] have a sonority distance of less than ‘3’; which is the Minimal Sonority Distance expected of adjacent consonants in a pre-nuclear cluster in English under the sonority scale in (2-14). That consonant can be an obstruent, however, because obstruents and [w] have a sonority distance of more than ‘3’.

(2-41) Obstruent followed by [w] in American English

- a. Fricatives and [w]: [θwæk] *thwack*, [swɪm] *swim*, [ʃwa] *schwa*
- b. Stops and [w]: [twɪt] *tweet*, [dwell] *dwel*, [kweɪl] *quail*, [gwen] *Gwen*
- c. Disallowed: *vw, *fw, *bw, *pw
- d. Gaps: zw, ʒw, ðw,

Among logically possible pre-nuclear sequences involving an obstruent and [w], those in (2-41c) are absent because English does not allow two labials to co-occur in the pre-nuclear section of a syllable (Fudge 1969). As for the pre-nuclear sequences in (2-41d), the fricatives in them are more than the required ‘3’ ranks apart from [w] under the English

¹⁴ Davis & Hammond (1995: 162) also suggest a non-technical explanation for the gaps in (2-40l). [ʊ], [aw] and [oy] were reportedly the most infrequent vowels in a pool of 20,000 words they surveyed. The non-occurrence of these vowels after [w] might therefore have just reflected the general under-representation of these vowels.

sonority scale in (2-14). The sequences are nonetheless absent; a fact for which I presently have no explanation.

What is important though is that all the attested obstruent-[w] sequences in (2-41a, b) also respect the pre-nuclear MSD of ‘3’, and are duly well-formed. The upshot is that in a CwV sequence C and [w] are tied together on grounds of sonority whereas [w] and V are not. This indicates that C and [w] are associated with the same sonority domain, the domain being the Onset in the Constituency Dimension. The claim that the C and [w] in a CwV sequence are associated with the Onset receives further support from Pig Latin.

Pig Latin progenies are typically thought of as being derived from their English parents in the following way. Firstly, an English word is chosen as input. Secondly, all pre-nuclear consonants from the initial syllable of said word are transposed to the right-edge of the word. Finally, the vowel [e] is added to the right of the transposed string, yielding the Pig Latin form. These three steps are shown in (2-42):

(2-42) **English to Pig Latin**

English Input:	kr ɪ.mə.nəl	tip
Pre-nuclear transposition:	ɪ.mə.nəl. kr	ɪp. t
[e]-epenthesis and Pig Latin output:	ɪ.mə.nəl. kre	ɪp. te
	(<i>criminal</i>)	(<i>tip</i>)

Just like the cluster [kr] in the word *criminal*, any pre-nuclear [Cw] sequence in the initial syllable of English words is transposed rightwards to derive the corresponding Pig Latin forms. This is seen in (2-43).

(2-43) **Pre-nuclear [Cw] in Pig Latin** (Davis & Hammond 1995: 166)

	<i>English</i>	<i>Pig Latin</i>	<i>Gloss</i>
a.	tw ɪn	ɪnt we	‘twin’
b.	dw ɛl	ɛld we	‘dwell’
c.	sw ægər	ægərs we	‘swagger’
d.	kw out	out kw e	‘quote’
e.	ʃw a	a ʃw e	‘schwa’

Under the Constituency Dimension (2-39a), the movement of all pre-nuclear melodies from the initial syllable of the words in (2-43), including [w], has a simple explanation. If

these melodies are all associated with the Onset of the initial syllable, moving that Onset entails moving every melody associated with that Onset. On the other hand, if syllable-internal structure is held to be flat (2-39b), the motivation behind moving all, but not some pre-nuclear segmental melodies, in the initial syllable is unclear.

Nor is any commitment to ‘movement’ necessary to demonstrate the significance of the Onset in the context of Pig Latin. One could, for example, assume that Pig Latin inputs consist of an English word followed by a monomoraic suffix; the suffixal mora pre-associated with /e/ as in (2-44a). The pre-moraic part of the suffix may then be filled by copying all pre-moraic (i.e. pre-nuclear) melodies from the initial syllable of the input, and be followed by their deletion from the initial syllable of the input. This suffix-plus-copy approach to the derivation of Pig Latin forms is contrasted with the traditional movement-plus-epenthesis approach in (2-44b):

(2-44) **Pig Latin: comparison of approaches**

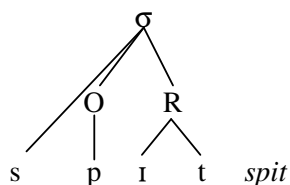
	<i>Input</i>	<i>Intermediate forms</i>	<i>Output</i>
a.	kr _{I_μ} .mə.nəl + _{-e} _μ	_{I_μ} .mə.nəl. kre _μ (copying and deletion)	_{I_μ} .mə.nəl. kre _μ
b.	kr _I .mə.nəl	_I .mə.nəl. kre (movement + epenthesis)	_I .mə.nəl. kre

If all that is copied/moved is a linear sequence of pre-moraic (2-44a) or pre-nuclear melodies (2-44b), however, there is no explanation as to why [Cw] clusters are treated on par with regular pre-nuclear clusters¹⁵ such as [br], [pr], [tr] and [kr] in deriving Pig Latin forms, even though there is inter-speaker variation (Barlow 2001) in the treatment of pre-nuclear sequences with [s] followed by a stop. When encountering English words beginning with [st], [sk] or [sp], Barlow reports, at least some speakers copy only the stop in deriving the corresponding Pig Latin forms. For such speakers [s] and the following stop must not constitute a structural unit, so that they cannot be copied or moved together. The stop, for them, is arguably associated with the Onset, while [s] directly reports to the syllable.

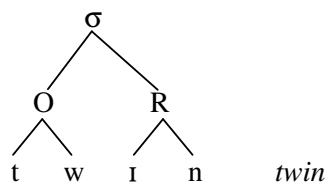
¹⁵ The term ‘regular pre-nuclear clusters’ refers to those which respect the Minimal Sonority Distance of ‘3’ under the English sonority scale in (2-14).

(2-45) **Sample word-initial clusters in English**

a. *s-plus-stop*



b. *True clusters*



In contrast to [st], [sp] and [sk] sequences, regular pre-nuclear clusters in the initial syllable, including [Cw], are moved/copied in their entirety, suggesting that all segmental melodies in these clusters are associated with the Onset (2-45b).¹⁶ The upshot is this: if the Onset is the sub-syllabic unit being transposed, the transposition by some speakers of only the stop in pre-nuclear [st], [st] and [sk] sequences and the general transposition of all melodies in regular pre-nuclear clusters are both explained. The differences in transposition go unexplained, however, if one assumes that a linear sequence of pre-nuclear/pre-moraic melodies is all that is being copied or moved.

To summarise: Pig Latin provides first-rate support for the Constituency Dimension because it shows that some, and not all, linearly adjacent melodies behave as a group. Those melodies which do behave as a group must then do so not merely due to adjacency, but also due to their sharing a structural space. The Onset has been shown to be such a space in this subsection. The next subsection shows that the Coda is, too.

2.4.2 *Coda [h] in Adhilabad Gondi*

A small number of plural nouns end in the consonant sequence [hk] in Adhilabad Gondi. Some of those are given below:

(2-46) **Post-vowel [h] in Adhilabad Gondi**

- a. nuh-k 'hundreds' (nu:r 'hundred')
- b. roh-k 'houses' (ro:n 'house')
- c. nah-k 'villages' (na:r 'village')
- d. koh-k 'horns' (ko:r 'horn')
- e. goh-k 'wheat-PL' (goh 'wheat')

¹⁶ This remark concerns only one of the two 'dialects' of Pig Latin studied by Barlow (2001). In the other dialect, only the first consonant of a pre-nuclear cluster is moved, regardless of its composition.

According to Srinivas (2010: 89), the [h] seen in the plural nouns above is a reduced (i.e. placeless in the sense of McCarthy 2007) variant of the word-final sonorants seen in the corresponding singular nouns. Srinivas (2011), however, suggests that the [h] in the plural nouns is an underlying part of the stem allomorph to which the suffix [-k] attaches. Whether or not [h] is underlying, the surface [h] in the forms in (2-46) can be shown to be a voiceless glide in Adhilabad Gondi; and to be associated with the Coda.

At least four arguments support the treatment of post-vowel [h] in Adhilabad Gondi as a glide. Firstly, [h] is a consonant produced from the glottal region at the back of the vocal apparatus, and hence serves as a convenient articulatory transition between the back vowels [a, o, u] and the back/velar obstruent [k] in (2-46). Secondly, it is reasonable to assume that [h] plays the role of the back glide in Adhilabad Gondi in the absence of [w] (see (2-17b)). It is even possible that the sound Subrahmanyam (1967: 9) transcribes as [h] is closer to a voiceless labio-velar glide [ɸ] than a glottal fricative.

Thirdly, just like [h], the front glide [j] clusters only with the suffix [-k]: e.g. [buj-k] ‘groundnuts’, [kaj-k] ‘hands’. That post-vowel [j] and [h] have remarkably similar distributions with reference to a following consonant lends further support to the treatment of [h] as a glide. Finally, [h] is phonetically like a voiceless vowel, and is in that sense more akin to a glide than a consonant. As for the syllable-internal location of the voiceless glide in the forms in (2-46), two sonority-related facts suggest that it is associated with the Coda.

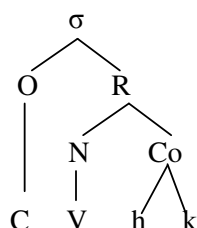
It is well-known that the lower the height of the tongue in producing a vocalic melody, the more sonorous the melody is (see (2-10) and (2-11); cf. Kiparsky 1979). In light of this observation, the fact that [h] follows low, mid and high vowels in (2-46) suggests that a nuclear vowel and a post-nuclear [h] are not jointly targeted by any sonority restriction in Adhilabad Gondi. Moreover, [h] and [k] are four sonority ranks apart under the sonority scale in (2-19). Since post-nuclear Minimal Sonority Distance (MSD) in the language is just ‘2’, however, the [hk] sequence in (2-46) is a well-formed post-nuclear cluster.

The absence of any sonority restrictions to tie up vowels with post-vowel [h] suggests that vowels and post-vowel [h] are not associated with the same sub-syllabic domain. On the other hand, the fact that the [hk] sequence respects the post-nuclear MSD in the language (see (2-20)) suggests that [h] and [k] are associated with the same post-nuclear domain. This domain is the Coda under the Constituency Dimension (2-47a). In a model where syllables are deemed to be internally flat (2-47b), there is no domain that would include [h] and [k], and exclude the nuclear vowel. One could indeed imagine [h] and [k] sharing a mora (2-47c) but there is no compelling evidence for mora-sharing in Adhilabad Gondi; a language

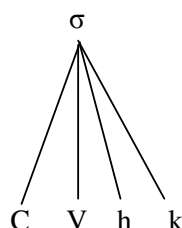
without any obvious prominence marker such as stress or tones. μ_2 in (2-47c) may be regarded at best, therefore, as a metrical unit and Coda rolled into one.

(2-47) **[hk] cohesion in Adhilabad Gondi**

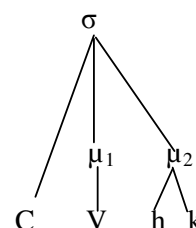
a. *Constituency Dimension*



b. *Flat syllable*



c. *Moraic syllable*



This section has thus far argued for the association of post-consonantal [w] in American English with the Onset, and of post-vowel [h] in Adhilabad Gondi with the Coda. In §2.4.3, putative diphthongs in Tamil are reanalysed as vowel-plus-glide sequences. The glide in these sequences will in turn be seen to lie outside the Nucleus.

2.4.3 *Non-nuclear [j] in Tamil*

The Tamil orthography treats only [aj] and [aw] as unitary vowels though [a(:)j], [e(:)j] and [o(:)j] also occur in the language. This section, however, argues that each of the vocalic items listed consists of a vowel followed by a glide, as transcribed, and that none of them is a ‘true’ diphthong. As well as that, the glides in these vocalic items will be argued to be associated outside the Nucleus in Tamil. The argument provides negative support for the Nucleus as well as the Constituency Dimension of which it is a part.

One can begin by considering the data below. Words containing [aj] or [aw] are given in (2-48a) and those having (non-diphthongal) long vowels are given in (2-48b).

(2-48) **Post-nuclear stops in Tamil**

a. *Words with [aj] and [aw]*

- i. [ajk].ki.jam ‘merging’
- ii. m[ajt].tu.ŋan ‘brother-in-law’
- iii. s[awk].ki.jam ‘wellness’
- iv. p[awt].ti.ran ‘child (from Skt)’

b. *Words with long vowels*

- i. [e:k].kam ‘yearning’
- ii. u[a:t].ti ‘duck’
- iii. u[i:k].kam ‘swelling’
- iv. k[o:p].paj ‘cup’

The words in (2-48) show that voiceless stops are allowed to follow non-diphthongal long vowels as well as [aj] and [aw] in a Tamil syllable. However, this distributional fact

cannot be taken to suggest that [aj] and [aw] are unitary syllable peaks just like long vowels are, because voiceless stops also occur after post-nuclear [ɹ] and [r] in a Tamil syllable (see also §2.5.3).

(2-49) **Post-rhotic stops in Tamil**

a.	ki:[rt].ti	‘a name’	e.	pu:[rt].ti ¹⁷	‘completion’
b.	je.dir.pa:[rp].pɪ	‘expectation’	f.	ti:[rp].pɪ	‘judgment’
c.	va:[ɹk].kaj	‘life’	g.	vi:[ɹç].ci	‘fall’
d.	su:[ɹç].ci	‘conspiracy’	h.	ta:[ɹp].pa:l	‘bolt’

Post-nuclear consonants are therefore unhelpful in deducing whether [aj] and [aw] are diphthongs or vowel-plus-glide sequences in Tamil. The vocalic items [a:j], [o:j] and [e:j] exemplified in the data below can be definitively characterised as vowel-plus-glide sequences, however.

(2-50) **V:j in Tamil**

a.	pa:j	‘pounce (IMP)’	pa:.j-um	‘pouncing-ADJ’
b.	ta:j	‘mother’	ta:.j-in	‘mother-POSS’
c.	te:j	‘fade’	te:.j-um	‘fading-ADJ’
d.	pe:j	‘ghost’	pe:.j-o:.dɪ	‘with the ghost’
e.	no:j	‘disease’	no:.j-a:.li	‘sick person’
f.	va:j	‘mouth’	va:.j-a:.di	‘a talkative girl’

The word-final [j] in the morphologically simple forms on the left must be a non-nuclear glide, seeing as it splits from the preceding vowel and begins the suffixal syllable in the forms on the right (see (2-6a) from English for comparison). One could now extrapolate from the data above and argue that the post-(short)-vowel [w] and [j] in (2-48a) are non-nuclear glides just like the [j] that follows long vowels is in (2-50). This argument is supported by more data from Tamil, given in (2-51). In the words below, [j] is preceded by a

¹⁷ An examiner points out that since [V:RT] sequences (T: any voiceless stop; R: any rhotic sound) occur in Tamil, one would expect sequences such as [aiRT] to occur, too. After all, V: and [ai] are prosodically equivalent. Unlike V:, however, [ai] is a vowel-glide sequence i.e. [aj] in the language. The glide [j] is associated with the Coda where it can be followed by a T: e.g. [vajk.ko:l] ‘hay’, [ajp.pa.si:] ‘seventh month in the Tamil calendar’; cf. [ka:jç.cal] ‘fever (colloquial)’ [va:jp.pɪ] ‘opportunity’. It cannot be followed by a RT sequence, however, because the resultant cluster [jRT] would be tri-segmental; in violation of the bi-segmental maximum that governs the Coda in Tamil (see §2.5.3). Nor can it just be followed by R because post-nuclear [jR] sequences are disallowed by sonority constraints in the language (Srinivas 2013).

short vowel, rather than a long vowel, as in the words in (2-48a). Morphologically simple words ending in [w] are hard to come by, but all upcoming remarks are as applicable to post-vowel [w] as they are to post-vowel [j].

(2-51) **Vj in Tamil**

a.	kaj	‘hand’	kaj-jop.pam	‘thumbprint’
b.	sej	‘say’	sej.juɻ	‘written word’
c.	mej	‘truth’	mej.jappan	‘a name’
d.	paj	‘bag’	paj-jo:ɖɨ	‘with the bag’

The interesting thing about the words on the right in (2-51), which are either morphologically complex or represent some type of compounding, is that [j] appears geminated in them. The gemination of [j] may also be taken to indicate that the [j] in a [Vj] sequence is a non-nuclear glide in Tamil. In this connection, my larger proposal is that sequences of melodies associated with the (same) Nucleus should pass two tests: they should resist hetero-syllabification (the inseparability test) and they should be fully accommodated in a single syllable (the integrity test).

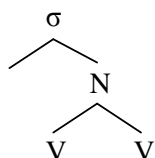
The *integrity test* and the *inseparability test* are both justifiable on empirical grounds. The former is based on the fact that the ‘parts’ of a non-diphthongal long vowel are typically tautosyllabic across languages. Their tautosyllabicity can be directly attributed to the association of a (melodically single) long vowel with a single Nucleus. If the vowels in a diphthong are also associated with a single Nucleus, as argued in §2.1.2, then one would expect all ‘parts’ of diphthongs to be tautosyllabic as well.

The *inseparability test* is based on the fact that, other things being equal, when sonority declines (e.g. [dɒ.jən] *doyen*, [lɔː.jə] *lawyer*) or rises (e.g. [l.æ.gəu] *Iago*, [əu.ɛɪ.sɪs] *oasis*) from one (vocalic) melody to another, the melodies are split across syllables. On the other hand, if a pair of vocalic melodies needs be seen as a diphthong, they should resist separation during the course of (re)syllabification.

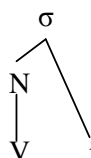
English diphthongs (VV) are nuclear according to both tests (2-52a), seeing as the vowels composing these diphthongs are neither split across syllables (§2.1.2) nor individually undergo gemination to become heterosyllabic entities. The Tamil [j] (2-52b) on the other hand fails both tests. It fails the inseparability test by splitting from a preceding long vowel to begin the next syllable in the forms on the right in (2-50). It fails the integrity test by

undergoing gemination after short vowels to become heterosyllabic in the forms on the right in (2-51). The Tamil [j] is therefore clearly a non-nuclear glide (2-52b).

(2-52) a. *VV unity in English*

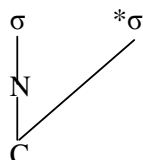


b. *Vj disunity in Tamil*

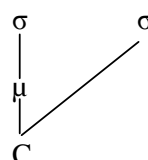


To analyse post-vowel [j] in Tamil simply as a non-moraic rather than a non-nuclear melody would be erroneous because sonorant geminates, wherefore the geminated [j] in (2-51), are moraic in the language (see §3.3.5). It would also be erroneous from a cross-linguistic perspective because geminates can be partly moraic (2-53b). In Hong Kong English and Singapore English, for example, the post-nuclear part of a heterosyllabic geminate is moraic (Wee 2008): [hʌn_μ.ni] *Honey*, [stɔp_μ.pɪŋ] *stopping*, and [dʒæm_μ.mɪŋ] *jamming*. Geminates are never partly nuclear, however (2-53a).

(2-53) a. *No partly nuclear geminates*



b. *Partly moraic geminates*



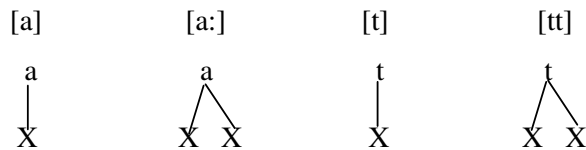
The characterisation of Tamil [j] as a non-nuclear glide is therefore correct, and concludes this section where post-consonantal [w] in American English and post-vowel [h] in Adhilabad Gondi were earlier seen to be associated with the Onset and the Coda respectively. Moving on from glides, the next section enlists the support of segmental restrictions for the Constituency Dimension. More specifically, the section shows that segmental restrictions can indirectly constrain the amount of melodic material that can be associated with constituents, even though segmental X-slots belong to the Moraic Dimension in MCI (see §5.1.2).

2.5 Segmental Constraints and Constituents

It has been argued that every melody, whether or not moraic, is associated with at least one segmental X-slot (Levin 1985, Selkirk 1990, Kim 2002, Muller 2002). This argument is the

precursor to the ‘segment-melody’ complexes in (2-54),¹⁸ where a short melody is associated with one X-slot and long melodies, including geminates, are associated with two. The length of a melody is thus encoded by the number of X-slots it occupies (see also §4.1 and §5.1.2).

(2-54) **Segmental-melody complexes**



The upshot is that while melodic material in a syllable is directly constrained by constraints and processes, it can also be indirectly constrained by restricting the number of segmental X-slots available for mapping melodies. The preponderance of diphthongs and long vowels in languages, as opposed to the rarity of triphthongs and extra-long vowels, for example, can be seen as the melodic result of a constraint which requires the Nucleus to have no more than two segments (Rubach & Kenstowicz 1987: 476). In §2.5.1, bi-segmental maximality is shown to hold over the Nucleus in at least one ‘old’ and one ‘new’ variety of English.

Segmental restrictions jointly constraining nuclear and post-nuclear melodies also occur in languages, and are best understood as holding over the Rhyme. One such restriction is a bi-segmental maximum that explains the correlation between diphthong-type and the (non-)allowance of post-diphthongal consonants in Sixian Hakka. This restriction is discussed in §2.5.2.

In §2.5.3, the Coda in Tamil is seen to allow no more than two segments of melodic material. This bi-segmental ceiling on the Tamil Coda is evidenced by the occurrence of voiceless stops after a (monosegmental) post-nuclear flap or approximant, but their absence after a (bi-segmental) trill in the language. Tamil remains the focus of §2.5.4, where the Onset in the language is argued to be governed by a monosegmental maximum.

One may note from the last two paragraphs that all the segmental restrictions to be discussed in this section, save one, are binary. The restrictions in question should not, however, be taken as arguing for a binary organisational bias at the level of individual constituents or the Constituency Dimension.

¹⁸ McCarthy (1979/1985) and Clements & Keyser’s (1983) models have C-slots and V-slots instead of the ‘featurally bare’ X-slots in (2-54).

2.5.1 Bi-segmental Nucleus in English

As per the Online version of the Oxford Dictionary, the diphthongs [ɪə], [uə], [ʌɪ], [ɔɪ], [eɪ], [aʊ] and [əʊ] and the triphthongs [ʌɪə] and [aʊə] are part of the vowel inventory of Standard British English (SBrE). Evidence concerning the post-diphthongal distribution of the consonant cluster [st], however, suggests that the schwa does not form a diphthong with [ɪ] in [ɪə] and [u] in [uə]; or a triphthong with [ʌɪ] in [ʌɪə], and [aʊ] in [aʊə]. The evidence suggests instead that the schwa is associated with the Coda in these cases, with the pre-schwa vowels alone being nuclear. Consider, for instance, the data below where [st] is seen to occur after [ʌɪ], [ɔɪ], [eɪ] [aʊ] and [əʊ] in SBrE (2-55a). The [st] cluster is, however, conspicuous by its absence after the schwa-final diphthongs and triphthongs (2-55b).¹⁹

(2-55) Post-diphthongal [st] in SBrE

a. VVst					
hʌɪst	<i>heist</i>	krʌɪst	<i>Christ</i>	zʌɪt.gʌɪst	<i>zeitgeist</i>
hɔɪst	<i>hoist</i>	fɔɪst	<i>foist</i>	mɔɪst	<i>moist</i>
heɪst	<i>haste</i>	teɪst	<i>taste</i>	peɪst	<i>paste</i>
aʊst	<i>oust</i>	dʒaʊst	<i>joust</i>	faʊst	<i>Faust</i>
kəʊst	<i>coast</i>	təʊst	<i>toast</i>	rəʊst	<i>roast</i>
b. *(V)Vəst					
*ɪəst	*ʊəst	*ʌɪəst	*aʊəst		

If English allows a maximum of two segmental melodies of falling or even sonority in the post-nuclear section of the syllable,²⁰ given the sonority scale in (2-14), the occurrence of post-diphthongal [st] in (2-55a) is unsurprising. What is surprising is the absence of [st] after the triphthongs and the diphthongs ending in a schwa (2-55b), assuming that the schwa in these cases is nuclear. The absence is simply explained, however, if the schwa in question is associated with the Coda instead of the Nucleus. With the schwa associated with the Coda, only one more consonant can follow it. That consonant may be either [s] or [t] but not both,

¹⁹ Tautomorphemic instances of [st] after schwa are hard to find even when the schwa is not immediately preceded by another vowel. They do occur, however, in words such as [breɪk.fəst] *breakfast* and [sted.fəst], the latter listed as one of two possible pronunciations for the word *steadfast* in the Oxford (Online) Dictionary.

²⁰ English also allows tautomorphemic clusters consisting of more than two consonants at the end of words, as evidenced by [tekst] *text*. Tri-consonant clusters have not been considered here, however, because they do not occur after any of the diphthongs under focus.

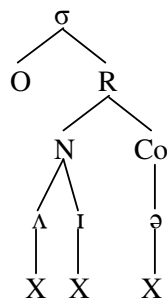
as seen in (2-56). While tautomorphemic instances of [ΛΙə] and [Ιə] followed by [s] or [t] are adequately represented, those involving [aʊə] or [ʊə] followed by [s] or [t] are hard to come by in SBrE.

(2-56) **Post-Və [st] in SBrE**

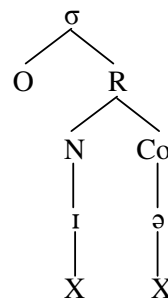
a.	ΛΙə[s/t]		b.	Ιə[s/t]	
<hr/>			<hr/>		
i.	b[ΛΙəs]	<i>bias</i>	i.	ɛ.l[Ιət]	<i>Elliott</i>
ii.	p[ΛΙəs]	<i>pious</i>	ii.	ɛ.l[Ιəs]	<i>alias</i>
iii.	kw[ΛΙət]	<i>quiet</i>	iii.	ɪ.d[Ιət]	<i>idiot</i>
iv.	d[ΛΙət]	<i>diet</i>	iv.	sai.pr[Ιət]	<i>Cypriot</i>

If the schwa in the words above is indeed associated with the Coda, [ΛΙə] is simply a nuclear vowel sequence (i.e. diphthong) followed by a non-nuclear schwa (2-57a); and [Ιə] is a nuclear short vowel followed by a non-nuclear schwa (2-57b). In either case, the Nucleus does not have more than two segments (X-slots) of melodic material associated with it:

(2-57) a. *Diphthong-plus-schwa*



b. *Short vowel-plus-schwa*²¹



(see note 24)

It is worth mentioning at this point that the constraint that requires the Nucleus to have maximally two segments in SBrE is independent of the constraint that requires syllables in English to have maximally two moras (see §3.3.4). Because [ΛΙ] and [aʊ] are themselves bimoraic, they already make up, in moraic terms, a maximal syllable in English: e.g. [dΛ_μɪ_μ]_σ ‘die’, [ka_μʊ_μ]_σ ‘cow’. Any (potential) melodic material that follows [ΛΙ] and [aʊ] in a syllable must, therefore, be non-moraic, and cannot be accounted for in terms of moraic maximality.

²¹ See §5.1.1 on the direct association of the melodic, rather than the segmental, portion of segment-melody complexes with constituents.

A segmental analysis such as outlined above, which corroborates a bi-segmental ceiling on the Nucleus, is thus necessary. Nor is such a ceiling unique to SBrE. Rubach & Kenstowicz (1987) argue for it in Slavic, while Booij (1989) makes a case for it in his analysis of Frisian diphthongs. The maximality constraint also seems to have a place in at least in one (relatively) ‘new’ variety of English, namely Hong Kong English (HkE).

When words which have a vowel-plus-schwa sequence are reversed by HKE speakers, for example, the vowel and the schwa end up in different syllables. This can be seen from a comparison of the normal and reverse renditions by two HkE speakers (one female, one male) of the words in (2-58). The speakers recorded the normal form of each word first, immediately followed by what they thought was its reverse. The process was repeated three times for every word (over separate sessions).²² Since phonological variation across iterations does not significantly impact on this discussion, however, only one ‘normal-and-reverse iteration’ of these words by each speaker is given below (see Appendix II for all iterations).

(2-58) **Reverse language data**

		<u>HKE-F</u>		<u>HKE-M</u>	
		<i>Normal</i>	<i>Reverse</i>	<i>Normal</i>	<i>Reverse</i>
a.	‘ears’	i:ərs	ə:rs.ji:	iə:s	sə:i:s
b.	‘clear’	kli:ə:	ə:.kli:	kliə:	ə:.kli:
c.	‘pure’	pju:ə:	ə:.pju:	pju:ə:	ə:.pi:w
d.	‘chair’	tʃe:ə:	ə:.tʃe:	tʃe:ə:	ə:.tʃe:
e.	‘fear’	fi:ə:	ə:.fi:	fiə:r	ə:.fi:

That the schwa and the vowel preceding it are both often long even in the normal rendition for both speakers makes it tricky to argue that the vowel and schwa belong to the same syllable but simply do not constitute a nuclear unit in HKE. Moreover, since consecutive long vowels are typically heterosyllabic across languages, it would only be reasonable (*ceteris paribus*) to treat them as heterosyllabic in the normal HKE renditions as well. There is, however, no need to assume that it is ‘long-ness’ that renders schwa and a preceding vowel heterosyllabic. One could just as well assume the opposite: that the vowels, especially schwa, are long because they head their own syllables in HKE. As for the heterosyllabification of the schwa and an adjacent vowel in the reverse forms, it just mirrors their

²² The data reported here is from a corpus compiled for a research project coded GRF-HKBU250712. The project was spearheaded by Dr. Lian-Hee Wee, who was assisted by Ms. Liu Yang and Mr. Qin Chuan.

hetero-syllabification in the normal form regardless of whether hetero-syllabification causes vowel lengthening (as just assumed above) or *vice versa*.

The hetero-syllabification of schwa and the vowel preceding it in the normal forms itself, however, indicates that they do not constitute a single nuclear unit in HkE. Rather they constitute two nuclear units, each being no more than two segments long in any particular case. While this suggests that the Nucleus in HkE, just like the Nucleus in SBrE, is constrained by a bi-segmental maximum, the suggestion is currently tentative and is susceptible to revision upon examination of more data.

All the same, this subsection has made a case for a bi-segmental cap on the Nucleus in one old and one new variety of English. The next subsection argues for a bi-segmental ceiling on the Rhyme in Sixian Hakka.

2.5.2 *Bi-segmental Rhyme in Sixian Hakka*

Syllables in Sixian Hakka are maximally tri-segmental (Hsu 2004a). The first of the three X-slots in a syllable is generally associated with a consonant, or a glide homorganic with the following vowel. The other two may be associated with either a rising diphthong and a following consonant (2-59a), or a falling diphthong (2-59b).

(2-59) **Sixian Hakka**

a. *Rising diphthongs and consonants*

[iaC]	[ieC]	[ioC]	[uaC]	[ueC]
iam, iaŋ, iap, iak	ien, iet	ion, ioŋ, iok	uan, uat	uen, uet

b. *Falling diphthongs*

[ai]*C	[au]*C	[eu]*C	[oi]*C
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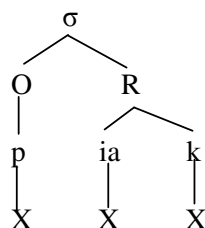
Just like in Sixian Hakka, a tautosyllabic consonant may follow a rising diphthong but not a falling diphthong in Taiwanese Southern Min (Hsu 2004b) and Rotuman. In Rotuman, however, there is metrical evidence to suggest that the second vowel in a falling diphthong and a post-vowel consonant both compete for the second mora in a syllable (McCarthy 2000). This moraic competition adequately explains why falling diphthongs are not followed by a tautosyllabic consonant in the language. In Sixian Hakka, a tonal language, on the other hand, the post-nuclear obstruents [k, p, t] may at the very least be deemed non-moraic because tones cannot be realised over obstruents. The absence of tautosyllabic consonants

(particularly obstruents) after falling diphthongs therefore requires a non-moraic explanation in Sixian Hakka.

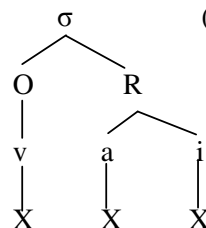
Segmental X-slots provide one. According to Hsu (2004a), falling diphthongs are long and associated with both the second and third X-slots in a syllable, leaving no segmental room for another consonant. Rising diphthongs on the other hand are short and are associated with only the second X-slot,²³ allowing a consonant to associate with the third. That a falling diphthong (2-60b) and a melodic sequence comprising a rising diphthong and a consonant (2-60a) compete for the same two X-slots suggests that these X-slots are reserved to be part of the Rhyme. Such a reservation is also consistent with the occurrence of pre-nuclear consonants before both rising and falling diphthongs: e.g. [vai] and [piak] (Hsu 2004a; no glosses available).

(2-60) **Bi-segmental Rhyme in Sixian Hakka**

a. *Example with rising diphthong*



b. *Example with falling diphthong*



(see notes 23 & 24)

If pre-nuclear and nuclear melodies competed for the same X-slots, diphthong-type would be predicted to influence the (non-)occurrence of pre-nuclear consonants. Such a prediction is not borne out in any language as far as I know. Nuclear and post-nuclear melodies on the other hand do compete for the same X-slots, as seen above, providing yet more evidence of their structural union under the Rhyme.

In summary, this subsection has shown that the association of melodies with the Rhyme can be constrained by segmental restrictions, just as the association of melodies with the Nucleus can be. The next subsection shows that association of melodies with the Coda can be similarly constrained, too.

²³ The [i] and [u] in (2-60a) may be thought of as being co-articulated with a pre-nuclear consonant rather than as the first half of a rising diphthong. Hsu (2004a) settles for the latter option, but choosing the former would not still affect the argument that vowels and post-vowel consonants (if any) must be accommodated within two X-slots in Sixian Hakka.

2.5.3 Bi-segmental Coda in Tamil

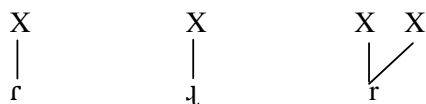
In Tamil, a post-nuclear rhotic flap [r] or approximant [ɻ] may be followed by a tautosyllabic voiceless stop. A post-nuclear trill [r] on the other hand is never followed by a consonant in the same syllable. More to the point, voiceless stops always appear as geminates after [r] or [ɻ] and their first segmental part is associated with the syllable with which the post-nuclear flap/approximant is associated (2-61a, b). After a post-nuclear trill, however, a voiceless stop always appears single and this consonant begins the syllable following the trill (2-61c).

(2-61) Post-rhotic consonants in Tamil

- | | | | |
|---|------------------------------------|------|------------------------------------|
| a. | <i>Tautosyllabic [r]-plus-stop</i> | b. | <i>Tautosyllabic [ɻ]-plus-stop</i> |
| i. | ti:[rp].pɪ ‘judgment’ | i. | va:[ɻk].kaj ‘life’ |
| ii. | ka[rt].tar ‘Jesus Christ’ | ii. | ta:[ɻt].tɪ ‘lower.IMP’ |
| iii. | ki:[rt].ti ‘a name’ | iii. | vi:[ɻc].ci ‘fall’ |
| iv. | a[rt].tam ‘meaning’ | iv. | va:[ɻt].tɪ ‘wish’ |
| c. <i>Heterosyllabic [r]-plus-consonant</i> | | | |
| i. | me:[r.k]ɪ ‘west’ | iii. | te[r.k]ɪ ‘east’ |
| ii. | so[r.p]am ‘meagre’ | iv. | ka[r.p]a.naj ‘imagination’ |

One key to explaining the absence of tautosyllabic consonants after a post-nuclear trill and the occurrence of voiceless stops after a post-nuclear flap/approximant lies with the articulatory differences involved in the production of the rhotic sounds in question. A flap, for instance, is produced by bringing the tongue rapidly in contact with a passive articulator (e.g. the alveolar ridge, the back of the teeth, the velum) once; an approximant is articulated by bringing the tongue approximately in contact with a passive articulator, also once. A trill on the other hand is produced by bringing the tongue repeatedly in contact with a passive articulator. For this reason, trills are intrinsically longer than flaps and approximants. This difference in intrinsic length can be phonologically recast by assuming that the flap [r] and the approximant [ɻ] are mono-segmental and the trill [r] is bi-segmental, at least in Tamil.

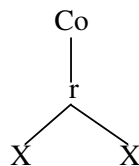
(2-62) Rhotic consonants in Tamil



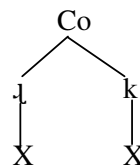
The occurrence of tautosyllabic voiceless stops after post-nuclear [r] and [ɻ], and the non-occurrence thereof after post-nuclear [r], can now be attributed to a bi-segmental maximality constraint holding over the Coda. Since [r] is bi-segmental, it is exhaustively associated with both X-slots reserved to be part of the Coda, and leaves no segmental room for any other consonant (2-63a). The other rhotic melodies [r] and [ɻ] are associated with only one X-slot, however, leaving the second free for association with a stop (2-63b). The underlined melodies in the words [va:ɻk.kaj] ‘life’ and [teɻ.ki] ‘east’ are represented below, with only the Coda shown:

(2-63) **Tamil Coda**

a. *Post-nuclear trill*²⁴



b. *Approximant followed by stop*



Note that it is necessary to interpret the bi-segmental ceiling as holding over the Coda rather than the Rhyme in Tamil. Since both short and long vowels may be followed by up to two consonants in the language (see (2-61a)), it is clear that post-nuclear consonants themselves are free to take up two segments in Tamil. This scenario can be contrasted with the one in Sixian Hakka where there are altogether only two X-slots that any combination of nuclear vowels and post-nuclear consonants can take up (see (2-60)).

Bi-segmental maximality cannot be reinterpreted as a moraic constraint either because even if the Tamil trill is considered moraic on account of its ‘long-ness’ (§4.1.3), flaps and approximants are short and are not moraic. Stops, too, are non-moraic in the language even when they are geminated (see §3.3.5). Since stops, flaps and approximants are all non-moraic, the occurrence in Tamil of tautosyllabic voiceless stops after a post-nuclear flap/approximant and their non-occurrence after a post-nuclear trill demands an explanation that is not based on moras. The Coda-based segmental maximality constraint is thus necessary. An Onset-based segmental maximum is also seen to be necessary in the next subsection to explain the non-occurrence of the trill [r] in word-initial and post-consonantal contexts in Tamil.

²⁴ In Levin’s (1985) model of the syllable, constituent-nodes (Onset, Nucleus, Coda) are connected to melodic content through X-slots. In (2-63) (and (2-60)), however, it is melodies which are directly connected to constituent-nodes, while X-slots are connected to them through melodies. The latter schema anticipates the discussion in Chapter 5 where melodies rather than X-slots are shown to be directly organised in terms of constituents.

2.5.4 Monosegmental Onset in Tamil

Pre-nuclear consonant clusters often arise in colloquial Tamil, especially in word-initial contexts. Two pieces of evidence, however, suggest that the Onset in Tamil, at least as traditionally conceived, allows no more than one segment.

The first piece of evidence comes from Tamil orthography, which employs separate symbols to denote the CV sequences and the post-vowel consonants which are possible in the language. If pre-nuclear consonant clusters were normal in Tamil, one would expect possible CCV sequences to be orthographically represented in the language too. The fact they are not suggests that Tamil limits the pre-vowel material in its syllables to one segment. Moreover, even those consonants which cluster word-initially in colloquial Tamil are treated as ‘onsets’ of two different syllables by the Tamil orthographic system.

(2-64) Pre-nuclear consonants in Tamil

	<i>Colloquial form</i>	<i>Orthographic form</i>	<i>Gloss</i>
a.	<u>p</u> ra.da.mar	pi. <u>ra</u> .da.mar	‘Prime Minister’
b.	<u>s</u> ra.mam	si. <u>ra</u> .mam	‘arduousness’
c.	<u>d</u> ro:.gam	du. <u>ro</u> :.gam	‘betrayal’
d.	<u>k</u> ri:.dam	ki. <u>ri</u> :.dam	‘crown’
e.	<u>s</u> ne:.gam	si. <u>ne</u> :.gam	‘friendship’

The orthographic treatment of clustering consonants as heterosyllabic ‘onsets’ is simply explained by assuming that Tamil imposes a one-segment ceiling on the Onset. The one-segment maximum has the added advantage of explaining the occurrence of [r] in pre-consonantal (2-65a) and intervocalic (2-65b) contexts in the language, and its absence in post-consonantal and word-initial ones.

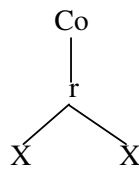
(2-65) The Tamil trill

a.	<i>Before consonants</i>	b.	<i>Between vowels</i>
i.	ka[r.p]a.naj ‘imagination’	i.	[i.ra]j.van ‘God’
ii.	so[r.p]am ‘meagre’	ii.	k[u.ra]j ‘fault’
iii.	a[r.p]am ‘mean-spirited’	iii.	ka.j[i.ri] ‘rope’
iv.	me:[r.k]i ‘west’	iv.	k[u.ri]m.bi ‘naughtiness’
v.	i.ja[r.k]aj ‘nature’	v.	p[i.ra]p.pi ‘birth’
vi.	mu.ja[r.c]i ‘effort’	vi.	n[i.ra]j.vi ‘satisfaction’

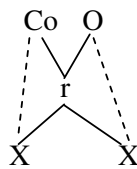
Recapitulating from the previous subsection, the Tamil [r] is long and spans two X-slots. When pre-consonantal, as in (2-65a), [r] takes up the two segments of space that are available within the Tamil Coda: this is seen in (2-66a). When [r] occurs between two vowels, as in (2-65b), it takes up one segment of space in a Coda and another in the Onset of the following syllable, as in (2-66b). (The dotted lines bridging the X-slots and the Coda/Onset in (2-66b, c) show the amount of segmental space [r] would take up in each constituent. These lines are intended to enhance representational clarity given that it is melodies, and not X-slots, which directly report to constituents in MCI (see note 24)).

(2-66) **Distribution of [r] in Tamil**

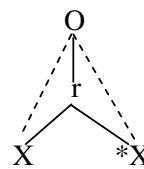
a. *Pre-consonantal*



b. *Intervocalic*



c. *Post-consonantal/word-initial*



On the other hand, if [r] were to occur in post-consonantal or word-initial contexts, it would need two segments of space, all in an Onset (2-66c). That amount of space is just not available in the Tamil Onset, however, since it is subject to a monosegmental maximum as assumed earlier. The upshot is that [r] cannot occur after a consonant or a left-edge boundary in Tamil without violating the Onset maximality constraint operational in the language. It is, therefore, disallowed in these contexts.²⁵

Indeed, the maximality constraint in question can be assumed to operate over the pre-moraic portion of the syllable in Tamil. Such an assumption is, however, tantamount to recognising the pre-moraic part of syllables as a legitimate syllable-internal domain. That domain is generally referred to as the Onset.

2.6 Chapter Summary

This chapter has shown that the Constituency Dimension encompassing the Nucleus, the Coda, the Onset and the Rhyme has the solid stamp of empirical support. In specifically arguing for each of the aforementioned constituents, moreover, the chapter has redirected

²⁵ The trill [r] is also not found word-finally in Tamil. As a long consonant, however, the absence of [r] in word-final position is typologically unsurprising because geminates, which are long consonants in a sense, are also absent peripherally in many languages (see Bakovic & Pajak 2010 for an Optimality-theoretic explanation of this absence).

attention beyond just the Onset-Rhyme division, which typically preoccupies research in favour of and against syllable-internal constituents.

For example, the Nucleus has been expressly argued for in this chapter. Firstly, association with the Nucleus was argued to make syllable peaks out of consonants that typically occur in syllable margins. The Nucleus was then seen to underpin the resistance of the vowels which make up a diphthong to hetero-syllabification (§2.1).

In the second part of the chapter, the Onset and the Coda were shown to be sonority domains divorced from the Nucleus (§2.2). As well, they were argued to be the sub-syllabic domains with which non-nuclear vocalic melodies (i.e. glides) are associated (§2.4). The distinction between nuclear and non-nuclear vocalic melodies was consolidated further based on two principled tests: (a) the inseparability test which asks whether two vocalic melodies, which usually occur in a sequence, are always tautosyllabic; and (b) the inseparability test which asks whether all parts of those two vocalic melodies are always tautosyllabic. Sequences of vocalic melodies associated with the (same) Nucleus were seen to pass both tests; sequences with one or more non-nuclear vocalic melodies fail both (§2.4.3).

Elsewhere in the chapter, the hypothesis that nuclear and post-nuclear melodies are associated with the Rhyme was justified by similarity and dissimilarity constraints targeting these melodies, but not pre-nuclear ones. Furthermore, the Rhyme was seen to mediate syllable-bound nasalisation processes in Chaoyang and Tamil (§2.3). Finally, the Rhyme was seen to be, along with the Nucleus, the Coda and the Onset, a syllable-internal domain in terms of which the occurrence of melodies is constrained by segmental restrictions (§2.5; see also §5.1.3.1).

While this chapter has predominantly focused on phonological evidence supplied by natural languages, other types of evidence have a bearing on the Constituency Dimension as well. Orthographic evidence of certain types has, for example, been held to support the Onset-Rhyme division by Gnanadesikan (2008). Appendix III presents a summary of the same.

CHAPTER 3

The Moraic Dimension

Discussing evidence in favour of the Onset, the Nucleus, the Coda and the Rhyme, Chapter 2 argued for the Constituency Dimension in MCI. This chapter shows that whether or not a segment-melody complex is metrically relevant cannot always be deduced from – or reduced to – its seat in the Constituency Dimension. Moras are consequently necessary as metrically relevant units of time, and so is the Moraic Dimension.

To drive home the necessity of moras, mora-based account of metrical phenomena will be compared with constituency-based alternatives in this chapter. Consider, for example, the Chugach dialect of Yupik where post-nuclear consonants count towards stress only in the word-initial syllable. A parametric statement such as “the right branch of the Rhyme (i.e. Coda) is metrically relevant in Chugach” is not sufficient because it does not capture the asymmetry that post-nuclear consonants in the initial syllable are metrically relevant while those elsewhere are not. The asymmetry is, however, straightforwardly captured if a post-nuclear consonant in the initial syllable is associated with a mora and those in other syllables are not. The upshot is that every post-nuclear consonant sits on the right branch of the Rhyme in Chugach, but not every post-nuclear consonant is moraic. Simply put, the association of a segmental melody with moras does not depend on its association in the Constituency Dimension; as the rest of this chapter will show.

The chapter opens in §3.1 with a recapitulation of the argument that only the loss (or weakening) of moraic melodies may trigger compensatory lengthening. Pre-nuclear consonant lengthening in Malaysian Cantonese is then argued to be compensatory on the basis that it offsets the loss of metrically relevant duration from the deletion of (originally) moraic material within a syllable.

In §3.2, the stress patterns in Khalkha Mongolian, Sindhi, Hindi, Chugach Yupik and Kwakwala are taken up for discussion. This discussion will show that post-nuclear consonants may be moraic on a parametric (i.e. language-specific) basis, or depending on their word-internal context and intrinsic sonority.

In §3.3, some prosodic size constraints on words and syllables in English, Chungli, Tamil and Adhilabad Gondi are examined. These constraints will be seen to be most effectively formulated in terms of mora count.

In §3.4, the mora will be shown to play a crucial role in the correct placement of a CV affix in a Japanese language game called Babuebo.

The chapter concludes with a summary of it in §3.5.

Consonants and vowels will be treated as irreducible segmental melodies for a better part of this chapter. The justification for seeing them as complexes involving a melodic portion and a segmental (X-slot) portion will be provided in Chapter 4 (see also §2.5).

3.1 Compensatory Lengthening

Although the term ‘mora’ dates back at least to Trubetzkoy (1939, as cited in Blevins 1995), the most persuasive early argument for the mora within Generative Phonology was put forth by Hayes (1989) as part of his discussion on the various types of compensatory lengthening attested in languages. §3.1.1 recounts Hayes’ moraic analysis of compensatory vowel lengthening¹ in Latin, and shows that this analysis is superior to a constituency-based alternative. In §3.1.2, pre-nuclear consonant lengthening in Malaysian Cantonese is argued to be compensatory because it compensates for the loss of all (previously) moraic melodies within a syllable.

3.1.1 Nuclear vowel lengthening

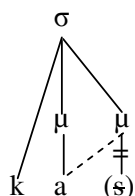
The Rhyme-based and moraic approaches to compensatory lengthening differ in important ways, as pointed out in §1.4.2. In the former approach, compensatory vowel lengthening is seen as the lengthening of a Rhyme-internal melody to compensate for the loss/weakening of another Rhyme-internal melody (see Steriade 1982: chapter 2). In the latter, compensatory lengthening is seen as the lengthening of a melody to compensate for the deletion/weakening of a moraic melody (Ingria 1981, Hock 1986, Hayes 1989).

Considering the latter approach first, post-nuclear consonants were seen to be moraic in Latin in §1.4.2. The deletion of post-nuclear [s] before an anterior sonorant (i.e. [m] or [n]) therefore leaves behind a mora in Latin; with which the preceding vowel comes to be associated and surfaces long, as seen in (3-1a): e.g. /ka_μs_μ.nus/ → [ka:μ_μ.nus] ‘grey’. Pre-nuclear consonants on the other hand are non-moraic in Latin like in a vast majority of the world’s languages. The loss of pre-nuclear [s] is hence not compensated for as seen in (3-1b): e.g. /snurus/ → [nu.rus] ‘daughter-in-law’. Only the relevant syllables are represented below.

¹ See Steriade (1982) and Kashav (2013) on compensatory consonant gemination.

(3-1) **Mora-based (non-)lengthening in Latin**

a. *Compensatory lengthening*



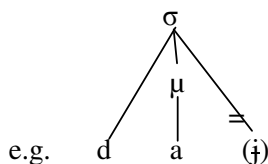
b. *No compensatory lengthening*



As an examiner points out, however, the argument that the loss of pre-nuclear [s] is not compensated for because it is non-moraic assumes that initial geminates are acceptable in Latin. More precisely, the fact that the anterior consonant does not geminate to compensate for the loss of pre-nuclear [s], even though initial geminates are acceptable in Latin, leads one to the conclusion that pre-nuclear consonants are non-moraic in Latin. If initial geminates are unacceptable in Latin on the other hand, the absence of forms like *[nnurus] (from //snurus//) “could have nothing to do with moras and everything to do with acceptable syllable-initial sequences (in the language)” [quotation from examiner’s report; parentheses mine].

Moving on, loss of post-nuclear melodies is also observed in many varieties of Spoken Tamil. Post-nuclear [j] is deleted, for example, if it occurs word-finally in non-monosyllabic words, while post-nuclear [l] is shed at word junctures: e.g. //ku:raj// → [ku:ra] ‘roof’, //kan.dal ## tu.ɲi// → [kan.da ## tu.ɲi] ‘rags’. Neither the loss of [j] nor the loss of [l], however, triggers compensatory lengthening. This is because all heterorganic post-nuclear melodies, a set which automatically includes word-final ones, are non-moraic in Tamil (see §3.3.5). The loss of non-moraic pre-nuclear [s] does not trigger compensatory lengthening in Latin, as seen in (3-1b). Likewise, the loss of a non-moraic post-nuclear glide (or lateral) does not trigger compensatory lengthening in Spoken Tamil, as seen from the second syllable of the word [ka.da(ɟ)] ‘story’ below:

(3-2) **CVC_{heterorg} in Spoken Tamil**

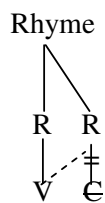


The upshot is that though post-nuclear consonants undergo deletion in Spoken Tamil and in Latin, compensatory vowel lengthening occurs only in languages like Latin (3-1a) because only in these languages does the deleted melody leave behind a mora with which a

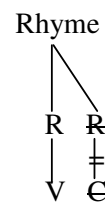
preceding vowel can associate. Under the Rhyme-based approach, however, compensatory lengthening is predicted to be possible in both (types of) languages (3-3a) or not possible in either (3-3b). The R-s below may be viewed as Rhyme-internal placeholders.

(3-3) **Rhyme-based (non-)lengthening**

a. *Compensatory lengthening*



b. *No compensatory lengthening*



While the representation in (3-3a) captures compensatory vowel lengthening in Latin at least as well as the moraic representation in (3-1a) does, it fails to account for the lack of compensatory lengthening in Spoken Tamil. The representation in (3-3b) captures the lack of compensatory lengthening in Spoken Tamil, but fails to account for its occurrence in Latin. One could indeed contend that in languages like Latin, when a Rhyme-internal melody undergoes deletion, its placeholder somehow survives, so that the preceding vowel can lengthen and occupy it (3-3a). In Spoken Tamil on the other hand, the placeholder must be deleted (3-3b) too, so that the preceding vowel does not come to associate with it. Such a contention while descriptively adequate is explanatorily problematic, however, because the motivation for the survival of the placeholder in one language and its deletion in another is unclear.

The moraic approach faces no such explanatory problems. Under this approach, the occurrence of compensatory lengthening in Latin and non-occurrence of it in Tamil are due, respectively, to the mora left vacant by the deletion of (the relevant) post-nuclear consonants in the former language (3-1a) and the lack of such a mora in the latter (3-2). That post-nuclear consonants in Latin are moraic is independently evidenced by the stress patterns in the language (Mester 1994). That (heterorganic) post-nuclear consonants are non-moraic in Spoken Tamil is supported by the occurrence of these consonants after long vowels in the language (see (3-37)). Geminates are never found after long vowels, however, and are moraic.

In summary, the moraic approach offers a principled account of the occurrence of compensatory lengthening in languages like Latin and its non-occurrence in languages like Spoken Tamil. Furthermore, pre-nuclear consonant lengthening in Malaysian Cantonese, which compensates for the loss of (all) previously moraic melodies within a syllable, will

also be seen to have a straightforward moraic analysis in the next subsection. It presents an intractable problem, however, for the constituency-based approach to compensatory lengthening.

3.1.2 *Pre-nuclear consonant lengthening*

In Malaysian Cantonese, the nuclear and post-nuclear material (if any) in the second syllable of words is elided if it is identical to the corresponding material in the third syllable (Ong 2007: 68). This elision occurs, however, only in ‘fast speech’.

(3-4) **(Post-)nuclear elision in Malaysian Cantonese**

	<i>Normal speech</i>		<i>Fast speech</i>		<i>Gloss</i>
a.	sən.k <u>ə</u> .l <u>ə</u>	→	sən.k.la		‘remote area’
b.	jət.k <u>au</u> .l <u>au</u>	→	jət.k.lau		‘a big lump of something’
c.	həm.p <u>an</u> .l <u>an</u>	→	həm.p.lan		‘all’

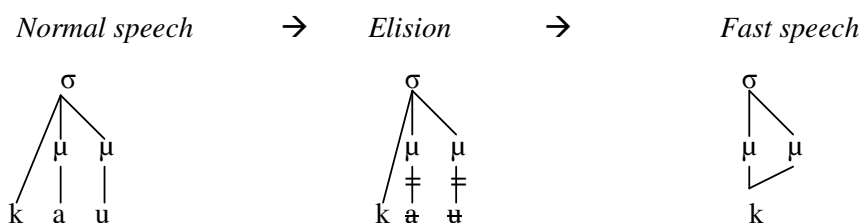
Interestingly, phonetic measurements (Ong 2007: 57, 62) show that the pre-nuclear obstruents [k, p] take up in fast speech a proportion of time very similar to the proportion of time that the syllables they are in take up in normal speech. This phonetic fact suggests that the obstruents in question do not blend with an adjacent in fast speech but ‘lengthen’ into standalone syllables, as transcribed above.

The ‘syllabic lengthening’ of obstruents in Malaysian Cantonese can, therefore, be analysed as compensatory: i.e. as association of the relevant obstruents with vacated moras. However, as a precursor to such an analysis, one must assume that *the loss of a syllable peak does not necessarily destroy the syllable of which it is a peak* (contra Hayes 1989: 268).² This assumption is necessary in Malaysian Cantonese, so that even when all (post-)nuclear melodies – which are moraic – are lost, the moras will remain associated with their (original) syllable. Any surviving melody within that syllable can then be associated with the surviving moras. This can be seen from (3-5) where the loss of [au] from the second syllable of [jət.kau.lau] leaves behind two moras (Elision). The obstruent [k] then associates with the vacated moras and becomes a bimoraic syllable (Fast Speech). There is also the possibility, as an examiner suggests, of associating the obstruent directly with the syllable node and with

² The destruction of a syllable upon the loss of nuclear material in it is known as Parasitic Delinking. To allow pre-nuclear lengthening to be compensatory, Parasitic De-linking must be reformulated as a parameter.

one mora inside that syllable. This possibility is not represented here, however, because syllables are minimally bimoraic in Malaysian Cantonese (Ong 2007).

(3-5) **Pre-nuclear (compensatory) lengthening**



This moraic analysis of pre-nuclear obstruent lengthening in Malaysian Cantonese is elegant. Appealing to constituency would be of no avail here since the target of elision is the Rhyme, while the lengthening melody is, before lengthening, pre-nuclear (i.e. pre-Rhyme). One could, of course, assume that the loss of Rhyme material in a syllable can be compensated for by lengthening pre-nuclear material. Such an assumption would still require us to stipulate that the loss of pre-nuclear material cannot be compensated for by lengthening Rhyme material. The lack of compensation for the loss of pre-nuclear material follows without stipulation in the moraic story because deleted pre-nuclear consonants are typically not survived by a mora (see (3-1b); cf. Topintzi 2006b and Kiparsky 2010)). Since there is no restriction, however, on pre-nuclear consonants becoming moraic (especially when they cease to be pre-nuclear) the mora-based account of the ‘syllabic lengthening’ of obstruents in Malaysian Cantonese is sound.

The mora-based account must still be considered with a little caution, however. The caution is necessary because the obstruents in question do not undergo any doubling to underscore their lengthening in fast speech. Despite this limitation, the moraic account of obstruent syllables in Malaysian Cantonese is neat, and is superior to the constituency-based alternative. The next section shows that mora-based accounts fare better than constituency-based ones in dealing with prominence (essentially stress) as well.

3.2 Consonants and Moras

‘Prominence’ refers to the demarcation of some phonological units, typically syllables, relative to others in an utterance; with stress and tone being the most common manifestations of it (Hyman 2006). The languages where prominence is realised as stress fall into two categories: those where stress is sensitive to the amount of moraic material in syllables; and

those where stress is insensitive to that information (Kager 1992a, b, 1993; Hewitt 1994, Hayes 1995, Crowhurst & Hewitt 1995, Hyde 2007, 2011; Elenbaas & Kager 2003, Al-Jarrah 2011 among many others). The mora-sensitive languages are the focus of this section, with specific heed paid to post-nuclear consonants.

In the Chugach dialect of Yupik, Goroa and Adhilabad Gondi, for example, post-nuclear consonants are moraic only in specific syllables of words (Rosenthal & van der Hulst 1999, Srinivas 2010: 35-40). In Lithuanian, Tiv and Kwakwala on the other hand post-nuclear sonorants are moraic, while obstruents are not (Zec 1995). The stress patterns of Chugach (§3.2.1) and Kwakwala (§3.2.2) are selected, from among these two sets of languages, for examination in the first two parts of this section. The examination will show that moras are given (or not given) to segmental melodies without any reference to the latter's seat in the Constituency Dimension.

The third part of the section (§3.2.3) focuses on stress in Khalkha Mongolian and Sindhi. Besides revealing that both languages have maximally bimoraic syllables, the stress facts indicate that Sindhi has uniformly moraic post-nuclear consonants and Khalkha Mongolian has uniformly non-moraic ones. Finally, a contrastive look at stress in Hindi and Syrian Arabic (§3.2.4) shows that a moraic consonant may follow a bimoraic (i.e. long vowel) in the former but not the latter language.

While a constituency-based analysis of stress also seems possible in some of the languages under focus, the accounts betray, on careful examination, an implicit appeal to the mora. Moraic analyses of stress, however, do not have to refer to constituency. Furthermore, moras capture stress in simpler terms than constituents do: this makes moraic accounts of stress better, even in principle, than the constituency-based accounts thereof (§3.2.5).

3.2.1 Consonant moras by context

In the Chugach dialect of Yupik (hereafter Chugach), long-vowelled syllables (CV:) and syllables with diphthongs (CVV) are stressed, as evidenced by [qi:]_σ in (3-6a-iii) and [lia]_σ in (3-6c-iii). This is because long vowels and diphthongs are bimoraic. Initial (C)VC syllables (or closed syllables) are always stressed, too, as seen in (3-6a); suggesting that they too are bimoraic, with the short vowel and the post-vowel consonant each associated with a mora. The rightmost column in (3-6) provides a moraic expansion of the syllabified words given in the leftmost column (to be explained further below) as well as their organisation into feet, whose boundaries are denoted by brackets.

(3-6) **Stress in Chugach**

(Kager 1993, Hewitt 1994, Hayes 1995: 87, Rosenthal & van der Hulst 1999: 506ff)

a. *Initial CVC stressed*

- | | | | |
|------|---------------------|-------------------|--|
| i. | 'an.ci.qu.'kut | 'we'll go out' | (¹ a _μ n _μ)ci _μ (qu _μ .'ku _μ t) |
| ii. | 'ag.ku.tar.'tua.nga | 'I'm going to go' | (¹ a _μ g _μ)ku _μ (ta _μ r.'tu _μ a _μ)nga _μ |
| iii. | 'iq.llu.'qi:.nga | 'she lied to me' | (¹ i _μ q _μ)llu _μ (¹ qi: _{μμ})nga _μ |

b. *Initial CV: stressed*

- | | | | |
|------|-------------------|-------------------------|---|
| i. | 'na:.qu.ma.'lu.ku | 'apparently reading it' | (¹ na: _{μμ})qu _μ (ma _μ .'lu _μ)ku _μ |
| ii. | 'ta:.ta.qa | 'my father' | (¹ ta: _{μμ})ta _μ .qa _μ |
| iii. | 'na:.ma.ci.'qua | 'I will suffice' | (¹ na: _{μμ})ma _μ (ci _μ .'qu _μ a _μ) |

c. *Initial CV not stressed*

- | | | | |
|------|-----------------------|----------------------------|--|
| i. | mu.'lu.'ku:t | 'if you take a long time' | (mu _μ .'lu _μ)(¹ ku: _{μμ} t) |
| ii. | a.'ku.tar.tu.'nir.tuq | 'he stopped eating akutaq' | (a _μ .'ku _μ)ta _μ r(tu _μ .'ni _μ r)tu _μ q |
| iii. | pa.'lu.'lia.qa | 'the fish pie I am making' | (pa _μ .'lu _μ)(¹ li _μ a _μ)qa _μ |

Bimoraic syllables are always stressed because they may be independently footed in Chugach, as evidenced by the initial closed syllable in the words in (3-6a), [qi:]_σ in (3-6a-iii) and [lia]_σ in (3-6c-iii). A bimoraic syllable may also occur as the rightward syllable of a disyllabic foot and receive stress, as evidenced by [qua]_σ in (3-6b-iii). Crucially, a bimoraic CV: or CVV syllable does not occur as the leftward syllable of a foot: this suggests that (disyllabic) feet in Chugach are iambic. More emphatic confirmation of iambic feet in the language comes from the fact that in feet consisting of two short-vowelled open syllables (CV) – i.e. monomoraic syllables – it is again the rightward syllable that receives stress. This can be seen from the initial foot in all the words in (3-6c).

While a CV: or CVV syllable does not occur as the leftward syllable or tail of an iambic foot, a non-initial CVC syllable can, as endorsed by [kut]_σ in (3-6a-i). A non-initial CVC syllable may also occur as the rightward syllable or head of an iambic foot, however, in which case it is stressed as [nir]_σ in (3-6c-ii). Finally, a non-initial CVC syllable may also remain unfooted, as [tar]_σ and [tuq]_σ are in (3-6c-ii). The upshot is that while word-initial

(C)VC syllables are always stressed (3-6a) on par with CVV syllables and CV: syllables; non-initial closed syllables are stressed, like CV syllables are, only if they are heads of iambic feet. One could therefore infer that non-initial CVC syllables in Chugach are monomoraic like CV syllables, even as initial ones are bimoraic like CV: and CVV syllables.

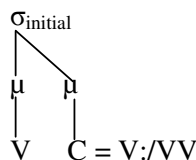
This inference receives further support from the data given in (3-6). Even a cursory look at the data makes it clear, for example, that monomoraic CV syllables are not footed independently in the language (Hayes 1995: 87, Hewitt 1994). Moreover, some CV syllables – like the pen-initial syllables in the words in (3-6a, b) – are simply not footed at all. That word-final [tuq]_σ and word-medial [tar]_σ in (3-6c-ii) are also not footed can, then, be taken to buttress the view that non-initial CVC syllables are monomoraic like CV syllables.

While the details of why some non-initial CVC syllables remain unfooted are not important here,³ the data in (3-6) clearly show that only non-initial CVC syllables may be left unfooted apart from CV syllables. By contrast, CVV, CV: and word-initial CVC syllables are all obligatorily footed. The metrical likeness of CVV, CV: and word-initial CVC syllables on the one hand and of CV and non-initial CVC syllables on the other is thus starkly clear once again.

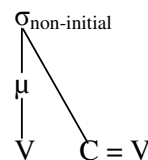
In sum, independent stress on initial (C)VC syllables, paralleling stress on CV: and CVV syllables, reveals that these closed syllables are bimoraic in Chugach. Non-initial CVC syllables, like CV syllables, receive stress only when they are iambic heads because they are monomoraic. This moraic contrast between initial and non-initial closed syllables is reflected in the representations below where the pre-vowel C is omitted:

(3-7) **Moraification by word-internal context**

a. *Initial syllable*



b. *Elsewhere*



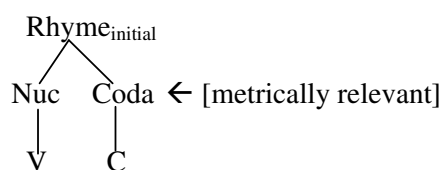
A moraic account thus explains uniform stress on initial closed syllables, as opposed to the lack of uniform stress on other closed syllables, in Chugach. A constituency-based

³ According to Hayes (1995: 334), foot parsing is ‘locally weak’ in Chugach in that after every foot is constructed, the next syllable available is ignored by the foot-building mechanism if it is monomoraic. The fact that only CV and non-initial CVC syllables are so ignored again suggests that they exhaust the types of monomoraic syllables in Chugach. See Kager (1993) for an alternative treatment of the ‘unfooted’ syllables.

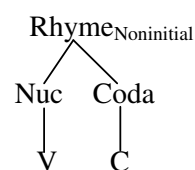
account that does not appeal to moras cannot offer a viable alternative explanation of Chugach stress, however. Under such an account, stress on CVC syllables would be seen as the metrical effect of a branching Rhyme i.e. a Coda associated with a melody. However, to explain the stress facts concerning closed syllables in Chugach, only the Coda in the initial syllable of words must be marked metrically relevant.

(3-8) **Constituency and metrical relevance**

a. *Initial syllable*



b. *Elsewhere*



If this relevance is formalised as a unit, it would resemble the mora, which can be associated directly with post-nuclear consonants in word-initial syllables, without referring to the association of the latter in the Constituency Dimension (see (3-7)). The upshot is that a constituency-based account of the role that post-nuclear consonants play in Chugach stress requires implicit appeal to (something like) the mora, but the moraic account of the same requires no appeal to constituency. The mora-based account is thus simpler and hence superior. The same conclusion will emerge at the end of the next subsection, where stress and reduplication in Kwakwala are discussed.

3.2.2 *Consonant moras by sonority*

Just like in Chugach, some post-nuclear consonants in Kwakwala directly influence stress and others do not. In Kwakwala, however, it is the intrinsic sonority of a post-nuclear consonant that determines its relevance to stress. More specifically, post-nuclear sonorants will be seen to be moraic and obstruents to be non-moraic in the language (Zec 1995).

The final syllable of a word receives stress if all of its syllables are CV (3-9a) in Kwakwala. When CV: syllables occur in a word, the leftmost of such syllables is stressed (3-9b). In words containing short-vowelled syllables closed by a sonorant (CVS), the leftmost CVS syllable is stressed (3-9c). Stress defaults to the final syllable in words which have short-vowelled syllables closed by an obstruent (CVO), but do not have any CV: or CVS syllable (3-9d).

(3-9) **Stress in Kwakwala** (Zec 1995: 105)

a. *Words with only CVs* (final stress)

nə. ¹ pa	‘to throw a thing’	bə. ¹ ha	‘to cut’
wə. ¹ da	‘it is cold’	m ^w .ə.k ^w . ¹ la	‘moon’
ts ^w .ə.xə. ¹ la	‘to be sick’	mə.ts ^w .ə. ¹ ta	‘to heal’

b. *Words with CV:* (leftmost CV: stressed)

¹ qa:.sa	‘to walk’	¹ n’a:.la	‘day’
¹ ts ^w .e:k ^w a	‘bird’	¹ x ^w .a:k ^w .ə.na	‘canoe’
¹ x ^w .a:x ^w .ə:k ^w .ə.na	‘canoe (PL)’	t ^w .ə.li:.dzu	‘large board’

c. *Words with CVS* (leftmost CVS stressed)

¹ man.sa	‘to measure’	¹ dal.xa	‘damp’
¹ tal.q ^w a	‘soft’	¹ man.dza	‘to make kindling food’
¹ dzam.bə.təls	‘to bury in a hole’	mə. ¹ xan.γənd	‘to strike edge’

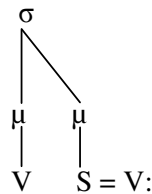
d. *Words with CVO* (final stress)

ts ^w .ət. ¹ xa	‘to squirt’	təγ. ¹ tša	‘to warm oneself’
səx ^w . ¹ tša	‘to be willing’	k ^w .əs. ¹ xa	‘to splash’
max ^w . ¹ tša	‘to be ashamed’	gas. ¹ xa	‘to carry on fingers’

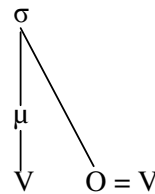
From the identical stress patterns displayed by words with CV: syllables (3-9b) and those with CVS syllables (3-9c), it is clear that the two types of syllables are treated alike for metrical purposes in Kwakwala. CV syllables and CVO syllables form another metrical pair, as evident from the identical stress pattern of words with only CV syllables (3-9a) and those with CV and CVO syllables (3-9d). The metrical similarity of CV: and CVS syllables in Kwakwala is simply explained if VS sequences are bimoraic, just like long vowels are in the language (3-10a). The metrical likeness of CVO and CV syllables is analogously explained if VO sequences are monomoraic like short vowels (3-10b).

(3-10) Moraification by sonority⁴

a. *Moraic sonorants*



b. *Non-moraic obstruents*



Further support for the bimoraicity of VS sequences and long vowels, and the monomoraicity of VO sequences and short vowels, is to be found in the prosodic morphology of Kwakwala. Consider, for example, the data in (3-11) which involves reduplication triggered, according to Zec (1995), by the suffixation of [-mut] or [-dzo].

Reduplication of roots ending in a V:O sequence is exemplified in (3-11a). In (3-11b), examples of reduplication of roots ending in a VS sequence are given. Finally, the reduplication of roots ending in a VSO sequence is exemplified in (3-11c). The qualitative differences between root vowels and the vowels corresponding to them in the post-reduplication forms will not be commented on here. Stress is also omitted in my transcriptions of the data below, taken from Zec (1995: 104).

(3-11) Reduplication in Kwakwala

a. *CV:O roots*

qa:s	qa:-qas-mut	‘tracks’
ts’a:s	ts’a:-ts’əs-mut	‘old eel-grass’

b. *CVS roots*

səl	səl-sə-mut	‘what is left after drilling’
məl	məl-mə-dzo	‘white on surface’

c. *CVSO roots*

qəns	qən-qas-mut	‘chips’
xəlt	xəl-xat-mut	‘sawdust’
yənt	yən-yat-mut	‘gnawing of a large animal’

⁴ In Lithuanian, the high tone of the circumflex accent lodges on VS syllables, not on VO syllables. VS sequences in the language therefore receive the moraic expansion in (3-10a) and VO sequences receive the expansion in (3-10b) (Zec 1995). Vowel deletion in Ao (Temsunungsang 2009: 60-2) results in a post-nuclear sonorant ending up with the tone of the deleted vowel in monosyllables. VS sequences in the monosyllables in question would thus correspond to (3-10a) in Ao and VO sequences therein would correspond to (3-10b).

The generalisations to be gleaned from (3-11) are as follows:

In the initial syllable⁵ of the output forms in (3-11a), the long vowel of the root is retained, but the post-vowel obstruent is shed. In the second syllable of the same forms, the vowel is shortened but the obstruent surfaces. In (3-11b), the short vowel and the post-vowel sonorant from the root are both retained in the initial syllable of the suffixed forms, but the sonorant is shed in the pen-initial syllable thereof. In (3-11c), the post-nuclear sonorant from the root is preserved in the initial syllable of the output forms (as in (3-11b)); it is, however, deleted in the second syllable of those forms, where the post-nuclear obstruent of the root is retained instead (as in (3-11a)). The retention of root vowel length and post-nuclear sonorants in the initial syllable of the output forms (and the non-retention thereof in the second syllable) shows that long vowels and VS sequences are treated alike for morphological purposes as well in Kwakwala. Post-vowel obstruents on the other hand are treated differently.

The foregoing generalisations are simply explained if the initial syllable and the pen-initial syllable in the suffixed forms in (3-11) are assumed to map, respectively, to a two-mora template and a one-mora template. In (3-11a), for example, retaining the long vowel from the root in the initial syllable of the suffixed forms satisfies the bimoraic template; and fitting a shortened version of the same vowel in the pen-initial syllable satisfies the monomoraic template. If the retention and shortening of long vowels serves to satisfy moraic templates, it is not a stretch to assume that the retention and deletion of post-nuclear sonorants serves the same function, too. Simply put, post-nuclear sonorants from the root are retained in the initial syllable of the suffixed forms in (3-11b, c), just like root-internal long vowels are in (3-11a), so that the initial syllable is bimoraic. They are deleted in the second syllable, just as vowels are shortened, to make the second syllable monomoraic.

While long vowel retention/shortening and sonorant retention/deletion are thus easily accounted for in terms of moraic templates, the retention of post-nuclear obstruents in the second syllable, where post-nuclear sonorants are shed, and the loss of these obstruents in the initial syllable, where they are retained, still need to be explained. Post-nuclear obstruent retention is unproblematic because obstruents in Kwakwala, being non-moraic, cannot contribute to the satisfaction or transgression of any moraic template.

To explain why post-nuclear obstruents undergo deletion in the initial syllable, however, one must look beyond moras and appeal to a constraint that restricts the Rhyme in Kwakwala from having no more than two segments. Given such a constraint, post-nuclear

⁵ Zec (1995) refers to the syllable immediately preceding the suffix [-mut]/[-dzo] as the root syllable, and the syllable preceding that as the reduplicant.

There is also another problem with how metrical relevance is encapsulated in constituency-based accounts. It is that these accounts make implicit reference to a unit like the mora, as mentioned earlier (see end of §3.2.1). This unit is, however, seldom apparent because its ‘work’ is done behind a smokescreen of ‘parameter settings’ and ‘constituent branching’ in constituency-only accounts. This latter point will become clearer as languages with uniformly (non-)moraic post-nuclear consonants are considered.

3.2.3 *Consonant moras by parametrisation*

Khalkha Mongolian (KM) is spoken in east Mongolia, and is widely regarded as the Standard dialect of Mongolian (Walker 1997: 22-25; cf. Gordon 2002, Gordon *et al* 2010: 208). Sindhi (Walker 1997) gets its name from the northern Indian people who speak the language. In both languages, content words have only one (primary) stress. As well as that, words with only short/monomoraic syllables and those with long/bimoraic syllables⁷ receive stress in different locations in each language. Post-nuclear consonants, however, make a short-vowelled syllable bimoraic only in Sindhi where they are moraic. In KM by contrast, all non-nuclear material is non-moraic.

Both KM and Sindhi are reported to have fixed stress in words containing only CV syllables. In Sindhi, the penultimate syllable is where the fixed stress falls (3-13a), while in KM it is realised on the word-initial syllable (3-13b).

(3-13) **Words with only CVs**

a. *Sindhi* (penult stress)

- | | | | | | |
|----|----------------------|--------|-----|----------|--------------|
| i. | 'b ^h i.ti | ‘wall’ | ii. | u.'tə.lə | ‘inundation’ |
|----|----------------------|--------|-----|----------|--------------|

b. *KM* (initial stress)

- | | | | | | |
|----|-------|-----------|-----|--------|------------|
| i. | 'a.xa | ‘brother’ | ii. | 'xa.da | ‘mountain’ |
|----|-------|-----------|-----|--------|------------|

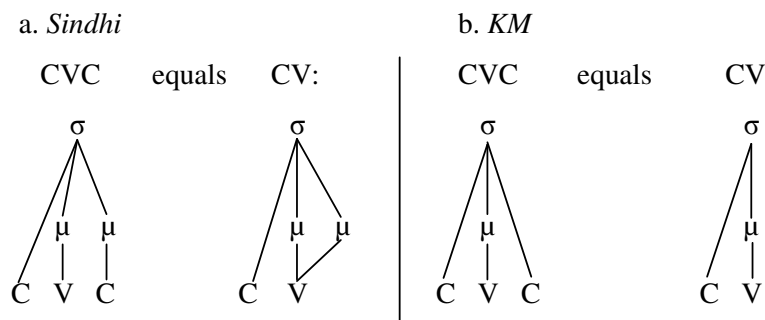
If a word has one CV: or CVV syllable, that syllable is stressed in both languages, as seen in (3-14). If there is more than one CV: or CVV syllable in a word, the rightmost of such syllables is stressed, excluding (if any) a final CV: or CVV syllable, as seen in (3-15).

⁷ Short syllables go by the name ‘light’ syllables and long ones by the name ‘heavy’ syllables in the literature. I prefer the terms ‘short’ and ‘long’ (and ‘extra-long’ for ‘super-heavy’) in this dissertation given the earlier definition of a mora as a metrically relevant unit of time (§1.4.2).

- | | | |
|------|---|---|
| ii. | di.k ^h i.'dʒən.də.ɽu | ‘one (MASC) getting anointed’ |
| iii. | 'kuɽ.mi: | ‘farmer’ |
| iv. | k ^h o:.'lin.da: | ‘they will open (TRANS)’ |
| v. | kho:.la:.ra:.'in.də.ɽu | ‘one who gets X open’ |
| vi. | k ^h o:.'la:.ra:.in.'dju:.si | ‘we (fem.) shall get X open’ |
| vii. | k ^h o:.'la:.ra:.in.da:.'su:.si | ‘we (masc.) shall get X open from him/her/them’ |
-
- | | | |
|------|-------------------|-------------------|
| b. | <i>KM</i> | |
| i. | 'un.ʃi.san | ‘having read’. |
| ii. | bae.'gu:.lag.dax | ‘to be organised’ |
| iii. | xø.n.di:.'ry:.len | ‘separate’ |

Closed syllables are thus treated like long-vowelled open syllables in Sindhi and like short-vowelled open ones in KM. This difference can be explained straightforwardly using the logic of moraic equivalence adopted earlier: CVC syllables, like CV: syllables, are bimoraic in Sindhi (3-17a). In KM, they are monomoraic, like CV syllables (3-17b).

(3-17) Moraic equivalences

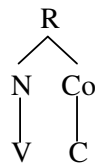


It is indeed possible to capture the different language-specific treatments of CVC syllables in a constituency-based account as well. This is typically done by ‘parametrising’ Rhyme-branching for metrical relevance. More specifically, Rhyme-branching, i.e. a phonetically filled Coda, is marked for metrical relevance in the Sindhi-type languages (3-18b) – a list that includes English, Yana, Lake Miwok and Classical Latin (Tranel 1991). In these languages, therefore, post-nuclear consonants influence stress assignment. Rhyme-branching is not marked for metrical relevance, however, in the KM-type languages (3-18a) –

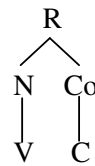
a list including Arrernte, Lardil and Malayalam. In these languages, therefore, post-nuclear consonants are passive spectators to stress assignment.

(3-18) **Parametrising Rhyme-branching**⁸

a. *M-irrelevant in KM*



b. *M-relevant in Sindhi*



In broad terms, parametrising⁹ Rhyme-branching for metrical relevance assigns the Rhyme a property – suppose it is called ‘MORA’, as opposed to mora – that makes it visible for metrical processes in the Sindhi-type languages. From the Rhyme, MORA percolates to the Nucleus and the Coda; whence it is passed onto the segmental melodies associated with these constituents. This top-down percolation of MORAS from constituents to segmental melodies does not fetch any empirical or explanatory mileage, however, when compared to the direct association of moras with segmental melodies.

Moreover, as observed earlier, metrical relevance is a surface property of (a subset) of syllabified consonants and vowels, not of constituents. The mora-based account captures this fact, and in terms far simpler than the constituency-based account does. The moraic account also has typological utility in the world of prosody. It explains, for example, the rarity of languages where consonants are moraic even after long vowels (e.g. Hindi) vis-à-vis languages where they are moraic only after short vowels (e.g. Syrian Arabic).

3.2.4 *Consonant moras and long vowels*

In Hindi, stress falls on a CV:C syllable if there is one (3-19a-iii, iv). Otherwise, a CV: or CVC syllable is stressed (3-19a-i, ii). In Syrian Arabic, penultimate syllables of the shape CV: or CV(:)C receive stress, as evidenced by the top three forms in (3-19b). When the penult is CV, however, stress falls on the antepenult (3-19b-iv).

⁸ The representations in (3-18) assume, ceteris paribus, that all consonants must be associated with some constituent in every model of constituency (see also note 16).

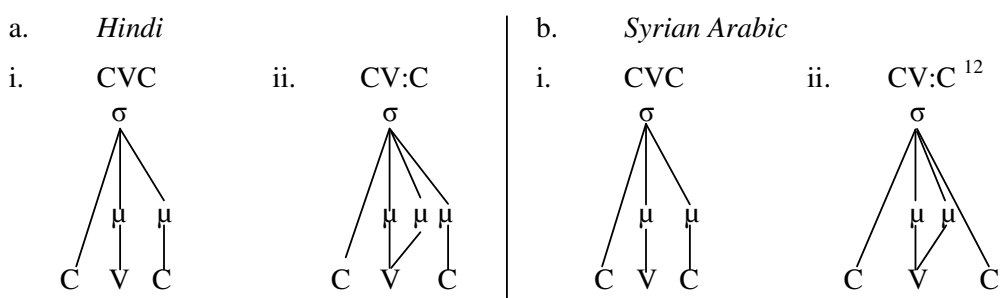
⁹ On the related parameter Weight-by-Position, see Hayes (1989), Zec (1995) etc.

(3-19) **Stress** (Broselow, Chen & Huffman 1997)

- | | | | |
|------|-------------------------------|------|--|
| a. | <i>Hindi</i> ¹⁰ | b. | <i>Syrian Arabic</i> ¹¹ |
| i. | ro:.'za:.na: 'daily' | i. | da.'ras.hon 'he studied them' |
| ii. | ki.'d ^h ar 'where' | ii. | ma.'na:m.hon 'he did not dream them' |
| iii. | 're:z.ga:.ri: 'change' | iii. | da.ras.'tu:.ha 'you (PL) studied it (FEM)' |
| iv. | mu.sal.'ma:n 'Moslem' | iv. | 'ma.sa.lan 'example' |

CV:C syllables and CV:/CVC syllables are treated as different kinds of metrical creatures in Hindi seeing as CV:C syllables attract stress over both CV: syllables (3-19a-iii) and CVC syllables (3-19a-iv) in the language. In Syrian Arabic by contrast, there is at least no positive evidence to hint at any metrical difference between CV:/CVC syllables and CV:C syllables. Broselow *et al* (1997) in fact cite phonetic evidence, to supplement the data in (3-19), in arguing that CV:C syllables are trimoraic (i.e. extra-long) in Hindi, unlike the bimoraic (i.e. long) CV:/CVC syllables over which they attract stress. In Syrian Arabic, however, they hold CV:C syllables to be bimoraic along with CV:/CVC syllables. The upshot is that post-nuclear consonants are moraic even after long vowels in Hindi (3-20a-ii), but only after short vowels in Syrian Arabic (3-20b-i).

(3-20) **CV:C syllables**



The 'extra-long-ness' of CV:C syllables in Hindi and their 'long-ness' in Syrian Arabic can also be captured through the offices of constituency. The stipulation required in Syrian Arabic is that Rhyme-branching is metrically relevant only when the Nucleus does not

¹⁰ Hindi words consisting only of CV syllables are not considered here because they are not relevant, one way or another, to the concerns of this section.

¹¹ Syrian Arabic does allow stress on specific types of word-final syllables. However, since final stress in the language does not influence the point made here anyway, it is not discussed.

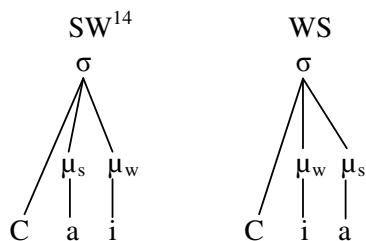
¹² For CV:C syllables in Syrian Arabic, Broselow *et al* (1997) propose a representation wherein the second mora is shared by the vowel and the post-nuclear consonant. The fact I have chosen to have the post-nuclear consonant report directly to the syllable (3-20b-ii) does not detract from the moraic difference between the CV:C syllables in Syrian Arabic and those in Hindi; which is the main focus of this section.

branch. In Hindi on the other hand, Rhyme-branching is metrically relevant regardless of Nucleus-branching. While the stipulation descriptively distinguishes Syrian Arabic from Hindi, it fails to explain why languages having maximally long syllables, like Syrian Arabic, far outnumber languages having maximally extra-long syllables, like Hindi. Here again, the mora offers a viable explanation.

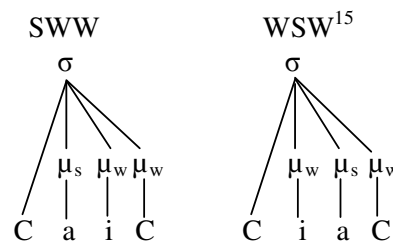
The typological commonness of languages like Syrian Arabic can be attributed to a cross-linguistic preference for maximally bimoraic syllables. This preference in turn can be interpreted as showing the metrical desirability of maximal syllables with one ‘s(trong) mora’ and one ‘w(eak) mora’ (3-21a).¹³ Trimoraic syllables on the other hand are less metrically desirable because they have more than one ‘w mora’ (3-21b). They are therefore less preferred.

(3-21) Moraic maximality

a. *Sample bimoraic syllables*



b. *Sample trimoraic syllables*



In conclusion, when long syllables are viewed as bimoraic syllables and extra-long syllables are seen as trimoraic ones, there is a metrical explanation for the rarity of the latter relative to the former. Terms like ‘bimoraic’ and ‘trimoraic’, in fact, point to the amount of metrically relevant segmental material in syllables. Moras, thus, capture the metrically relevant material in a syllable directly. This makes moraic analyses of stress simpler and better than constituency-based ones, even in principle—a point elaborated in the next subsection.

¹³ The underlying assumption is that every (metrically relevant) syllable has one strong mora, in addition to which it MAY have weak moras. Any monomoraic syllable is therefore a potential *minimal* syllable; which explains the abundance of such syllables in languages.

¹⁴ The labels ‘strong’ and ‘weak’ given to the moras in (3-21) are admittedly feature-based, and depend on the sonority of the melody with which a mora is associated (see also note 15).

¹⁵ Consider a syllable with a bimoraic diphthong followed by a moraic consonant. The mora associated with the more sonorous vowel in the diphthong must be ‘strong’ as that vowel is also the syllable peak. The moras associated with the less sonorous vowel in the diphthong and the post-nuclear consonant are thus both weak with respect to the strong mora. However, between the weak moras, there are degrees of weakness at play. Since every (post-nuclear) consonant is less sonorous than the less sonorous vowel in a diphthong, the mora associated with the former is weaker than the mora associated with the latter, even as both moras are (collectively) weaker than the mora associated with the syllable peak.

3.2.5 *Moras versus constituents*

The earlier parts of this section have shown that moraic analyses of stress fare better than the constituency-based analyses I have sketched in lieu of them. Even in principle, however, mora-based accounts of stress are simpler and better than their constituency-based alternatives. This has to do with the architectures of the OR Model and the μ -Model of the syllable.

To be more precise, the machinery of the OR Model is superfluous for the purpose of analysing stress. This is evident from the fact that, under the OR model, stress in certain languages is considered as being sensitive to whether a syllable-internal constituent branches or not.¹⁶ In making reference to constituent-branching, however, all the model really does is make reference, obliquely (and typically), to the segmental melodies which constitute the peak and the right margin of a syllable. For example, a syllable with a branching Nucleus is simply a syllable with a long or diphthongal syllable peak (see (3-31a) below). Analogously, a syllable with a branching Rhyme is one comprising a peak followed by one or more segmental melodies (3-31b).

The upshot is that stress in the languages in question depends on the amount of peak (and post-peak) material that a syllable contains. This insight is captured far more directly in the μ -Model where moras are assigned to some segmental melodies in every syllable (on a language-specific basis): the moras mark out the ‘moraified’ segmental melodies as relevant for metrical purposes, including stress.

Closely related to stress is the concept of ‘minimal word’. In languages where prosodic prominence is realised as stress, the minimal word is the smallest word which can receive stress. English is one such language, and as seen in §3.3.1, has a minimal word requirement that can be stated in terms of constituents or moras. In moraic terms, English has a bimoraic Minimal Word; in terms of constituent-structure, English words are required to have a branching Rhyme or Nucleus.

Defining the English minimal word as bimoraic is, however, more general because it accounts for both (C)V:/(C)VV and (C)VC monosyllables. Defining the English Minimal Word in terms of constituent-structure, however, obliges one to postulate two conditions: Nucleus-branching to capture the occurrence of (C)V:/(C)VV monosyllables and Rhyme-

¹⁶ Alternatively, stress in those languages can be regarded as being sensitive to whether a melody belongs to a constituent and therefore a syllable; or sits outside all constituents, and is adjoined to a syllable (cf. Levin 1985). Here again, the simple fact that stress depends typically on the amount of (peak and post-peak) material in a syllable is expressed indirectly, while moras, as the foregoing argument shows, express the same fact directly.

branching to account for the occurrence of (C)VC monosyllables. A further condition (probably foot-branching) is also required under the constituency-based regime to allow for (C)V.(C)V disyllables. (C)V.(C)V disyllables are, however, accepted readily under the moraic story because, like CV:/CVV and CVC monosyllables, they are bimoraic.

Extrapolating from the above discussion on English, prosodic size constraints typically constrain the amount of peak (and post-peak) material in a syllable—the same material to which stress is sensitive. In the μ -Model, this material is directly associated with moras, as evidenced earlier in this chapter. In the OR Model, however, the material is evaluated, rather needlessly, in terms of the constituents which dominate them.

In summary, moras offer simpler and, therefore, better accounts of stress than constituents. The next section of this chapter examines prosodic size constraints from English, Ao, Adhilabad Gondi and Tamil in detail, and shows that these constraints are also best captured in terms of mora count (McCarthy & Prince 1990, Kager 1992a, b, 1995; Mester 1994, Selkirk 1995, Feng 2001, Topintzi 2004, 2008). The section also shows that both segmental statements and constituency-based statements of minimality/maximality emerge poorer than the moraic statements thereof.

3.3 Moraic Constraints

This section begins with a discussion of the minimal word in English, where stress assignment is sensitive to the metrical duration of syllables (§3.3.1). The discussion on English is followed by a look at the minimal word in Ao, a tonal language (§3.3.2), and Adhilabad Gondi, a language where no phonological manifestation of prominence is reported (§3.3.3). It will be seen that in all three languages, words with semantic content (hereafter ‘content words’) are bimoraic.

The section concludes by examining one phonological process apiece from two languages—each motivated by a prosodic-size constraint on the syllable. Closed syllable shortening (§3.3.4), for example, ensures that (non-final) syllables are maximally bimoraic in English. On the other hand, the gemination of sonorant consonants ensures that syllables are minimally bimoraic in Tamil (§3.3.5).

3.3.1 Bimoraic words in English

Monosyllabic content words in English are minimally of the shape (C)VC, (C)V: or (C)VV (as in Latin; see Mester 1994). This can be seen in (3-22a). Monosyllables of the shape (C)V do not occur as content words in the language, however (3-22b).

(3-22) English monosyllables

a. Attested shapes

$(C)V_{\mu}C_{\mu}$ ¹⁷	$(C)V:_{\mu\mu}$	$(C)V_{\mu}V_{\mu}$
tɪp <i>tip</i>	ti: <i>tea</i>	ɪə <i>ear</i>
pʊt <i>put</i>	tu: <i>two</i>	pʊə <i>poor</i>
nɛt <i>net</i>	fi: <i>fee</i>	deɪ <i>day</i>
mæt <i>mat</i>	ɜ: <i>err</i>	wəʊ <i>woe</i>
rɒt <i>rot</i>	pɑ: <i>par</i>	kəʊ <i>cow</i>
rʌn <i>run</i>	ɜ:dʒ <i>urge</i>	dʌɪ <i>dye/die</i>

b. (C)V unattested

*(t)ɪ, *(p)ʊ, *(θ)ɔ, *(n)ɛ, *(m)æ, *(r)ɒ, *(r)ʌ

Moras help distinguish the attested word shapes in (3-22a) from the unattested ones in (3-22b) in a simple way. The monosyllables in (3-22a) are all bimoraic. In (C)VC monosyllables, the vowel and the post-vowel consonant are each associated with a mora (see note 17). In (C)V: monosyllables, the long vowels are bimoraic; and in (C)VV monosyllables, the diphthongs are bimoraic. In contrast to the attested (C)V:, (C)VC and (C)VC monosyllables, the unattested (C)V monosyllables in (3-22b) are monomoraic since the monomoraic short vowel in these cases is not followed by any other material that could be moraic. In the moraic story, therefore, content words in English must be minimally bimoraic.¹⁸ A literal translation of the bimoraic minimum as bi-segmental minimum will not

¹⁷ That post-nuclear consonants are moraic in English is independently evidenced by the fact that CVC penults are stressed in non-derived adjectives in the language, just as (bimoraic) CV:/CVV penults are: e.g. *in.dig.nant* [ɪnˈdɪg.nənt], *egregious* [ɪˈɡriː.ɡɪ.əs], *insolent* [ɪn.səʊ.lənt].

¹⁸ Function words may be monomoraic in English, however, as evidenced by the articles *a* ([ə]) and *the* ([ðə]), the preposition *to* ([tə]) etc. These ‘words’ usually cliticise with adjacent nouns; which suggests that they do not really count as words for prosodic purposes. Under emphasis, they acquire the status of prosodic words and are bimoraic (Selkirk 1995): e.g. *the* [ðiː] *greatest invention yet*; *I am going to* [tuː] *the film*, etc.

work because English allows bi-segmental monosyllables which are VV (e.g. [ɪə] *ear*), but not those which are CV (3-22b).

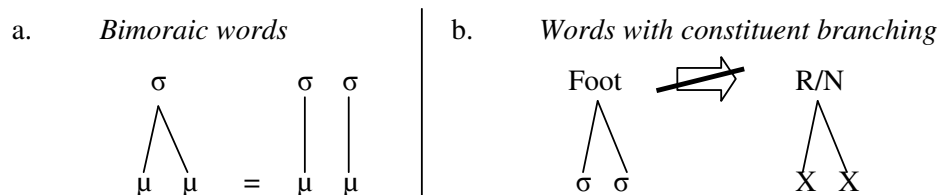
It is, however, possible to establish a constituency-based distinction between the attested types of monosyllables and the unattested ones in English. The occurring monosyllables in (3-22a) all have either a branching nucleus (V: or VV; see (3-31a)) or a branching Rhyme (CVC). The non-occurring ones in (3-22b), however, do not. Branching at the level of the Rhyme/Nucleus may, therefore, be posited as a condition that content words in English must satisfy. Such a condition does not, however, offer a principled explanation of the abundance of disyllabic words of the shape CV.CV in English, even as CV monosyllables are markedly absent.

(3-23) CV.CV disyllables in English

si_μ.ti_μ *city* bu_μ.li_μ *bully* pi_μ.ti_μ *pity* si_μ.li_μ *silly*

To explain the allowance of CV.CV words in the constituency-based account, one could contend that a disyllabic unit (presumably a foot) is akin to a branching Nucleus/Rhyme (3-24b). Relating within-syllable branching to branching beyond the syllable is, however, specious because it fails to establish any metrical similarity between the minimally occurring monosyllables and disyllables in English. On the other hand, the minimal monosyllables in (3-22a) and the CV.CV disyllables in (3-23) are similar under a moraic analysis because they have the same mora count (i.e. two).

(3-24) Minimal words in English



To summarise: English has a bimoraic word minimum, which accounts for the minimal monosyllables as well as disyllables in the language (3-24a). In the constituency-based account by contrast, minimal monosyllables and minimal disyllables will have to be explained by referring to branching within and beyond the syllable (3-24b) respectively. The moraic characterisation of the word minimum in English is hence simpler than a constituency-based one. Such a characterisation also works in the case of the Chungli dialect of Ao (hereafter Chungli), as seen in the next subsection.

3.3.2 *Bimoraic disyllables in Chungli*

“Almost 90% of [the] verbs” in Chungli are disyllables (Temsunungsang 2009: 63). Some of these disyllabic verbs are given in (3-25a) and can be contrasted with their monosyllabic nominal counterparts in (3-25b). Acute accent marks a high tone and grave accent a low tone in the data below; mid-toned syllables are not marked.

(3-25) **Grammaticalised minimality in Chungli** (p. 64, 69)

a. *Minimal verbs*

m̩. cáŋ	‘sleep’	í. núk	‘put’
núk. ták	‘stand’	ca. ca	‘walk’

b. *Minimal nouns*

kú	‘hair’	i	‘wine’
mít	‘anger’	nùk	‘anger’

The preference for minimally disyllabic verbs is highlighted by the augmentation of (otherwise) monosyllabic verb roots with the vowel [a] in Chungli: e.g. /s̩m/ → [a.s̩m] ‘wear’. Nominal roots never receive such augments. The assumption that [a] is an augment motivated by considerations of prosodic size is further supported by the fact that disyllabic verbs which occur with [a] in the dialect occur without it as monosyllables in the Mongsen dialect of Ao. Still, the verbs in (3-26) are regarded as monosyllables or just as “virtual disyllables” by Temsunungsang (2009: 65) even though they have undergone a-augmentation.

(3-26) **Virtual disyllables in Chungli**

ai	(< /a/ + /i/ ‘enter’)
au	(< /a/ + /u/ ‘go’)
ain	(< /a/ + /in/ ‘grow’)

The need to call the verbs above monosyllabic arguably stems from the assumption that word-medial syllables do not begin with a vowel in Chungli. If that assumption is set aside, the verbs in (3-26) are really, rather than just virtually, disyllabic like the verbs in (3-25a). Furthermore, the fact that Chungli countenances sequences of vowels only in purported monosyllables suggests that the vowels are not really diphthongs, but heterosyllabic vowels in charge of disyllabic words.

Temsunungsang's conclusion that verbs in Chungli are preferred to be minimally disyllabic therefore seems even more robust than he probably intended. All the same, the disyllabic verbs in Chungli need not be thought of as a response to a constraint that requires verbs to be disyllabic (3-27a); they may also be thought of as a response to a constraint that requires verbs to be simply bimoraic (3-27b).

(3-27) **Constraints enforcing verb disyllabicity**

a. *Verbs < [σσ] .

(Temsunungsang 2009: 63)

b. *Verbs < [μμ]

(Temsunungsang & Sanyal 2005)

For starters, both the Chungli and the Mongsen dialects of Ao lack vowel length contrasts.¹⁹ Secondly, post-nuclear consonants are non-moraic in Chungli as evidenced by the fact that every syllable carries only one level tone in the dialect (see (3-25)). In the absence of long vowels and moraic consonants (but see note 4) – the two most common recipes for a bimoraic syllable – even a bimoraic minimum can only be satisfied by disyllables.

The upshot is that a constraint specifying mora count can be met in the manner in which a constraint specifying syllable count is met. This was also seen in English where CV.CV disyllables satisfy a bimoraic minimum as well as bimoraic monosyllables do (§3.3.1). In the constituency-based approach, however, it is difficult to see how disyllabic words can be explained as a response to a constraint that does not explicitly demand disyllables. While this *per se* does not make the approach unsound, the fact that the approach fails to liken a long monosyllable with two short disyllables in languages which allow both makes it explanatorily weak. This weakness appears particularly egregious in light of the fact that the likeness is straightforwardly available in the form of mora count (see (3-24)).

In the moraic account, a single long syllable is metrically equal to two short syllables because the former as well as the latter contain two moras' worth of melodic material. The consequence of this metrical equivalence is that, in a Chungli-like system with maximally monomoraic syllables, a bimoraic word minimum can also be met only by two syllables. The bimoraic word minimum is in fact fairly common across the world's languages, and is operational in Adhilabad Gondi, too. The next subsection, however, focuses on the need for word-initial syllables in the language to be minimally bimoraic.

¹⁹ Long vowels occur in monosyllabic words but only if the words have no post-nuclear consonant, or if that consonant is an obstruent. Vowel 'lengthening' in monosyllables in turn has to do with an independent constraint that requires Chungli verbs to be bi-tonal. Since obstruents are poor tone-bearing units, however, vowels lengthen even in monosyllables closed by an obstruent to ensure the realisation of a second tone.

3.3.3 *Bimoraic initial syllables in Adhilabad Gondi*

Adhilabad Gondi has already been discussed in this dissertation in connection with sonority constraints and glides (see §2.2.3 and §2.4.2). The focus of this subsection, though, is on the minimal prosodic size of initial syllables and monosyllables in the language. In melodic terms, monosyllables in Adhilabad Gondi can be minimally (C)VC or (C)V:C, as seen below:

(3-28) **Minimal monosyllables in Adhilabad Gondi** (Srinivas 2010: 23)

(C)VC		(C)V:C	
pir	‘rain’	ni:r	‘ashes’
buj	‘groundnut’	ku:r	‘dead body’
pal	‘tooth, fang’	pa:l	‘milk’
mal	‘peacock’	ma:l	‘property’
ul	‘urine’	u:s	‘sugarcane’
col	‘saliva’	ro:g	‘disease’
vik	‘poison’	ku:r	‘deer’

The CVC and CV:C monosyllables in (3-28) are best regarded as reflecting a bimoraic word minimum, with the short vowel and the post-vowel consonant each associated with one mora in the former case; and the long vowel associated with two moras in the latter (Srinivas 2010: 36-40). By this logic, initial syllables in the language, which are minimally (C)VC or (C)V:, are also bimoraic:

(3-29) **Minimal initial syllables**

(C)VC		(C)V:	
<u>bur</u> .ku:m	‘snail’	<u>to</u> :.ko:r	‘tail’
<u>gar</u> .ci:	‘thunder’	<u>ci</u> :.ce:	‘young berry’
<u>man</u> .di:	‘people’	<u>ga</u> :.di:	‘donkey’
<u>kun</u> .bi:	‘farmer’	<u>ha</u> :.ba:r	‘sky’
<u>uṣ</u> .ke:	‘sand’	<u>a</u> :.ki:	‘leaf’

There is also processual evidence to support the hypothesis that monosyllables and word-initial syllables are minimally bimoraic in Adhilabad Gondi. When the initial syllable of a word has a short vowel and has no underlying consonant to close it, for example, the

consonant following the short vowel ‘automatically geminates’²⁰ to make the initial syllable bimoraic.

(3-30) **Gemination in #CV_.C**

	$CV_{\mu}.CV\dots$	\rightarrow	$CV_{\mu}C_{\mu}.CV$	
a.	sa _μ .bal	\rightarrow	sa _μ b _μ .ba:l	‘crowbar’
b.	ma _μ .gu:r	\rightarrow	ma _μ g _μ .gu:r	‘crocodile’
c.	si _μ .nu:m	\rightarrow	si _μ n _μ .nu:m	‘bracelet’
d.	ku _μ .me:	\rightarrow	ku _μ m _μ .me:	‘hornet’
e.	ba _μ .je:	\rightarrow	ba _μ j _μ .je:	‘mother’
f.	pa _μ .di:	\rightarrow	pa _μ d _μ .di:	‘pig’
g.	sa _μ .va:d	\rightarrow	sa _μ v _μ .va:d	‘taste’
h.	du _μ .pa:ri:	\rightarrow	du _μ p _μ .pa:ri:	‘afternoon’

If, as indicated above, the motivation for automatic gemination is making initial syllables bimoraic, there should be no gemination after long vowels and (underlying consonants syllabified as) post-nuclear consonants because they themselves render the initial syllable bimoraic. This prediction is correct as evidenced by the absence of forms such as [ci:μμ*c.ce:] ‘young berry’ and [ga_μr_μ*c.ci:] ‘thunder’. Moreover, automatic gemination is also related to a bimoraic initial syllable minimum in Tamil, a related language, and dialects of Yupik, which are far more distant from Gondi (Hewitt 1994). There is thus the stamp of cross-linguistic support, too, for the argument that automatic gemination serves to make initial syllables bimoraic in Adhilabad Gondi. The conclusion is that the word-initial syllable of words, and that includes monosyllables (3-28), are bimoraic in the language.²¹

Indeed, the leftmost syllable in words like [a:ki:] ‘leaf’, [u_s.ke:] ‘sand’ and [ul] ‘urine’ suggest that the initial syllable in Adhilabad Gondi may just be minimally bi-segmental rather than bimoraic. A bi-segmental minimum does not really work, however, as

²⁰ Vowel lengthening would also make the initial syllable bimoraic. It is avoided, however, to preserve the vowel length contrast which manifests only in the initial syllable of words in Adhilabad Gondi (Srinivas 2011).

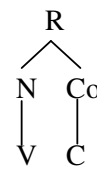
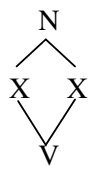
²¹ Word-initial monomoraic syllables are attested in the language, but only when the second syllable begins with one of /s, h, ʃ, r/. These consonants do not undergo gemination, so a word-initial CV cannot become CVC (and bimoraic) when followed by one of them. A word-initial CV cannot become CV: either (see note 20). Monomoraic initial syllables in Adhilabad Gondi thus constitute a principled exception to the ‘rule’ of the bimoraic minimum.

evidenced by the fact that the potentially bi-segmental initial syllables in (3-30) all become tri-segmental after gemination.

While a segmental characterisation of the initial syllable minimum does not work in Adhilabad Gondi, a constituency-based statement does, if only descriptively. Note how, across the data items in (3-28), (3-29) and (3-30), monosyllables and initial syllables of words either end in a long vowel, which constitutes a branching Nucleus (3-31a); or a VC sequence, which constitutes a branching Rhyme (3-31b). (Since bi-melodic representations of long vowels violate the Obligatory Contour Principle, a long vowel is typically treated, in the absence of moras, as one melody associated with two segmental X-slots [or V-slots].)

(3-31) Constituency-based word minimum

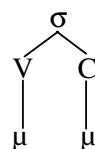
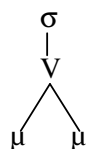
- a. *Branching Nucleus* (or) b. *Branching Rhyme*



While ‘Rhyme-branching (VC) or Nucleus-branching (long vowel)’ may be imposed as a minimality condition on the initial syllables in Adhilabad Gondi, why the condition requires a VC sequence OR a long vowel – rather than AND – lacks any explanation. In the moraic account, however, the disjunction (and the lack of conjunction) makes sense because long vowels themselves make a syllable bimoraic (3-32a). Only when a long vowel is absent does a post-nuclear consonant become necessary to make the initial syllable bimoraic (3-32b) in Adhilabad Gondi.

(3-32) Moraic word minimum

- a. *Bimoraic vowel* b. *Bimoraic VC sequence*



It is clear then that prosodic-size constraints, as reflected in the static shape of words/ syllables in English, Chungli Ao and Adhilabad Gondi, are better characterised in moraic terms than in terms of segments or constituents. The next two parts of this section show that syllable-size constraints in English and Tamil trigger phonological processes, and that these

are again best stated in moraic terms. In §3.3.4, closed syllable shortening in English is seen to follow from a bimoraic syllable maximum. A bimoraic (initial) syllable minimum is then seen to motivate sonorant gemination in Tamil in §3.3.5.

3.3.4 *Moraic shortening in English*

Shortening processes which fall under the head ‘closed syllable shortening’ are reported in a number of languages. Among these are Yawelmani Yokuts (Archangeli 1991) and the so-called CV/onset dialects of Arabic (Kiparsky 2003, Broselow 1992). Something akin to closed syllable shortening is found in English, too, where the addition of a level 1 suffix (Kiparsky 1982, Borowsky 1989) such as *-ive*, *-ling*, *-dom* or *-ture* to a form ending in a long vowel (3-33a) gives rise to non-final closed syllables. The vowels in those closed syllables are invariably short (3-33b).

(3-33) **Closed syllable shortening in English**

a. *Non-suffixed forms*

prɪs.kraɪb *prescribe*

rɪ.zju:m *resume*

gu:s *goose*

skraɪb *scribe*

waɪz *wise*

b. *Suffixed forms*

prɪs.kɪp.tɪv *prescriptive*

rɪ.zʌmp.tʃən *resumption*

gɒz.lɪŋ *gosling*

skɪp.tʃə *scripture*

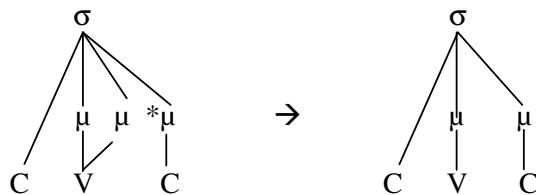
wɪz.dəm *wisdom*

The underlined syllables in (3-33a) all have a long vowel, while the corresponding syllables in the suffixed forms in (3-33b) all have a short vowel. Even if the latter are not ‘dynamically’ related to the former by a synchronic process of vowel shortening, the vowel length asymmetry in the two sets of data needs an explanation. Moras provide one.

In English, non-final CVC syllables are bimoraic due to a monomoraic short vowel and a moraic post-nuclear consonant (see note 17 and §3.3.1). If non-final syllables in English are assumed to be maximally bimoraic, the short vowels in the underlined non-final closed syllables in (3-33b) follow simply enough. Speaking in processual terms, long

vowels/diphthongs are ‘shortened’ in non-final closed syllables²² in English to ensure that these syllables are maximally bimoraic, as seen below.

(3-34) **Bimoraic shortening in English**



Closed syllable shortening can also be expressed in a fully constituency-based setting by invoking the, by now familiar, condition in (3-35).

(3-35) **Condition on Nucleus- and Rhyme-branching**

A branching Nucleus (V: or VV) is allowed if and only if there is no branching Rhyme (VC); and vice versa.

The problem with the condition in (3-35) is, to risk repetition, explanatory. Just as there is no explanation as to why the Nucleus OR the Rhyme should branch in a minimally acceptable syllable in Adhilabad Gondi (see (3-31)), there is no explanation as to why the Nucleus OR the Rhyme should not branch in a maximally acceptable syllable in English. On a related note, it is also unclear why Rhyme-branching is often metrically irrelevant when both the Nucleus and the Rhyme do branch (see §3.2.4). The disjunctive relationship between Rhyme-branching and Nucleus-branching thus brings no explanatory insight into the analysis of stress, prosodic-size constraints, or processes triggered by such constraints.

In the moraic analysis, however, a bimoraic ceiling on non-initial syllables can be straightforwardly seen as the trigger of closed syllable shortening in English. The nub of the matter is this: when the amount of metrically relevant (i.e. moraic) melodic content exceeds the maximum allowed in a syllable, there is melody-shortening (3-34). Melody-lengthening is, therefore, predicted when the amount of metrically relevant melodic content falls short of the minimum expected in a syllable. Sonorant gemination in Tamil confirms the prediction.

²² In word-final closed syllables, consonants which follow a long vowel are presumably adjoined to the syllable node or report to the Prosodic Word. Consequently, they do not have to compete with long vowels or diphthongs for the second mora in an English syllable.

3.3.5 Moraic gemination in Tamil

A number of commonly uttered Tamil nouns have a monosyllabic variant and a disyllabic variant (Vijayakrishnan 2007). The disyllables are preferred in everyday speech, and are given below alongside their monosyllabic alternatives. ('S' refers to a sonorant consonant.)

(3-36) Doublets in Tamil

a.	$CV:S \sim CV:.S_i$		b.	$CVS \sim CVS_i.S_i$	
i.	te:l ~ te:.li	'scorpion'	i.	je ~ je .li	'a kind of grain'
ii.	va:l ~ va:.li	'tail'	ii.	pal ~ pal.li	'tooth'
iii.	ma:n ~ ma:.ni	'deer'	iii.	pon ~ pon.ni	'gold'
iv.	ra:m ~ ra:.mi	'name'	iv.	*mam ~ mam.mi	'food (parentese)'
v.	tu:ŋ ~ tu:.ŋi	'pillar'	v.	puŋ ~ puŋ.ŋi	'wound'
vi.	ku:ɻ ~ ku:.ɻi	'porridge'	vi.	pul ~ pul.li	'grass'

The monosyllables in (3-36a) are all of the shape CV:S and have disyllabic variants of the shape CV:.S_i. The monosyllables in (3-36b) are CVS, however, and their disyllabic variants are CVS_i.S_i. Simply put, the monosyllable-final sonorant appears geminated in the disyllabic renditions of CVS monosyllables, but not those of CV:S monosyllables.

To account for the presence of the sonorant geminate in one set of disyllables but not the other, I propose that sonorant geminates – more precisely, the (initial or) post-nuclear part of such geminates – are moraic in Tamil.²³ The gemination of sonorants following a short vowel, in the words in (3-36b), may now be explained as owing to a constraint that requires the initial syllables of (preferred) disyllabic nouns to be bimoraic. The initial syllables of the disyllables in (3-36a) are also bimoraic, but because they have a long vowel. Gemination of the monosyllable-final consonant would be gratuitous in this case; for which reason, it is presumably avoided.

While avoidance of gratuitous processes is well-known, there is an even stronger explanation for the lack of sonorant geminates in the disyllables in (3-36a). Following the proposal that sonorant geminates are moraic in Tamil, any long-vowelled syllable closed by (the first part of) a sonorant geminate would be trimoraic in the language: e.g. [va:μμ*_l.li] 'tail'. However, trimoraic syllables are metrically undesirable (see (3-21b)) and are probably

²³ Since languages have moraic sonorants (e.g. Kwakwala; see §3.2.2) and moraic geminates (e.g. Sinhala, cf. Davis 2003), it is unsurprising to find a language having moraic sonorant geminates.

avoided in Tamil, too, so as to keep syllables maximally bimoraic. The case for a bimoraic syllable maximum is itself supported by the fact that sonorant geminates do not follow long vowels even underlyingly in Tamil.

The non-gemination of sonorant consonants after long vowels (3-36a) is thus explained by a bimoraic syllable maximum in Tamil, even as their gemination after a short vowel in (3-36b) is explained by a bimoraic minimum holding over the initial syllable of (preferred) disyllabic nouns. Accounting for these instances of (non-)gemination²⁴ using constituents again requires the stipulation that the Rhyme can branch if and only if the Nucleus cannot. The stipulation is not even descriptively adequate in Tamil, given that the language allows long vowels (i.e. branching Nucleus in (3-31a)) to be followed by singleton sonorants or the first part of obstruent geminates (i.e. branching Rhyme in (3-31b)).

(3-37) **Post-long vowel consonants**

a.	<i>Obstruent geminates</i>	b.	<i>Singleton sonorants</i>	
i.	ka:k.kaj ‘crow’	i.	ke:ɭ.vi ‘question’	(*CV:ɭ.[V])
ii.	to:t.ɕam ‘garden’	ii.	so:r.vi ‘tiredness’	(*CV:r.rV)
iii.	je:p.pam ‘burp’	iii.	ma:ŋ.bi ‘respect’	(*CV:ŋ.ŋV)
iv.	va:t.ti ‘duck’	iv.	to:l.vi ‘defeat’	(*CV:l.lV)
v.	pa:c.caj ‘cockroach’	v.	ga:n.dam ‘magnet’	(*CV:n.nV)
vi.	ko:p.paj ‘cup’	vi.	sa:m.bal ‘ashes’	(*CV:m.mV)

That singleton sonorants and obstruent geminates are allowed after long vowels, however, suggests that they are not moraic. If they were moraic, they should not be found after long vowels, just as sonorant geminates are not (see (3-36a)), so as to preclude trimoraic syllables.

Returning briefly to the dataset in (3-36), I agree with Vijayakrishnan (2007) who argues for a ‘preferred disyllabic minimum’ in Tamil. Since the disyllabic minimum itself does not explain why the disyllabic forms in (3-36b) have a geminate but those in (3-36a) do not, however, my proposal that speakers of Tamil prefer *disyllabic nouns with a bimoraic initial syllable* becomes necessary. One may recall here that the initial syllable in Adhilabad Gondi, a Dravidian language like Tamil, is also bimoraic (see §3.3.3). While two languages represent too small a pool from which to draw any conclusions about a language family, it is

²⁴ The non-occurrence of sonorant geminates after long vowels cannot be explained in terms of a maximally bi-segmental Rhyme because Tamil allows up to two post-nuclear consonants even after long vowels: e.g. [ti:ɕp.pɪ] ‘judgment’, [vi:ɕc.ci] ‘fall’ (see §2.5.3).

plausible that the initial syllable carries some sort of prosodic privilege in Dravidian languages (Vijayakrishnan 2001, 2007).

That speculative remark on a small aspect of Dravidian phonology brings to a close the empirical meat of this chapter. The chapter has so far validated the role of the mora as a metrically relevant unit of time by examining its role in metrical phenomena, both static (size-constraints) and dynamic (processes). The final section of this chapter demonstrates the significance of the mora in a Japanese language game called Babuebo.

3.4 Moras in a Language Game

Japanese is often referred to as the prototypical mora-timed language (e.g. Blevins 1995). This means that the smallest repetitive unit of metrical organisation is the mora rather than the syllable in Japanese: minimal pairs like [reE] and [rEe], for example, suggest that pitch-accent in the language can fall on either half of a long vowel, each of which corresponds to a mora.

Other than vowels, post-nuclear consonants – a set which includes (word-final) heterorganic nasal consonants, (word-medial) nasal consonants which share place of articulation with a following stop and the first part of heterosyllabic geminates (Ito 1986: 21, 26) – count as moras in Japanese. The rest of this section shows how these moraic vowels and consonants play an influential role in a language game called Babuebo familiar among speakers of Japanese (Hisagi m.s).

In Babuebo, any Japanese lexical item given as input surfaces with the melodic sequence [bV] interrupting the input string at various places, as seen below. Melodic material specific to the language game is transcribed in italics to distinguish it from the input material in (3-38) and the datasets following it. The quality of the vowel in [bV] varies with surrounding context, and is not relevant to the discussion here (see Hisagi m.s).

(3-38) [bV] placement in Babuebo

	<u>Input</u>		<u>Output</u>	<u>Gloss</u>
a.	ki.bi	→	ki. <i>bi</i> .ri. <i>bi</i>	‘tree’
b.	a.ri	→	a. <i>ba</i> .ri. <i>bi</i>	‘ants’
c.	mi.kan	→	mi. <i>bi</i> .ka. <i>ba</i> .m. <i>bɨ</i>	‘tagline’
d.	riŋ.go	→	ri. <i>bi</i> .m ²⁵ . <i>bɨ</i> .go. <i>bo</i>	‘apple’

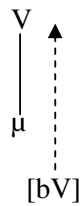
²⁵ Post-nuclear nasals in word-medial position assimilate to the place of a following stop in Japanese.

e. to.kei → to.bo.ke.be.i.bi ‘clock’

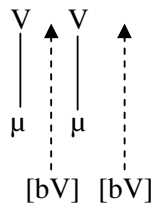
The contexts in which [bV] appears in the output forms in (3-38) are all correctly captured if [bV] is assumed to be placed after every mora(ic melody). In the output forms in (3-38a, b), for example, the affix occurs immediately after every short vowel, associated with one mora as seen in (3-39a). In (3-38c, d), [bV] surfaces after short vowels, and after nasal consonants which correspond to post-nuclear nasals in the Japanese input. Since these nasals are also moraic, as mentioned earlier, the appearance of [bV] after them is unsurprising (3-39c). Finally, in the output in (3-38e), [bV] shadows each vowel from the two-vowel sequence in the second syllable of the input. If vowels in a sequence are associated with one mora apiece, as in (3-39b), the appearance of [bV] after each of those vowels is also simply explained.

(3-39) **Post-mora [bV] insertion**

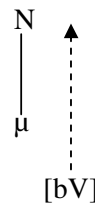
a. *After (C)V*



b. *After each V of VV_*



c. *After post-nuclear nasal*



The hypothesis that [bV] is placed after every moraic melody also holds good in the case Babuebo outputs generated from Japanese words containing long vowels. Even though (3-40c) is the expected output for the input in (3-40a) under the above hypothesis in Hisagi’s view (m.s), the view probably fails to factor in an important difference between long vowels and vowel sequences. Once this difference is taken into account, it would be easy to see in purely moraic terms why the input in (3-40a) yields (3-40b) rather than (3-40c).

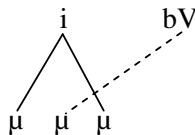
(3-40) **[bV] and inputs with long vowels**

- a. Input: o_μo_μki_μi_μ (Gloss: ‘big’)
- b. Output: o_μ.bo.ki_μ.bi
- c. Expected output: o_μ.bo.o_μ.bo.ki_μ.bi.i_μ.bi

While melodic sequences comprising two vowels and long vowels are both bimoraic in Japanese, there is a difference between them: in the former case, two moras are associated

with two separate vowel melodies, but in the latter two moras are associated with a single vowel melody. This difference entails that [bV] can be inserted after the first mora and after the second mora pertaining to a two-vowel sequence (3-39b), but not after the first of two moras associated with a single vowel melody. Placing [bV] after the first mora associated with a vowel melody such as [i] would mean that the association line between the vowel in [bV] and its own mora would cross the association line between [i] and its second mora, as seen below. Crossing of association lines is, however, avoided in phonology because it leads to ordering paradoxes.

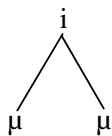
(3-41) **[bV] insertion into a long vowel**



In (3-41), for example, the melody [i] precedes V, while the second mora associated with [i] follows the mora associated with V. The result is temporally incongruous because [i] melodically precedes V, but ‘moraically’ (precedes and) follows V. One way to place [bV] adjacent to a bimoraic vowel, but without creating crossed association lines, is to place it after both the moras associated with that vowel. That would, however, mean: /o_μo_μ.ki_μi_μ/ → *[o_μo_μ.bo.ki_μi_μ.bi]. The alternative is to shorten the vowel so that it becomes monomoraic. Post-shortening, [bV] can be placed after the monomoraic vowel as seen in (3-42c), which is like (3-39a).

(3-42) **Vowel shortening and [bV] insertion**

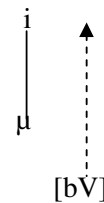
a. *Input vowel*



b. *Vowel shortening*



c. *[bV] insertion*



That the latter alternative is chosen in Babuebo is evidenced by: /o_μo_μ.ki_μi_μ/ → ([o_μ.ki_μ]) → [o_μ.bo.ki_μ.bi]. The hypothesis that [bV] is inserted after every moraic melody thus accounts for Babuebo outputs generated from inputs with long vowels (3-42) as well as

those with short vowels, vowel sequences or post-nuclear nasal consonants (3-39). It can now be tested against cases where the input has a geminate, as in (3-43).

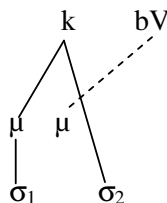
(3-43) **[bV] and inputs with geminates**

- a. Input: $ga_{\mu}k_{\mu}.ki_{\mu}$ (Gloss: ‘instrument’)
- b. Output: $ga_{\mu}.ba.k_{\mu}.ki_{\mu}.bi$
- c. Expected output: $ga_{\mu}.ba.k_{\mu}.b\dot{i}.ki_{\mu}.bi$
- d. Possible output: $ga_{\mu}k_{\mu}.ba.ki_{\mu}.bi$

If [bV] is indeed placed after every moraic melody, (3-43c) is expected as the output for the input in (3-43a). Since post-nuclear nasals in the input, which are moraic, are immediately followed by [bV] in the output (3-38c, d), one also expects the moraic part of a geminate in the input to be immediately followed by [bV] in the output. In the correct output (3-43b), however, the affix does not immediately follow the first, moraic part of the geminate; but occurs after the syllable containing the second, non-moraic part of the geminate. The reason for this is geminate integrity (Hayes 1986).

Note how in both the unattested outputs (3-43c, d), a token of [bV] intervenes between moraic [k] and non-moraic [k]. In representational terms, this means that the association line between the affixal V and its mora crosses the rightward association line linking [k] to σ_2 (below), effectively splitting the moraic part of the geminate from its non-moraic counterpart. Such splitting (3-44) violates geminate integrity, leads to an ordering paradox such as seen in (3-41) and is avoided. (For fleshed-out MCI representations of moraic geminates, see §4.1).

(3-44) **No [bV] insertion into geminates**



Geminate integrity can be (vacuously) satisfied by degeminating [k]. The lack of degemination is therefore surprising in Babuebo. It is even more surprising because degemination is akin to vowel shortening, which ‘feeds’ [bV] insertion in (3-42). The only way to satisfy geminate integrity (non-vacuously) then is to keep the two parts of a geminate

adjacent. This adjacency, however, hinges on [bV] not occurring immediately after the moraic part of a geminate, as apparent from the correct output [ga_μ.ba.k_μ.ki_μ.bi]. Between inserting a [bV] after every moraic melody and preserving geminate integrity, the latter receives priority in Babuebo.²⁶ When geminate integrity is not at stake, however, moraic melodies are immediately followed by a token of [bV] (see (3-39) and (3-42)).

In conclusion, if language games offer a window into the phonological rules/constraints characterising the mental grammars of language users, it is not a stretch to assume that they also offer tests of entities which play a part in those grammars. In the present case, Babuebo has supplied reasonably strong evidence to suggest that the mora is a linguistically real entity in the minds of speakers of Japanese. In so doing, the language game has vested the Moraic Dimension in MCI with a little psycholinguistic reality.

3.5 Chapter Summary

This chapter has shown that the mora is a metrically relevant unit of time and that it associates with segmental melodies without referring to their associations in the Constituency Dimension. The Moraic Dimension is thus independent of the Constituency Dimension in MCI.

The first part (§3.1) of the chapter showed that compensatory lengthening receives a simple and insightful explanation given moras. When a moraic melody is lost from a syllable, for example, the metrical duration of the syllable is reduced. To compensate for the reduction, a non-moraic melody in the syllable becomes moraic (as in Malaysian Cantonese). More commonly, another moraic melody in the syllable also associates with the mora vacated by the lost melody and becomes bimoraic (as in Latin).

In the second part of the chapter, post-nuclear consonants were seen to be moraic in languages where they influence stress. In still other languages, post-nuclear consonants were shown to influence stress depending on their word-internal context (e.g. Chugach) or intrinsic sonority (e.g. Kwakwala). Whether or not a consonant is associated with a mora, therefore, depends on more than just its syllable-internal position (§3.2) in some languages. For that reason, a constituency-based analysis of the metrical relevance of post-nuclear consonants was seen to be a non-starter in these languages.

²⁶ This type of priority interaction is easily modelled in Optimality Theory (Prince & Smolensky 1993/2004). To handle the present case, a faithfulness constraint demanding the preservation of input association lines between (consonantal) melodies and (Japanese) syllables in the (Babuebo) output would have to outrank an alignment constraint that requires the left edge of every token of [bV] to be aligned with the right edge of a mora.

In §3.3, constraints on the prosodic size of syllables and words in Tamil, English, Chungli and Adhilabad Gondi were argued to be better stated in terms of mora count than segment count or constituent-branching. Finally, in §3.4, the affix [bV] was shown to be placed only after input melodies which are moraic in the language game called Babuebo. The moraic environment of the game-affix is, however, unsurprising since the game ‘belongs’ to Japanese, the prototypical mora-timed language.

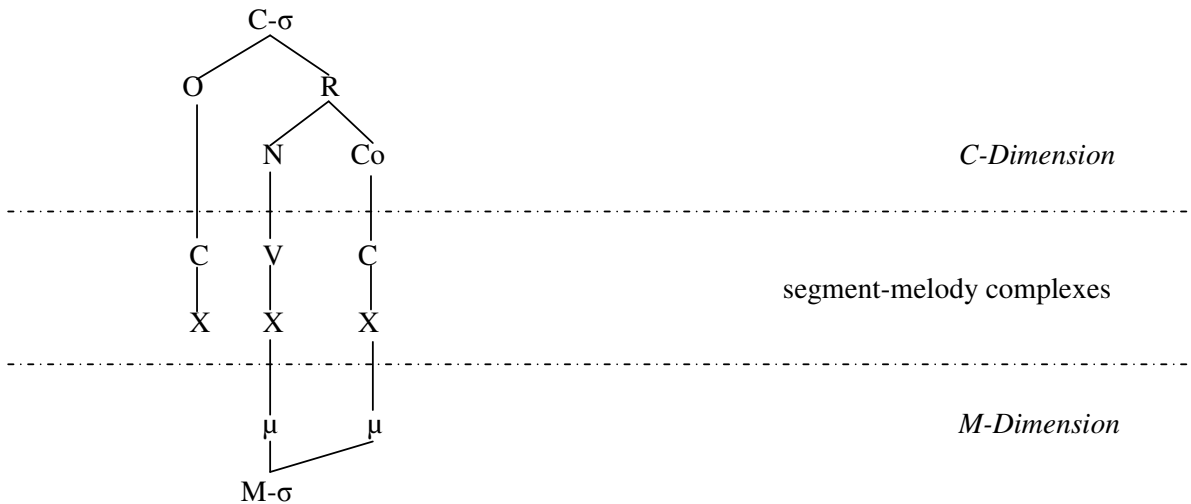
CHAPTER 4

Some Typological Implications of MCI

In chapters 2 and 3, the Constituency Dimension and the Moraic Dimension (hereafter C- and M-Dimension)¹ were shown to be independently necessary. Starting from where the earlier chapters left, this chapter examines some of the typological implications of having both those dimensions in MCI.

As a first approximation, a CVC syllable is represented in MCI as in (4-1). It may be noted that consonantal and vowel melodies are directly associated with constituents (contra Levin 1985), but associated with moras through segmental X-slots in MCI. Also, segments and melodies are treated together as complexes (see §1.5) below, and segment-melody complexes are placed outside both the C-Dimension and M-Dimension. This arrangement is just for expository convenience, however, and will be revised in the next chapter (see §5.1).

(4-1) **Mora-Constituent Interface Model (MCI)**



The current chapter is divided into three main sections. In §4.1, the length of (consonantal) melodies is shown to be encoded by the number of X-slots they are linked to, and is assumed to be read off in the C-Dimension (see also §5.1.3.2). Metrically relevant melodic length on the other hand is reflected as moras in the M-Dimension.

¹ C refers to ‘constituency’ as well as the melodic ‘content’ grouped in terms of constituents (see §5.1.1). M stands for ‘moraic’ and more generally ‘metrical’ (§5.1.2).

In §4.2, the deletion, retention and shortening of root melodies in post-reduplication outputs in Kwakwala are explained as joint effects of constraints operating over the M-Dimension and the C-Dimension. This section also shows that phonological processes can modify the material in one dimension without also modifying the material in the other dimension, citing *shm*-reduplication in English as a probable example of such a process. The final part of the section clarifies that moraification of pre-nuclear consonants, as happens in Bella Coola, is entirely predictable in MCI given its two dimensions.

In §4.3, two types of one-dimensional syllables (syllables without an M-Dimension and those without a C-Dimension) are seen to be possible in MCI, to go with two types of one-dimensional segmental melodies (those syllabified either in the C-Dimension alone or in the M-Dimension alone). All these four logical possibilities are empirically borne out.

The chapter is summarised in §4.4.

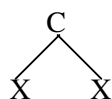
4.1 Geminates and Long Consonants in MCI

While the observation that length distinguishes geminate consonants from singleton consonants is uncontroversial, there is considerable disagreement on how this length distinction must be encoded. The winds of disagreement blow from at least two directions (cf. Tranel 1991). From the (auto)segmental direction, Selkirk (1990), Kim (2002) and Muller (2002) argue that singleton consonants are associated with one X-slot each and geminates are associated with two (4-2a). From the moraic direction, Hayes (1989), Bermudez-Otero (2001) and Davis (2003) contend that geminates, like vowels, are necessarily associated with a mora, whereas singleton consonants are not (4-2b):

(4-2) **Geminates and singleton consonants**

a. *Segmental distinction*

i. Geminate



ii. Singleton



b. *Moraic distinction*

i. Geminate



ii. Singleton



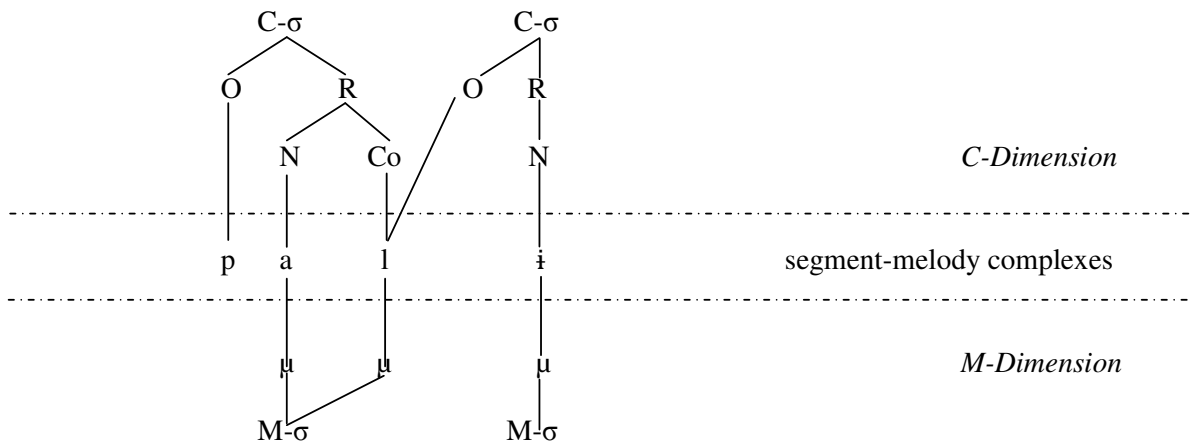
The cross-linguistic evidence discussed in §4.1.1 and §4.1.2 acts as a clear intermediary on the issue of geminate representation. The evidence indicates that geminates

can be moraic or non-moraic on the surface.² Non-moraic surface geminates at least must, therefore, be deemed bi-segmental as in (4-2a-i), because their long-ness cannot be captured otherwise. Analogously, non-moraic long consonants must be considered bi-segmental, as argued in §4.1.3 with respect to the trill [r] in Tamil. In essence, then, this section shows that X-slots encode melodic length in all languages, while moras mark that length in those languages where it is metrically relevant. In MCI, melodic length and metrically relevant melodic length are read off in the C-Dimension and the M-Dimension respectively.

4.1.1 Heterosyllabic geminates

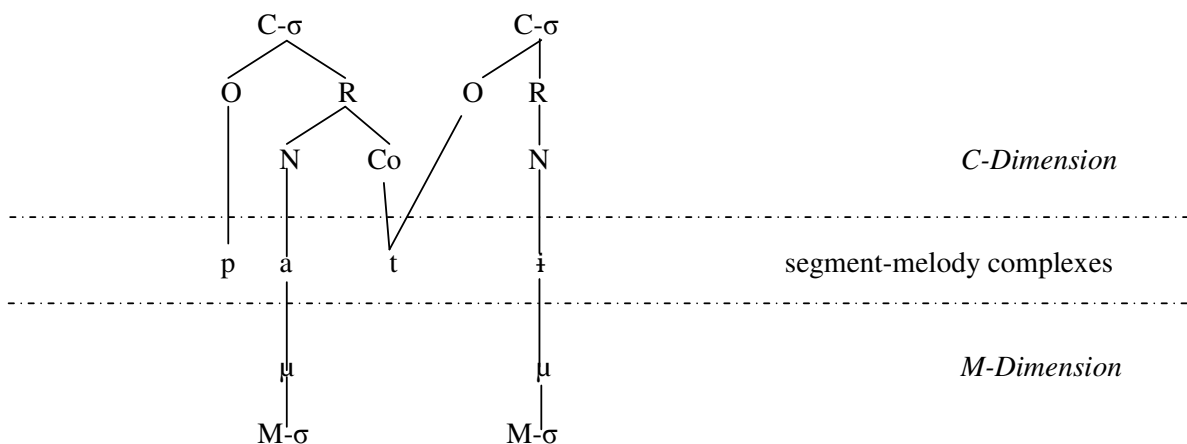
Tamil is an example of a language with heterosyllabic geminates, as seen in the last chapter. Sonorant geminates are moraic in the language, however, and obstruent geminates are not (see §3.3.5). This difference between obstruent and sonorant geminates is reflected in the MCI representations below where the Tamil disyllables [pal.li] ‘tooth’ and [pat.ti] ‘ten’ are evinced. Though geminates are explicitly treated just as melodies in these representations, they will be argued to be implicitly bi-segmental below.

(4-3) Moraic geminate (see also (4-27))



² Davis (2003) argues that geminates can be underlyingly moraic and still be non-moraic on the surface. This position is unfalsifiable, however, and is hence undesirable. Even if non-falsifiability is not a problem, associating a geminate with a mora in the input is akin to treating length as a melodic feature (Ulfsbjorninn 2014). The latter is essentially the approach to length advocated in SPE and is fraught with problems (see Odden 2011 for a comparison of the feature-based and autosegmental approaches to melodic length).

(4-4) **Non-moraic geminate** (see also (4-28))



In the foregoing representations, the associations of [l] and [t] with the Coda of the leftward syllable *and* the Onset of the rightward one show the heterosyllabic status of these consonants. Only the [l] is associated with a mora, however, reflecting the fact that sonorant geminates are moraic in Tamil and obstruent geminates are not. The mora associated with [l] in turn renders the leftward syllable in (4-3) bimoraic. This is in keeping with the fact that the post-nuclear position licenses moras in languages and the pre-nuclear position typically does not (but see §4.2.3). More specifically, [l] is post-nuclear in the leftward syllable in (4-3) and the mora associated with it has also been consequently associated with that leftward syllable in the representation.

Moving on, note that there is no segmental X-slot in the representations of either the moraic geminate (4-3) or the non-moraic geminate (4-4). However, as noted earlier in the section, non-moraic geminates at least must be associated with two segmental X-slots to encode the fact that they are long (Kim 2002, Muller 2002; cf. Selkirk 1990).³ Without such association, non-moraic heterosyllabic geminates would be indistinguishable from non-moraic ambisyllabic consonants.

In MCI, however, any melody associated with the Coda of one syllable and the Onset of another, as [l] and [t] are in (4-3) and (4-4), is implicitly bi-segmental. The reasoning is simple: if a constituent is allowed to contain one segment minimally, then associating a melody with two constituents is tantamount to associating it with two segmental X-slots. Heterosyllabic geminates, by virtue of their association with two constituents across syllables,

³ Two types of bi-segmental geminates are encountered in languages. The first type is common and simply involves one consonant associated with two X-slots. The second type, attested in Sanskrit, also involves a consonantal melody associated with two X-slots; one of these X-slots is also associated, however, with another melody (see Calabrese 2008 and Philip 2012).

are thus bi-segmental in MCI. An ambisyllabic consonant on the other hand is monosegmental (see (4-26) and note 12)).

The conclusion is that heterosyllabic geminates do not have to be expressly associated with two X-slots for them to be interpreted as bi-segmental entities. Tautosyllabic geminates on the other hand have to be so associated because they span only one constituent; either an Onset or a Coda. Representing them invariantly as moraic units would be erroneous because tautosyllabic geminates, like heterosyllabic ones, can be non-moraic, as in Leti, or moraic, as in Pattani Malay (also see note 2).

4.1.2 *Tautosyllabic geminates*

In Pattani Malay, default stress lodges on the final syllable (Topintzi 2006a; cf. Hajek & Goedemans 2003). This can be seen from the words in (4-5a). The initial syllable is stressed, however, in words beginning with a geminate (4-5b). Singleton consonants contrast with geminates only in word-initial position in the language.

(4-5) **Stress in Pattani Malay**

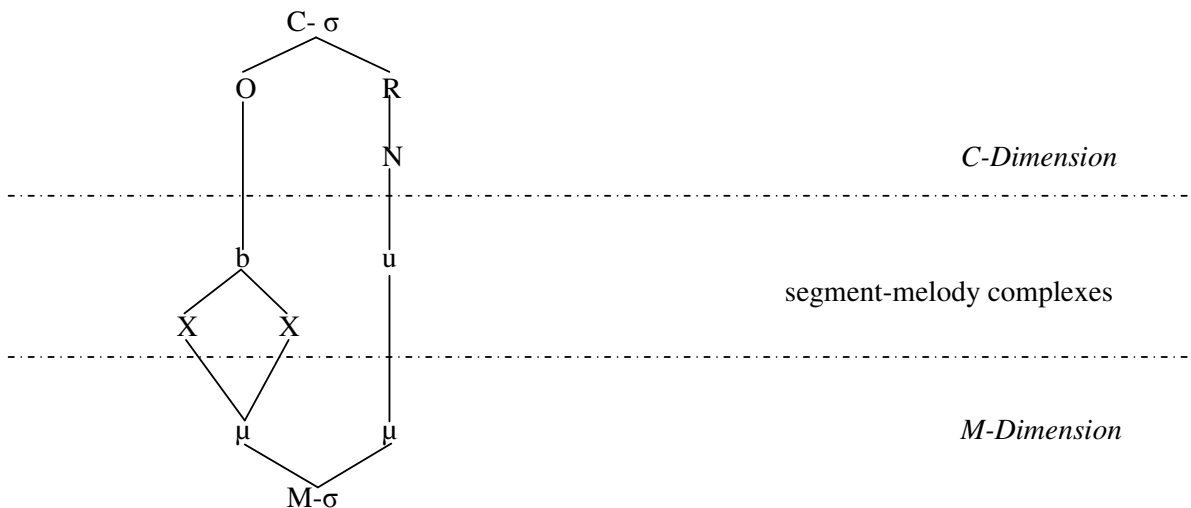
a.	<i>Words without a geminate</i>	b.	<i>Words containing a geminate</i>
i.	bu. ¹ wəh ‘fruit’	i.	¹ bbu.wəh ‘to bear fruit’
ii.	sɪ.da. ¹ du ‘police’	ii.	¹ dda.du ‘police’
iii.	ʃa. ¹ le ‘road, path’	iii.	¹ ʃʃa.le ‘to walk’
iv.	pɪ.ma. ¹ tə ‘jewellery’	iv.	¹ mma.tə ‘jewellery’

It is the presence of the geminate that attracts stress to the initial syllable in the disyllabic words in (4-5b). The attraction cannot be accounted for in terms of a ban on final stress because all the words in (4-5a) receive stress on the final syllable. Nor can it be explained as a ban on disyllabic iambs (i.e. [σσ]) because the disyllables (4-5a-i, iii) are stressed on the second syllable.

Post-nuclear consonants in Pattani Malay do not seem to influence stress assignment either. This is clear from the lack of stress on the closed second syllable in (4-5b-i), as opposed to the appearance of stress on the closed second syllable in (4-5a-i). If post-nuclear consonants were metrically relevant, the closed syllables in both cases would have received stress. Furthermore, the lack of vowel length contrasts in the language (Topintzi 2006a) entails that the CV(C) syllables it accommodates are monomoraic.

Final stress in Pattani Malay thus obtains when words have only monomoraic CV(C) syllables, as in (4-5a). Juxtaposed against this observation, the fact that words beginning with a geminate are stressed on the initial syllable (4-5b) suggests that the initial syllable in these words is bimoraic. For the initial syllable in question to be bimoraic, however, the geminate at its left has to be moraic. In MCI, a moraic word-initial geminate, such as the one beginning [bbu.wɔh] ‘to bear fruit’, receives the representation in (4-6). The [b] associated with the Onset is long as conveyed by its association with two X-slots. The two X-slots in turn report to a mora, signifying the treatment of bi-segmental [b] as a metrical unit in Pattani Malay.

(4-6) **Moraic Onset geminate** (Pattani Malay)⁴



If a tautosyllabic geminate is bi-segmental and moraic, as [b] is above, the familiar question returns: it concerns the possibility of representing a tautosyllabic geminate as a moraic entity or as a bi-segmental entity (but not as both). Word-initial geminates have already been seen to influence stress in Pattani Malay, so the mora associated with [b] must stay in (4-6). On the other hand (mono-segmental) singleton consonants are not moraic in the language, as evidenced by their lack of metrical influence. The upshot is that a consonant has to be bi-segmental for it to be moraic in Pattani Malay. Therefore, the two X-slots which make the [b] in (4-6) moraic cannot be expunged either.

Unlike the word-initial geminates in Pattani Malay just discussed, those in Leti, an Austronesian language spoken in the eponymous island off the coast of East Timor, are not even metrically relevant. They should therefore not be associated with a mora. The geminates must still be contrasted from the singleton consonants in the language; to which end X-slots

⁴ See also Baker (2009, cited in Davis 2011) for a treatment of geminates involving both X-slots and moras.

are once again necessary. (While word-initial geminates are the focus of the present discussion on Leti, the language also has word-medial geminates.)

Content words must be minimally bimoraic in Leti. Words of the shape [C_iC_iV] are absent, though, suggesting that word-initial geminates do not serve to satisfy the bimoraic minimum (Hume et al 1997). This means that word-initial geminates in Leti are non-moraic—a conclusion corroborated by the stress facts from the language. For starters, words made up of one morpheme always receive stress on the penultimate syllable in Leti, as seen below. The data in (4-7) and (4-8) have been taken from Hume et al (1997).

(4-7) **Stress on monomorphemic words in Leti**

'spou	'kind of boat'	pdu.'duk.lu	'bubbling'
'ppu.na	'nest'	tu.'vu.ri	'kind of shell'
'kun.si	'key'	mar.'si.na	'machine'
'lo.pu	'dolphin'	kar. 's ^y o.na	'pumpkin'
'ma:.nu	'bird'	po.'li:.sa	'police'

The penultimate syllable is also stressed in words having more than one morpheme. Additionally, these words receive stress on the initial syllable if the syllable contains a bimoraic i.e. long vowel (4-8a). A short-vowelled initial syllable remains without stress, however, even if it begins with a geminate (4-8b-iv, v, vi). In the dataset below, the bracketed forms on the right are morphological expansions of the words syllabified on the left.

(4-8) **Stress on words with more than one morpheme**

a. *Long-vowelled initial syllable stressed*

i.	'ma:.n ^w o. 'r ^y o.ri	'crow'	('ma:.nu + o.'r ^y o.ri	'bird' + 'buffalo')
ii.	'ro:.'ne.nu	'they eat turtle'	('ro:.na + 'e.nu	'eat' + 'turtle')
iii.	'ma:.'n ^w a:.na	'chick'	('ma:.nu + 'a:.na	'bird' + 'child')

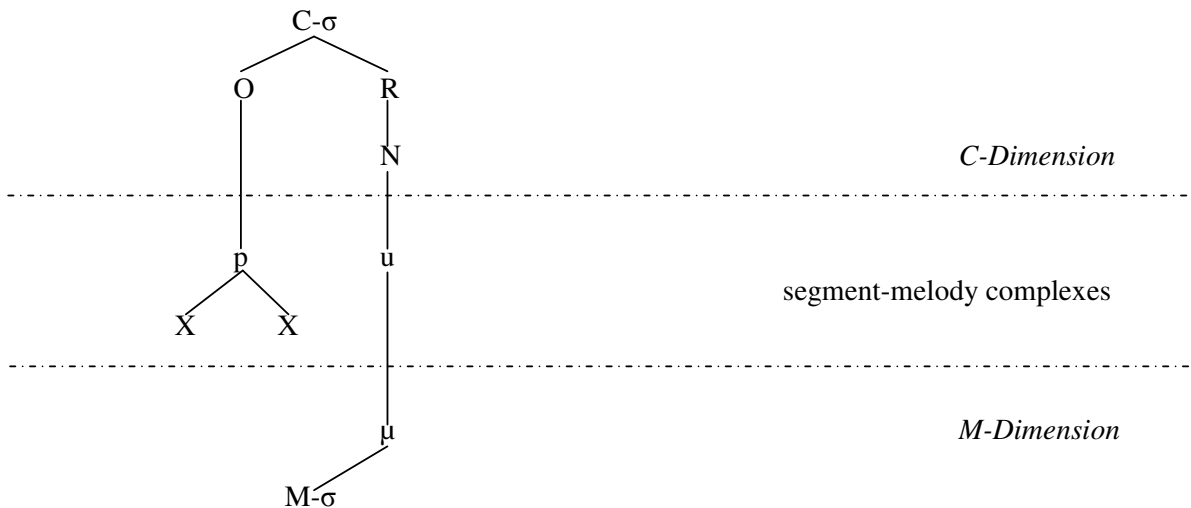
b. *Short-vowelled initial syllable not stressed*

i.	ri.'mɔ.ta	'kind of turtle'	('ri.a + 'mɔ.ta	'man + green')
ii.	pu.'p ^w e.ni	'dragonfly's chrysalis'	('pu.pu + 'we.ni	'fly' + 'place')
iii.	nval.'t ^y a.ni	'he digs'	('nva.li + 'ta.ni	'he turns' + 'dirt')
iv.	ppu.'nar.ta	'nest's edge'	('ppu.na + 'a.rat	'nest' + 'edge')

- v. nnɛ.ˈmʲa.sa ‘golden sign’ (ˈnnɛ.i + ˈma.sa ‘sign’ + gold’)
- vi. kkan.ˈtʲa.ni ‘earthenware’ (ˈkka.ni+ ˈta.ni ‘plate’ + dirt’)

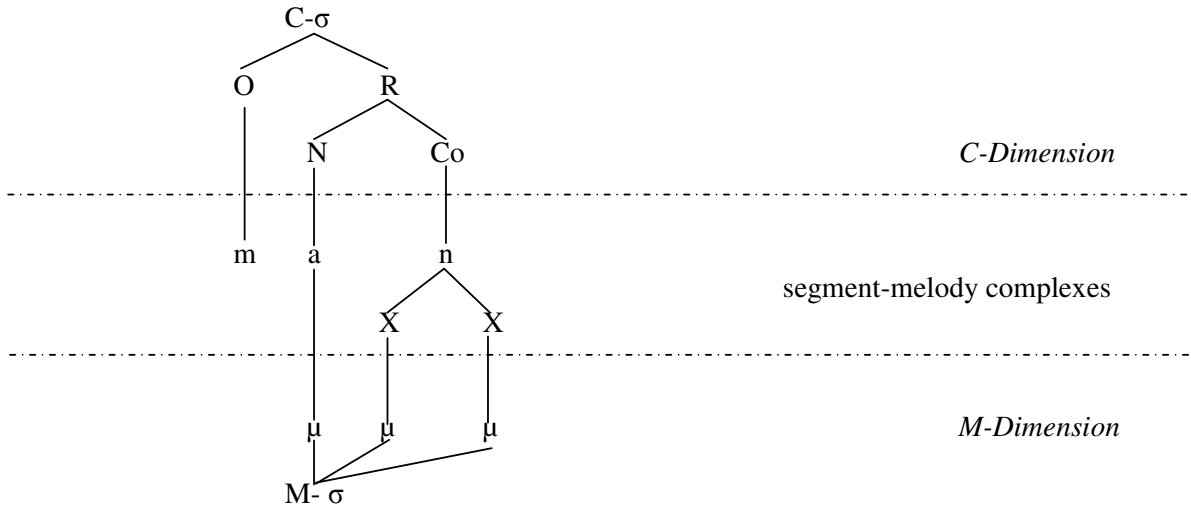
The fact that a short-vowelled initial syllable is not stressed even when it begins with a geminate suggests that the geminate does not contribute the second mora required by the initial syllable for it to receive stress. Word-initial geminates in Leti are thus non-moraic. This fact is reflected in (4-9) where the initial syllable of the word [ppu.nar.ta] ‘nest’s edge’ is represented in MCI:

(4-9) **Non-moraic Onset geminate (Leti)**



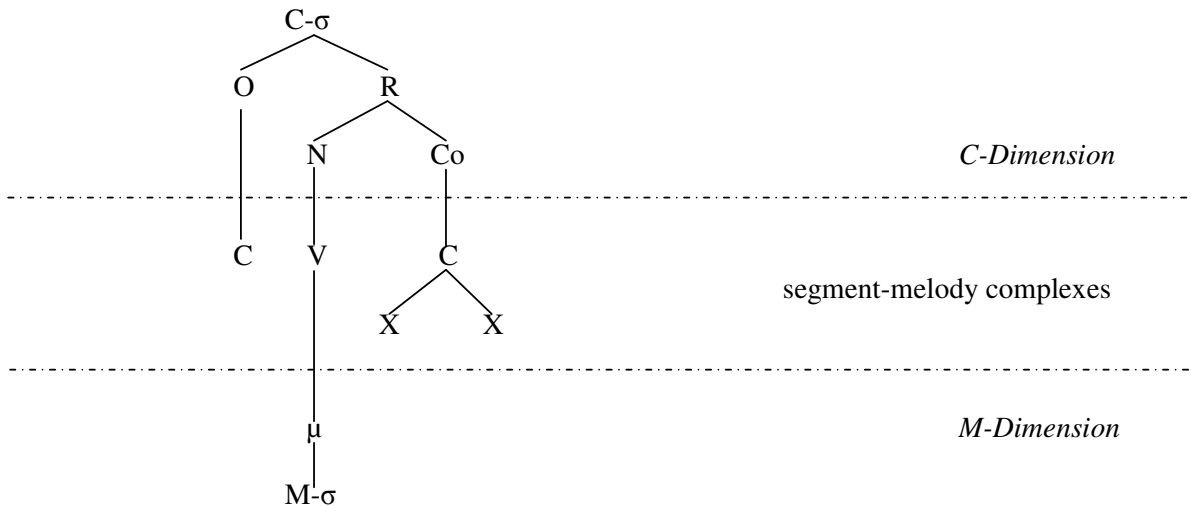
Other things remaining equal, the MCI representations of word-final geminates will differ from those of the word-initial geminates in (4-6) and (4-9) only in one way. Whereas the two X-slots spanned by a word-initial geminate are associated with the Onset of a syllable, those spanned by a word-final geminate will be associated with the Coda of a syllable. Moraic word-final geminates occur, for example, in Mandyali, and are bimoraic according to Kashav (2013: 99-100). Their bimoraicity is reflected in the MCI representation of the Mandyali word [mann] ‘mind’ below:

(4-10) **Moraic Coda geminate** (Mandyali)



While word-final geminates are (bi)moraic in Mandyali, they are non-moraic in Hungarian (Davis & Topintzi 2014), as evinced by the following representation:

(4-11) **Non-Moraic Coda geminate** (Hungarian)



Two takeaways are crucial from this rather lengthy discussion on geminates. The first is that the ‘long-ness’ of geminates is divorced from whether or not that long-ness is metrically relevant and needs to be encoded as such. The second is that within MCI, melodic length as encoded by X-slots is read off (via melodies) in the C-Dimension⁵ and metrically relevant length is marked (as moras) in the M-Dimension.

⁵ Though it is melodies which belong to the C-Dimension in MCI (see §5.1.1), the length of a melody, which is encoded by the number of X-slots it is associated with, should also be accessible to the C-Dimension. This is to

One clarification is necessary before curtains fall on this discussion of geminates. While word-edge geminates have been treated as tautosyllabic entities in the foregoing discussion, they may be treated as non-tautosyllabic entities too. The latter option has not been considered here only because it does not change the aforementioned insight that geminates are always bi-segmental and sometimes moraic. The same thing can be said about long consonants which are not geminates.

4.1.3 Long consonants

The Tamil trill [r] was earlier discussed in relation to the Coda (see §2.5.3). That discussion showed that the [r] in Tamil is associated with two X-slots i.e. it is a long consonant. The issue of whether [r] is moraic is taken up here. In this connection, one may recall the proposal that sonorant geminates alone are moraic among consonants in Tamil (see §3.3.5).

The proposal was seen to explain the absence of (derived and non-derived) sonorant geminates after long vowels in the language. With sonorant geminates being moraic, any syllable that has a long vowel followed by a sonorant geminate would be trimoraic: e.g. *[ve:μμlμ.li] (vs. [ve:.li] ‘fence’). In disallowing sonorant geminates after long vowels, Tamil effectively clamps down on trimoraic syllables, which are not metrically desirable anyway (see (3-21)). Melodic sequences comprising a long vowel followed by a singleton sonorant abound, however, suggesting that such sequences do not render a syllable trimoraic. The upshot is that sonorant consonants, which are not geminated, are non-moraic in Tamil:

(4-12) Non-geminated sonorants in Tamil (see also (3-37b))

a.	ke:ɭ.vi	‘question’	(*CV:μμlμ.lV)
b.	so:r.vi	‘tiredness’	(*CV:μμrμ.rV)
c.	ma:ŋ.bi	‘respect’	(*CV:μμŋμ.ŋV)
d.	to:l.vi	‘defeat’	(*CVμμlμ.lV)
e.	ga:n.dam	‘magnet’	(*CV:μμnμ.nV)
f.	sa:m.bal	‘ashes’	(*CV:μμmμ.mV)

The question now is whether bi-segmental [r] is moraic like the geminated sonorants in Tamil, or non-moraic like the non-geminated ones. Words such as [me:r.ki] ‘west’ and

ensure that the amount of melodic material associated with any constituent is in keeping with any segmental constraints defined over it (see also §2.5 and §5.1.3.2).

[na:r.pa.d̪i] ‘forty’, where a long vowel is followed by [r], support the latter hypothesis. If the [r] in these words were moraic, the long-vowelled syllables of which it is a part would be trimoraic: e.g. [me:_μr̪.k̪i]. Given that trimoraic syllables never occur in Tamil, however, (see the bracketed forms in (4-12)), it seems unlikely that syllables consisting of a [V:r] sequence would be trimoraic; which they will be if [r] is moraic. The emergent conclusion is that the Tamil [r] is non-moraic: [r] can hence follow a long vowel without threatening to make a syllable trimoraic: e.g. [me:_μr̪.k̪i]. This conclusion is, however, tentative at best because tautosyllabic instances of a long vowel followed by [r] are rare in Tamil.

Though tentative, the conclusion that the Tamil trill is long but non-moraic lends further credence to the claim that melodic length and metrically relevant melodic length, though related, are not the same. In MCI, the former is encoded by X-slots and read off in the C-Dimension and the latter is marked as moras in the M-Dimension. The next section moves away from the treatment of consonant length in MCI, and looks at some important implications of the model.

4.2 Other Implications

Envisioning moras and constituents as objects on independent dimensions predicts the independent occurrence of mora-based constraints and constituency-based constraints in languages (§1.5). In Kwakwala, both types of constraints are shown to be jointly responsible for the shortening, deletion and retention of root melodies observed in post-reduplication outputs (§4.2.1).

The empirically evidenced independence of the two dimensions in MCI also predicts phonological processes which modify material in one dimension, but leave the material in the other dimension untouched. A probable example of such a process is English *Shm*-reduplication, which is briefly discussed in §4.2.2. The autonomy of the two dimensions in MCI implies, too, that the association of segment-melody complexes with moras should not depend on their association with specific constituents (and vice versa). Simply put, any segment-melody complex in a syllable has the potential to be moraic under MCI. This potential is realised in Bella Coola where (non-geminated) pre-nuclear consonants become moraic in monosyllables to satisfy a minimal word requirement (§4.2.3).

4.2.1 Moraic and Rhyme-based constraints in Kwakwala

Consider the reduplication data below from Kwakwala where ‘O’ stands for any obstruent and ‘S’ for any sonorant (see also §3.2.2):

(4-13) Reduplication in Kwakwala (Zec 1995: 104)

a. *CV:O roots*

qa:s	qa:-qas-m’ut	‘tracks’
ts’a:s	ts’a:-ts’əs-m’ut	‘old eel-grass’

b. *CVS roots*

səl	səl-sə-m’ut	‘what is left after drilling’
məl	məl-mə-dzo	‘white on surface’

c. *CVSO roots*

qəns	qən-qas-m’ut	‘chips’
xəlt	xəl-xat-m’ut	‘sawdust’
yənt	yən-yat-m’ut	‘gnawing of a large animal’

The following are the generalisations accruing from the data in (4-13).

When the root ends in a long vowel followed by an obstruent (V:O), as in (4-13a), the long vowel is retained and the obstruent disappears in the initial syllable of the form with the suffix. In the pen-initial syllable, however, the obstruent emerges but the vowel is shortened.

If the root ends with a short vowel followed by a post-vowel sonorant (VS), as in (4-13b), the vowel and the sonorant are both retained in the initial syllable of the form with the suffix. In the second syllable, however, the sonorant is deleted.

When the root has a short vowel followed by a sonorant-plus-obstruent cluster (VSO), as in (4-13c), the vowel and the sonorant are retained in the initial syllable of the form with the suffix, as in (4-13b). The sonorant is deleted in the second syllable, where the short vowel is followed by the obstruent, as in (4-13a).

In Chapter 3, these three generalisations were (partly) explained by two moraic templates: a bimoraic template for the initial syllable⁶ (of post-reduplication outputs) and a monomoraic template for the second syllable. Long vowels and VS sequences are both

⁶ The bimoraic template is somewhat weakened by the absence of CVO roots in Kwakwala. Such roots, if present, are expected to yield forms of the shape [CV:_{μμ}]-CVO-suffix under the assumption that the initial syllable of post-reduplication forms is mapped to a bimoraic template.

bimoraic in Kwakwala, as evidenced by the stress patterns in the language (§3.2.2), and are retained in the initial syllable (4-13a, b) to satisfy the bimoraic template. Long vowels are shortened and post-nuclear sonorants are shed in the second syllable to satisfy the monomoraic template.

Post-nuclear obstruents, however, are expected to surface in both the initial and pen-initial syllables because they are non-moraic in Kwakwala and cannot encumber the satisfaction of any moraic template. The fact that post-nuclear obstruents appear only in the second syllable of post-reduplication outputs (4-13a, c) is hence surprising. This could mean that the moraic templates proposed earlier are erroneous. More promisingly (for MCI), it hints at a segmental constraint targeting the Rhyme in addition to the two moraic templates.⁷

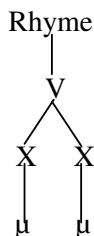
It is a maximality constraint and requires the Rhyme in Kwakwala to allow no more than two segments (i.e. X-slots) of melodic material. The constraint is corroborated by the fact that (non-final) syllables in Kwakwala do not have tri-segmental sequences involving a long vowel followed by a consonant (V:C) or a short vowel followed by two consonants (VCC).⁸ Syllables do have long vowels (V:) and VC sequences, however, because they are bi-segmental and can therefore be accommodated within the Rhyme.

The representations in (4-14) show how the bi-segmental ceiling on the Rhyme joins the two moraic templates mentioned earlier to account for the surface fate of root vowels and post-vowel consonants in post-reduplication outputs in Kwakwala:

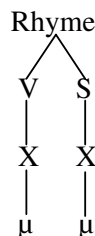
(4-14) **Vowel/consonant distribution in Kwakwala**

a. *Initial syllable*

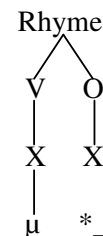
i. Attested (4-13a)



ii. Attested (4-13b)



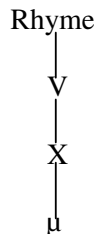
iii. Unattested



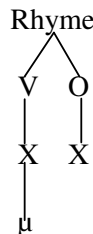
⁷ Cheung (2008) argues that “rhymes” in Singapore English are mapped to both moraic and X-slot templates.
⁸ VCC sequences like [els] do occur at the right-edge of words in Kwakwala: e.g. [ˈdzam.bə.təls] ‘to bury in a hole’. The word-final consonant in such sequences may be thought of as reporting to the Prosodic Word, however; in which case the Rhyme accommodates only VC, respecting bi-segmental maximality (see also note 9).

b. *Pen-initial syllable*

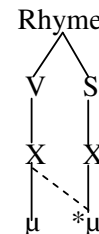
i. Attested (4-13b)



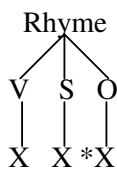
ii. Attested (4-13a, c)



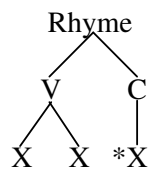
iii. Unattested



c. i. Unattested



ii. Unattested⁹



[where C = obstruent or sonorant]

It is clear that the absence of VSO and V:C sequences in post-reduplication outputs follows from the bi-segmental restriction targeting the Rhyme in Kwakwala (4-14c). The absence of long vowels and post-nuclear sonorants in the pen-initial syllable (4-14b-iii) is owing to the monomoraic template to which the second syllable is mapped. The retention of long vowels and post-vowel sonorants in the initial syllable (4-14a-i, ii) is due to the bimoraic template to which the first syllable is mapped. Finally, the absence of obstruents after short vowels in the initial syllable (4-14a-iii) has to do with the fact that they cannot, being non-moraic, contribute the second mora required to make the syllable conform to the bimoraic template. Obstruents surface after a short vowel in the second (4-14b-ii) syllable, however, because VO sequences do not contravene the monomoraic template to which the second syllable is mapped or the bi-segmental ceiling on the Rhyme.

An examiner points out the Kwakwala reduplication patterns can be captured following McCarthy's The Emergence of the Unmarked (TETU), without appealing to a two-dimensional syllable as in MCI. If the reduplicant is considered to be an infix of the shape CV, the facts follow. As will be seen shortly, however, a TETU-oriented analysis itself is not free from making reference to two syllable dimensions, exactly as the MCI analysis does.

First and foremost, the site of CV-insertion cannot be determined without appealing to moras (i.e. the Moraic Dimension). Assuming that CV is an infix, it is inserted in (4-13b, c) after a CVS sequence (e.g. [məl-mə-dzo], [yən-yat-m'ut]), and in (4-13a) after a CV:

⁹ Kwakwala bans not just tri-segmental 'rhymes', but also trimoraic syllables (Kirchner 2009).

sequence (e.g. [qa:-qas-mut]). What is common to CVS and CV:, of course, is that they are bimoraic units. The CV-infix, therefore, must be stated as being inserted after the second mora of the root syllable.

Secondly, independent of where the infix is placed, none of the syllables in the reduplication data in (4-13) above have syllables of the shape CV:C or CVCC. The absence of syllables of these shapes in the reduplication data is merely a reflection of their (non-final) absence in the language. The absence is simply explained, as seen above, by assuming that the Rhyme in Kwakwala accommodates no more than two segments of melodic material.

In conclusion, two different types of constraints are at work in Kwakwala, with the bi-segmental maximum restricting the association of melodies with the Rhyme, and the moraic templates serving to restrict metrically relevant melodic material. The sighting of both constituency-based and mora-based constraints in a single language is, however, only par for the course in MCI where the C-Dimension is independent of the M-Dimension and vice versa. This independence predicts, inter alia, phonological processes which alter material in one dimension, without altering material on the other. The process in English which yields echo words like *table* ~ *shamble* is arguably one such, and is briefly discussed in §4.2.2.

4.2.2 Two-dimensional ‘echoes-shmechoes’

There is a well-known process of echo word formation in English exemplified by words like *bagel* ~ *shmagel*, *table* ~ *shmable* and *momentum* ~ *shomentum*. In the mentioned words, *shm* replaces in the echo word a word-initial singleton consonant from the English input. Informants, however, show varied judgment in the placement of *shm*, when the English input begins with a consonant cluster. Even here, as the data below attest, replacement of all the consonants in the initial syllable of the English input by *shm* is the preferred option, albeit only slightly. The data and statistics presented in this section are from Nevins & Vaux (2003):

(4-15) Complex initial onsets

	<u>Input</u>	<u>Echo form I</u>	<u>Echo form II</u>	<u>No output</u>
a.	[bru:m]	[ʃmu:m] (37%)	[ʃmru:m] (30%)	33%
	<i>broom</i>	<i>shmoom</i>	<i>shmroom</i>	
b.	[breikfəst]	[ʃmeikfəst] (87%)	[ʃmreikfəst] (10%)	3%
	<i>breakfast</i>	<i>shmeakfast</i>	<i>shmreakfast</i>	
c.	[stri:t]	[ʃmi:t] (71%)	[ʃmri:t] (4%)	22%
	<i>street</i>	<i>shmeet</i>	<i>shmreet</i>	

d.	[flɒs]	[ʃmɒs] (88%)	[ʃmlɒs] (16%)	11%
	<i>floss</i>	<i>shmoss</i>	<i>shmloss</i>	

Note that the English inputs in (4-15) as well as those given in-text earlier have a stressed vowel in the initial syllable. When the stressed vowel is non-initial, *shm* may still be prefixed to the word-initial vowel, as above, or to the stressed vowel, obliterating the consonants before it. As the following data bear out, informants still favour the replacement by *shm* of consonants before the initial vowel rather than the stressed vowel (except in (4-16a)), although they prefer ‘no output’ over both in a couple of cases.

(4-16) Non-initial stress

	<u>Input</u>	<u>Echo form I</u>	<u>Echo form II</u>	<u>No output</u>
a.	kənʃju:dʒən <i>confusion</i>	[ʃmənʃju:dʒən] (13%) <i>shmonfusion</i>	[kənʃmjɜ:dʒən] (44%) <i>(con)shmusion</i>	42%
b.	əbsi:n <i>obscene</i>	[ʃməbsi:n] (33%) <i>shmobsceine</i>	[əbʃmi:n] (31%) <i>(ob)shmene</i>	40%
c.	məsɑ:ʒ <i>massage</i>	[ʃməsɑ:ʒ] (36%) <i>shmassage</i>	[məʃmɑ:ʒ] (11%) <i>(ma)shmage</i>	48%
d.	təriʃɪk <i>terrific</i>	[ʃməriʃɪk] (67%) <i>shmerrific</i>	[tə(r)ʃmɪʃɪk] (5%) <i>tershmific</i>	26%
e.	ɑ:(r)keɪd <i>arcade</i>	[ʃmɑ:(r)keɪd] (87%) <i>shmarcade</i>	[(ɑ:r)ʃmeɪd] (3%) <i>(ar)shmade</i>	9%

The overall preference shown by informants to replace word-initial consonants (from the English input) by *shm* (in the echo) hints at a preference for the entire Onset of the initial syllable (from the English input) to be ‘overwritten’ by *shm* (in the echo). Even without this preference, the fact that there are informants who replace all pre-nuclear consonants in the initial syllable by *shm* indicates that for these informants the echo-affix overwrites a constituent, namely the (initial) Onset—a part of the C-Dimension. In contrast, the vowels which precede the consonant(s) replaced by the echo-affix (or other vowels) are never altered in the *shm*-form. This suggests that all material in the M-Dimension – the preserve of melodic length (see §5.1.2) – is copied intact when forms like ‘*echoes-shmechoes*’ are created. The

upshot is that *shm*-reduplication, as Nevins & Vaux (2003) term it, involves modifications in the C-Dimension and an invariant M-Dimension, vis-à-vis its English input.¹⁰

Moving on, the final part of this section presents evidence (discussed by Topintzi 2004) suggesting that pre-nuclear consonants are also moraic in Bella Coola, albeit only ‘under duress’. The evidence lends credence to the MCI-internal hypothesis that a segmental melody does not have to be associated anywhere specific in the C-Dimension (say Rhyme) for it to be associated with a mora. In doing so, it provides empirical reinforcement to the MCI layout, where constituents and moras are arrayed on two independent dimensions.

4.2.3 *Moraic pre-nuclear consonants in Bella Coola*

Non-geminated pre-nuclear consonants have been shown to influence stress in a few languages including Arrernte (Davis 1989, Gordon 2002) and Pirahã (Everett & Everett 1983, Everett 1988). Topintzi (2004), for example, argues for voiceless pre-nuclear consonants to be moraic in Pirahã because they affect stress assignment in the language. In Arrernte, pre-nuclear consonants in general are claimed to be moraic on the basis of the fact that stress falls on the word-initial syllable only when it begins with a consonant. While the influence that pre-nuclear consonants exert on stress assignment in Arrernte and Pirahã is, therefore, clear, the influence can be analysed as a function of the presence (and degree) of the rise in sonority towards a syllable peak (Srinivas 2012). Such purely sonority-based analyses preclude the need to make pre-nuclear consonants moraic in Arrernte and Pirahã.

Pre-nuclear consonants must be deemed moraic, however, to distinguish minimally occurring words from non-occurring ones in Bella Coola (Topintzi 2008; cf. Bagemihl 1991). Monosyllables in the language come in one of three basic shapes, namely MP, PM and M (where M stands for margin and P for peak). They do not come in the shape P, however.

(4-17) **Monosyllables in Bella Coola**

- | | | | |
|----|---------------------------------------|----|-----------------------|
| a. | PP: [ia] ‘good’ | c. | PM: [ɲʌ] ‘dark night’ |
| b. | MP: [ʃi] ‘fast’, [cm̩] ‘index finger’ | d. | *P |

The presence of MP words usually implies the presence of P words in languages. This, though, is not the case in Bella Coola where MP words are attested but P words are not. Assuming that words in Bella Coola are minimally bi-segmental can explain the presence of

¹⁰ In other words, *shm*-reduplication involves reduplication of material in the M-Dimension and overwriting of material in the C-Dimension.

MP words and the absence of P words.¹¹ The assumption is flawed, however, because minimality and maximality restrictions in languages are almost always defined in terms of mora count rather than segment count (see §3.3). Reduplication templates in Bella Coola are also defined in terms of moras, providing strong context to Topintzi's (2008) contention that the minimal word in the language is defined in moraic terms.

Topintzi (2008) proposes that Bella Coola has a bimoraic minimal word. PP and PM monosyllables straightforwardly meet the bimoraic minimum (cf. [P_μP_μ], [P_μM_μ]). To explain the occurrence of MP monosyllables, Topintzi assumes that pre-nuclear (i.e. pre-peak) material is also moraic in Bella Coola monosyllables. This assumption makes monosyllables of the shape MP bimoraic and minimally well-formed (cf. [M_μP_μ]). Those of the shape P are monomoraic, however, and are consequently ruled out (cf. [P_μ]).

Indeed, the assignment of moras to pre-nuclear consonants in order to make them a part of the minimal word seems ad-hoc at first glance. It finds support, however, from languages like Ao (Temsunungsang 2009) and Mizo (Vijayakrishnan p.c) where post-nuclear consonants are given moras only in monosyllables. Moraic pre-nuclear consonants must therefore be tolerated in Bella Coola at least until an alternative is found that correctly distinguishes minimally occurring monosyllables from non-occurring ones in the language.

The latter conclusion is important from the MCI standpoint because it shows that a segmental melody need not be associated with the Rhyme in the C-Dimension for it to be moraic. The association of a segment-melody complex in the M-Dimension is thus not parasitic on its association in the C-Dimension. Nor is the association of a segment-melody complex in the C-Dimension parasitic on its association in M-Dimension, as seen from the association of non-moraic pre-nuclear consonants with the Onset in the C-Dimension (see §2.4.1).

The fact that segment-melody complexes are independently associated in the C-Dimension and the M-Dimension, however, makes it logically possible for them to be associated in the one or the other dimension, but not necessarily both. By extension, it is possible for syllables themselves to have just the one or the other dimension. All these logical possibilities are seen to be empirically borne out in the next section.

¹¹ One could argue that Bella Coola requires its words to begin with a consonantal rather than a vocalic element so as to ensure that word-beginnings are clearly marked. If this were the case, however, words such as [ia] with two vocalic elements should not occur in the language either.

4.3 One-Dimensional Objects in MCI

Extrametrical consonants are shown to have a limb in the C-Dimension but not the M-Dimension in §4.3.1. It is hard to imagine a segment-melody complex having a limb in the M-Dimension and none in the C-Dimension, but pre-schwa consonants in Dutch provide a case in point (§4.3.2). In §4.3.3, extrametrical syllables are shown to have only the C-Dimension in MCI. Catalectic syllables, the logical opposite of extrametrical syllables, are shown to have only the M-Dimension in §4.3.4.

4.3.1 Consonants in the C-Dimension

According to Rosenthal & van der Hulst (1999), extrametrical consonants are consonants which are non-moraic on account of their word-internal context, and stand in direct contrast to consonants which are moraic because of the same reason (see §3.2.1). A consonant in absolute word-final position is extrametrical, for example, in Palestinian Arabic, and will be argued to be associated with the C-Dimension but not the M-Dimension in MCI.

In Palestinian Arabic, stress is oriented towards the right edge of words (Rosenthal & van der Hulst 1999, Brame 1974). Stress falls on the antepenultimate syllable if the penult is a monomoraic short-vowelled open syllable (CV) as in (4-18a). If the penult is long-vowelled (CV:) as in (4-18b-iii) or closed (CVC) as in (4-18b-i, ii), it is stressed.

(4-18) Non-final stress in Palestinian Arabic

a. Stress on antepenult

	<u>Syllabification</u>	<u>Feet</u>	<u>Gloss</u>
i.	'za.la.me	(^l za _μ .la _μ).me	'man'
ii.	'da.ra.bo	(^l da _μ .ra _μ).bo	'he hit him'
iii.	'ba.ka.ra	(^l ba _μ .ka _μ).ra	'cow'

b. Stress on bimoraic penult

	<u>Syllabification</u>	<u>Feet</u>	<u>Gloss</u>
i.	da.'rab.na	da.(^l ra _μ b _μ).na	'he hit us'
ii.	ka.'tab.na	ka.(^l ta _μ b _μ).na	'we wrote'
iii.	'ba:.rak	(ba: _{μμ}).rak	'he blessed'

The fact that CVC penults are stressed (4-18b-i, ii) indicates that VC sequences are bimoraic in Palestinian Arabic just like long vowels are. Independent stress on bimoraic penults (4-18b) also indicates that bimoraic syllables are footed on their own in the language; suggesting that foot-building in Palestinian Arabic is sensitive to a syllable's mora count (Rosenthal & van der Hulst: 519). Palestinian Arabic also accommodates feet made up of two monomoraic syllables, however, such as those seen in (4-18a), where a monomoraic penult and a monomoraic antepenult are footed together. The antepenultimate syllable receives stress in these cases, indicating that the leftward syllable is the head of a disyllabic foot in Palestinian Arabic. In other words, the language has trochaic feet.

Moving on from non-final syllables, a final syllable of the shape CV cannot be footed on its own and stressed in Palestinian Arabic because it is monomoraic. Nor is a CV ultima footed with a CV penult, as evident from the lack of stress on CV penults: e.g. *[za_μ(^lla_μ.me_μ)]. Word-final CVC/CV: syllables are not footed alone either. If they were, stress should fall on the final syllable in the words below, rather than on the penult:

(4-19) **Stress-less final syllables**

	<i>Syllabification</i>	<i>Feet</i>	<i>Gloss</i>
a.	'fi.him	(fi _μ)him	'he understood'
b.	'mak.tab	(ma _μ k _μ)tab	'office'
c.	'ba:.rak	(ba: _{μμ})rak	'he blessed'

According to Rosenthal & Van der Hulst (1999), the right edge of a foot must not coincide with the right edge of a word in Palestinian Arabic. Feet, in other words, must be non-final in the language. While this requirement explains the lack of stress on the word-final CVC/CV: syllables in (4-19), it does not explain why word-final CVCC (4-20a-d) and CV:C (4-20e) syllables are stressed in Palestinian Arabic. Why then are CVCC and CV:C ultimas stressed while those of the shape CVC are not?

(4-20) **Stressed final syllables**

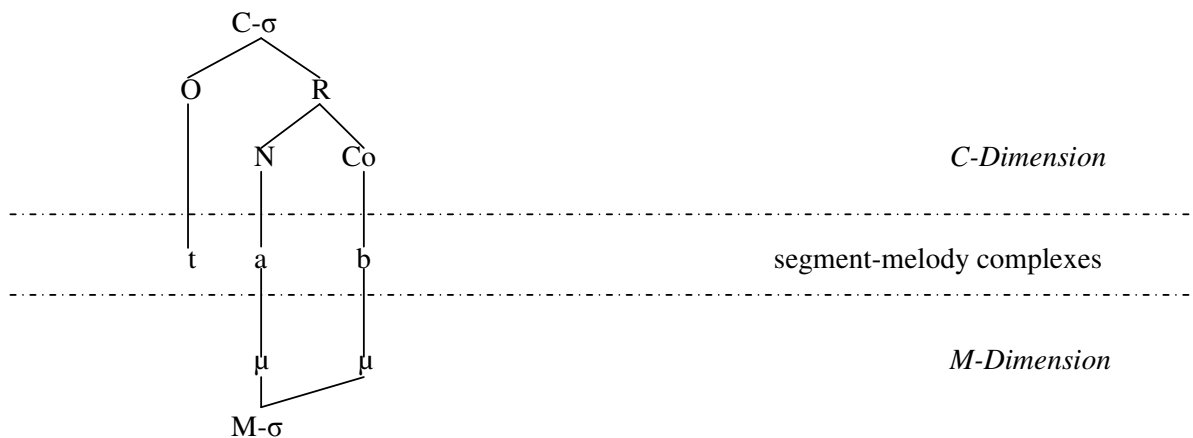
a.	ka. ^l tabt	'wrote-1.SG'
b.	xar. ^l maft	'scratched'
c.	ba:. ^l rakt	'gave blessing-3.FEM.SG'
d.	da. ^l rast	'studied-1.SG'

e. ba.'na:t 'girls'

Rosenthal & van der Hulst's (1999: 521) answer to the question is twofold. They argue that a word-final consonant is extrametrical (i.e. non-moraic) in Palestinian Arabic. A non-moraic word-final consonant makes a word-final CVC syllable monomoraic; wherefore CVC ultimas are not independently footed and stressed. The story is different for word-final syllables of the shape CVCC and CV:C. These syllables are bimoraic even if the word-final consonant is non-moraic as evident from $[CV_{\mu}C_{\mu}C]_{\sigma}$ and $[CV:_{\mu\mu}C]_{\sigma}$. They are, therefore, stressed (4-20), just like the bimoraic penults in (4-18b).

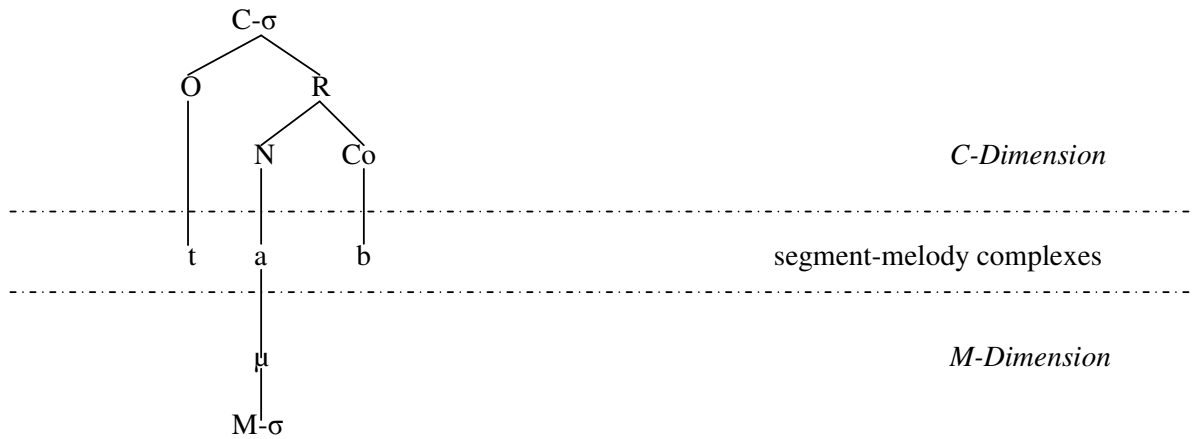
If a word-final consonant is non-moraic in Palestinian Arabic, all CVC syllables save word-final ones are bimoraic in the language. This makes final and non-final CVC syllables both similar and different in MCI. They are similar in the C-Dimension where, ceteris paribus, the post-vowel consonant in all CVC syllables is associated with the Coda. They are different in the M-Dimension where the post-vowel consonant in a final CVC syllable is not associated with a mora. The difference and similarity can be seen from the following representations of non-final $[tab]_{\sigma}$ in $[ka.tab.na]$ 'we wrote' (4-21) and final $[tab]_{\sigma}$ in $[mak.tab]$ 'office' (4-22).

(4-21) **Non-final $[tab]_{\sigma}$ in Palestinian Arabic**



While X-slots have been omitted in (4-22) and the representations to follow in this section, the consonants and vowels represented must be seen as complexes involving a melodic component and a segmental component (see §4.1.2 and §5.1).

(4-22) **Final [tab]_σ in Palestinian Arabic**



A consonant that concurs with the right-edge of words is thus associated with the Coda (4-22) in Palestinian Arabic, just as post-nuclear consonants elsewhere are. It is not associated with a mora, however, unlike them. In terms of the physiological metaphor used earlier in the section, the non-final [b] in (4-21) has one limb apiece in the C-Dimension and the M-Dimension, while the word-final [b] in (4-22) has a limb only in the C-Dimension.

If segmental melodies can be associated with one dimension or another in MCI (but not necessarily both), it is predicted that different segmental melodies can be ‘final’ in a C-σ and its corresponding M-σ. While processes which speak to the point are hard to come by, I can think of a constraint which may bear it out. Consider in this connection word-final stop clusters in English, which always consist of a non-coronal (labial or velar) stop followed by a coronal stop, as evidenced by the following verbs and unsuffixed adjectives, for which only primary stress is transcribed:

(4-23) **Final stop clusters in English**

- | | | | |
|------|---|------|---|
| a. | <i>velar-coronal sequences</i> | b. | <i>labial-coronal sequences</i> |
| i. | ri. ¹ træ[kt] <i>retract</i> | i. | 'æ[pt] <i>apt</i> |
| ii. | kəm. ¹ pæ[kt] <i>compact</i> | ii. | ɪ. ¹ nɛ[pt] <i>inept</i> |
| iii. | nɪg. ¹ lɛ[kt] <i>neglect</i> | iii. | ə. ¹ dæ[pt] <i>adapt</i> |
| iv. | rɪ. ¹ fræ[kt] <i>refract</i> | iv. | ə. ¹ dɛ[pt] <i>adept</i> |
| v. | sɪ. ¹ lɛ[kt] <i>select</i> | v. | kə. ¹ rʌ[pt] <i>corrupt</i> |
| vi. | ɪn.tə. ¹ sɛ[kt] <i>intersect</i> | vi. | ɪn.tə. ¹ sɛ[pt] <i>intercept</i> |

The final – coronal – stop [t] in each of the words listed above is non-moraic in that it is extrametrical. The extrametrical status of the final consonant above is evident from the fact that stress is non-final in verbs and unsuffixed adjectives which end in a short-vowelled syllable closed by a single consonant (Hayes 1982): e.g. [əs.'tɒ.nɪʃ] *astonish*, [dɪ.'vɛ.ləp] *develop*, [ɛŋ.'kʌ.rɪdʒ] *encourage*; [ɪ.'ɪl.sɪt] *illicit*, [kɒ.'mən] *common* [tə.'rɪ.fɪk] *terrific*. With the word-final consonant in the listed words being non-moraic, their final syllable is monomoraic and, therefore, remains stressless. In the words in (4-23), however, the ultima is bimoraic, even when extrametrical [t] is discounted, owing to the consonant preceding [t] and the short vowel before it. It can, therefore, host a foot on its own and is stressed.

Now, because the word-final [t] in the words in (4-23) is extrametrical i.e. non-moraic, it cannot be the final segment in the M-Dimension of the final syllable of those words. For example, with [t] being non-moraic, [p] is the final segment in the M-Dimension of the (monosyllable and) final syllable [æpt]. On the other hand, [t] is the final melody in the C-Dimension of the final syllable [æpt], where it satisfies a constraint which requires the second stop of word-final stop clusters to be coronal.

Rhyming provides a simpler illustration of the point that different segmental melodies can be final in the two dimensions of the same syllable. The words *inept* and *adept* rhyme, for example, even though the final [t] is metrically irrelevant on account of being non-moraic. This suggests that [t] is the last melody in the Rhyme and C-σ of the final syllable of *inept* as well as *adept*. The labial stop [p], however, is the last segment in the final M-σ of the same pair of words.

In summary, this subsection has shown, using the example of extrametrical consonants, that segmental melodies can be associated only with the C-Dimension in MCI. The next part of this section shows that they can also be associated only with the M-Dimension. Pre-schwa consonants in Dutch illustrate this point, after a fashion.

4.3.2 Consonants in the M-Dimension

Examples of segment-melody complexes associated only with the M-Dimension of a syllable seem non-existent for starters (see §4.3.4 for a related argument concerning catalectic syllables). However, metrically relevant ambisyllabic consonants may be interpreted as being associated only with the M-Dimension of one syllable and only with the C-Dimension of another in MCI. Such an interpretation is supported by pre-schwa consonants in Dutch.

In Dutch, words having a penultimate syllable of the shape CV come in two prosodic flavours (Kager 1990): some of these words are stressed on the penultimate syllable (4-24a), and the others are stressed on the antepenult (4-24b).

(4-24) **Dutch stress on non-final CV syllables**

a.	<i>Penult stress</i>		b.	<i>Antepenult stress</i>	
i.	spi.'na.zi	'spinach'	i.	'a.li.bi	'alibi'
ii.	ma.'rɔ.ko	'Morocco'	ii.	'mi.ka.do	'mikado'
iii.	a.'ro.ma	'aroma'	iii.	'a.na.nɔs	'pineapple'

The following words also have a CV penult. Unlike the words in (4-24), however, those in (4-25) all have penult stress. The only obvious difference between the two sets of words is that the latter have a schwa in the final syllable and the former have a non-schwa vowels.

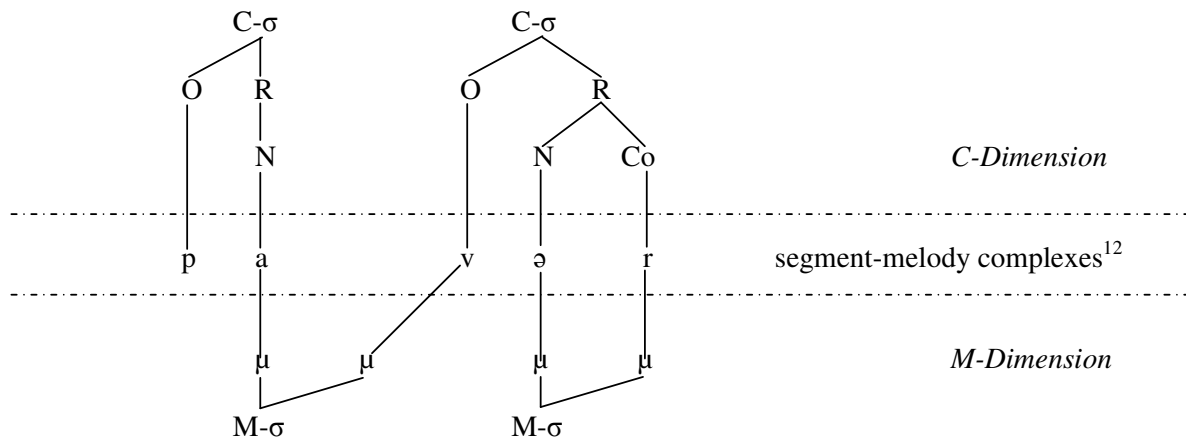
(4-25) **Pre-schwa penult stress**

ka.'li.bər	'calibre'	fy.'ro.rə	'furore'	pa.'pa.vər	'poppy'
------------	-----------	-----------	----------	------------	---------

Kager (1990) points out that the pre-schwa consonants in the words in (4-25) are, on the surface, part of the final syllable headed by schwa. This view is reportedly supported by native speaker intuitions. However, he also postulates an abstract level of syllabification where the pre-schwa consonant is argued to close a CV penult. The upshot is that pre-schwa CV penults are abstractly CVC and bimoraic—for which reason they are stressed. However, in words where the final syllable is not headed by a schwa, a CV penult is presumably monomoraic at all levels of syllabification. Whether such words are stressed on the penultimate syllable (4-24a) or the antepenult (4-24b), therefore, has to be lexically specified.

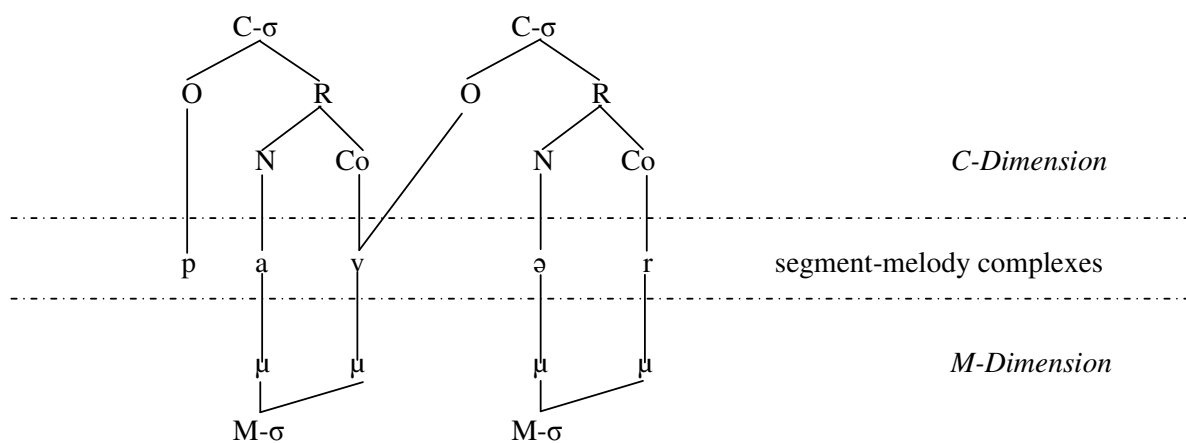
The crux of Kager's (1990) analysis is that a consonant which immediately precedes schwa is ambisyllabic in Dutch. Melodically, the consonant coheres with the schwa, as affirmed by native speaker judgments. Metrically, it behaves as part of the syllable preceding schwa. Pre-schwa consonants in Dutch are thus schizophrenic, and the schizophrenia can be effectively captured in MCI. In (4-26), the pre-schwa [v] in [pa.'pa.vər] 'poppy' is associated with the Onset of the C-σ containing schwa. It is also (simultaneously) associated with a mora, which reports to the M-σ to the left of schwa. Put simply, the ambisyllabic [v] in Dutch is bi-syllabic across dimensions in MCI (and so, arguably, is a non-syllabic consonant that precedes a syllabic consonant in English—see Chapter 2, note 3):

(4-26) **Metrically relevant ambisyllabic consonant**



The leftward association of [v] in (4-26) shows that a segment-melody complex may have a limb only in the M-Dimension of a syllable. Its rightward association shows, adding to the evidence in §4.3.1, that a melody may be associated only with the C-Dimension of a syllable. If [v] were a heterosyllabic moraic geminate rather than an ambisyllabic (singleton) consonant, it would be associated with the C-Dimension of two syllables and the M-Dimension of one, as seen in (4-27).

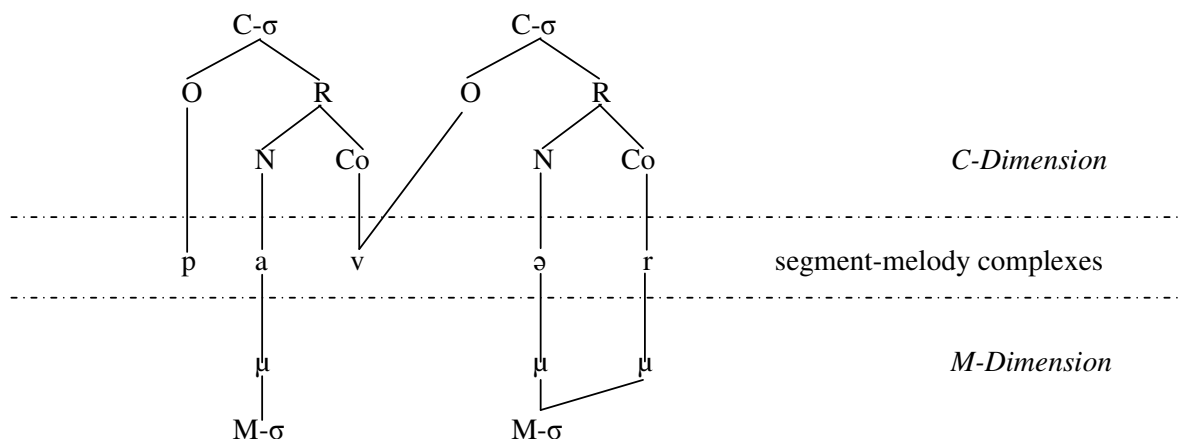
(4-27) **Heterosyllabic moraic geminate** (see also (4-3))



If [v] were a heterosyllabic non-moraic geminate, it would be associated with the C-Dimension of two syllables and the M-Dimension of none as seen in (4-28):

¹² The ambisyllabic [v] must be linked to an X-slot, not shown in the representation in (4-26). Assuming the presence of the X-slot, that representation may be understood in the following way: as a melody, [v] is associated with the C-σ headed by schwa; the X-slot linked to [v] would, however, be associated with a mora (see §5.1.2) that reports to the M-σ to the left of schwa.

(4-28) **Heterosyllabic non-moraic geminate** (see also (4-4))



This subsection has shown so far that segment-melody complexes need not always be associated with the C-Dimension as well as the M-Dimension of syllables. The remainder of this section will show that syllables themselves may have just the C-Dimension (§4.3.3) or just the M-Dimension (§4.3.4). The upshot is that MCI can also countenance one-dimensional syllables just like the OR Model and the μ -Model do.

4.3.3 Syllables sans M-Dimension

In §4.3.1, extrametrical consonants were argued to be associated only with the C-Dimension, but not the M-Dimension, of the relevant syllables in MCI. This argument can be extended beyond extrametrical consonants, however, with the consequence that extrametrical syllables have only the C-Dimension in MCI. Word-final syllables in Hopi are extrametrical, and will be shown to lack an M-Dimension below.

In Hopi, stress falls on the initial syllable of words if it is bimoraic (Hayes 1982: 230-1). Both CV: and CVC syllables must be bimoraic in the language given that initial syllables of either shape receive stress (4-29a, b).

(4-29) **Initial stress in Hopi**

a. #CV: stressed

i. 'ta:.vo 'cottontail' Foot structure: [(^lta:_μ)vo]

ii. 'pa:.wik.^ja 'duck' Foot structure: [(^lpa:_μ)wik.^ja]

b. #CVC stressed

i. 'ʔac.ve.wa 'chair' Foot structure: [(^lʔa_μc_μ)ve.wa]

- ii. 'les.ta.vi 'roof beam' *Foot structure:* [(^lle_μs_μ).ta.vi]

When the initial syllable is CV and monomoraic, however, the pen-initial syllable is stressed, as in the words below:

(4-30) **Pen-initial stress**

- a. qo.'to.som.pi 'headband' *Foot structure:* [(qo_μ.'to_μ)som.pi]
 b. me.'lo:ni 'melon' *Foot structure:* [(me_μ.'lo:μ_μ)ni]

It is clear from (4-30) that stress in Hopi is underpinned by a single iambic foot built at the left-edge of words. When a word begins with a monomoraic syllable followed by a bimoraic syllable (4-30b), the two syllables are footed together. The result is a canonical iamb [$\sigma_{\mu}\sigma_{\mu\mu}$], with stress on the rightward foot-internal syllable (Prince 1990, Hayes 1995: 80-1; cf. Kager 1993). When a word begins with two monomoraic syllables (4-30a), the two syllables are also footed together since feet are required to be bimoraic in the language. Stress is once again realised on the rightward syllable in the foot (i.e. second syllable in the word), reinforcing the point that Hopi has iambic feet.

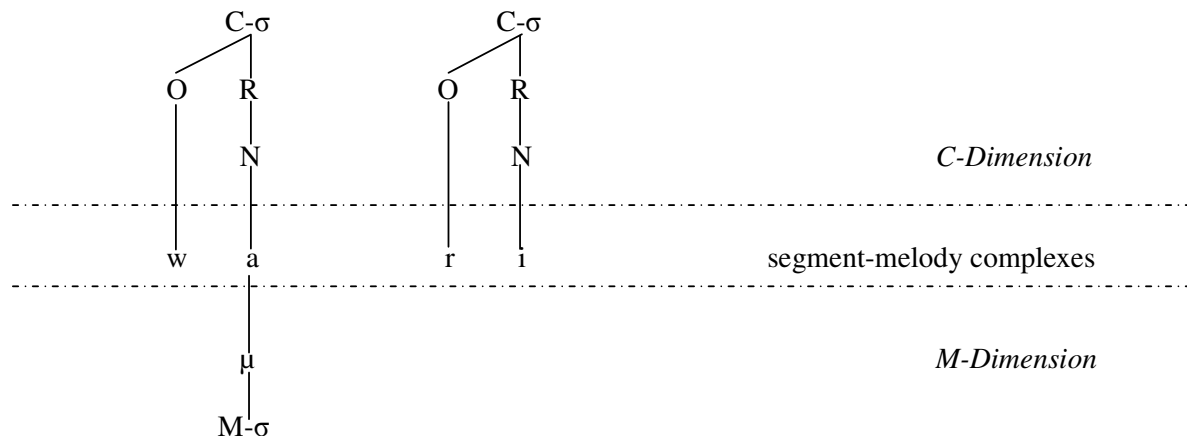
Since a word beginning with two monomoraic syllables receives stress on the pen-initial syllable (4-30a), one would expect disyllabic words made up of two monomoraic syllables to be stressed on the pen-initial syllable, too. It is the initial syllable that carries stress in such cases, however, as seen below:

(4-31) **Initial stress in disyllables**

- 'ko.ho 'wood' 'wa.ri 'to run' 'la.ho 'bucket'

The lack of stress on the final syllable of the words in (4-31) (and of those in (4-29) and (4-30)) indicates that the word-final syllable is extrametrical in Hopi. Extrametrical syllables may be viewed as syllables having only the C-Dimension, especially given that extrametrical consonants are associated only with the C-Dimension of syllables in MCI (see §4.3.1). In the following representation, the initial syllable of the Hopi word [wa.ri] 'to run' has both the C-Dimension and the M-Dimension. The extrametrical final syllable [ri]_σ on the other hand has only the C-Dimension.

(4-32) **Moraic and non-moraic syllables in Hopi**

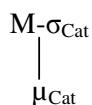


If syllables may have the C-Dimension without having an M-Dimension, the logical question is whether they may have the M-Dimension without having a C-Dimension. The question is answered in the affirmative by catalectic syllables in §4.3.4.

4.3.4 *Syllables sans C-Dimension*

Catalexis was proposed by Kiparsky (1991) as the logical opposite of extrametricality (Kager 1995). Extrametrical syllables, as seen earlier, have melodic content but are metrically irrelevant. Catalectic syllables on the other hand are metrically relevant but have no melodic content. The upshot is that a catalectic syllable is a (mono)moraic syllable¹³ without a C-Dimension in MCI. This can be seen in (4-33).

(4-33) **Catalectic syllable in MCI**



Besides depicting catalectic syllables as syllables having the M-Dimension but not a C-Dimension, MCI reveals why these syllables necessarily lack melodic content. Suppose the singleton consonants [t], [m] and [f] are allowed as words in some language. If these consonants are not regarded as ‘syllables’, nothing more needs to be said.¹⁴ The alternative is to view them as mono-melodic syllables. However, implicit in the latter view is the

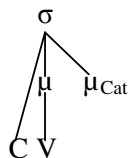
¹³ A catalectic syllable makes an apparently monosyllabic word/foot disyllabic (Vijayakrishnan 2007) and a catalectic mora makes an apparently monomoraic word/foot bimoraic.

¹⁴ Topintzi (2008) indicates that Bella Coola, for example, has words made up entirely of unsyllabified consonants.

assumption that the consonants in question are associated with the Nucleus of the syllables they constitute. If a syllable with any melodic content at all has a Nucleus, it will also logically have the C-Dimension of which the Nucleus is a part. The upshot is that only syllables without melodic content can be catalectic¹⁵ and may have the M-Dimension without also having a C-Dimension.

With the necessary lack of melodic content in catalectic syllables now established, comments can be made about the representation in (4-33), where a catalectic mora is associated with a catalectic syllable. This, according to Kager (1995), would be syllable-and-mora-catalexis and is empirically indistinguishable from simple mora-catalexis where a catalectic mora is associated with a non-catalectic syllable (i.e. a syllable with melodic content) as in (4-34). Syllable-and-mora catalexis and mora-catalexis cannot be empirically distinguished from one another because both options serve to turn a monomoraic word/foot into a bimoraic word/foot. All the same, the MCI representation displaying syllable-and-mora catalexis (4-33) is schematically superior to the representation displaying mora-catalexis (4-34), as will be seen shortly.

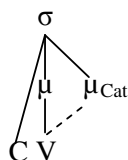
(4-34) **Mora-catalexis**



Hungarian and Cahuilla are two languages for which Kager (1995) postulates mora-catalexis. Since both languages possess vowel length contrasts, the lengthening of an underlying short vowel would not violate Structure Preservation (Kiparsky 1982, 1985; Borowsky 1989) in either language. If the V in (4-34) were to spread to the catalectic mora in a language like Hungarian or Cahuilla, however, the resultant bimoraic V would make its syllable really, rather than virtually, bimoraic as seen in (4-35). Simply put, providing melodic content to a catalectic mora erases all evidence of mora-catalexis, creating a paradox (see note 13). While one could obviously preclude the paradox by proscribing melodies from associating with a catalectic mora, such proscription would merely be a stipulation.

¹⁵ This constitutes a narrow view of catalectic syllables. From time to time, syllables with an empty Nucleus and a filled Onset/Coda are also referred to as catalectic syllables.

(4-35) **Vowel lengthening to μ_{Cat}**

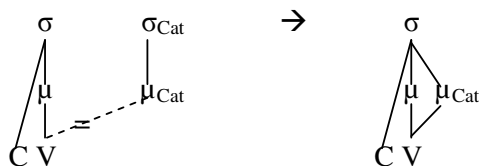


No stipulation is necessary, however, if a catalectic mora always resides in a catalectic syllable, as in (4-33). A moraic vowel in a non-catalectic syllable cannot associate with a mora in a catalectic syllable because a single melody cannot be the sonority peak of two syllables. If such associations were permitted, the catalectic syllable and non-catalectic syllable would effectively fuse to become one syllable. This can be seen from (4-36b), which is identical to (4-35), where all evidence of mora-catalexis has been obliterated.

(4-36) **Peak-triggered syllable fusion**

a. *Pre-fusion*

b. *Post-fusion = (4-35)*



The interim conclusion of this subsection is that it is better to capture even simple mora-catalexis by having the catalectic mora report to a catalectic syllable, as in the MCI representation in (4-33), rather than to a non-catalectic syllable, as in (4-34). The context is now perfect to demonstrate the effectiveness of catalectic syllables as a metrical tool (see note 13). Consider, for example, the following nouns from the Chungli dialect of Ao:

(4-37) **Monosyllabic nouns in Chungli**

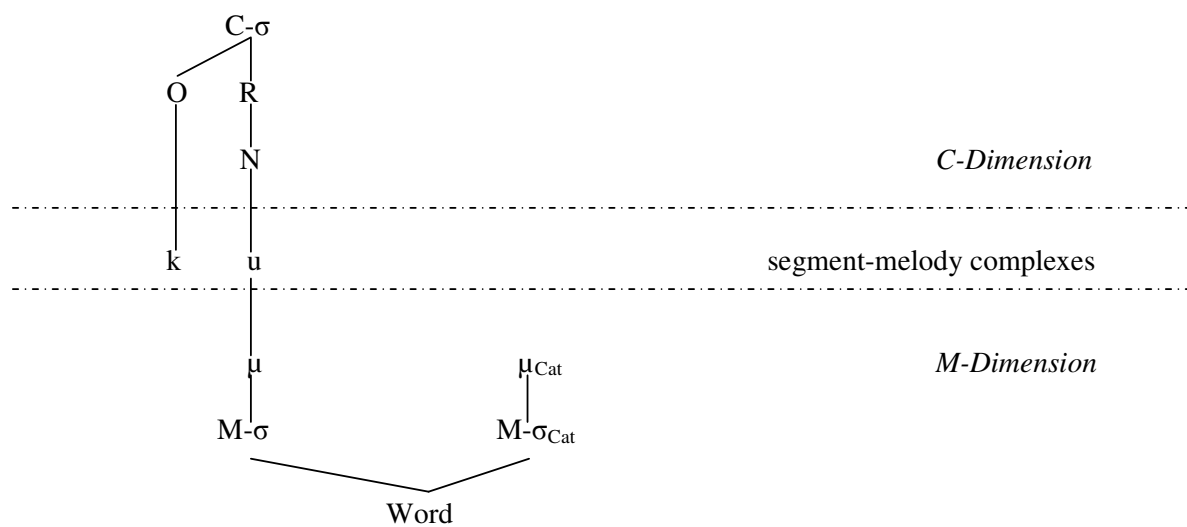
kú	‘hair’	i	‘wine’
mít	‘anger’	nùk	‘anger’

One may recall (from §3.3.2) that while verbs in Chungli are predominantly disyllabic, monosyllabic nouns such as those in (4-37) freely occur in the dialect. Given catalexis, however, even monosyllabic nouns can be reanalysed as having two syllables, of which the first has phonetic content and the second – the catalectic syllable – does not (see (4-38)).¹⁶

¹⁶ If moras directly associate with X-slots rather than melodies (see §5.1.2), a catalectic syllable must be assumed to have a melodically bare X-slot, this X-slot in turn associated with the catalectic mora.

The advantage of such a reanalysis is that under it nouns also become minimally disyllabic just like verbs in Chungli. Consequently, different phonological minima need not be stipulated for words belonging to different syntactic categories in the dialect.

(4-38) **Catalexis in Chungli**



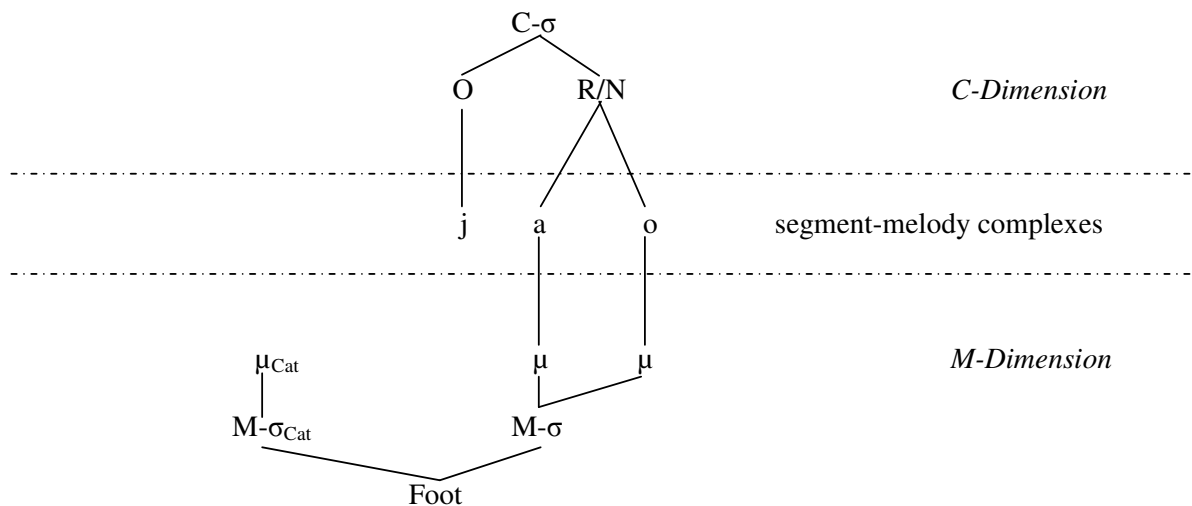
A second phonological system where catalexis may be useful is Paumari (discussed in greater detail in §5.2.2.1). In this language, stress falls on every odd-numbered syllable from the right edge of words, suggesting that adjacent pairs of syllables counted from right-to-left constitute disyllabic feet. This means that in words with an odd number of syllables the leftmost syllable has to either remain unfooted or be footed on its own. Since the word-initial syllable in odd-parity words – as well as monosyllables – receives stress in Paumari, the latter option appears to be the correct one. Brackets mark foot boundaries in the second column below:

(4-39) **Stress in Paumari**

	<i>Syllables</i>	<i>Feet</i>	<i>Gloss</i>
a.	vait.'xa.na.'va	(vait.'xa)(na.'va)	'little ones'
b.	'kai.hai.'hi	('kai)(hai.'hi)	'type of medicine'
c.	'jao.ho.'ra	('jao)(ho.'ra)	'cutia'
d.	'goa	('goa)	'knocking sound'
e.	'vao	('vao)	'gourd'

Monosyllabic feet such as evidenced at the left edge of the words in (4-39b-e) need not be countenanced, however, if a catalectic syllable is assumed to stand at the left edge of odd-parity words in Paumari. The catalectic syllable, together with the leftmost phonetic syllable, can form a disyllabic foot, as seen in (4-40), where the phonetic syllable is [jao]_σ, (from the word [jao.ho.ra] ‘cutia’). Stress would still fall on the phonetic syllable correctly (and trivially) because it occupies an odd-numbered position when counting from the right-edge of the word.

(4-40) **Catalexis in Paumari**



The representations in (4-38) and (4-40) both show instances of syllable-catalexis. In the former case, a catalectic syllable makes a phonetically monosyllabic word disyllabic, whereas in the latter, it makes a monosyllabic foot disyllabic. As argued earlier, however, even instances of mora-catalexis are better captured “by having the catalectic mora report to a catalectic syllable...rather than to a non-catalectic syllable.” In essence, then, the aforementioned representations also capture mora-catalexis, whereby a phonetically monosyllabic foot/word becomes bimoraic. The upshot is that with the advent of catalexis a bimoraic or disyllabic minimum can be seen as a requirement on words/feet in all languages.

4.4 Chapter Summary

While the earlier chapters established empirical support for the C-Dimension and the M-Dimension, this chapter has presented some of the important typological implications of bringing the two dimensions together under MCI. One of these implications is that all

geminate are read off as long (i.e. bi-segmental) consonants in the C-Dimension, but only the metrically relevant ones are given a mora in the M-Dimension (§4.1).

Furthermore, MCI predicts the occurrence of mora-based constraints as well as constituency-based constraints in languages (§1.5). It was therefore not surprising to find both types of constraints have a say in a language like Kwakwala (§4.2.1). Nor was it surprising to find a process, like *shm*-reduplication in English, which overwrites material in the C-Dimension, while leaving the M-Dimension perfectly intact (§4.2.2). The moraic pre-nuclear consonants in Bella Coola are also to be expected under MCI, because any segment-melody complex can be associated with a mora in the model, regardless of where it is associated in the C-Dimension (§4.2.3).

MCI was also shown to logically allow for segment-melody complexes associated either with the C-Dimension or with the M-Dimension of a syllable. Pre-schwa consonants in Dutch, which are associated only with the M-Dimension of one syllable and only with the C-Dimension of another, bear out both logical possibilities (see (4-26)). Syllables having just one dimension were also seen to be logically possible in MCI. Extrametrical syllables (§4.3.3) and clitics like the English definite article [ðə] *the*,¹⁷ for example, have the C-Dimension, but no M-Dimension. It is entirely predictable then that catalectic syllables, the logical opposite of extrametrical syllables, should have the M-Dimension but no C-Dimension (§4.3.4).

¹⁷ Its stressed variant [ði:] should, however, have both the C-Dimension and the M-Dimension.

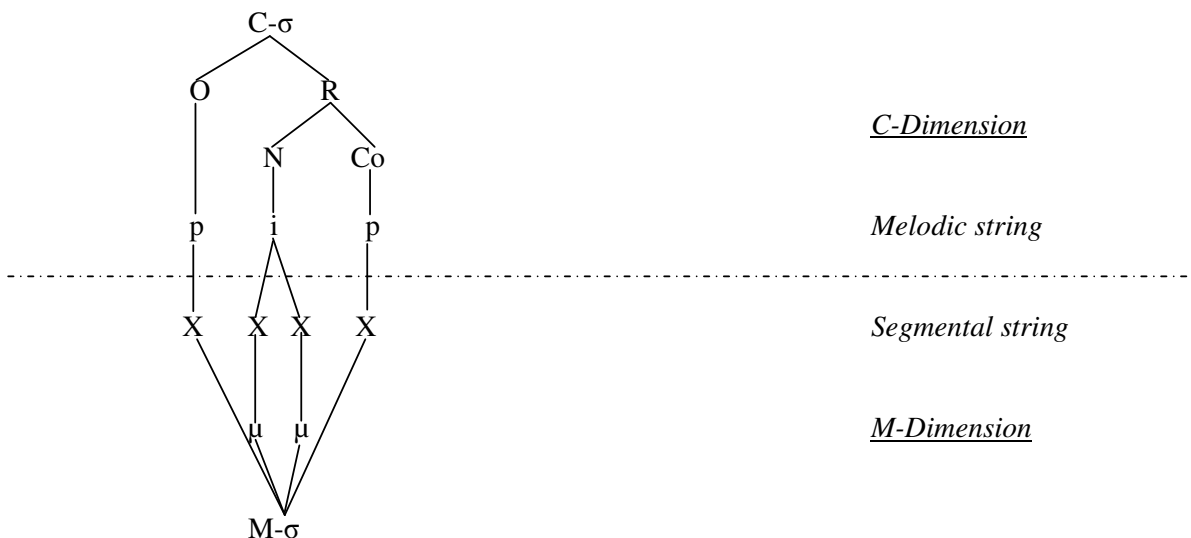
CHAPTER 5

Towards a Generalised Theory of the MCI: Segments, Melodies and Feet

MCI was articulated as a model of syllable-internal structure in the first four chapters of this dissertation. In this chapter, a generalised theory of the MCI is envisioned, with focus on two questions concerning the model's architecture.

The first question is whether 'segment-melody complexes' are arrayed on a 'dimension' or tier separate from the C-Dimension and the M-Dimension in MCI. Answering that question in the negative, the first section of this chapter (§5.1) argues that melodies belong to the C-Dimension (since melodies represent the phonological content being grouped in terms of constituents) and segmental X-slots belong to the M-Dimension (since segments encode the length of melodies, which is a metrically relevant property). Even at the basic level of the segment/melody, the C-/M-Dimensions must, therefore, be recognised. This can be seen from the MCI representation of the English word [pi:p] *peep*:

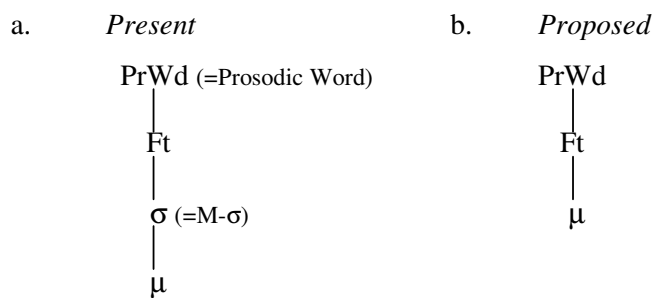
(5-1) **Syllable in MCI**



The second question concerns the role of the object called the Mora-syllable i.e. 'M-σ' in the Prosodic Hierarchy, represented in (5-2a). In connection to it, the second part of this chapter shows that feet can be directly built from moras without the intervention of the M-σ

even in languages which are traditionally considered to have syllable-counting, rather than mora-counting, foot and stress systems (§5.2). The construction of feet from moras in the latter type of languages in turn allows for a uniformly mora-based classification of feet across languages, showing the redundancy of the M- σ in the Prosodic Hierarchy (5-2b).

(5-2) **Prosodic Hierarchy**



Though feet need not be built from M- σ s and the M- σ node is thence not crucial to the Prosodic Hierarchy (see (5-2b)), it is still necessary to encode the effects of stressed-syllable lengthening in trochaic languages. This point will become clearer before the chapter concludes, in §5.3.

5.1 Segment-Melody Affiliations

The first two parts of this section present empirical evidence supporting the proposal that the melodic component of segment-melody complexes belongs to the C-Dimension (§5.1.1) and that the segmental component (i.e. X-slots) thereof belongs to the M-Dimension (§5.1.2). In the final part of this section, two pieces of empirical evidence from earlier chapters, which seemingly contradict the above proposal, are reconciled with it (§5.1.3).

5.1.1 *The place of melodies*

This subsection opens with a recapitulation of evidence from earlier chapters, which suggests a close relationship between melodic content and the C-Dimension (§5.1.1.1). Later in the subsection, arguments are presented against the direct of association of melodies with moras (§5.1.1.2): these arguments are, in effect, arguments against the affiliation of melodies with the M-Dimension.

5.1.1.1 Melodies in the C-Dimension

All melodies have intrinsic features (e.g. sonorancy, frontness, continuancy) as well as properties which are extrinsically encoded by segmental X-slots (e.g. length). Importantly, however, constraints and processes involving intrinsic features of syllabified melodies invariably target the C-Dimension rather than the M-Dimension.

Consider again, for example, the following case from Chungli (from §2.3.2) where schwa has a [-back] allophone [ə] and a [+back] allophone [ɯ]. The back [ɯ] occurs only before the back velar consonants [k, ŋ] in Chungli and the non-back allophone [ə] occurs only before the non-back labial and coronal consonants. This can be seen from the words below:

(5-3) VC harmony in Chungli

a.	V [-back] ə	C [-back] n, t, p, m	b.	V [+back] ɯ	C [+back] k, ŋ
<hr/>			<hr/>		
i.	a.m[ə̀n]	‘sit’	i.	ts[ɯ́k]	‘grain’
ii.	kà.k[é̌t]	‘book’	ii.	z[ɯ́k].taŋ	‘beat.CON’
iii.	à.s[ə̌p]	‘off’	iii.	á.n[ɯ́ŋ]	‘sky’
iv.	á.c[ə̌m]	‘fear’	iv.	á.r[ɯ́k]	‘drown’

The data in (5-3) show that VC sequences where the V is schwa are required to agree in their ‘plus’ or ‘minus’ specification for the feature [back] in Chungli. That this requirement targets the Rhyme is confirmed by the fact that CV sequences need not agree for ‘backness’. In the words in (5-4a), for example, the schwa is back but the preceding consonant is front. Contrastingly, the schwa is non-back and the pre-schwa consonant is back [k] in the words in (5-4b). The upshot is that a requirement involving the feature [back], intrinsic to a melody, targets the Rhyme, which is part of the C-Dimension.

(5-4) CV non-harmony in Chungli

a.	C [-back] t, n, p, m	V [+back] ɯ	b.	C [+back] k	V [-back] ə
<hr/>			<hr/>		
i.	[tɯ].zɯ	‘vein’	i.	kà.[kə́]t	‘book’
ii.	á.[nɯ́]k	‘grind’	ii.	[kə]n	‘song’
iii.	[pɯ́].rúk	‘scatter’	iii.	a.[kə́].tsɯ́?	‘give’

iv. [m̩].cáŋ ‘sleep’

iv. *[ŋV] (see §2.3.2)

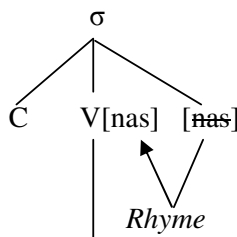
Processes involving features intrinsic to a melody also target the C-Dimension. One may recall, for example, that when a word-final [m] or [n] from is deleted in Spoken Tamil, the [nasal] feature of the deleted consonant is realised on the preceding vowel (see §2.3.3 for a detailed discussion). This can be seen from the nasalised word-final vowels in the Spoken Tamil forms below.

(5-5) **Vowel Nasalisation in Spoken Tamil**

	<i>Standard Tamil</i>	→	<i>Spoken Tamil</i>	<i>Gloss</i>
a.	mar.mam	→	mar.mõ	‘mystery’
b.	pu:.ra:n	→	pu:.rã:	‘millipede’
c.	mu:.lam	→	mu:.lõ	‘source’
d.	e:..j̥-a:m	→	e:..j̥-ã:	‘seventh’
e.	kap.pam	→	kap.põ	‘tax’
f.	kam.bam	→	kam.bõ	‘pole’

It is noteworthy that only vowels are nasalised in Spoken Tamil, even as oral pre-vowel consonants remain oral, whether they are sonorants (5-5a-d), obstruents (5-5e, f)) voiced (5-5a-d, f) or voiceless (5-5e). Vowel(-only) nasalisation cannot be analysed as the spreading of the feature [nasal] from a moraic post-nuclear consonant to a moraic vowel, as argued in §2.3.3, because all heterorganic consonants, including word-final [m] and [n] which trigger nasalisation, are non-moraic in Tamil (see §3.3.5). It may be analysed, however, as the spread of nasality from one Rhyme-internal melody to another. Under this analysis, the non-nasalisation of pre-vowel consonants in Spoken Tamil simply follows from their location outside the Rhyme, the domain of [nasal] spread in the language:

(5-6) **[Nasal] spread in Spoken Tamil**



The feature [nasal] is intrinsic to melodies in Tamil, just as the feature [back] is in Chungli. The spread of the feature [nasal] in Spoken Tamil is bounded by the Rhyme, while agreement for the specifications of the feature [back] is required only of melodies associated with the Rhyme in Chungli. Melodic features are thus tied to constituents, which in turn are targeted by processes or constraints involving those features. This insight supports the proposal that the melodic component of segment-melody complexes belongs to the C-Dimension in MCI.

The assumption that melodies belong to the C-Dimension also makes an important and testable prediction. It predicts that two melodies which differ only in length (e.g. [i] and [i:]), which is not a melodic feature, will be perceived as more phonologically similar than two melodies which have the same length but differ in respect of some melodic feature (e.g. [i], a high front vowel, and [e], a non-high front vowel). This prediction is readily borne out in Tamil where words which differ only in the length of their initial vowel (5-7) are often used in pairs by rhetoricians to enhance the power of their message. Rhetorical devices which manipulate melodic features but keep length constant, however, are hard to come by.

(5-7) **Melodic assonance in Tamil**

a.	pa:si	‘hunger’	~	pa:si	‘algae’
b.	ni:lam	‘land’	~	ni:lam	‘blue’
c.	ku:ɖaj	‘umbrella’	~	ku:ɖaj	‘basket’
d.	pe:t̪i	‘box’	~	pe:t̪i	‘interview’
e.	to:ɖi	‘touch.imp’	~	to:ɖi	‘earring’
f.	a:ɖi	‘foot (measure)’	~	a:ɖi	‘fourth Tamil month’
g.	u:ɖal	‘body’	~	u:ɖal	‘a romantic fight between lovers’
h.	(j)e:ɖi	‘pick.imp’	~	(j)e:ɖi	‘cheese’

In English, too, a short vowel having certain (melodic) feature specifications, say [ɪ], is arguably more similar to a long vowel bearing the same feature specifications, say [i:], rather than to a short vowel having different feature specifications, say [e]. Such an argument implies that [bɪd] *bid* rhymes better with [bi:d] *bead* than with [bed] *bed*.¹ This implication

¹ The state of affairs in English is, however, subtly complicated by the fact that (non-final) short vowels are lax and long vowels are tense in the language. If the tense/lax distinction – which is melodic and therefore encoded in the C-Dimension – is primary, [bɪd] *bid* is expected to rhyme better with [bed] *bed* rather than with [bi:d] because *bid* and *bed* both have lax vowels. If the length distinction – which is encoded by X-slots in the M-

can be tested based on rhyming judgments from proficient users of English.² If it is discovered to be correct, it would support the hypothesised affiliation of melodies with the C-Dimension.

Given the two dimensions in MCI, however, it is not adequate to establish that melodies belong to the C-Dimension; their relationship with the M-Dimension needs to be made explicit as well. In this connection, the next subsection argues that melodies do not belong to the M-Dimension in MCI.

5.1.1.2 No melodies in the M-Dimension

In the μ -Model, segmental melodies are viewed as indivisible entities and moras are thought to be associated with those units. In MCI on the other hand, the segmental melody is viewed as a ‘complex’ with a segmental component (i.e. X-slot) and a melodic component. While the previous subsection adumbrated why the melodic component of segment-melody complexes must be seen as belonging to the C-Dimension, this subsection argues against affiliating it with the M-Dimension.

The argument, in a nutshell, is as follows: if melodies are to be treated as part of the M-Dimension, a close relationship must exist between moras and melodic features. Such a relationship predicts that any melodic feature (i.e. specifications for a melodic feature) may play a role in the (non-)assignment of moras to melodies. The prediction is demonstrably false, however, because the (non-)moraification of melodies is not influenced by all individual features. For example, there are phonological systems in which all [+son] melodies are moraic and [-son] ones are not (e.g. Kwakwala), but none wherein all [-cont] melodies are non-moraic and [+cont] ones are not (or vice versa).

Nor do all ‘feature classes’ hold any influence in making melodies (non-)moraic. Place features and laryngeal features, for example, have no say on whether a melody should be moraic. Suppose for the sake of argument, however that in some language a melody must be coronal or labial for it to be moraic. In this language, coronal, labial and labio-dental obstruents would be moraic but velar or uvular sonorants would not be. Languages like these are absent, and their absence cautions one against envisaging too proximate a relationship between melodic features and moras.

Dimension – is primary, [bɪd] *bid* is expected to rhyme better with [bi:d] *bead* than with [bed] *bed* because the vowels in *bid* and *bead* are melodically alike.

² On the problematic nature of the term ‘native speaker’, see Agnitori & Singh (2010) and Kumar & Wee (2014).

All the same, not all melodic features are inert when it comes to designating a melody as moraic. More to the point, [+son] melodies have been shown to attract moras in Kwakwala and Tiv (Zec 1995), whereas [-cons] melodies are assigned moras in Khalkha Mongolian and Lake Miwok. In these languages, however, the specifications for the root features [son] and [cons] are arguably shared by melodies with segmental X-slots (see §5.1.3), effectively transforming the latter into root nodes. Moras may be seen as associating with root nodes in such languages, rather than with melodies. There is thus little that warrants the affiliation of melodies with the M-Dimension. The assumption that X-slots belong to the M-Dimension is, however, amply supported by empirical evidence, as will be seen in short order.

5.1.2 *The place of segments*

In the previous chapter of this dissertation, the length of a melody was seen to influence (a) whether it is moraic and (b) the number of moras received by the melody on the surface. This shows – since melodic length is just an ‘extension’ of the number of segmental X-slots with which a melody is associated – that a close relationship exists between segments and moras. The relationship is shown to lend support to the assumed affiliation of segments with the M-Dimension in the first part of this section (§5.1.2.1). On the other hand, affiliating segments with the C-Dimension predicts phonological scenarios without empirical import, and is, therefore, undesirable, argued in the second part of this section (§5.1.2.2).

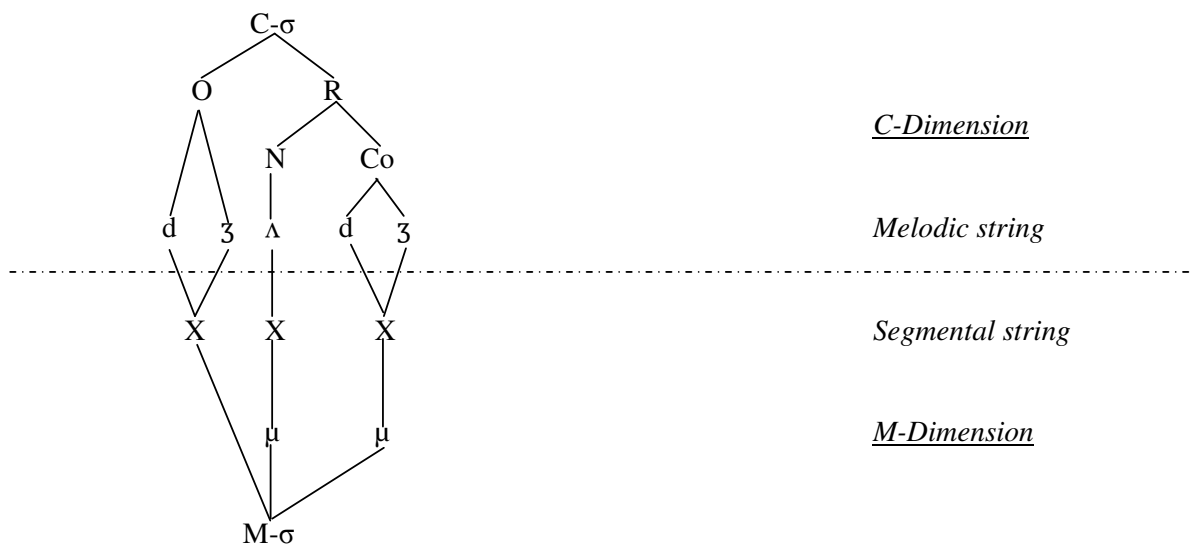
5.1.2.1 *Segments in the M-Dimension*

The strongest support for the hypothesis that segmental X-slots belong to the M-Dimension in MCI comes, arguably, from affricates. The commonly held view about affricates is that they are single segments with the content of two different melodies (see, for example, Sagey 1986: 81 and Duanmu 2009: 22³ and references therein). Two predictions emerge from the latter view about affricates.

³ One important difference between Duanmu’s (2009) and Sagey’s (1986) treatment of affricates is that only the former allows for affricates in which the stop is produced by one articulator and the fricative is produced by another: e.g. [k̥s], [p̥x], [p̥ʃ]. Such affricates are simply accommodated in MCI as well. In the C-Dimension, there is no difference between the stops and fricatives in affricates like [k̥s], [p̥x] and [p̥ʃ] and those in non-affricate sequences such as [ks], [px] and [ps]. In the M-Dimension, however, the stop and fricative in the former cases would be associated with one X-slot (just as [d] and [ʒ] are in (5-8)), while those in the latter are associated with two X-slots. Also, the ordering of the stop before the fricative in affricates need not be regarded as a phonetic result in MCI, unlike in Duanmu’s (2009: 22) story. The temporal ordering is simply achieved by the placement of the stop to the left of the fricative in the C-Dimension.

The first prediction⁴ is relevant in the present context: the prediction is that if affricates are monosegmental (assuming that a single segment may not have more than one metrical face, i.e. mora), they should be maximally monomoraic. This prediction seems true without exception, and no language I know of has bimoraic affricates. In the representation below, the focus is on the twin occurrences of the affricate [dʒ] in the English word [dʒʌdʒ] *judge*. While the pre-nuclear instance of [dʒ] is non-moraic in the language just like other pre-nuclear material, the post-nuclear token is associated with one mora. (If post-nuclear [dʒ] was also non-moraic, the word [dʒʌdʒ] would be monomoraic and sub-minimal in English.)

(5-8) **Affricates in MCI**



In essence, the representation in (5-8) captures the insight that a single X-slot may be metrically translated into no more than one mora, even if it is associated with two melodies as in the case of affricates. This insight in turn points to the close relationship between moras and segments, and supports the proposed affiliation of segments with the M-Dimension. Facts concerning geminate- and vowel-moraification provide yet more support for the proposal.

While an affricate involves two consonant melodies associated with a single X-slot, as seen in (5-8), a geminate involves a single consonantal melody associated with two X-slots (see §4.1.2). In this context, it is appropriate to recall that there are languages like Pattani

⁴ The second prediction is that affricates, if they are monosegmental, cannot be split across syllables. Consider, for example, an English input with the nominal root /dʒʌdʒ/ ‘judge’, followed by the affix /-ɪŋ/ which marks the progressive aspect in the language. When the input is syllabified, the result is [dʒʌ.dʒɪŋ], rather than [dʒʌd.ʒɪŋ]. Furthermore, outputs where the two parts of an input affricate have been hetero-syllabified, such as [dʒʌd.ʒɪŋ], are not reported in any variety of English or any other language.

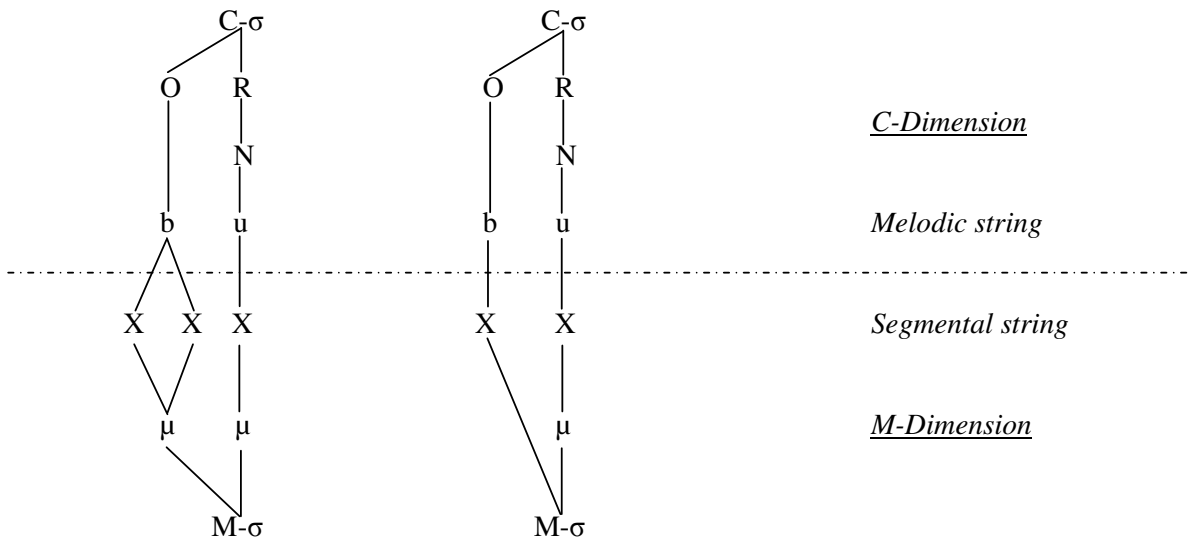
Malay where bi-segmental (geminate) consonants are moraic and mono-segmental (singleton) consonants are not. The moraic versus non-moraic contrast between bi-segmental and mono-segmental consonants emerge clearly from the representations below.

The initial syllable of the Pattani Malay word [bbu.woh] ‘to bear fruit’ (5-9a) begins with an instance of [b] which is associated with two X-slots and which is therefore moraic. On the other hand, the token of [b] which begins the word [bu.woh] ‘fruit’ (5-9b) is associated with only one X-slot and is consequently non-moraic (5-9b):

(5-9) **Consonants in MCI**

a. *Geminate*

b. *Singleton*⁵



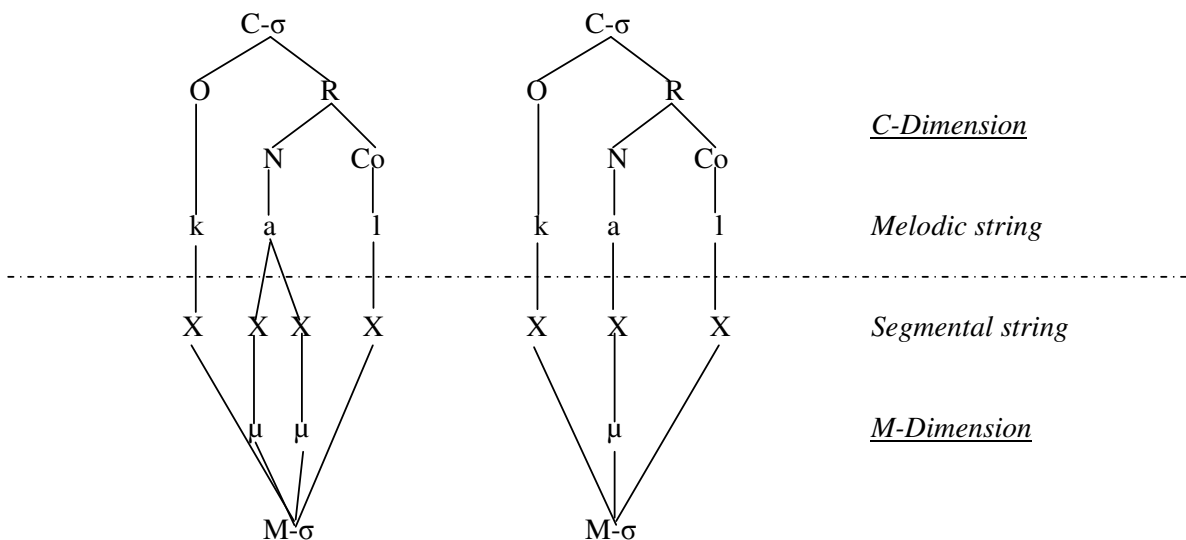
The non-assignment of moras to mono-segmental consonants and assignment of one to bi-segmental consonants languages like Pattani Malay can be compared with the assignment of one mora to mono-segmental (short) vowels and two moras to bi-segmental (long) vowels in all languages. In (5-10a), for example, the vowel [a:] in the Tamil word [ka:l] ‘leg’ is associated with two X-slots and two moras. In (5-10b), the vowel [a] in the word [kal] ‘stone’ is associated with one X-slot and one mora:

⁵ An examiner asks whether a third situation, where a pre-nuclear (singleton) consonant is associated with a mora, is not possible. It is indeed possible and is exemplified by pre-nuclear (singleton) consonants in Bella Cooola monosyllables, which are moraic (§4.2.2).

(5-10) **Vowels in MCI**

a. *Long vowel*

b. *Short vowel*



The representations in (5-9) and (5-10) show that a melody can be non-moraic/moraic or more/less moraic depending on the number of X-slots with which it is associated. Note, however, that the number of X-slots spanned by a melody does not always equal the number of moras it receives. While the two numbers are almost always equal in the case of vowels, they are not in the case of consonants, as evident from the fact that bi-segmental consonants are often monomoraic.

All the same, a strong positive correlation does exist between the number of segments spanned by a melody and its moraic contribution to a syllable.⁶ This correlation reinforces the close relationship between segments and moras, and in doing so, lends strong credence to the view that segments belong to the M-Dimension in MCI. The other possibility – namely the affiliation of segments with the C-Dimension – is considered in the next part of this section and shown to be undesirable because it makes predictions which have no clear phonological import.

5.1.2.2 *No segments in the C-Dimension*

If segmental X-slots are assumed to belong to the C-Dimension, bizarre predictions follow. One such prediction is given in (5-11):

⁶ If segment count depended on mora count (rather than mora count on segment count, as argued above), non-moraic consonants would be of uniform length in any given language. This prediction is falsified in Cypriot Greek (Muller 2002) and Leti (§4.1.2) among other languages where non-moraic singleton consonants contrast with non-moraic geminates in word-initial position.

(5-11) **X-slots in the C-Dimension** (a sample prediction)

- a. Only X-slots sharing a melody may belong to the Nucleus.
- b. Other X-slots may not belong to the Nucleus.

What (5-11) predicts is essentially a language where bi-segmental melodies (i.e. long vowels and geminates) are part of the Nucleus (5-11a) and mono-segmental ones (i.e. short consonants and short vowels) are not (5-11b). The prediction is patently false, however, because there is not a single language where geminate consonants and long vowels pattern alike structurally, to the exclusion of short vowels. The type(s) of evidence that should be produced in support of the existence of such a language also seems hard to come by.

Moreover, to even suggest that long vowels may be nuclear but short vowels may not be in some language requires one to demonstrate at least one of the following scenarios in the context of that language: (a) in open syllables a consonant and a following long vowel constitute separate sonority domains (respectively Onset and Nucleus), whereas a consonant and a following short vowel do not; (b) a long vowel and a corresponding short vowel (if any) may not participate in assonance; or (c) the degree of co-articulation between a consonant and a following short vowel is considerably lower than that between a consonant and a following long vowel.

There are, in fact, no known languages where even one of the aforementioned scenarios obtains. This fact indicates that the length of a melody is not directly relevant in deciding whether it is associated with a particular constituent (e.g. Nucleus). More generally, segmental X-slots which encode the length of the melodies with which they are associated have no say in the organisation of those melodies in the C-Dimension.

Assuming that X-slots belong to the C-Dimension is thus infeasible from an empirical standpoint. The assumption is also mathematically unsound given that X-slots represent timing units, while constituents such as Onset and Coda are organisational nodes. On the other hand, there is no mathematical issue with the assumption that X-slots belong to the M-Dimension: this is because moras, which provide content to the M-Dimension, and X-slots are both temporal objects.

In summary, there is reasonable support for the claim that X-slots belong to the M-Dimension, just like there is support for the claim that melodies belong to the C-Dimension (§5.1.1.1). Two phonological phenomena are, however, consistent with the opposite pattern of affiliation – X-slots with the C-Dimension and melodies to the M-Dimension – and have to be addressed. The role played by sonority (an intrinsic quality of melodies) in the

moraification of segments is, for example, consistent with an arrangement of MCI where melodies are directly associated with moras and are, consequently, part of the M-Dimension. The presence of segmental constraints targeting constituents (§2.5) itself may be taken to suggest that segments belong to the C-Dimension. The next subsection, however, shows that the role of sonority in segment-mora associations and the presence of segmental constraints targeting constituents can both be captured in MCI without compromising on the proposed affiliation of melodies with the C-Dimension and segments with the M-Dimension.

5.1.3 Further discussion

This subsection is divided into three parts. In §5.1.3.1, those X-slots which receive moras in languages like Kwakwala and Khalkha Mongolian are argued to be root nodes specified for a root feature value (e.g. [+sonorant], [-consonantal]). Non-moraic segments, however, are held to be bare X-slots in all languages. The upshot is that in all languages moras are directly associated either with X-slots or X-slots transformed as root nodes, but not with melodies. The assumption that X-slots belong to the M-Dimension can, therefore, still be maintained.

In §5.1.3.2, segmental constraints are shown to target constituents in the C-Dimension (Onset, Nucleus, Rhyme, Coda) through the offices of inter-dimensional alignment constraints, which require said constituents to coincide with a specified number of segmental X-slots in the M-Dimension. The conclusion is that segmental constraints can target the C-Dimension even if X-slots belong to the M-Dimension as hypothesised in this section.

Finally, in §5.1.3.3, the proposed two-dimensional setup of MCI is shown to be superior to close one-dimensional competitors on both mathematical and empirical grounds.

5.1.3.1 X-slots and root nodes

One may recall from §3.2.2 that, in Kwakwala, sonorants and vowels are moraic, but obstruents are non-moraic.⁷ This means only [+son] elements receive a mora in the language. That only [+son] elements receive a mora in Kwakwala indicates that phonological features, which are intrinsic to a melody, can decide whether a segmental melody is moraic or non-moraic in a language. Feature-constrained moraification of segmental melodies in turn makes problematic the position that segmental X-slots, and not melodies, are directly associated with moras (whence the proposal that segments belong to the M-Dimension).

That position need not be compromised, however, because featural influences on the moraification of segmental melodies (Zec 1995) can be captured without assuming that

⁷ The discussion in this subsection pertains only to nuclear and post-nuclear material in syllables.

Comparably, the X-slots attached to consonants need not be specified as [+cons] in Khalkha Mongolian. They would be non-moraic by default, given the assignment of moras to X-slots associated with vowels, owing to the [-cons] specification of the latter:

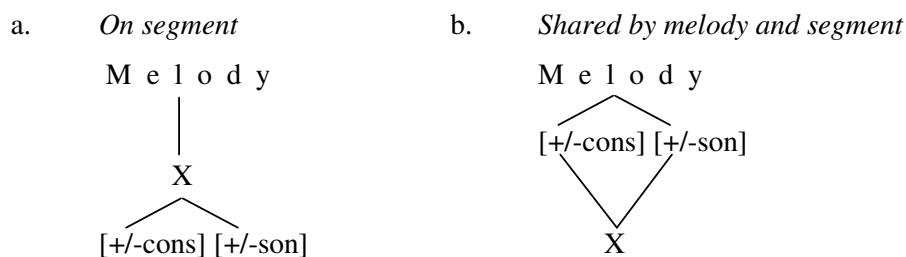
(5-13) **Root features and moras in Khalkha Mongolian**



The general idea then is that in languages like Kwakwala and Khalkha Mongolian some X-slots act as 'root nodes' by carrying specific values for one (or more) root features. These root nodes receive moras, whereas bare X-slots do not. The relationship between root feature values and moras is thus clear, but how X-slots happen to receive those values remains to be seen. Two possible answers to the question are considered below.

The first one involves postulating that root feature specifications such as [+son], [-son], [+cons] and [-cons] are borne by segments rather than melodies (5-14a) in the languages under discussion. The second option assumes that root feature specifications, like others, are part of the internal makeup of melodies, but allows for them to be shared (5-14b) with X-slots (presumably during syllabification).

(5-14) **Root feature specifications**

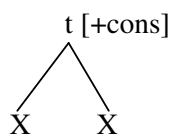


The second option is to be favoured on two grounds. First, it provides an organic characterisation of the melody as a bundle of phonological features. Under the first option, however, the melody emerges as a bundle of phonological features minus the specifications for the features [son] and/or [cons]. The former characterisation of the melody is obviously the correct one given that “there is a very real sense in which [melodies, all features told]... are integral units in their own right” (Clements 1985: 228; parentheses mine).

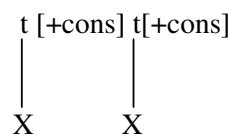
Secondly, if all feature values are melodic, as per the second option, geminated consonants can have a single [+cons] specification shared by two X-slots, as demanded by facts of geminate inalterability and integrity (Hayes 1986), which characterise true geminates but not fake ones.

(5-15) **Root features on melodies**

a. *True geminates*



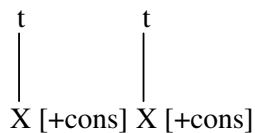
b. *Fake geminates*



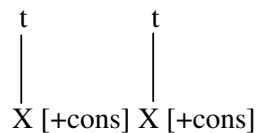
However, if values for root features are assigned exclusively to segments according to the first option, then true geminates will have two [+cons] specifications linked to two X-slots, and will be indistinguishable from fake geminates which also have two [+cons] specifications linked to two X-slots.

(5-16) **Root features on segments**

a. *True geminates*¹⁰



b. *Fake geminates*



The upshot is that the second option, according to which root feature values are essentially melodic but may be shared with segmental X-slots, offers a better account of how X-slots become root nodes in languages where the association of moras with segmental melodies is feature-constrained. That moraic X-slots in these languages are root nodes has already been shown. Moras, in summary, are not directly associated with melodies but with (bare or 'rooted') X-slots in languages—supporting the assumption that moras and segments belong to the M-Dimension.

The other hypothesis defended in this section is that melodies and constituents belong to the C-Dimension, and X-slots do not. In connection to it, the final part of this section argues that segmental constraints which target constituents may do so through the mechanism

¹⁰ Another possible representation for true geminates involves two X-slots, each with a [+cons] specification, linked to a single melody. Such a representation is suspicious, however, because two instances of a root feature value automatically imply the presence of two melodies given that every instance of a root feature value correlates with a unique melody.

of inter-dimensional alignment. The presence of such constraints should not be taken, therefore, to imply that segments and constituents belong to the same dimension.

5.1.3.2 *Inter-dimensional alignment*

The view that segmental X-slots and constituents belong to different dimensions seems decidedly at odds with the occurrence of segmental constraints targeting constituents (§2.5). For example, the Rhyme in Sixian Hakka is allowed to have only two segments of melodic material at most. This restriction can be enforced, however, without abandoning the idea that segments belong to the M-Dimension; rather than to the organisational space of the C-Dimension. It can be done through an inter-dimensional alignment constraint like (5-17):

(5-17) **COINCIDE (Rhyme, X₁₋₂)**

The Rhyme in the C-Dimension coincides with no more than two segments in the M-Dimension.

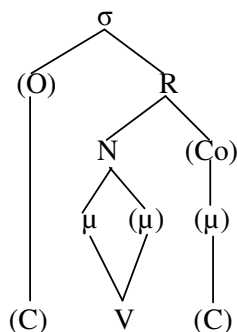
As per the constraint in (5-17), the Rhyme in Sixian Hakka would maximally coincide with the two segmental X-slots associated with a falling diphthong. This explains why falling diphthongs are never followed by a tautosyllabic consonant in the language (§2.5.1) Since rising diphthongs are associated with only one X-slot in Sixian Hakka, however, a consonant following a rising diphthong may correctly take up the second X-slot with which the Rhyme is allowed to coincide. Inter-dimensional alignment constraints thus ensure that segmental constraints can target constituents in the C-Dimension, even if segmental X-slots belong to the M-Dimension.

The main focus of this section so far has been the affiliation of melodies with the C-Dimension and of segments with the M-Dimension. An examiner, however, questions the two-dimensional setup of MCI, contending that even for someone who accepts the necessity of both moras and constituents, a model of the syllable need not place moras and constituents on different dimensions. The final part of this section takes up the question, and shows how two-dimensionality is just a natural consequence of accepting moras and constituents as functionally independent entities.

5.1.3.3 *Two-dimensionality revisited*

As an alternative to two-dimensional MCI, the examiner suggests a model of the syllable wherein constituents dominate moras and moras dominate segments [melodies, in my terminology], as in the representation below.

(5-18) **Moras and constituents in one dimension (I)** ¹¹



While syllable-internal structure as sketched in (5-18) is indeed parsimonious compared to MCI because it gives up the assumption of two dimensions, it has problems. For starters, in putting moras and constituents under one roof, the model of the syllable represented above mixes up temporal and organisational objects. It is, therefore, mathematically not as neat as MCI where temporal (moras and X-slots) and organisational objects (melodies and constituents) are kept separate.

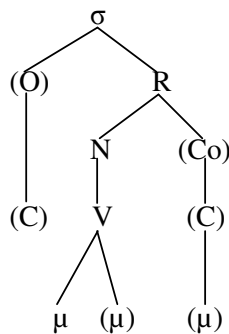
Even if mathematical neatness is not considered important in choosing one phonological theory over another, a mono-dimensional model of the syllable that accommodates both moras and constituents is rife with problems. Firstly, such a model puts constituents and moras in a relationship of dependency. From the representation in (5-18), where the Rhyme (via the Nucleus and Coda) dominates moras, for example, one may be tempted to conclude that the Rhyme ‘license’ moras. The conclusion, however, becomes erroneous in light of the fact that even non-Rhyme material can be moraic, as in *Bella Coola*—indicating that constituents are just spectators to melody-mora associations.

Suppose then that a mono-dimensional model of the syllable with both moras and constituents is configured as in (5-19). The model below differs from that in (5-18) only in that, here, constituents directly dominate melodies – not moras – and melodies in turn dominate moras. This variant of one-dimensional syllable structure has to contend with the question of (a) whether to have melodies associate with moras first and then have melody-

¹¹ The examiner’s report contains four representations: one for monomoraic syllables, two for bimoraic syllables and one for trimoraic syllables. I have combined the representations into one with the help of brackets, which denote the optional nature of the element bracketed. Each bracketed element at a particular level (i.e. moraic, constituent or segmental) can be present in a syllable regardless of the presence or absence of other bracketed elements at that level. Also, I have replaced the examiner’s terminal X’es with C’s and V’s. This change is to ensure that the examiner’s X-es, which stand for segmental melodies, are not confused with the segmental X-slots used in MCI.

mora combines associate with (or ‘project’) constituents; or (b) to have melodies associate with constituents first and then have the melody-constituent combines associate with moras.

(5-19) **Moras and constituents in one dimension (II)**



(see note 11)

The second option leads us, as (5-18) does, to the incorrect conclusion that constituents ‘license’ moras, when they really have no say in mora-melody associations. The first option entails, for example, that only moraic melodies can project a certain constituent (e.g. Rhyme) and only non-moraic melodies can project other constituents (e.g. Onset). This conclusion is once again flawed because any material in a syllable can be moraic.

Indeed, simultaneous but separate association of melodic material with constituents and moras seems *prima face* possible in a one-dimensional model of the syllable. Such a model does avoid the issue of dependency between moras and constituents. The model cannot be strictly seen as one-dimensional, however, because in allowing melodies to associate separately and simultaneously with moras and constituents, the model situates moras and constituents as independent entities which report to two functionally different syllabic objects. Moreover, since it is counterintuitive to have functionally different objects under one roof, it makes sense to think of them as heading different dimensions. The objects are dubbed C-σ and M-σ in MCI, and head the C-Dimension and M-Dimension respectively.

The focus of this chapter now shifts to the construction of binary feet directly from moras, without the intervention of the M-σ, in MCI. Direct construction of feet from moras allows for the elimination of syllable-based feet in languages, ensuring a uniformly mora-based classification of linguistic foot systems.

5.2 Moraic Feet in MCI

This section opens (§5.2.1) with an examination of feet in Syrian Arabic and Hixkaryana. Both are languages where foot-building (and therefore stress) is sensitive to the mora count of

syllables. The second part of the section (§5.2.2) concentrates on Paumari and Finnish, languages where foot-building does not depend on a syllable's mora count (but directly on syllable count) according to traditional metrical analyses. The final part of the section (§5.2.3) shows that though feet can be directly built from moras in MCI, the M- σ is not eliminable as it is necessary to capture the phonological effect of stressed syllable lengthening (i.e. addition of X-slots and moras) in trochaic languages.

5.2.1 *Mora-sensitive systems*

It is well-known that a bimoraic syllable (i.e. M- σ) constitutes an independent bimoraic foot in many languages (Kager 1993, Hayes 1995, Selkirk 1995, Elenbaas & Kager 2003 among others). This section, however, argues that a combination of two moras from two separate M- σ s also constitutes a bimoraic foot, rather than a bimoraic-because-disyllabic foot. The argument is firstly demonstrated to be true in a mora-sensitive trochaic language: Syrian Arabic (§5.2.1.1). It is then shown to true in a mora-sensitive iambic language: Hixkaryana (§5.2.1.2).

5.2.1.1 *Syrian Arabic*

In Syrian Arabic, penultimate syllables carry stress when they are closed by a consonant (CVC) as in (5-20a), or have a long vowel (CV:) as in (5-20b, c). When the penult is a short-vowelled open syllable (CV), however, the antepenultimate syllable is stressed, as in (5-20d).

(5-20) **Stress in Syrian Arabic** (Broselow, Chen & Huffman 1997)

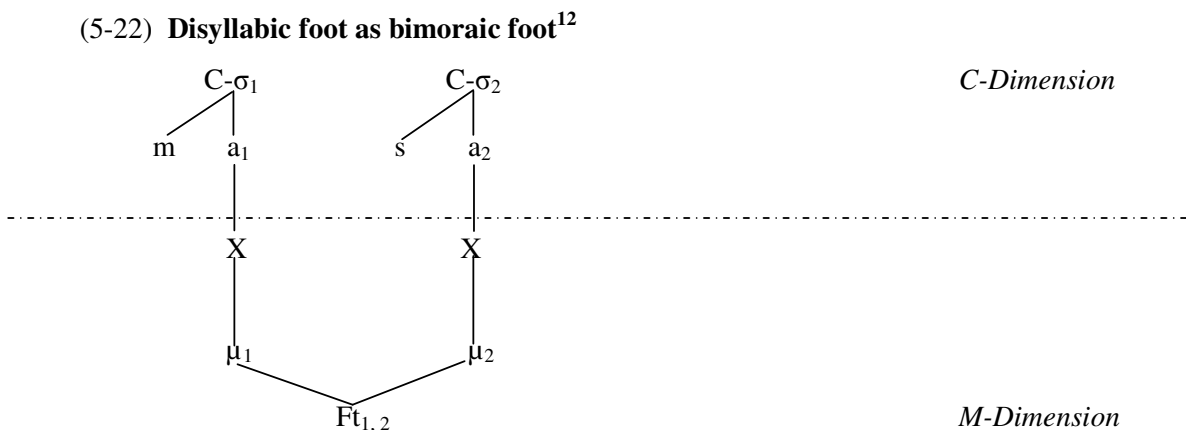
- | | | |
|----|-----------------------------|-----------------------------|
| a. | da. ¹ ras.hon | ‘he studied them’ |
| b. | ma. ¹ na:m.hon | ‘he did not dream them’ |
| c. | da.ras. ¹ tu:.ha | ‘you (PL) studied it (FEM)’ |
| d. | ¹ ma.sa.lan | ‘example’ |

The fact that penultimate syllables of the shape CVC and CV: are stressed shows that these types of syllables are independently footed (5-20a-c), which in turn reveals that they are bimoraic (see also §3.2.4). That bimoraic syllables constitute standalone trochaic feet (cf. Kager 1993) indicates that foot-building is sensitive to a syllable's mora count in Syrian Arabic. Moreover, the placement of stress on a monomoraic CV antepenult when the penult is also monomoraic points to the penult and antepenult forming a trochaic foot (5-21d). The words in (5-20) are given again in (5-21), with brackets denoting foot boundaries:

(5-21) **Feet in Syrian Arabic**

- | | | | |
|----|---|----|---|
| a. | da.(^l ra _μ s _μ).hon
‘he studied them’ | c. | da.ras.(^l tu: _{μμ}).ha
‘you (PL) studied it (FEM)’ |
| b. | ma.(^l na: _{μμ} m).hon
‘he did not dream them’ | d. | (^l ma _μ .sa _μ).lan
‘example’ |

While all the words in (5-21) have feet comprising two moras, the foot in (5-21d) is commonly considered bimoraic because it contains two monomoraic syllables. In MCI, however, this foot can be just bimoraic because it can be directly built from two moras rather than from two syllables (i.e. M-σs). This point should be evident from the representation below where the moras associated with [a₁]_σ and [a₂] are conjoined into a foot, without the intervention of M-σs, in the M-Dimension. Constituents are omitted in (5-22) and the representations which follow it, since they are not relevant to the discussion in this section. X-slots linked to pre-nuclear consonants are also suppressed for the sake of clarity:



After the foot is built, μ₁ – the mora associated with [a₁] – is marked as the trochaic head of the bimoraic foot. In the C-Dimension, this head-marking is realised as stress over the C-σ containing [a₁].

The MCI-based reinterpretation of a bimoraic-because-disyllabic foot as a bimoraic foot brings together two prosodic insights: feet are built in terms of moras but stress is

¹² While the M-σ is omitted in most representations in this section (i.e. §5.2) for sake of clarity, the representations assume that foot-building follows syllabification. More precisely, feet are directly constructed from moras which report to different M-σs, even though M-σs themselves do not count in foot-building (hence its omission in the representations).

realised over syllables (Hyman 2006: 231) i.e. C-σs. One may note in this connection that a single foot in the M-Dimension straddles two C-σs in the C-Dimension in (5-22). This type of straddling, which is predicted under MCI (cf. §1.5), also explains the brilliant illusion of a disyllabic foot, both in trochaic languages, as seen above in the case of Syrian Arabic, and in iambic ones, as seen below with Hixkaryana.

5.2.1.2 Hixkaryana

Stress in Hixkaryana is sensitive to the mora count of syllables. This can be seen from the fact that CV: syllables, which are bimoraic due to a long vowel, are systematically stressed among the surface forms in (5-23). CV syllables, which are monomoraic, on the other hand are systematically not stressed. Word-initial closed syllables are stressed as well (5-23c, d), and so are penults closed by a consonant (5-23a, b). This indicates that (C)VC syllables are also bimoraic in Hixkaryana.

(5-23) **Stress in Hixkaryana** (Hyde 2011: 1053)

	<i>Underlying forms</i> ¹³	<i>Surface forms</i>	<i>Feet</i>
a.	k ^h æ. næ. nʷh.nɔ	k ^h æ. 'næ:. 'nʷh.nɔ	(k ^h æ _μ . 'næ: μ _μ)('nʷh _μ h _μ)nɔ
		'I taught you'	
b.	mʷ. hæ.næ.nʷh.nɔ	mʷ. 'hæ:. næ. 'nʷh.nɔ	(mʷ _μ . 'hæ: μ _μ)(næ _μ . 'nʷh _μ h _μ)nɔ
		'you taught him'	
c.	ɔw.tɔ. hɔ.næ	'ɔw.tɔ. 'hɔ:. næ	('ɔw _μ)(tɔ _μ . 'hɔ: μ _μ)næ
		'to the village'	
d.	tɔh.ku. r'i.hɔ.næ	'tɔh.ku. 'r'i:. hɔ.næ	('tɔ _μ h _μ)(ku _μ . 'r'i: μ _μ)hɔ.næ
		'to Tohkurye'	

That Hixkaryana has iambic feet is evidenced by the fact that in feet composed of two syllables it is the syllable to the right that receives stress. Moreover, the stressed syllable in a foot (foot-head) is always bimoraic while its unstressed opposite (foot-tail) is always monomoraic, reflecting a mora-count contrast within the foot. Such a contrast is typical of iambic systems as per to the Iambic-Trochaic Law (Hayes 1995: 80).

A final point regarding the words in (5-23) is that they all lack stress on the final syllable. The final syllables of the words in (5-23a-c) cannot be footed on their own because

¹³ Underlying forms are my reconstructions.

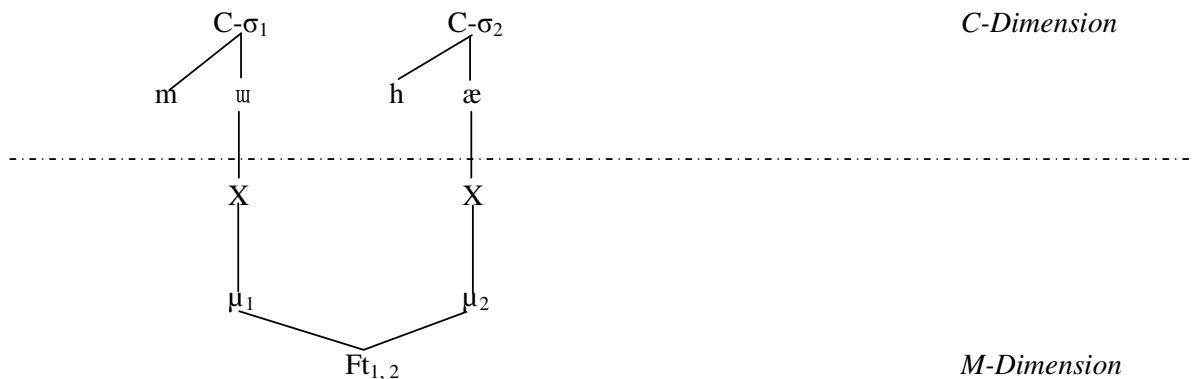
they are monomoraic; whereas feet in Hixkaryana are required to be minimally bimoraic. In (5-23d), however, the last *two* monomoraic syllables remain unfooted, even though they can form a bimoraic foot together. Footing those syllables together would in turn cause the final syllable in (5-23d) to receive stress. Final stress is avoided in Hixkaryana, however, exactly as in many other iambic systems (Van de Vijver 1998: 2-3).

Returning to non-final syllables, the placement of stress on the initial closed syllable in (5-23c, d) and the penultimate closed syllable in (5-23a) does not require special comment in MCI. Being bimoraic, these syllables would constitute standalone feet in any account. The disyllabic feet require deeper attention, however, because these are trimoraic, unlike the bimoraic ones in Syrian Arabic (see (5-21d)).

The data in (5-23) show that the disyllabic feet in Hixkaryana come in one of two melodic shapes: [(CV. 'CV:)] or [(CV. 'CVC)]. In the first case, both syllables in the foot are open. The difference between the syllables is that the leftward syllable (foot-tail) has a short vowel and the rightward syllable (foot-head) has a long vowel. Long vowels are, however, restricted to open syllables which are foot-heads in Hixkaryana. Their occurrence is therefore predictable.

The upshot is that a footed sequence such as [(mʷ.hæ:)] in (5-23b) may well have just two short vowels underlyingly, as in /mʷhæ/. A bimoraic foot can then be built from the mora associated with [ʷ] and the mora associated with [æ] without referring to M-σs. As for the surface appearance of /æ/ as [æ:], it can be explained in fully moraic terms following a proposal made by Hyde (2007).

(5-24) **Disyllabic foot as bimoraic foot**



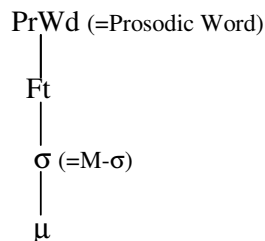
Note that after the construction of the bimoraic foot from the moras associated with [ʷ] and [æ], μ₂ – the mora associated with [æ] – is marked as the iambic head of the foot. Since

μ_2 is the final mora within the foot, however, the head-marking on it, which would be realised as stress, conflicts with a constraint that guards against stress corresponding to a foot-final mora.¹⁴ To resolve that conflict, another mora is added to the foot (Hyde 2007). The vowel [æ] undergoes lengthening to associate with the new mora as well, yielding the surface foot [(m μ μ .¹hæ: μ μ)].¹⁵ The head-marking remains on the now penultimate (formerly final) mora within the foot. Stress consequently corresponds to the penultimate mora within the foot.

With iambic feet of the melodic shape [(CV.¹CV:)] thus tackled, those of the shape [(CV.¹CVC)] can be taken up. The simplest way to deal with the latter involves assuming that the CVC syllable in a [CV.CVC] sequence constitutes a standalone foot, because closed syllables are bimoraic in Hixkaryana. Such an assumption is amply supported by the fact that even closed syllables which are not footed with any other syllable, like the initial syllables in (5-23c, d), are independently footed (and stressed). The CV syllable in a [CV.CVC] sequence is monomoraic, however; the foot constructed from the two moras corresponding to the CVC syllable may, therefore, be expanded to include the single mora corresponding to the CV syllable (see Kager 1993). Alternatively, that mora may remain unfooted, without impacting surface facts in any way.

In summary, the stress patterns in iambic Hixkaryana and trochaic Syrian Arabic (see §5.2.1.1), both mora-sensitive systems, can be accounted for by constructing feet directly from moras. When one more simple assumption is made, construction of feet from moras will also be seen to explain stress patterns in the so-called mora-*insensitive* languages. The presence, in the Prosodic Hierarchy, of the syllable (=M- σ) between the foot and the mora will, hence, prove superfluous by the end of the next subsection:

(5-25) Prosodic Hierarchy



¹⁴ In Optimality-theoretic terms, this means Hixkaryana has a highly ranked NONFINALITY constraint relativised to the foot.

¹⁵ According to Hyde (2007: 321-6), all head-lengthening in iambic languages can be explained in this fashion.

5.2.2 *Mora-insensitive systems*

The term ‘mora-insensitive systems’, when applied strictly, refers to those languages where the basic contrast between monomoraic and bimoraic syllables does exist (Kager 1992a, b),¹⁶ but where the contrast does not influence foot-building. For this reason, binary feet in mora-insensitive languages are simply seen as encompassing two syllables, viz., as (di)syllabic feet. This subsection, however, shows that even in mora-insensitive languages binary feet are *essentially bimoraic*.

Nonetheless, binary feet in mora-insensitive languages will be seen to differ from those in mora-sensitive languages in that they (obligatorily) span two peak moras – a simple assumption. The term ‘peak mora’ refers to the mora associated with (the X-slot linked to) a short syllable peak or the most sonorous vowel in a diphthong (or triphthong). It also refers to the leftmost mora associated with a long syllable peak.¹⁷ Given that syllables have one unique sonority peak and thence a maximum of one peak mora, a foot that spans two peak moras should span two syllables, too. Hence the prevalent thinking that binary feet are (di)syllabic in mora-insensitive languages!

Disyllabic feet in such languages are reanalysed in MCI as conjunctions of specific pairs of adjacent peak moras from the M-Dimension. This point will become clearer during the analysis of the stress facts in Paumari, which are underpinned by the typologically rare mora-insensitive iambic feet (§5.2.2.1). It will also be illustrated in the context of Finnish, a language where primary stress and secondary stress are both attributed to mora-insensitive trochaic feet (§5.2.2.2).

5.2.2.1 *Paumari*

In Paumari (Everett 2003), stress falls on every odd-numbered syllable counting from the right edge of a word to the left. This implies that a stressed syllable and an unstressed syllable to its immediate left constitute an iambic foot in Paumari. While words with an even number of syllables are thus exhaustively parsed into disyllabic iambic feet (5-26a), odd-parity words have a word-initial syllable which is footed on its own and is stressed (5-26b-e):

¹⁶ As opposed to the trivially mora-insensitive ones where all syllables are monomoraic or – but less commonly – bimoraic.

¹⁷ This is related to the fact that, at least in non-tonal languages, the sonority of a long melody gradually declines from its onset to offset. The decline in turn may have to do with physiological factors.

(5-26) **Stress in Paumari**

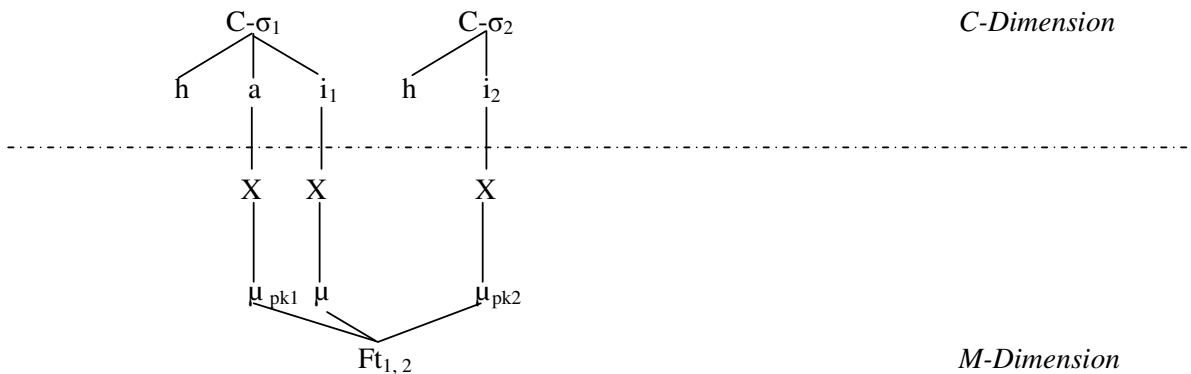
	<i>Syllables</i>	<i>Feet</i>	<i>Gloss</i>
a.	vait.'xa.na.'va	(va _μ i _μ t.'xa _μ)(na _μ .'va _μ)	'little ones'
b.	'kai.hai.'hi	('ka _μ i _μ)(ha _μ i _μ .'hi _μ)	'type of medicine'
c.	'jao.ho.'ra	('ja _μ o _μ)(ho _μ .'ra _μ)	'cutia'
d.	'nao.t ^h i.'nia	('na _μ o _μ)(t ^h i _μ .'ni _μ a _μ)	'after'
e.	'hoa.'ra.ni	('ho _μ a _μ)(ra _μ .'ni _μ)	'one'

Bimoraic syllables do not necessarily attract stress in Paumari as exemplified by [va_μi_μt]_σ; the leftward syllable (or tail) of the initial iambic foot in (5-26a). Stress is thus not sensitive to a syllable's mora count in the language. It is merely sensitive to whether a syllable is the head of an iambic foot when counting from right to left. The mora-insensitive iambic feet in Paumari, evidenced in the second column in (5-26), in turn are amenable to an MCI analysis, given the assumption that binary feet are built from two peak moras in mora-insensitive languages.

Disyllabic feet are the main focus of this section, and these come in the shapes [(CV_μV_μ.'CV_μ)] [(CV_μ.'CV_μV_μ)] and [(CV_μ.'CV_μ)] in Paumari; exemplified respectively by [(ha_μi_μ.'hi_μ)] in (5-26b), [(t^hi_μ.'ni_μa_μ)] (5-26d) and [(na_μ.'va_μ)] in (5-26a). All the three types of disyllabic feet are binary feet built from two peak moras in MCI.

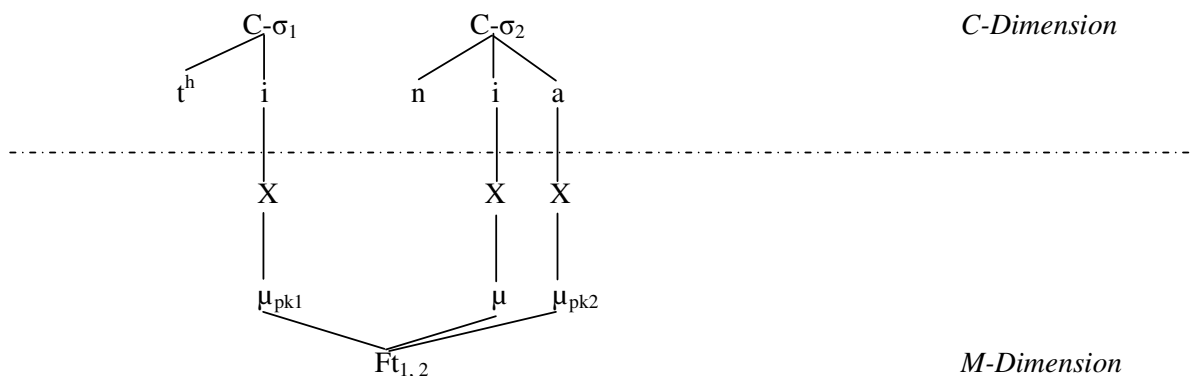
Consider the foot [(ha_μi_μ.'hi_μ)] of the shape [(CV_μV_μ.'CV_μ)] first. It is built from two peak moras i.e. the moras associated with [a] and [i₂], as evident from (5-27). Bi-peak-moraic feet may include non-peak moras, just as the foot below includes the mora linked to [i₁], but such inclusion is presumably not necessary:

(5-27) **Disyllabic foot as bi-peak-moraic foot**



The peak mora associated with [i₂] is the iambic head of the bi-peak-moraic foot in (5-27). Stress is consequently realised over the syllable containing [i₂], namely C-σ₂. Stress is likewise realised over the C-σ containing [a] in (5-28), namely C-σ₂, because [a] is associated with the rightward peak mora, the iambic head. The bi-peak-moraic foot represented below is [(t^h_i_μ.^l_{ni}_μa_μ)] and is of the melodic shape [(CV_μ.^lCV_μV_μ)]:

(5-28) **Disyllabic foot as bi-peak-moraic foot**



Disyllabic bimoraic feet of the shape [(CV_μ.CV_μ)] have already been shown to be feet built from two moras in (5-22) and (5-24). Monosyllabic feet are also realised as stress in Paumari, however, as evidenced by the word-initial feet in the words in (5-26b-e). Moreover, monosyllabic words carry stress in Paumari, pointing to their status as independent feet in the language. In the words in (5-29), the acute accent marks the vowel over which stress is most saliently realised:

(5-29) **Stressed monosyllables in Paumari**

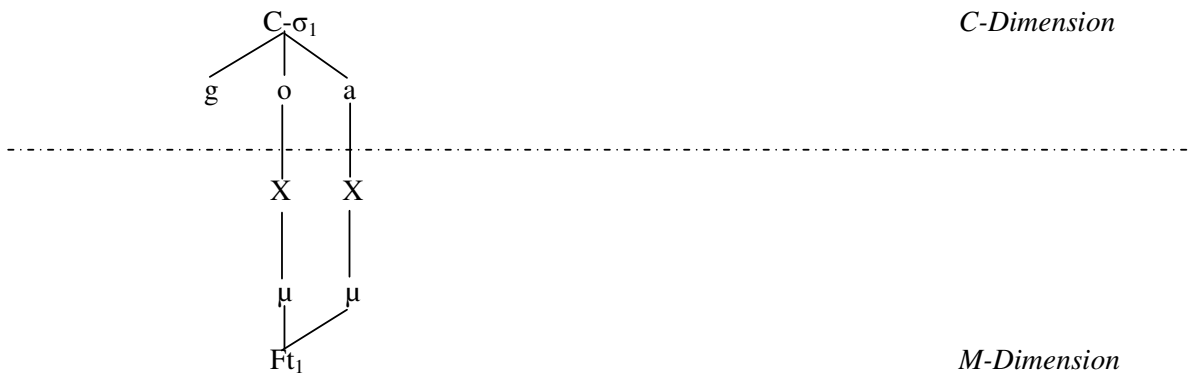
- a. goá 'knocking sound'
- b. haí 'yes'
- c. koá 'mouse'
- d. vaó 'gourd'
- e. pió 'wild turkey'
- f. miá 'mother'

Though the feet attested at the left-edge of the words in (5-26b-e) and those exemplified by the words above are monosyllabic, they are bimoraic. In other words, monosyllabic feet which are monomoraic are disallowed in Paumari. The upshot is that mora-sensitive feet do occur in Paumari but only at the left-edge of odd-parity words – a context

that covers monosyllabic words too. Paumari may therefore be regarded as a ‘generalized iamb’¹⁸ where iambic feet are insensitive to the mora count of syllables in general, but are sensitive to the same at the left-edge of odd-parity words. In this connection, it is worth noting that the monosyllables in (5-29) have an iambic metrical profile; which is evident from the fact that they all receive stress on the rightward vowel of a diphthong even if it is less sonorous than the leftward vowel (5-29b, d).

Capturing monosyllabic bimoraic feet in MCI is straightforward. While a disyllabic bimoraic foot is one foot straddling two C-σs, as in (5-27) and (5-28), a monosyllabic bimoraic foot is one foot corresponding to one C-σ. This can be seen from the MCI representation of [goá] ‘knocking sound’ below. Stress is realised over [a] in (5-30) because it is associated with the rightward mora, the iambic head of the bimoraic foot.

(5-30) **Monosyllabic bimoraic foot**



Returning to the main thread of this section, it was seen that disyllabic feet in Paumari are simply reanalysed as bi-peak-moraic feet in MCI. Paumari is thus different from the so-called mora-sensitive iambic languages only in that it imposes a restriction on the types of moras from which feet can be built. The idea that some languages build feet from any binary sequence of moras (i.e. mora-sensitive ones) while others build feet only from a sequence of peak moras (i.e. mora-insensitive ones) can be related to Zec’s (2003) proposal about the sonority thresholds imposed on foot-heads by various languages.

While Zec’s proposal explains why some languages stress only non-high vowels, the idea of peak-moraic feet explains how, in certain other languages, a mora has to be associated with the unique sonority peak of a syllable for it to host a foot. Finnish, like Paumari, is such

¹⁸ Generalized trochees differ from generalized iambs only in making the leftward subordinate of a foot – syllable or peak-mora in the general case and mora in context-specific cases –, rather than the rightward one, prominent.

a language; and the word-initial trochaic foot which underpins primary stress in the language will be seen to be bi-peak-moraic in the next subsection.

5.2.2.2 Finnish

In Finnish (Kiparsky 1991; as cited in Kager 1992b), the initial syllable is stressed and the second syllable is not, without any regard to the amount of moraic material in either syllable. This suggests that the initial and pen-initial syllables together form (speaking in traditional metrical terms) a mora-insensitive trochaic foot in Finnish.

(5-31) Stress in Finnish

	<i>Syllables</i>	<i>Feet</i>	<i>Gloss</i>
a.	'lo.pe. ₁ te.ta	(¹ lo _μ .pe _μ)(₁ te _μ .ta _μ)	'finish (NEG)'
b.	'lo.pe. ₁ tet.ta.va	(¹ lo _μ .pe _μ)(₁ te _μ t _μ .ta _μ).va _μ	'to be finished'
c.	'teu.ras. ₁ ta.mo	(¹ te _μ u _μ .ra _μ s _μ)(₁ ta _μ .mo _μ)	'slaughterhouse'
d.	'lo.pe. ₁ tet.ti:n	(¹ lo _μ .pe _μ)(₁ te _μ t _μ)ti:n	'one finished'
e.	'puo.lus. ₁ tet.ta. ₁ vis.sa	(¹ pu _μ o _μ .lu _μ s _μ)(₁ te _μ t _μ .ta _μ)(₁ vi _μ s _μ .sa _μ)	'defensible'
f.	'o.loit. ₁ te.li.ja. na	(¹ o _μ .lo _μ i _μ t)(₁ te _μ .li _μ)(₁ ja _μ .na _μ)	'as a beginner'
g.	'lo.pe.te. ₁ ta:n	(¹ lo _μ .pe _μ)te _μ (₁ ta _μ :n)	'one finishes'
h.	'ra.kus.tu. ₁ nei.ta	(¹ ra _μ .ku _μ s _μ)tu _μ (₁ nei _μ .ta _μ)	'infatuated lovers'
i.	'lo.pet.ta.jai.set	(¹ lo _μ .pe _μ t _μ)ta _μ (₁ jai _μ .se _μ t _μ)	'concluding ceremonies'
j.	'lu.e. ₁ tut.te.lu. ₁ tel.la	(¹ lu _μ .e _μ)(₁ tu _μ t _μ .te _μ)lu _μ (₁ te _μ l _μ .la _μ)	'to gradually cause to have been read'

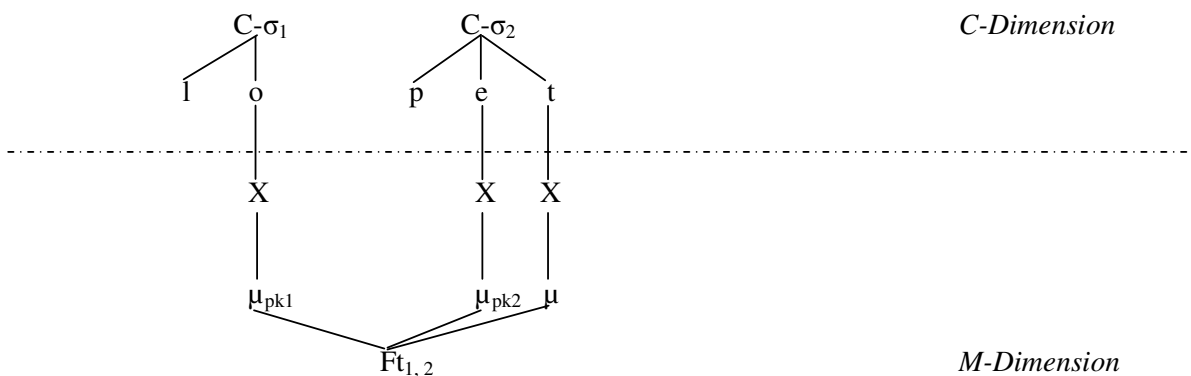
That the word-initial trochaic foot, realised as primary stress, is indeed mora-insensitive is confirmed by the fact that Finnish does have both monomoraic and bimoraic syllables. Furthermore, the binary moraic contrast among syllables partially influences how non-initial feet, realised as secondary stress, are built. This influence is revealed by the words in (5-31g-j), where a word-medial monomoraic CV syllable, immediately followed by a bimoraic (CV:, CVV or CVC) syllable, is not part of any foot.

Since the feet in Finnish must minimally span two moras, as seen from the middle column in (5-31), a word-medial CV syllable cannot be footed on its own because it is monomoraic. It may still be footed with another monomoraic syllable, as evinced by the final

and pre-final feet in (5-31f). A word-medial CV syllable cannot be footed with a following bimoraic syllable, however, because the resultant foot would be of the shape $[(\sigma_{\mu}\cdot\sigma_{\mu\mu})]$ – a canonical iamb but a poor trochee (see Prince 1990)!¹⁹ In summary, the word-medial CV syllables in (5-31g-j) are not footed so as to avoid monomoraic feet as well as non-initial trochaic feet of the shape $[(\sigma_{\mu}\cdot\sigma_{\mu\mu})]$.

The word-initial trochaic foot may be of the shape $[(\sigma_{\mu}\cdot\sigma_{\mu\mu})]$, however, lending further credence to the claim that it is built without any regard to the volume of moraic material in the initial syllable or the pen-initial syllable (see (5-31e-h)). It can also take the shape $[(\sigma_{\mu\mu}\sigma_{\mu\mu})]$, as exemplified by $[('te_{\mu}u_{\mu}.ra_{\mu}s_{\mu})]$ in (5-31c); or $[(\sigma_{\mu}\sigma_{\mu})]$, as exemplified by $[('lo_{\mu}.pe_{\mu})]$ in (5-31d, g). All word-initial trochaic feet have one thing in common, however: they span two syllables (in traditional metrical terms), each syllable having only one peak mora like all metrically relevant syllables do. Simply put, the word-initial trochaic foot evidenced in Finnish is bi-peak-moraic, as illustrated by the MCI representation of the initial foot in $[('lo_{\mu}.pe_{\mu}t_{\mu})ta.jai.set]$ ‘concluding ceremonies’: stress is realised on the C- σ containing [o] because [o] is associated with the leftward peak mora (μ_{pk1}), the trochaic head of the foot.

(5-32) **Disyllabic foot as bi-peak-moraic foot**



While the disyllabic foot, sketched above as a bi-peak-moraic foot, has the moraic shape $[\sigma_{\mu}\sigma_{\mu\mu}]$, disyllabic feet of other moraic shapes in Finnish may also be viewed as bi-peak-moraic feet. This is because every syllable has only one peak mora (on account of having one unique sonority peak), and any foot that spans two syllables must be built from two peak moras.

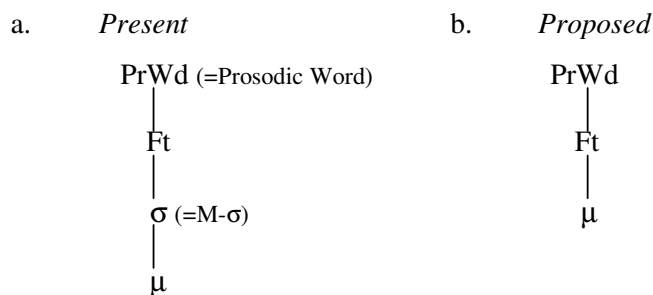
¹⁹ In Classical Latin, for example, potential feet of the shape $[(\sigma_{\mu}\sigma_{\mu\mu})]$ are changed to $[(\sigma_{\mu}\sigma_{\mu})]$ by a process known as *brevis brevians* or ‘iambic shortening’ (Mester 1994: 11-12).

Like in Paumari, however, monosyllabic feet are also realised as stress in Finnish, as evidenced by the final foot in [(lo.pe.te_μ(₁ta_{μμ}n)] ‘one finishes’. Although gathering [te_μ]_σ and [ta_μa_μn]_σ together would produce a surface foot with two peak moras, the result would be an undesirable trochaic foot in the shape of a canonical iamb i.e. [(σ_μ.σ_{μμ})]. Consequently, [ta_μa_μn]_σ forms a bimoraic (albeit mono-peak-moraic) word-final foot on its own and receives secondary stress. (The representation in (5-22) shows what such a foot would look like in MCI.)

A word-final bimoraic syllable in Finnish is not footed, however, if it is immediately preceded by a stressed syllable according to Kager (1992b). This can be seen from (5-31d) and is arguably a strategy to avoid stress-clash at the level of the syllable (Kager 1993). Lastly, word-final *monomoraic* syllables are not counted as feet either in MCI or in traditional moraic analyses because of the bimoraic foot minimum operational in Finnish.

This section has so far shown that feet can be directly built from moras in MCI (and the possibility can be countenanced in other theoretical models as well). A uniformly mora-based classification of feet across languages is thus possible, in lieu of the mora-and-syllable based classification currently available. Such uniform classification of feet in terms of moras ensures that feet can directly dominate moras in the Prosodic Hierarchy (5-33b), without the intervention of the M-σ (5-33a):

(5-33) **Prosodic Hierarchy**



While the M-σ in the Prosodic Hierarchy can, therefore, be dispensed with, it cannot be eliminated as a theoretical object. As the final part of this section shows, the M-σ is necessary to encode the phonological effect of the lengthening of melodies (i.e. addition of moras and segments to them) in trochaic languages.

5.2.3 Whence $M-\sigma$ s

In Chimalapa Zoque, a Mixe-Zoque language spoken in New Mexico, primary stress falls on the penultimate syllable of words, while the initial syllable receives secondary stress (in words with three or more syllables). This can be seen from the words in (5-34):

(5-34) **Stress in Chimalapa Zoque** (McCarrity 2003: 107, cited in Revithiadou 2004)

	<i>Syllabification</i>	<i>Feet</i>	<i>Gloss</i>
a.	$\text{,min.}'\text{ke}\text{?t.pa}$	$(\text{,min})(''\text{ke}\text{?t.pa})$	'he is coming again'
b.	$\text{,min.suk.}'\text{ke}\text{?t.pa}$	$(\text{,min.suk})(''\text{ke}\text{?t.pa})$	'they are coming again'
c.	$\text{,min.suk.ke}\text{?t.pa.}'\text{?it.ti}$	$(\text{,min.suk})\text{ke}\text{?t.pa}(''\text{?it.ti})$	'they were going to come again'
d.	'ho:.ho	$('\text{ho:.ho})$	'palm tree'
e.	,hu:.'ku:.ti	$(\text{,hu:})(''\text{ku:.ti})$	'fire'

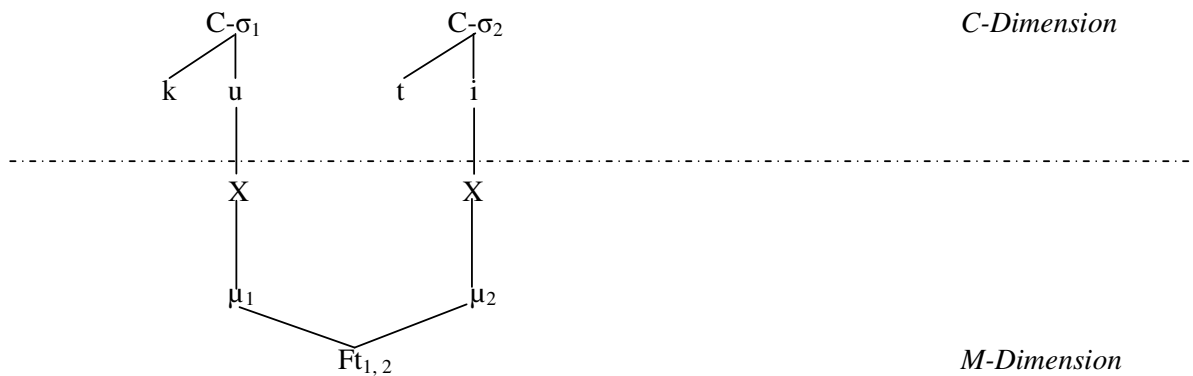
The stress pattern observed in the words in (5-34) can be explained by building two trochaic feet: one at the right-edge of words, accounting for primary stress, and another at the left-edge, accounting for secondary stress (cf. McGarrity 2003). One may further note that when there are three syllables in a word, the two rightward syllables combine into a primary-stress foot, while the leftmost syllable becomes a secondary-stress foot (see (5-34a, e)). This indicates that the final and penultimate syllables of a word are first gathered into a primary-stress foot. If a syllable (or two) remains at the left-edge of the word after the construction of the primary-stress foot, it is made the secondary-stress foot, as a comparison of (5-34d) with (5-34a, b, c, e) will show.

Despite the natural preference for building primary-stress foot first, all stressed syllables in Chimalapa Zoque are bimoraic, given that each of them has either a bimoraic long vowel or a monomoraic short vowel followed by a moraic consonant on the surface. More to the point, long vowels and post-vowel consonants occur only in stressed syllables in Chimalapa Zoque, highlighting the fact that stress determines the (moraic) length of syllables in the language.

Back to the trochaic feet in charge of stress in Chimalapa Zoque, they are easily captured in MCI. A monosyllabic foot such as $[(\text{'mi}_\mu\text{n}_\mu)]$ would be a bimoraic foot in the M-Dimension corresponding to one $C-\sigma$ in the C-Dimension (like (5-30)). A disyllabic foot such as $[(\text{'ke}_\mu\text{?t.pa}_\mu)]$ on the other hand would be a bi-peak-moraic foot which straddles two $C-\sigma$ s in the C-dimension (like (5-28) and (5-32); see also surrounding discussion).

The MCI-internal fate of a disyllabic foot with a long vowel, such as [^lku: _{μμ}.ti_μ] from (5-34e), can now be considered. Given that [u:] occurs in a stressed open syllable and stress in turn hinges on feet, the foot in question may be assumed to have the initial melodic shape [^lku_μ.ti_μ] – with two short vowels. In MCI, this is a simple bimoraic foot as seen below (also see (5-22)). The foot-initial mora (μ_1) is the trochaic head of the foot, and stress is consequently realised on the C- σ_1 containing the vowel [u], with which μ_1 is associated.

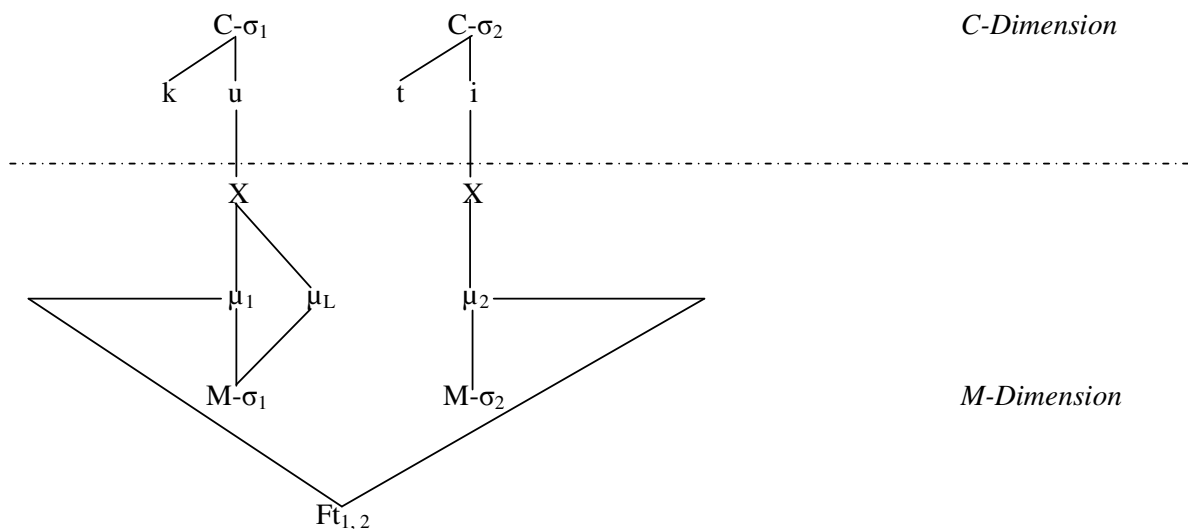
(5-35) **Disyllabic foot as bimoraic foot**



The lengthened appearance of [u] as [u:] on the surface does require an account, however. Hyde’s (2007) NONFINALITY constraint – which guards against stress corresponding to the foot-final mora – is of no avail here, since stress in a trochaic language like Chimalapa Zoque would never correspond to the final mora of a foot. More precisely, the NONFINALITY constraint in question is respected in trochaic systems even without lengthening anything. This can be seen from the representation above where stress corresponds to μ_1 , the non-final mora within the foot, and readily satisfies NONFINALITY.

The lengthening of [u] should, therefore, be regarded as a direct consequence of its place in a syllable that is stressed i.e. C- σ_1 in (5-35). The phonological effect of this lengthening is the association of [u] with a second mora (and X-slot). The effect cannot be encoded over C- σ_1 , however, because moras do not have a membership in the C-Dimension in MCI. Nor can it be simplistically explained as the lengthening of the stressed vowel within a foot because such an explanation incorrectly predicts the occurrence of long vowels even in closed stressed syllables. The effect has to be encoded, therefore, in terms of an object in the M-Dimension which corresponds to C- σ_1 , over which stress is melodically realised as noted above. In (5-36), that object is M- σ_1 .

(5-36) **Disyllabic foot as bimoraic foot**



The most important aspect of the representation in (5-36) is that the foot in it has ‘limbs’ on μ_1 and μ_2 (like in (5-35)) but not μ_L , the second mora associated with the lengthened vowel. This indicates that vowel lengthening in the case at hand has nothing to do with trochaic foot optimisation, as opposed to lengthening processes in iambic languages which typically have the canonical LH iamb as their target (Prince 1990, Hayes 1985: 80-5, Kager 1993, Hyde 2007, 2011). The conclusion, then, is that the M- σ is necessary to capture trochaic lengthening in MCI, though iambic lengthening can be explained even without it, purely in terms of moraic feet (see §5.2.1.2).

5.3 Chapter Summary

As the penultimate part of this dissertation, this chapter has attempted to sketch a generalised theory of the MCI, focusing firstly on the affiliation of segment-melody complexes within the model (§5.1). Melodic content, in this connection, was argued to belong to the C-Dimension and segmental X-slots to the M-Dimension. Secondly, a fully mora-based inventory of feet was shown to be possible under MCI, because feet in general – including those traditionally labelled as mora-insensitive feet – can be built from moras in the model (§5.2). A fully mora-based foot inventory is arguably more economical than a mixed inventory that accommodates both syllable- and mora-based feet because it has a smaller logical membership.

CONCLUSION

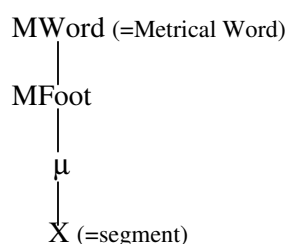
C.1 Implications and Significance of MCI

The Mora-Constituent Interface Model (MCI) is a model of syllable-internal structure wherein the melodic information pertaining to syllabified segment-melody complexes is reflected in the C-Dimension of syllables (Chapter 2), and the metrical relevance thereof is encoded (as moras) in the M-Dimension (Chapter 3). More simply, the C-Dimension of syllables can be viewed as a projection of melodies – whose features are themselves organised in terms of constituents (Clements 1985, Sagey 1986) – and the M-Dimension as a projection of segments under MCI (§5.1). This view entails that the segment-melody complex is the most basic prosodic unit there is in phonology.

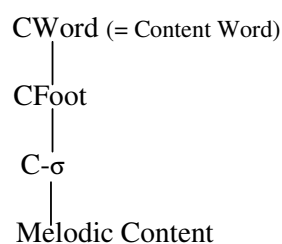
If the segment-complex is indeed the most basic prosodic unit, everytime a student of phonology transcribes a sound in the International Phonetic Alphabet, what she really does is transcribe a segment-melody complex. At a more advanced level, too, considering the segment-melody complex as the most basic prosodic unit has broad implications for phonological theory. It suggests, for example, the possibility of two prosodic hierarchies. The first is a metrical hierarchy (see (5-33b) and surrounding discussion): it originates from the segment, encodes metrical structure, and is relevant in the context of stress-assignment, tone-assignment etc (C-1a). The second is a (melodic) content hierarchy: this hierarchy originates from the melody and is supported by the fact that phonological processes targeting melodic features can be defined in terms of constituents larger than the syllable, i.e. C- σ (Harris 2012). One such process is English ‘tapping’ and Harris (2004) analyses it in terms of the foot – which (arguably) corresponds to the CFoot in (C-1b).

(C-1) Prosodic Hierarchies

a. *Metrical*



b. *Content*



The foregoing discussion makes it clear that MCI has far-ranging scope. Though essentially a model of syllable-internal structure, MCI sheds light on the composition of the most basic prosodic unit as well as the types of larger structures that can originate from that unit. This makes MCI a potentially sound theory of prosodic structure. The model has its limitations, however, and three of these are spelt out in the next section.

C.2 Limitations of MCI

The case for MCI is somewhat weakened by the fact that there are few telling examples from any single language (Kwakwala reduplication and English *shm* reduplication aside) which justify the separation of moras and constituents in two independent dimensions. Consequently, functional reasons (M-Dimension: metrically relevant, C-Dimension: melodically relevant) and mathematical ones (temporal objects in the M-Dimension and organisational ones in the C-Dimension) have been called on to justify the dimensions. The functional and mathematical reasons themselves are empirically grounded, however, as seen in §5.1.3.

A second limitation of MCI has to do with its adoption of X-slots as well as moras. Since both are temporal objects, the question whether both are necessary has been asked and will probably continue to linger. Within the confines of MCI, the question has been answered in the affirmative based on two arguments. Segmental X-slots do not mark melodies as metrically relevant, but moras do. Moras on the other hand are problematic, when viewed as markers of the underlying length of melodies, so X-slots encode the latter (see §4.1.2). The second point of the argument is easily countered, however, at least in Optimality Theory, where output segments can be moraic even if their input correspondents are not (Davis 2003).¹

A third limitation of MCI, as it is currently laid out, concerns syllabification. While syllable-internal structure has been discussed in some detail in the context of the two dimensions in MCI, how syllabification takes place in each dimension has not been discussed explicitly. Indeed, as briefly pointed out elsewhere in this dissertation, if the C-Dimension and the M-Dimension are to be considered truly independent, then the syllabification of sounds in the C-Dimension should be barred from having an effect on the syllabification of sounds in the M-Dimension; and *vice versa* (see §4.2.3). This can be ensured if

¹ This Optimality-theoretic counterpoint obviously sidesteps the problems which arise out of treating moras as encoders of melodic length (see Chapter 4, note 2).

syllabification of sounds takes place simultaneously in the C- and M-dimensions. The viability of simultaneous syllabification, however, remains to be ascertained.

C.3 Terminus

After the significance and limitations of MCI have been discussed and evaluated (for better or for worse), one can look at the model from two vantage points. If one starts with the syllable and queries how the internal structure of a typical syllable looks in MCI, the picture that emerges is somewhat complicated, with the C-Dimension and the M-Dimension meeting at (or interfacing through) the segment-melody complex. If one starts with segment-melody complexes, however, and ask what happens to them in MCI, the C-Dimension and M-Dimension dimension emerge simply enough. It may even be said that the segmental and melodic ends of a segmental-melody complex potentially carry two different dimensions of prosodic structure, just like the opposite ends of a battery emit two different charges.

APPENDIX I

Languages and language varieties discussed in this dissertation

Adhilabad Gondi (a dialect of Gondi)	§: 2.2.3, 2.4.2, 3.3.3
American English	§: 2.4.1
Bella Coola	§: 4.2.3
Cantonese	§: 1.4.1, 2.3.1
Chaoyang	§: 2.3.3
Chimalapa Zoque	§: 5.2.3
Chugach (dialect of Yupik)	§: 3.2.1
Chungli (dialect of Ao)	§: 1.4.1, 2.3.2, 3.3.2, 5.1.1
Dutch	§: 4.3.2
English	§: 2.1, 2.2.2, 3.3.1, 3.3.4, 4.2.2
Finnish	§: 5.2.2.2
Hindi	§: 3.2.4
Hixkaryana	§: 5.2.1.2
Hong Kong English	§: 2.5.1
Hopi	§: 4.3.3
Japanese	§: 3.4
Khalkha Mongolian	§: 3.2.3, 5.1.3.1
Kwakwala	§: 3.2.2, 4.2.1, 5.1.3.1
Latin	§: 1.4.2, 3.1.1
Leti	§: 4.1.2
Malaysian Cantonese	§: 3.1.2
Mandarin Chinese	§: 2.2.4
Palestinian Arabic	§: 4.3.1
Pattani Malay	§: 4.1.2
Paumari	§: 5.2.2.1
Sindhi	§: 3.2.3
Sixian Hakka	§: 2.5.2, § 5.1.3.2
Standard British English	§: 2.5.1
Syrian Arabic	§: 3.2.4, 5.2.1.1
Tamil (Spoken/Standard)	§: 1.4.2, 2.3.3, 2.4.3, 2.5.3-4, 3.3.5, 4.1.3, 5.1.1

APPENDIX II

Data from the reverse language project (GRF-HKBU250712)

Those normal-and-reverse renditions of the following words which have been cited in the main text (§ 2.5.1) are boxed below:

HKE-F

<u>Normal 1</u>	<u>Reverse 1</u>	<u>Normal 2</u>	<u>Reverse 2</u>	<u>Normal 3</u>	<u>Reverse 3</u>	
i:ərs	ə:rs.ji:	i: ə:rs	ə:rs.ji:	i:ə:s	ə:s.ji:	<i>ears</i>
kli:ə:	a:.kli:	kli:ə:	ə:.kli:	kli:ə	ə:.kli:	<i>clear</i>
pjuuə:	a:.pju:	pjuu.ər	ər.pjuu	pju:ə:	ə:.pju:	<i>pure</i>
tʃe:ə	ə:.tʃe	tʃe:ə:	ə:.tʃe	tʃe:ə:	ə:.tʃe:	<i>chair</i>
fi:ə:	a:.fi:	fi:ə:	ə:.fi:	fi:ə:	ə:.fi:	<i>fear</i>

HKE-M

<u>Normal 1</u>	<u>Reverse 1</u>	<u>Normal 2</u>	<u>Reverse 2</u>	<u>Normal 3</u>	<u>Reverse 3</u>	
iə:s	sə:.i:s	iə:s	si:.ə:.ri:	iə:s	si.ə:s	<i>ears</i>
kliər	ə:.kli:	kli:ə:	ə:.kli:	kliə:r	ə:.kli:	<i>clear</i>
pju:ə:	ə:.pi:w	pju:ə:	ə:.pi:w	pjoə:	ə:.piu	<i>pure</i>
tʃe:ə:	e:.tʃə:	tʃe:ə:	ə:.tʃe:	tʃe:ə:	ə:.tʃe:	<i>chair</i>
fe:ə:	i.eef	fiə:	i.ə:.f	fiə:r	ə:.fi:.	<i>fear</i>

APPENDIX III

Orthographic support for the Onset-Rhyme division

In a brief review of linguistic writing systems which denote syllables rather than just segmental melodies, Gnanadesikan (2008: 512-3) lists Bopomofo and Hmong as languages having orthographies which encode the Onset versus Rhyme distinction as well. Bopomofo has, apart from symbols for tones, separate symbols to denote pre-vowel consonants (C_{Onset}), short vowels (V), tautosyllabic vowel sequences/diphthongs (VV) and melodic sequences consisting of a vowel followed by a (nasal) consonant (VC). The Hmong orthography also has symbols standing for various pre-vowel consonants and consonant clusters (C_{Onset}), and a symbol each to represent the diphthongs [ia], [au] and [ai] and the VC sequence [ɛŋ].

The use of unitary symbols to represent VV and VC reflects, according to Gnanadesikan (2008), the status of VV and VC as Rhyme material (see § 2.3). A potential problem for this argument is the Tamil orthography, wherein unitary symbols represent combinations involving a pre-vowel consonant and a vowel (CV), and separate symbols denote post-vowel consonants: e.g. க [ka] த் [t] தி [ti] ‘knife’ from Tamil. The Devanagiri script in which Hindi is rendered is similar in using unitary symbols to denote CV sequences and separate symbols to denote post-vowel consonants: e.g. क [ka] म [ma] ल [l] ‘lotus’.

There is, however, a subtle but important difference between the unitary symbols representing VC/VV sequences in Bopomofo and Hmong, and those standing for CV sequences in Devanagiri and Tamil. The former are, according to Gnanadesikan (2008: 499), strictly unitary in that they cannot be decomposed into component symbols. The latter on the other hand can be decomposed into consonantal symbols and vocalic “appendages.”¹ The fact that symbols representing VV/VC combinations (Rhyme) cannot be decomposed, even as those representing CV combinations (Body) can be, arguably hints at the primacy of the Onset-Rhyme division.

The division is also supported by a slightly different type of evidence from the orthographic world. Among the writing systems reviewed by Gnanadesikan (2008), the Cherokee orthography and Linear B both have symbols to denote pre-vowel consonants but not (certain) post-vowel consonants. Before I argue how this orthographic asymmetry might support the Rhyme, however, here are some data.

¹ Except when the vowel in a CV sequence is [a], in which case the symbol representing the pre-vowel consonant alone is used.

In Linear B, pre-vowel consonant clusters in a syllable are rendered by repeating the symbol denoting the nuclear vowel of the syllable after the symbols standing for each of the consonants in the cluster. [tri] is thus rendered as [ti-ri], [kno] as [ko-no] and so forth (see Chapter 1, § 1.1). Post-vowel consonants on the other hand are never rendered in Linear B, as seen from the transliterations in the middle column below:

(AIII-1) **Linear B**

<u>Phonetic transcription</u>	<u>Transliteration of Linear B</u>	<u>Gloss</u>
tri.pos	ti-ri-po	‘tripod’
a.nam.pu.kes	a-na-pu-ke	‘without’
knos.sos	ko-no-so	‘place name’
ksun	ku-su	‘together with’
po.tni.a	po-ti-ni-a	‘lady’

In Cherokee, both pre-vowel consonants and post-nuclear consonants in a syllable are typically rendered in writing, as the transliteration in (AIII-2a) show. A post-nuclear glottal stop [ʔ] or fricative [h] is, however, not written, as seen from the transliterations in (AIII-2b).

(AIII-2) **Cherokee**

a. Vowels and consonant rendered

<i>Phonetic transcription</i>	<i>Transliteration</i>	<i>Gloss</i>
kaʔ.kwo:ki	ga-li-quo-gi	‘seven’
hi.jə.wi:ja:s	hi-yǝ-wi-ya-s	‘Are you Indian?’

b. Post-vowel glottal consonants not rendered

<i>Phonetic transcription</i>	<i>Transliteration</i>	<i>Gloss</i>
t ^h aʔ.li	ta-li	‘two’
suh.ti	su-di	‘fishhook’

Given that the Cherokee writing system and Linear B have symbols to denote all pre-vowel consonants but not all post-vowel consonants, it is logical to ask whether there are writing systems which have symbols to denote all post-vowel consonants but not all pre-vowel ones. The answer to that question seems to be negative.

In explaining the presence of the former type of writing systems and the absence of the latter, Gnanadesikan (2008) argues that “[...] the fact that most syllabaries allow only the

unmarked (C)V syllable shape in its signs can be considered a case of the Emergence of the Unmarked (TETU)...occurring in the domain of the written representation” (note 6, p. 508). While the TETU explanation is ingenious and persuasive, an alternative is available, too. It is based on the idea of segmental (or melodic, to be precise) dependence within syllables.

Languages which divide the syllable into Onset and Rhyme are, for example, far more common than languages which divide it into Body and Coda. Even in Korean, often cited as a typical Body-Coda language, some types of evidence point to an Onset-Rhyme split. The Onset-Rhyme division of the syllable predominates probably because the dependency between vowels and post-vowel consonants is stronger than the dependency between vowels and pre-vowel consonants, in actually occurring words in languages (see Myers 2015 and references in). Also, languages do not necessarily allow all the contrasts in post-nuclear position² that they allow in pre-nuclear position, reducing the number of post-nuclear consonants in them relative to pre-nuclear consonants.

The stronger lexical dependency between vowels and post-vowel consonants, coupled with the lower number of post-nuclear consonants vis-à-vis pre-nuclear ones in languages, suggests that the chances of correctly guessing a post-vowel consonant given a vowel are higher than the chances of guessing a pre-vowel consonant. In one sense, then, there is less to be ‘lost’ when post-nuclear consonants, rather than pre-nuclear ones, are omitted in writing. This probably explains why orthographic systems like Linear B and Cherokee do not represent (some or all) post-nuclear consonants, but faithfully denote all pre-nuclear ones.

Two cautionary notes are, however, necessary in summary. Firstly, the case made for the Onset-Rhyme division based on the absence, in some writing systems, of symbols to denote post-nuclear consonants; and the case made for it based on the type of symbols used to represent Rhyme material must be assessed separately. This is because the former evidence can be interpreted on strictly phonological lines as done above; but the latter requires reference to the fault lines of a phonology-orthography interface. Secondly, the case made for the Rhyme based on the orthographic ‘omission’ of post-nuclear consonants is, even when considered alone, tentative at best.

² Most famously, voicing contrasts are allowed among pre-nuclear stops, but not post-nuclear ones, in German (Itô & Mester 2003). Likewise, aspirated stops contrast with non-aspirated ones only in the pre-nuclear position in various varieties of Bangla; in the post-nuclear position the aspiration contrast is neutralised (Das 2010).

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