Optimal syllables are not always optimal: a prosodic structure of Yukaghir*

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1. Introduction

This paper has two objectives. It first presents a prosodic analysis of Yukaghir, a language not previously considered from this point of view.[1] I hope with this to enlarge the empirical base of prosodic research. The paper deals in particular with foot and syllable structure, following the basic assumptions of the prosodic morphology framework and the formalism of Optimality Theory. The analysis demonstrates that Yukaghir presents an unusual pattern: it prefers surface closed syllables to open syllables, which are universally thought to be optimal. My second goal, then, it to argue that such a situation is theoretically possible and can be accounted for by the constraint-based approach. I will show that this situation emerges when the grammar contains a very strong requirement for a bimoraic foot and a syllable to be aligned together. If this requirement dominates both syllable well-formedness and faithfulness to the input, closed syllables are preferred.

The paper is organized as follows. Since the material I will be addressing is neither easily accessible nor previously discussed in phonology papers, I will spend some time on descriptive issues. Section 2 presents the data on vowel deletion and lengthening in Yukaghir. In section 3 I show that these processes in fact apply only to one vowel, *ə*. The analysis of the morpheme types in section 4 reveals that in light syllables this is the only underlying vowel occurring after the leftmost foot. After introducing this data, I will be in a position to turn to prosodic analysis *per se*. Section 5 is dedicated to relevant prosodic constraints. Specifically, I will argue that a prosodic word must be continuously parsed into bimoraic feet from left to right. Sections 6 and 7 demonstrate how violations of this requirement are avoided. In order to satisfy foot well-formedness, word-medial light syllables are prohibited, and various repair strategies, such as vowel deletion and lengthening, apply. Furthermore, it will be argued that two adjacent light syllables, although theoretically able to form a bimoraic foot, are regularly transformed on the surface into one heavy syllable. I propose to capture this idea by introducing a constraint that crucially aligns both foot edges with edges of the same syllable. In the concluding section I suggest that such a constraint is conceivable in Universal Grammar, although it is normally ranked very low in the constraint hierarchy, and therefore does not operate in most languages.

2. Data

In this section, the relevant data are cited as in Kreinovich (1982). I transliterate his Cyrillic transcription, but do not change it essentially. Starting from section 3 I introduce my own transcription.

2.1. CV/C alternation in Yukaghir

Kreinovich (1979, 1982) was the first to show that in Yukaghir several inflectional and derivational morphemes realize in two allomorphs, C and Ce. According to Kreinovich, these are the following:

(1)	suffixes	Ce	C
	plural	-pe-	-p-
	intransitive denominal verb	-de-	-d-
	transitive denominal verb	-te-	-t-
	possessive denominal verb	-n^{y}e-	-n^y-

The morphemes that exhibit Ce/C allomorphy will be called "alternating suffixes." In fact, they include not only those listed in (1), but others not recognized as such by Kreinovich, in particular the future suffix *–te-/-t-* and the passive participle suffix *–me-/-m-*.

The distribution of the allomorphs depends, according to Kreinovich, on the type of root to which the suffix attaches (Kreinovich, 1982: 36). The so-called I class roots are followed by the allomorph Ce, while the II class roots are followed by the allomorph C. Examples (2) illustrate the contrast between the I class and II class nouns, while examples (3) show the same for the verbs.[2]

(2)

		plural	intransitive verb	transitive verb
I class				
nume	'house'	nume-pe	nume-de-	nume-te-
mino	'raft'	mino-pe	mino-de-	mino-te-
aŋa	'mouth'	aŋa-pe	aŋa-de-	aŋa-te
II class				
qorobo	'cow'	qorobo-p-	qorobo-d-	qorobo-t-
yaqte	'song'	yaqte-p-	yaqte-d-	yaqte-t-
ača	'reindeer'	ača-p-	ača-d-	ača-t

(3)

		future	passive participle + 3Sg –le
I class			
olo-	'steal'	olo-te-	olo-me-le
todi:-	'bite'	todi:-te-	todi:-me-le
a:-	'do'	a:-te-	a:-me-le
II class			
yo:do-	'play'	yodo-t-	yodo-m-le
londe-	'drop'	londe-t-	londe-m-le

The I class roots are said to end in *e, e:, i, i:, u, u:, a, a:, o, o:* (that is, any vowel in the Yukaghir inventory) or any of the consonants. The II class roots are those ending in *e, a, o*. So the surface final vowels *e*, *a, o* can be found finally in both classes.

Only one explanation of this data has been presented in the linguistic literature, and that was by Kreinovich himself. He suggested that the I class roots go back to old *e*-final roots, and the II class roots to old *a*-final roots. The historical development of root-final vowels is presented in the following way: **e* > *i, i:, u, u:, a, a:, o, o:, e, e:*; **a* > *e*, *o*, *a* (Kreinovich, 1979). This suggestion is based on the idea that Yukaghir is distantly related to the Uralic languages. Proto-Uralic is traditionally reported to have had two types of verbal and nominal roots, the so-called *e*-roots and *a/ä*-roots (e.g. Collinder, 1960). Extrapolating this statement, which is highly dubious in itself,[3] for the Yukaghir data, Kreinovich came to the conclusion that the two classes of Yukaghir roots go back to the same opposition.

This explanation is not satisfactory, either from an historical or synchronic perspective. Since Kreinovich does not cite a single Uralo-Yukaghir etymology supporting his claim, his comparison with Uralic is based only on a distant surface similarity, namely the presence of two types of roots.[4] It does not explain the variety of final segments in both classes, but merely suggests that all of them go back to only two elements for which no evidence exists. Nothing is said about the reasons and the contexts of these sound changes, so the proposal raises further historical questions. But even without taking into consideration the questionable method used in the comparison with Uralic, this analysis seems to be simply a restatement of the problem. Both the environment that conditions the Ce/C allomorphy, and its interaction with other phonological phenomena within the language, remain unclear.

Crucially, at least three further pieces of evidence suggest that the so-called I class roots and II class roots pattern differently in other respects as well. Some of them were mentioned by

Kreinovich in other contexts, others were not addressed at all. In no case does Kreinovich relate them to the Ce/C allomorphy. These pieces of evidence will be cited in the next section.

2.2. More data

First, I class and II class roots behave differently with respect to consonant epenthesis. When a vowel-initial morpheme follows the I class vowel-final root an epenthetic *-l-* is inserted (4a). The II class roots in the same environment lose their final vowel (4b), and so does the suffix Ce (4c):

(4)	(a)			resultative –o:l
		I class		
		yaqa-	‘come’	yaqa-l-o:l
		olo-	‘steal’	olo-l-o:l
	(b)	II class		
		yo:do-	‘play’	yo:d-o:l
		londe-	‘drop’	lond-o:l
	(c)	I class root + suffix -Ce-		
		nume-n^ye-	‘have a house’	nume-n^y-o:l

Second, the root-final vowel in the so-called II class roots and in the suffixes Ce is lengthened if followed by certain consonant-initial morphemes (other than the alternating suffixes Ce/C). The vowel is lengthened into *a:* or *e:* (this distribution will be commented on later in the paper). Examples are cited in (5b) and (5c). The I class roots remain unchanged when preceding any consonant-initial suffixes, that is, the root-final vowel of the I class roots does not lengthen as in (5a):

(5)	(a)			evidential -l^{y}el
		I class		
		yaqa-	'come'	yaqa-l^{y}el
		olo-	'steal'	olo-l^{y}el
	(b)	II class		
		yo:do-	'play'	yo:da:-l^{y}el
		londe-	'drop'	lond-a:-l^{y}el
	(c)	I class root + suffix –Ce-		
		nume-n^{y}e-	'have a house'	nume-n^{y}e:-l^{y}el

Finally, a word can include several adjacent alternating suffixes Ce/C, for example, the future suffix *-te-/t-* followed by the passive participle suffix *-me-/-m-*. According to the general rule, the allomorphs *-te-* and *-me-* attach the so-called I class root, and the alternants *-t-, -m-* follow the II class root:

(6)

		future	passive participle + 3Sg –*le*
I class			
a:-	'do'	a:-te-	a:-me-le
II class			
londe-	'drop'	londe-t-	londe-m-le

However, if the passive participle suffix is immediately preceded by the future morpheme, the former demonstrates the opposite alternation with respect to types of root. The allomorph *-m-* follows the future suffix *-te-* which in its turn follows the I class roots (7a), and the allomorph *-me-* follows the future suffix *-t-* attached after the II class roots (7b).

(7) future + passive participle + 3Sg -*le*

(a) a:-te-m-le Class I

(b) londe-t-me-le Class II

The data in (6) and (7) demonstrates that when several Ce/C suffixes follow each other the allomorphs alternate: Ce + C, or C + Ce. Two adjacent allomorphs of the same type (C + C, or Ce + Ce) are banned.

In the word-final position alternating suffixes appear as Ce, independent of the class of the root. For example, the future passive participle of the verb *a:*- 'do' without the 3Sg affix following it is *a:-te-me* 'will be done'. Compared to (7a), this form shows that the choice of the -

me-/-m- allomorphs is also influenced by its position within the word. This fact has not been made explicit and accounted for by Kreinovich.

2.3. Conclusion

The data in (4)-(7) demonstrates that the difference between the so-called I and II class roots determines other phonological processes in addition to those described in 2.1. In fact, it permeates the whole system of suffixation: it justifies the alternation of Ce/C suffixes, but is also relevant for non-alternating consonant-initial morphemes (5), and vowel-initial suffixes (6). The second important issue is that the allomorph Ce of the alternating suffix Ce/C triggers the same processes as the II class roots. Its final vowel (*e* in Kreinovich's transcription) is absent before the vowel-initial suffix (4c), lengthens before the consonant-initial suffix (5c), and triggers the C-shape allomorph of the following alternating affix (7a). This shows that it is not the type of root, but rather the segment immediately adjacent to the suffix that conditions the alternations. They are determined by the material immediately preceding, independent of whether it is part of the root, or part of the suffix.

3. Neutral vowel

Before suggesting my own analysis of the data in 2, in this section I will introduce a transcription different from that used by Kreinovich.

3.1. Changing the transcription

The vocalic inventory of Yukaghir includes 6 short vowels *a, e, o, ö, i, u* and their long correlates *a:, e:, o:, ö:, i:, u:*. Kreinovich claims that the I class roots end with any vowel, either short or long, while the root-final vowel in the II class roots is realized on the surface as *a, e,* or *o,* and the vowel-final allomorph of the alternating affixes ends in *e*. According to my own material, however, the phonetic quality of the final vowel in the II class roots and in the suffixes Ce varies for the same word among speakers. Most commonly it is pronounced as a central mid vowel ə.

The vowel ə can be characterized as a short underspecified non-high vowel that optionally harmonizes for features of roundness and backness. If the preceding syllables (the first two syllables in the word) contain non-high vowels many speakers tend to assimilate ə to them. This assimilation is sometimes treated as vowel harmony (Kreinovich, 1982; Jochelson, 1934: 158; Collinder, 1940: 9-10). However, it is highly optional, and at least in some idiolects ə remains a mid central unrounded vowel in all environments. Free and idiolectal variations such as those presented in (8) are possible:

(8)	[šoromo]	and	[šoromə]	‘man’
	[molojo]	and	[molojə]	‘mitten’
	[šaqala]	and	[šaqalə]	‘fox’

[a:ča]	and	[a:čə]	‘reindeer’
[ököčö]	and	[ököčə]	‘gulf’
[n^{y}anma]	and	[n^{y}anmə]	‘willow’
[te:ke]	and	[te:kə]	‘flying squirrel’

The transcription by Kreinovich of *ə* as a full non-high vowel is partly due to its distant assimilation (vowel harmony). On the other hand, it seems that Kreinovich, whose transcription is sometimes inaccurate, always recorded the full vowels *a, o, e* instead of *ə*, because they exist independently in the vocalic inventory of Yukaghir. However, even in his material variations are reflected: often the same word is recorded in two ways without him giving any particular reason (for example, in Kreinovich, 1982 both *a:ča* and *a:če* ‘reindeer; *touka* and *touke* ‘dog’ are found). His notation *e* must correspond to what I record as *ə*.

The data taken from the 18th and 19th century Yukaghir sources[5] also shows variations in transcribing the final vowel for the II class roots. In the same word, and often even when recorded by the same author, this vowel can be rendered as *a, o,* or *e,* cf.:

(9)	data of the sources	my transcription	
	SCH ača, aitscha, atsche, aača, aače, J a:če, a:ča	a:čə	‘reindeer’
	SCH unema, unama, oonomma, unemo, J unume	unemə	‘ear’
	SCH amda-, amde-, J amde-	amdə-	‘die’

SCH šoromo, soroma, šorome, šoromma, J šoromo	šoromə	'man'
SCH loda-, lode-, loode-, lioda-, J lodo-, loda-	yo:də-	'play'
SCH toweka, tabaka, tabake, towoka, towoko, J toboko	toukə	'dog'

Remarkably, such variations never occur with the I class roots, for which the final vowel is always given in the same way by all the authors, as illustrated in (10).

(10) data of the sources	my transcription	
SCH angga, anga, ananga, aŋga, aŋa, J aŋa	aŋa	'mouth'
SCH mogo, mongo, J moŋo	moɣo	'cap'
SCH kewe-, kebe-, kawe-, J kebe-	kebe-	'leave'

Although the transcription of practically all the authors dealing with the Yukaghir data is generally very inconsistent, the difference between (9) and (10) is significant.

As concluded in 2.3, the final vowel of the II class roots and of the Ce allomorph of alternating suffixes trigger the same phonological processes. For the alternating suffixes Kreinovich mostly records *e*, and therefore he describes "Ce/C allomorphy" (2.1). However, in his materials, as well as in other sources, variations in the transcriptions of the suffixes are reflected as well: SCH *kude-de-, kuda-da-*, J *kude-de-* 'kill'; KR *čoqo-yo, čoqo-ye* 'knife'; KR *tibo-ɣo-, tibo-γa-* 'blink' (in these examples suffixes are separated with a dash). The variations show that the suffixes contain the same neutral vowel and should be written as *–də-, -yə-*, and -

γə- respectively. CV allomorphs of alternating suffixes are in fact pronounced as Cə by most speakers.

An additional argument for treating the so-called II class roots as *ə*-final is provided by Russian loanwords in Yukaghir. The Russian nouns ending in an unstressed neutral vowel are all borrowed as II class roots, for example: *loškə* < Russian *ložka* [*lóškə*] 'spoon', *qorobə* < Russian *korova* [*karóvə*] 'cow', *terikə* 'wife, old woman'< Russian *staruxa* [*starúxə*] 'old woman'. On the other hand, the Russian words that have a final stressed full vowel are borrowed as I class roots: *mino* < Russian *vinó* 'wine', *šolna* < Russian (dialectal) *žolná* 'woodpecker', etc.

So, I propose that the II class roots as well as CV allomorphs of alternating suffixes should be reinterpreted as *ə*-final.[6] This proposal is based on the phonetic evidence, the evidence from the transcriptional variations in the sources, and of the Russian loanwords. The root-final and suffix-final *ə* trigger the same phonological processes, as shown in 2.2. I will therefore abandon the distinction made by Kreinovich between I and II class roots, and discuss the data in terms of the opposition "*ə* vs. a full vowel".

3.2. Is ə epenthetic?

As follows from section 2, the neutral vowel *ə* is either present or absent from the surface, and alternates with long vowels. There are two principal ways to account for its surface behavior. First, *ə* can be treated as underlying, in which case the Cə/C allomorphy and the alternations in (4) are instances of *ə*-deletion. Second, *ə* can be analyzed as an epenthetic vowel inserted after every second consonant. The underlying representation of the alternating suffixes in this case is simply C, and the so-called II class roots should be reinterpreted as consonant-final. In this section I will argue for the underlying status of *ə*, that is, for deletion analysis.

The crucial argument against epenthesis is that a phonological contrast between *ə*-final and consonant-final forms holds both for roots and suffixes. Roots CV:C and CV:Cə clearly contrast in the bare form.

(11)	(a)	po:yə	'pole'	a:rə	'baby's cloth'
	(b)	kö:y	'man'	qa:r	'skin'

The epenthesis analysis would imply that the *po:yə* and *a:rə* are derived from the consonant-final underlying forms */po:y/, /a:r/*. This solution fails to explain why the epenthesis applies to the consonant-final underlying forms in (11a) and does not apply in (11b). In suffixes a phonological contrast exists, for example, between the word-final passive participle suffix *–mə* and the 3Sg personal suffix of the transitive verbs, *–m*:

(12)	(a)	qartə-mə	'divide' + passive participle
	(b)	qartə-m	'divide' + 3Sg
	(c)	qartə-m-lə	'divide' + passive participle + 3Sg

(12c) shows that the passive participle suffix exhibits Cə/C allomorphy. In (12a) it appears as Cə because of its word-final position (see 2.2). However, the 3Sg suffix *–m* does not alternate and always surfaces as *–m* in the final position, therefore (12a) and (12b) contrast.

Epenthesis analysis fails to predict which hypothetical consonant-final roots exhibit a long vowel before the consonant-initial morpheme (5), and which do not. For the word *po:y(ə)* 'pole' a long vowel is present before the diminutive suffix *–de:* (*po:ya:-de*:), while for the word *kö:y* 'man' it is not (*köy-de:*). In any case one will have to postulate different underlying representations for these two roots. Moreover, under the epenthesis analysis the status of the long vowel (underlying vs. epenthetic) would require some additional discussion.

3.3. Conclusion

In this section I suggested that the so-called II class roots should be interpreted as *ə*-final, and similarly the affixes Ce should be written as Cə. I further concluded that in both roots and suffixes *ə* is underlying (in fact, there are reasons to believe that it appeared as a result of the historical reduction of the full non-high vowels). The crucial argument against the epenthesis analysis is that the environments for the epenthesis cannot be stated in phonological terms. This proposal permits a generalization to be made about the data in section 2: the alternations described there are due to the contrast between *ə* and the other vowels. Whether root-final or suffix-final, ə triggers the allomorphy of alternating suffixes (2.1), is deleted (4), or lengthened (5), while other vowels do not.

4. Morphemes

Using the transcription introduced in section 3, in this section I will explore the (syllabic) structure of morphemes, and the position of the vowel ə within the word.

4.1. Root types

A word in Yukaghir is morphologically a string "root + suffixes" (prefixation is only limited to two cases, neither entirely straightforward). The nominal root occurs in its bare form in the nominative singular, while the verbal root is normally followed by at least one inflectional suffix.[7] The root types given below present the nominative singular for nouns, and the uninflected stem for verbs. The original (non-borrowed) roots are either monosyllabic or bisyllabic. Trisyllabic stems, when they appear, are always the result of a certain derivational process, either synchronic or historical. The possible root types are presented in (13), where "V" means "any vowel not equal to ə." [8]

(13) (a) Monosyllabic roots (nouns):

(C)V: (C)V:C[9]

yo: ‘head’ qa:r ‘skin’

o: ‘pants’ kö:y ‘man’.

(b) Monosyllabic roots (verbs):

(C)V:-	(C)VC-
nö:- ‘laugh’	leg- ‘eat’.
o:- ‘scoop’	šar- ‘reach, cover’

(c) Bisyllabic roots (nouns and verbs):

(C)V:Cə(-)	(C)VCV(-)	(C)VCCə(-)
po:rə ‘spring’	mo♑o ‘cap’	yaqtə ‘song’
yo:də- ‘play’	mere- ‘fly’	londə- ‘drop’

The following generalizations can be made from (13).

(14) (a) monosyllabic roots with a short vowel are absent (*CV, *Cə)

(b) verbs CV:C- and nouns CVC are absent

(c) the syllable Cə is present only when following CV: or CVC

(d) by contrast, the syllable CV does not co-occur with CVC or CV:.

4.2. Affixes

Most affixes are monosyllabic. Apart from some special cases which are exceptional for different reasons and are not dealt with here, they fall within four major types (# means that the corresponding suffix occurs only word-finally):

(15)	I	C	II	Cə/C, Cə#
	III	CV:, CəC	IV	V:, V:C

The II type affixes are the alternating suffixes described in section 2.1; the allomorphy is determined by their lexical characteristics. Alternations do not occur in other types, for example, I type suffixes do not exhibit allomorphy and always surface as C. The suffixes Cə# seem to belong to the alternating type, but due to their fixed word-final position they are represented by only one allomorph (2.2).[10]

As follows from (15), the only short vowel found in suffixes is *ə*, so after the leftmost morpheme (the root) the vowels are realized only as long or as *ə*. This concerns only the underlying vocalism: epenthetic high vowels *i* and *u* may be present after the root as well, but vocalic epenthesis is not analyzed in this paper.

4.3. Conclusion

The data in (13)-(15) lead to the following observation: the vowel *ə* is in complimentary distribution with other short vowels. In the leftmost syllable, and in the second syllable following

CV (in the roots CVCV), only short vowels other than ə are allowed. The vowel ə appears elsewhere: after the second syllable (in the suffixes), and in the second syllable following CV: or CVC (in the roots CVCCə and CV:Cə).[11] Consequently, the syllable Cə is the only underlying syllable with a short vowel allowed after the complex CVCV, CV: or CVC. As was demonstrated in 2, on the surface the vowel ə undergoes certain phonological alternations, either deletion or lengthening. I will further argue that these processes can be accounted for in purely prosodic terms.

5. Prosodic well-formedness constraints

The purpose of section 5 is to introduce the apparatus that can account for the data cited in previous sections. It will demonstrate that certain prosodic constraints addressed in various places are motivated in the Yukaghir grammar as well.

5.1. Some theoretical assumptions

This paper follows the basic assumptions of a non-derivational constraint-based framework of Optimality Theory (OT) (Prince and Smolensky, 1993). In OT, the well-formed surface form is not assumed to be a result of serial rules applied to a unique representation. An underlying form produces an infinite set of outputs evaluated in parallel with respect to the constraint hierarchy. The output form is the candidate that satisfies the given constraints in the optimal way. The relationship between lexically specified input and surface output is accounted for by the correspondence (or faithfulness) constraints. Relevant for the paper will be the following correspondence constraints, which I take for granted (McCarthy and Prince, 1995b: 264-66):

(16) MAX-IO (or simply MAX) - Every segment in the input has a correspondent in the output.

DEP-IO (or DEP) - Every segment of the output has a correspondent in the input.

MAX-IO$_{\mu}$ (or MAX$_{\mu}$) - Every mora in the input has a correspondent in the output.

DEP-IO$_{\mu}$ (or DEP$_{\mu}$) - Every mora of the output has a correspondent in the input.

OT maintains the basic assumptions on prosodic structure advanced within the Prosodic Morphology framework, that is, the Prosodic Hierarchy: Segment - Mora - Syllable - Foot - Prosodic Word (McCarthy and Prince, 1993; McCarthy and Prince, 1995a: 320-321). The constituents higher than the prosodic word are not discussed here. Interaction between the prosodic categories, on the one hand, and between the prosodic and grammatical categories, on the other hand, is expressed by the family of alignment constraints generalized in the following format (McCarthy and Prince, 1993):

(17) *Generalized Alignment*

Align (Cat1, Edge1, Cat2, Edge2)=$_{def}$

✂ Cat1 👓 Cat2 such that Edge1 of Cat1 and Edge2 of Cat2 coincide

where

Cat1, Cat2 χ {grammatical and prosodic categories}

Edge1, Edge2 χ {Right, Left}

In (17) Cat1 is quantified as universal and Cat2 as existential. Accordingly, two different interpretations of the constraints on alignment between the two categories are commonly recognized:

(18) (a) ALIGN (PrWd L FT L)

(b) ALIGN (FT L PrWd L)

Constraint (18a) states that for each prosodic word there is a foot such that the left edge of the prosodic word aligns with its left edge, that is, it does not require that every foot should stand in initial position in the prosodic word. Constraint (18b) states that for each foot there is a prosodic word such that their left edges coincide. (18a) penalizes misalignment of the left edge of the prosodic word with some foot (for example, #♦(FT)#), while (18b) penalizes every foot not aligned with the left edge of the prosodic word (for example, the second foot in the configuration #(FT)(FT)#).

Making an assumption of the Prosodic Hierarchy need not entail that all output phonological elements must be directly dominated by a higher level constituent. Extraprosodic constituents fail to do so and remain prosodically unparsed if allowed by the corresponding alignment constraints. Parsing here is understood as the grouping of surface prosodic constituents into higher level constituents. Unparsed elements might be realized phonetically without being incorporated into the prosodic structure. This approach differs from the "Prosodic Licensing" view under which an unparsed constituent is a subject of deletion or reparsing, so that the output form consists only of properly parsed elements (Itô, 1989).

5.2. Moraicity of coda

The root types allowed in Yukaghir (13) demonstrate that the syllables CV: and CVC pattern similarly and differ from the syllable CV in the following respects:

(19) (i) they precede the syllable Cə in bisyllabic roots (14c);

(ii) they are ruled out as a second syllable in bisyllabic roots (14d);

(iii) they form a monosyllabic root (14a).

After Hayes (1989), the opposition between CV and CVC/CV: is usually formally represented as an opposition between light (monomoraic) and heavy (bimoraic) syllables. The heavy syllables pattern together in various phonological phenomena and are opposed to the light syllables in those languages where the coda consonant is moraic (the so-called Weight-by-Position effect).

In this paper, I will assume the moraic structure of vowels to be present at the level of the lexicon. Vowels come preassociated to moras in their input forms, as is proposed in Hayes (1989) and McCarthy and Prince (1993). They are inherently syllabic, and exhibit an underlying distinction in length. Onsets are universally not moraic, while moraicity of a coda consonant is a matter of language-specific constraints. In the Weight-by-Position languages, consonants receive a moraic representation when they syllabify into coda position in output forms. This view follows the approach of Hayes (1989) and differs from that suggested by Hyman (1985), where all the segments (vowels and consonants) start as moraic in the input.

Observe that syllabification in Yukaghir is straightforward. The following syllable well-formedness constraints, well motivated cross-linguistically, will be assumed: ONSET, NO-CODA and *COMPLEX (Prince and Smolensky, 1993, McCarthy and Prince, 1993). ONSET requires that syllables have consonant onset, NO-CODA prohibits codas, and *COMPLEX states that no more than one consonant is associated with one syllable position. ONSET and NO-CODA are violable in Yukaghir (see below), while *COMPLEX is not, so that tautosyllabic consonant clusters are totally disallowed.

The generalizations in (19) are the primary evidence for the moraicity of the coda in Yukaghir.

As the approach adopted here initially assumes the underlying non-moraicity of consonants, the moraic coda is input-unfaithful. The Weight-by-Position effect follows if the constraint that requires moraic codas dominates the constraint that prohibits the insertion of a non-input mora (DEP_{μ}) in the constraint hierarchy. Such a constraint (as introduced in Sherer, 1994 for different purposes) will be formulated here as the right alignment of the syllable and the mora:

(20) ALIGN (σ R μ R) - the right edges of the syllable and the mora align

(20) ensures that the right edge of each syllable is aligned with a moraic segment (a nucleus or a coda). Given the evidence in (19), I suggest that it is undominated in the Yukaghir grammar. The word-final consonant will be discussed in 5.5.

5.3. Foot Binarity

With the idea that the coda consonant is moraic, the root types in (13) can be represented in moraic terms. While monomoraic roots (CV) are totally banned, most of the roots are bimoraic (CVC-, CV:, CV:C or CVCV), and all the other roots are $\sigma_{\mu\mu}$ + Cə (CVCCə or CV:Cə). The absence of monomoraic minimal words is motivated cross-linguistically by two constraints: LxWd=PrWd and Foot Binarity (McCarthy and Prince, 1995a: 320-24). LxWd=PrWd demands that every lexical word corresponds to a prosodic word (Prince and Smolensky, 1993: 101).[12] Given the Prosodic Hierarchy, this means that every lexical word is at least one foot long and the minimal word is exactly equal to the foot. Foot Binarity is formulated as follows:

(21) FT BIN - feet are binary under syllabic or moraic analysis (McCarthy and Prince, 1995a: 321)

In the case of Yukaghir, which lacks prefixation, the prosodic word is equal to the root, followed by all derivational and inflectional suffixes. The root types in (13) demonstrate that the foot in Yukaghir is binary with respect to moras. Moraic Foot Binarity together with LxWd=PrWd rules out the monomoraic roots CV.

Importantly, in the nominal roots CV:C and suffixes V:C the vowel does not always surface as long. It appears short in the course of morphological derivation if the following morpheme is consonant-initial. In the roots CV:, on the other hand, the vowel is always long, cf. (22a) and (22b):

(22)

			ablative -gət
(a)	o:	'pants'	o:-gət
	yö:	'belt'	yö:-gət
(b)	ša:l	'tree'	šal-gət
	pa:y	'woman'	pay-gət

The alternation in length can be accounted for by Foot Binarity, in combination with the constraint on the right alignment of the syllable and the mora (20) and the right alignment of the foot and the syllable, formulated as follows:

(23) ALIGN (FT R σ R) - the right edge of each foot aligns with the right edge of some syllable

(23) is functionally similar to the principle of Syllable Integrity (Hayes and Lahiri, 1991). It prohibits a foot from splitting syllables and being aligned with the non-syllabified segment.

Word-internal trimoraic CV:C syllables are ruled out by Foot Binarity. On the other hand, if the coda does not receive a mora, this violates ALIGN (σ R μ R). A word-internal consonant that remains outside the foot is prohibited by (23), as shown in tableau (24) below.[13]

(24) Output: *šal-gət* 'tree' + ablative

	FT BIN$_\mu$	ALIGN (FT R σ R)	ALIGN (σ R μ R)
a. (ša:l$_\mu$)(gət)	*!		
b. (ša:)l$_\mu$(gət)		*!	
c. (ša:l $_{-\mu}$)(gət)			*!
d. (šal$_\mu$)(gət) ϕ			

Thus, word-internal syllables CV:C are banned. The alternation in vowel length in (22b) can in principle be described either as vowel shortening in the ablative, or as vowel lengthening in the bare form. Since it is not entirely clear whether the underlying representation here exhibits a short or a long vowel, I do not discuss Input-Output correspondence constraints at this stage. In other words, it is not entirely clear whether we are here dealing with a violation of MAX$_\mu$ or DEP$_\mu$. In both cases (independent of what we assume to be the underlying representation), Foot Binarity, ALIGN (FT R σ R), and ALIGN (σ R μ R) should overrank the correspondence constraints in the constraints hierarchy.

The related question of why the root CV:C is allowed when it is not followed by any affixes will be addressed in 5.5.[14]

To sum up, Foot Binarity operating on moras in combination with LxWd=PrWd accounts for the absence of monomoraic roots, and in combination with the alignment constraints accounts for the absence of word-internal syllables CV:C.

5.4. Directionality of foot parsing

One of the parameters of foot parsing is directionality, that is the left-to-right or right-to-left direction of foot construction. The directional footing effects are best captured by the constraint (a member of the Generalized Alignment family) which requires the alignment of feet with the left or the right edge of the prosodic word (Prince and Smolensky, 1993:103-4; McCarthy and Prince, 1993).

One piece of evidence for left-to-right directionality in Yukaghir is provided by the distribution of the vowel ə. I have argued in section 4 that ə and the other short vowels are distributed in a complementary manner. Using the concept of mora the distribution can be expressed in the following way: the two leftmost moras do not dominate ə, whereas they do dominate the other short vowels. This generalization can be stated in a more economical way adopting left-to-right foot parsing. Then, a full short vowel is present only in the leftmost foot, while ə is present after the leftmost foot. Right-to-left directionality is undesirable, because the left word boundary and the foot boundary would not necessarily align, and the generalization regarding the distribution of ə vs. the other short vowels could not be captured.

Thus, the distribution of ə in the word leads to the formulation of the left-to-right directionality of foot parsing. The left edge of the prosodic word always aligns with the left edge of a foot. This, in its turn, can be formulated either as a requirement on the left alignment of the initial foot (in format (18a)), or as a requirement on the left alignment of all feet in the prosodic representation of the word (in format (18a)). I will employ the first option here. The formulation (18a), which specifies the left alignment of the initial foot, is repeated as (25).

(25) ALIGN (PrWd L FT L) – the left edge of every prosodic word is aligned with the left edge of some foot

Section 6 will demonstrate that Yukaghir allows multiple feet. Left alignment (25) as such does not ensure that as many syllables as possible are assigned to feet. Another constraint determines whether footing is iterative or non-iterative and imposes dominance relationship between syllables and feet by requiring syllable-to-foot parsing:

(26) PARSEσ - all syllables must be parsed by feet

Importantly, if foot-prosodic word alignment is formulated as a constraint on the initial foot ((18a)=(25)), the mutual ranking of (25) and (26) is irrelevant in determining whether footing is iterative or not. However, if the left alignment is expressed as a requirement for all feet to be aligned with the left edge of the prosodic word (as in (18b)), the iterative vs. non-iterative footing depends on the mutual ranking of (26) and (18b). Multiple footing follows only when

PARSEσ dominates ALIGN (FT L Pr Wd L) (McCarthy and Prince, 1993; Crowhurst and Hewitt, 1995). Such an analysis would appear to present a difficulty for Yukaghir: in section 7.3 I will show that PARSEσ is ranked lower than correspondence constraints, while section 5.5 presents evidence that the left alignment constraint is superior. This contradicts the dominance, implied by iterative footing, of PARSEσ over the left alignment constraint. For this reason the left alignment constraint was chosen in format (25).

A drawback of using (25), however, is that an additional constraint on alignment of non-initial feet is necessary. This is because constraint (25) in combination with (26) would not ensure the alignment of non-initial feet, i.e. would not differentiate between candidates FT FT ♦ and FT ♦ FT (the formulation in (18b) would do this work as well). However, as I will argue in 6.1, the foot parsing is continuous, and no unfooted material is tolerated between two feet. This idea is formulated as foot-to-foot alignment: [15]

(27) ALIGN (FT1 ♋ FT2 -♋) (or simply ALIGN (FT FT)) – the edge of the foot is aligned to the opposite edge of the adjacent foot

Violations of (27) will be assigned to every word-internal unfooted constituent (syllable or segment). Constraint (27) together with PARSEσ and Initial Foot (25) ensures the continuous left-to-right parsing without overlapping feet and unparsed material word-internally. It does not, however, prohibit unfooted material at the edge of the prosodic word (the right edge, in this case). With the formulations adopted in (25)-(27), any ranking of these three constraints leads to this result.

Such an analysis is consistent with the usual claim that the extraprosodic units are limited to the edge of the corresponding domain (Prince and Smolensky, 1993: 38; Blevins, 1995: 223; Kager, 1995: 379). The notion of "extraprosodicity" is not actually used here, but the same result is only achieved through the interaction of several prosodic well-formedness constraints. This seems to be in line with the suggestion that extrametricality (extraprosodicity) is not in fact a "unified entity, but rather a family of consequences of the gradience of EDGEMOSTNESS" (Prince and Smolensky, 1993: 45).

5.5. Word-final consonant

Although a word-internal syllable CV:C is banned by Foot Binarity (5.2), it is found at the right edge of the word. This fact can be accounted for if the word-final consonant is not dominated by a mora, so the syllable CV:C# is strictly bimoraic.

Under the approach adopted here, the moraicity of the coda follows from the combination of alignment constraints (5.2). The first consonant in the word-internal cluster must be syllabified as a coda, given that complex onsets are forbidden. Furthermore, two alignment constraints predict that it cannot remain outside the syllable: foot-to-foot alignment (27) and the right alignment of the foot and the syllable (23). Foot-to-foot alignment justifies continuous foot parsing and prohibits unfooted word-internal material. Together with ALIGN (FT R σ R) it entails that no word-internal segment remains unsyllabified. The non-moraic coda consonant is prohibited by syllable-to-mora alignment. Tableau (28) illustrates how the alignment constraints guarantee the moraicity of the coda even at the expense of the violation of faithfulness (of DEP_μ in this case).

(28) Input: CVC.CV

	ALIGN (σ R μ R)	ALIGN (FT FT)	ALIGN (FT R σ R)	DEP_μ
a. $CVC_{-\mu}$.)(CV	*!			
b. CVC_μ .)(CV ϕ				*
c. CV.)C_μ (CV		*!		*
d. CV.)$C_{-\mu}$ (CV		*!		
e. CV.C_μ)(CV			*!	*
f. CV.$C_{-\mu}$)(CV			*!	

So the coda is moraic only by virtue of being aligned with the right edge of the syllable and the foot. By contrast, for the word-final consonant there is no requirement to be dominated by the foot (5.4). Consequently, it is not required to be within a syllable either (the constraint ALIGN (FT R σ R) does not apply in this case). Given that no syllables and feet are involved, ALIGN (σ R μ R) is irrelevant as well. The word-final consonant is then optimally non-moraic: it does not violate any alignment constraints, and is completely input-faithful (does not violate DEP_μ).

In sum, (28) shows that the word-internal coda consonant must be moraic in order to be incorporated into the syllable and the foot, and therefore satisfy continuous foot parsing and foot-syllable alignment. Alternatively, the word-final consonant is non-moraic because this does not violate continuous parsing, and provides a faithful candidate. The crucial difference is that it does not need to fulfill the requirements of the highly ranked alignment constraints.

The extraprosodicity of the word-final consonant explains the difference between the monosyllabic nominal and verbal roots (14b). Nominal roots in a bare form are CV: and CV:C. Word-internally, the syllable CV:C is ruled out by Foot Binarity, but the bare form CV:C is easily “ruled in” as a well-formed bimoraic foot given the non-moraicity of the word-final consonant. This conditions the alternation in vowel length for nouns (22). On the other hand, verbal roots always take suffixes, so the bare root is never equal to a lexical word. Since verbal roots do not appear in a bare form, they do not impose a requirement of bimoraicity. As a result, alternation in vowel length is not observed for verbal roots.

5.6. Summary

The constraints discussed 5.2-5.5 are surveyed in (29) below. Their mutual ranking and their ranking with respect to the correspondence constraints will be discussed in sections 6 and 7.

(29)

Constraint	Formulation	Accounts for
a. ALIGN (PrWd L FT L)	the left edge of the prosodic word aligns with the left foot edge	distribution of ə
b. ALIGN (σ R μ R)	the right edge of syllable and the mora align	Weight-by-Position effect
c. ALIGN (FT R σ R)	the right edge of the foot and of the syllable align	continuous syllabification
d. LxWd=PrWd	the lexical word corresponds to the prosodic word	every word is prosodisized
e. FT BIN$_{\mu}$	the foot is binary under moraic representation	foot shape, word minimality

f. PARSEσ	all syllables must be parsed by feet	iterative footing
g. ALIGN (FT FT)	the foot edge aligns with the opposite edge of another foot	continuous footing

6. ə-lengthening and ə-deletion

In sections 6 and 7 I return to the data presented in section 2.

6.1. Word-medial light syllables

If represented moraically, the morpheme types from (13) and (15) are: (a) monosyllabic and bimoraic; (b) bisyllabic bimoraic; (c) bisyllabic containing one bimoraic syllable and a monomoraic Cə; and (d) C or Cə.

(30) (a) $\sigma_{\mu\mu}$ (roots and affixes) (c) $\sigma_{\mu\mu}$ + Cə (roots)

(b) σ_{μ} σ_{μ} (roots) (d) C, Cə/C (affixes)

Most morphemes are strictly bimoraic ((30a) and (30b)): the morpheme and foot boundaries align. In the course of suffixation, when only these are present in the word, the word appears to be exhaustively parsed into bimoraic feet. When the word in addition contains non-bimoraic morphemes ((30c) and (30d)), the bimoraic morphemes (30a) and (30b) necessarily have also to each be parsed as separate feet. Bimoraic monosyllabic morphemes (30a) are aligned with a foot by the principle of Syllable Integrity (or, under the approach adopted here, the constraint ALIGN (FT R σ R), see 5.5). Bimoraic bisyllabic roots (30b) have to be parsed as one foot due to their leftmost position in the prosodic word and the constraint on the initial foot (24).

A parsing problem arises with the light syllables Cə found in (30c) and (30d). Theoretically, the underlying light syllables can be located in the following three positions:

(31) (a) word-finally: Cə#

(b) one Cə between two morphemes (feet): ...(FT)Cə(FT)...

(c) two or more Cə syllables between two morphemes (feet): ...(FT)CəCə(FT)...

Pattern (31a) is regularly present on the surface and will be dealt with later in section 7.3. On the other hand, and crucially for the purpose of this paper, outputs (31b) and (31c) are never found, that is, word-internal light syllables between two feet are banned. The fact that light word-medial syllables are avoided is of the particular importance for my analysis.

The surface absence of (31b) has several important implications. First, it provides primary evidence that footing is indeed iterative. If the word contained only one foot, the absence of (31b) would remain unexplained. Second, it suggests that both a degenerate monomoraic foot and a trimoraic foot are avoided. They are ruled out by Foot Binarity, which will be assumed to be unviolable on this ground. Finally, unfooted material between two feet is banned as well (as in (FT)Cə(FT)). This clearly follows from the constraint ALIGN (FT FT) and presents a piece of evidence for it being unviolable.

So the absence of (31b) supports continuous parsing and the inviolability of Foot Binarity and foot-to-foot alignment. In order to be properly footed, the underlying light syllable in (31b) should be transformed into a bimoraic syllable (assuming that deletion of the syllable is not a satisfactory option). Various strategies apply to avoid the surface occurrence of light syllables between two well-formed feet, and I will show in this section that they are precisely those alternations that were described in section 2.

Situation (31c) will be specially discussed in section 7.

6.2. Deletion of ə

This section aims to provide an account for the data in (4) partly repeated in (32). Two different devices are used to avoid vowel clusters: consonant epenthesis and vowel deletion. The resultative suffix *-o:l* immediately follows the consonant-final root in (32a), while in (32b) an epenthetic *l* is inserted between this suffix and the vowel-final root.

(32)			resultative -o:l
(a)	mon-	'say'	mon-o:l
(b)	olo-	'steal'	olo-l-o:l

(32b) demonstrates that onsetless syllables are not tolerated word-medially.[16] Cross-linguistically the problem of ONSET is solved either with vowel deletion or with consonant epenthesis (McCarthy and Prince, 1993: 18-19; Prince and Smolensky, 1993: 94). Yukaghir exhibits the second possibility (32b) which motivates the ranking {ONSET, MAX($_{\mu}$)} >> DEP. The notation MAX($_{\mu}$) here means that either MAX or MAX$_{\mu}$ must overrank DEP.

However, (33) shows that for the syllable Cə vowel deletion in the case of ONSET violation is preferred to consonant epenthesis, in contrast to (32b):

(33)

		resultative –o:l
yo:də-	'play'	yo:d-o:l
qartə-	'divide'	qart-o:l
kude-də-	'kill'	kude-d-o:l

The difference between (32b) and (33) follows from the interaction of ONSET with the requirements of foot well-formedness. (32b) can be properly footed as *(olo)(lo:)l.* For potential epenthesized forms in (33) (for example, **qartə-l-o:l*) there is no parsing that would satisfy foot well-formedness because the light syllable Cə cannot be properly parsed when it is located between two well-formed feet. As can be seen from (34), either FT BIN$_{\mu}$, or continuous foot parsing will always be violated.

(34) Input: *qartə-o:l* 'divide' + resultative

	FT BIN$_{\mu}$	ALIGN (FT FT)
a. (qar)(tə)([l]o:)l	*!	

b. (qartə)([l]o:)l	*!	
c. (qar)(tə[l]o:)l	*!	
d. (qar)tə([l]o:)l		*!

Thus, epenthesis does not apply because the resulting form would be ill-formed with respect to foot parsing. In this situation there are two possible candidates that have the potential to be properly footed: *qarta:lo:l* (epenthesis in combination with *ə*-lengthening, i.e. violation of DEP and DEP$_{\mu}$) and *qarto:l* (*ə*-deletion, i.e. violation of MAX and MAX$_{\mu}$). The latter possibility wins. As was argued above, MAX($_{\mu}$) must dominate DEP. This motivates the splitting of the constraint and DEP into two constraints, operating on segments and on moras respectively, as illustrated in (35).

(35) Input: *qartə-o:l* ‘divide’ + resultative

	DEP$_{\mu}$	MAX($_{\mu}$)	DEP
a. (qar)(ta:)([l]o:)l	*!		*
b. (qar)(t< >o:)l ϕ		**	

To conclude, consonant epenthesis prevents the violation of ONSET if the resulting output form can be properly parsed into feet (MAX($_{\mu}$) >> DEP). However, when epenthesis causes the violation of foot constraints, it does not apply and vowel deletion is preferred. This is important because it shows that the foot well-formedness constraints FT BIN$_{\circ}$ and ALIGN (FT FT) dominate all the correspondence constraints.

6.3. Lengthening of ə

This section analyses the data in (5). According to (5), ə undergoes lengthening when a ə-final root or suffix is followed by a consonant-initial bimoraic suffix CəC or CV:. I illustrate this again in (36) with the diminutive suffix *-de:*. In (36a) it follows a consonant-final bimoraic root or a bisyllabic bimoraic vowel-final root. The resulting form is exhaustively parsed into binary feet. In (36b) the diminutive suffix follows the ə-final root. The leftmost syllable is bimoraic, so it constitutes a well-formed foot. The diminutive suffix forms a bimoraic foot as well. The syllable Cə, when located between two well-formed feet, undergoes lengthening:

(36)				diminutive –de:
	(a)	mo♑o	'cap'	mo♑o-de:
		qa:r	'skin'	qar-de:
		eye	'bow'	eye-de:
	(b)	na:čə	'face'	na:ča:-de:
		yaqtə	'song'	yaqta:-de:
		pe:yə	'cheek'	pe:ye:-de:

The lengthening of *ə* in (36b) is another strategy to avoid a word-medial light syllable that cannot be properly footed. As it is easy to see, the faithful candidates **yaqtəde:* are ruled out by Foot Binarity and ALIGN (FT FT) independently of the way they are parsed. The reason that *ə*-deletion does not apply is that it would create a trimoraic foot at the left edge, such as **(na:č)(de:), *(yaqt)(de:),* etc., which is also ruled out by Foot Binarity.

A well-formed output could have been provided by a consonant epenthesis: **(yaq)(tə[l])(de:).* However, it provides violations of both DEP and DEP_{μ}, and it additionally violates NO-CODA.[17] In the output form *ə* undergoes lengthening. It should be stressed that there is no long *ə*. The neutral vowel always lengthens either to *a:* or to *e:* harmonizing to the full vowels present in the initial foot for the feature of backness. As mentioned above, I treat *ə* as a short vowel specified only as [-high]. The harmonizing *a*: and *e*: are long vowels also underspecified with respect to backness. With this understanding the schwa lengthening simply provides a mora to the vowel rather than bringing out a change of vowel features (non-identity of quality), so it violates only DEP_{μ}.

The choice between epenthesis and lengthening is shown in (37).

(37) Input: *yaqtə-de:* ‘song’ + diminutive

	DEP$_{\circ}$	DEP	NO-CODA
a. (yaq)(tə[])(de:)	*	*!	*!
b. (yaq)(ta:)(de:) ϕ	*		

Thus, ə-lengthening is another strategy aimed at continuous left-to-right parsing into bimoraic feet. It applies only when vowel-deletion would lead to the violation of foot well-formedness, since otherwise mora-deletion is preferred to mora-insertion (DEP$_{\circ}$ >> MAX$_{\circ}$). This confirms again that foot well-formedness constraints (Foot Binarity and foot-to-foot alignment) are ranked higher than the correspondence constraints in the Yukaghir grammar.

6.3. Conclusion

I have demonstrated that ə-lengthening and ə-deletion described in 2.2 are two strategies that lead to the satisfaction of the main prosodic requirement of Yukaghir, the continuous left-to-right parsing into bimoraic feet. This requirement is very strong and overrides all correspondence constraints. The discussion in this section has shown that mora-deletion (ə-deletion) is normally preferred to mora-insertion (ə-lengthening), however, the deletion does not apply if it could lead to the violation of foot well-formedness. The relevant hierarchy is presented in (38).

(38) {FT BIN_{μ}, ALIGN (σ R μ R), ALIGN (FT R σ R), ALIGN (PrWd L Ft L), ALIGN (FT FT)} >> DEP_{μ} >> $MAX_{(\mu)}$ >> DEP

Hierarchy (38), together with the structure of the Yukaghir lexicon (30), ensures that no word-internal light syllables are found after the leftmost foot.

7. Foot-syllable alignment

In this section I will focus on Cə/C allomorphy and show that it is conditioned by prosodic rather than segmental requirements. Its analysis requires an additional prosodic principle, not discussed above.

7.1. The constraint FT=σ

As argued in section 6, an isolated underlying light syllable cannot be included in the foot structure and undergoes various changes. However, the continuous foot parsing as formulated so far does not alone explain the absence of two or more adjacent word-medial light syllables Cə (31c). Such syllables can be properly dominated by a bimoraic foot, so that continuous footing would be satisfied. This is not the case: as shown in 2, two adjacent (word-internal) Cə allomorphs are prohibited. The underlying word-internal string CəCə is always realized on the surface as one heavy syllable CəC.

Since nothing so far discussed accounts for this crucial fact, I suggest an additional constraint on foot-syllable alignment with the following formulation:

(39) FT=σ - the foot corresponds to the syllable

By (39) each foot must dominate exactly one syllable. Both edges of the foot align with the edges of the same syllables, so the previously introduced right foot-syllable alignment constraint ALIGN (FT R σ R) is, in fact, redundant. Because (39) prohibits two light syllables from being parsed into a foot, it rules out the surface occurrence of (31c). As a result, the word appears to be continuously parsed into bimoraic monosyllabic feet.

The following point must be taken in consideration at this stage. An apparent violation of (39) is provided by the bisyllabic roots CVCV. I will ignore this violation here, but my general belief is that it may be explained by some variation of the principle of Root Integrity, which prevents deletion of a segment within the root. I will spend the remainder of section 7 studying how (39) works in Yukaghir grammar.

7.2. Analysis of Cə/C alternations

As argued in section 2, the distribution of allomorphs Cə vs. C occurs in an alternating manner: the allomorph C follows *ə*, while Cə follows all other segments. In the word-final position only Cə shows up:

(40) ə - C – Cə - C – Cə ... Cə#

V/C – Cə - C – Cə - C ... Cə#

This is exemplified again in (41) with the future suffix *-tə-/-t-* followed by the passive participle suffix *-mə-/-m-* and then by the 3Sg suffix *-lə*. The latter, being word-final, does not exhibit allomorphy, while the distribution of the *-tə-/-t-* and the non-final *-mə-/-m-* occurs on the basis of the pattern in (40):

(41)

		future+passive participle	future+passive participle+3Sg-lə
(a) ono-	'steal'	ono-tə-mə	ono-tə-m-lə
pad-	'cook'	pat-tə-mə	pat-tə-m-lə
(b) o:rə-	'show'	o:rə-t-mə	o:rə-t-mə-lə
poldə-	'pull up'	poldə-t-mə	poldə-t-mə-lə

Both the root-final and the suffix-final *ə* come from the input (3.2), so alternating suffixes have the underlying form Cə. Remarkably, when two input light syllables are adjacent (CəCə) they are ruled out by FT=σ as an ill-formed foot. Consider, for example, the input *o:rə-tə-mə.* The input-faithful candidate **(o:)(rətə)mə* does not violate any foot well-formedness constraints and provides only one violation of PARSEσ. The output form *(o:)(rət< >)mə* differs from it in only one respect: it does not contain bisyllabic feet. Tableau (42) demonstrates how the completely faithful and otherwise acceptable candidate (42b) is crucially ruled out by FT=σ. The optimal candidate is (42a), although it violates faithfulness constraints and NO-CODA. Comparing (42a) and (42b) shows that FT=σ dominates both of them in the hierarchy.

(42) Input: *o:rə-tə-mə* 'show' + future + passive participle

	FT=σ	MAX($_\circ$)	NO-CODA
a. (o:)(rət< >)mə ϕ		**	*
b. (o:)(rətə)mə	*!		

In a similar way, for the input *o:rə-tə-mə-lə* the input-unfaithful candidate (43a) takes precedence over (43b) due to dominance of FT=σ.

(43) Input: *o:rə-tə-mə-lə* 'show' + future + passive participle + 3Sg

	FT=σ	MAX($_\circ$)	NO-CODA
a. (o:)(rət< >)mələ ϕ		**	*
b. (o:)(rətə)mələ	*!		

The deletion of every second *ə,* which transforms a bisyllabic string CəCə into one heavy syllable CəC, is the optimal way to satisfy FT=σ according to the constraint hierarchy constructed in section 6. It is motivated by the ranking DEP_{μ} >> MAX_{μ} which favors mora deletion over mora insertion (6.2). The candidate that exhibits *ə*-deletion, even though it might provide massive violations of NO-CODA, is more harmonic that the one that exhibits *ə*-lengthening or consonant epenthesis in the coda position.

So, Cə/C allomorphy is conditioned by the domination of the foot well-formedness constraint F=σ. This constraint together with Foot Binarity on moras eliminates candidates that exhibit two adjacent light syllables. As a result, input-unfaithful heavy syllables are created and the violations of NO-CODA are sacrificed to the monosyllabicity requirement imposed by F=σ. The constraint F=σ importantly dominates both NO-CODA and MAX($_{\mu}$) in the constraints hierarchy.

Notice finally that the optimal candidate (43a) is represented with two unfooted light syllables at its right edge. This fact will be accounted for in the next section, as well as candidates such as *(o:)(rət)(məl)*, which exhibit deletion of the final vowel.

*7.3. FT=σ vs. *STRUCσ*

I have demonstrated in the previous section that the constraint FT=σ conditions the deletion of every second short vowel in light syllables. In principle the same effect (CəCə -> CəC) can be reached with the constraint *STRUCσ, sometimes used to minimize the total number of syllables in the word (Zoll, 1993; McCarthy and Prince, 1993:15; Prince and Smolensky, 1993:25). In this section I will show that adopting *STRUCσ will result in incorrect predictions, while the alignment constraint (39) works well.

For this purpose I will look at light syllables at the right edge of the word. Recall from 2.2 that the rightmost light syllable always remains unchanged (does not exhibit schwa-deletion) including those cases when it could potentially form a well-formed foot together with the previous syllable.

When the underlying form contains an odd number of light syllables at the right edge, one syllable always remains unfooted, while the preceding material is continuously parsed into bimoraic monosyllabic feet. The output form (for example, (42a)) has one stray syllable at the right edge, violating PARSEσ. This syllable cannot be incorporated into foot structure by Foot Binarity, so the position of PARSEσ in the hierarchy is low relative to Foot Binarity.

When there is an even number of light syllables, as in (43), the situation is more complicated. If, for example, the underlying form contains four light syllables after a well-formed foot, the footing (FT)CəCə(CəCə) is prohibited by foot-to-foot alignment, and the footing (FT)(CəCə)(CəCə) is prohibited by the constraint FT=♦. Thus, continuous foot parsing ensures that two light syllables following a foot be transformed into the well-formed foot (CəC) as well (see the previous section). The crucial question then is what happens to the last two syllables in the word.

Tableau (44) shows that in this situation all candidates that exhibit deletion of the final vowel violate MAX twice and some of them also provide violations of higher ranked constraints.

The most harmonic candidate (44e) has two unfooted light syllables at the right edge (FT)(CəC<>)CəCə (for example, (43a)).

(44)

	FT BIN❍	DEP❍	MAX($_{\mu}$)
a. (FT)(FT)(CəC$_{\circ}$< >)		*!	**
b. (FT)(FT)(CəC-$_{\circ}$< >)	*!		**
c. (FT)(FT)(Cə)C< >	*!		**
d. (FT)(FT)CəC< >			**!
e. (FT)(CəC<>)CəCə ϕ			

The critical choice is made between the candidates (44d) and (44e). Since in both cases the underlying light syllables are unfooted, foot well-formedness constraints make no decision in this case. But the parsing (44d) is less faithful than (44e), so (44e) is correctly predicted to be optimal. I noticed above that the absence of two adjacent light syllables can be captured either with FT=σ or with the constraint *STRUCσ, which requires as few syllables as possible. In the analysis so far the difference between these two formulations would not affect the choice of the optimal candidate, however, it becomes important in (44). If *STRUCσ is adopted instead of FT=σ, the optimal candidate is predicted to be (44d). Given *STRUCσ, in otherwise equal situations the candidate with the fewest syllables would be optimal. Candidate (41d) cannot be ruled out either by MAX or by NO-CODA, since they are clearly ranked lower than *STRUCσ, so (44d) should win over (41e). This shows that the constraint *STRUCσ here results in an incorrect prediction, while with the constraint FT=σ the crucial fact that the word-final Cə syllable always surfaces as Cə receives a natural explanation.

Notice that in theory (44e) can be represented with the two rightmost syllables parsed in a foot: (FT)(CəC<>)(CəCə). There is no formal way to differentiate between (44e) and (FT)(CəC<>)(CəCə), but I will assume that the latter is ruled out by FT=σ. Indeed, given the discussion in the previous section, we would expect the well-formed foot to consist of one heavy syllable (i.e. candidate (44a)). However, since continuous foot parsing from left to right does not enforce footing of the syllables located at the right edge of the word, they can remain unparsed.

Clearly, the unfooted material at the right edge violates PARSEσ, therefore PARSEσ is demoted to the position below MAX. As mentioned in 5.4, with the formulation of the foot alignment constraints adopted here the low ranking of PARSEσ does not exclude iterative footing provided that higher ranked foot constraints are not violated. PARSEσ is violated when well-formed footing cannot be reached. In forms with an odd number of light syllables, the rightmost syllable remains unfooted because of Foot Binarity. In forms with an even number of light syllables, the two rightmost syllables remain unfooted due to Foot Binarity, FT=♦, and the extraprosodisity of the word-final consonant.

The schema in (45) shows affixation of the alternating affixes to different types of roots. It demonstrates that the maximal number of unfooted light syllables at the right edge is two.

(45) (a) root equal to FT + Cə	(b) root equal to a foot
(FT)Cə-Cə	(FT)-Cə
(FT)(Cə-C)-Cə	(FT)-Cə-Cə
(FT)(Cə-C)-Cə-Cə	(FT)-(Cə-C)-Cə
(FT)(Cə-C)-(Cə-C)-Cə	(FT)-(Cə-C)-Cə-Cə, etc.

7.5. Conclusion

In this section the Cə/C allomorphy introduced at the beginning of the paper was shown to be another strategy to achieve continuous foot parsing, together with the vowel lengthening and deletion discussed in section 6. Its purpose is to create chains of heavy syllables from input light syllables. The major finding of this section is that Yukaghir avoids bisyllabic feet. This was captured with the help of the constraint FT=σ, which states that the foot must align with two edges of the same syllable and rules out two adjacent light syllables word-internally. Since, on the one hand, DEP_{μ} dominates $MAX(_{\mu})$, and, on the other hand, FT=σ dominates NO-CODA and $MAX(_{\mu})$, the optimal strategy to satisfy foot well-formedness is vowel deletion in light syllables. However, the left alignment constraint predicts that the light syllables can be found at the right edge of the word, where they remain unfooted.

A necessary remark at this point is that my analysis does not imply a lack of light syllables altogether. They occur on the surface for different reasons: (i) in roots CVCV (7.1); (ii) as word-final unfooted material (7.3); (iii) as a result of vocalic epenthesis in a particular environment (this case is not studied in this paper); (iv) in exceptional non-alternating Cə affixes (see footnote 10). Otherwise, I have found the constraint FT=σ unviolable.

8. Final remarks

In this paper, I have provided a unified prosodic account for several phonological phenomena in Yukaghir: vowel lengthening, vowel-deletion, and CV/C allomorphy. They were shown to be different strategies leading to the satisfaction of the major prosodic requirement: the continuous left-to-right parsing into bimoraic monosyllabic feet. As this requirement is incompatible with word-internal light syllables, my analysis has an important implication: it predicts that closed heavy syllables are more harmonic than light syllables.

As is well known, input heavy syllables /CVC/ preserve a coda only when this is forced by faithfulness constraints (McCarthy and Prince, 1993: 19; Prince and Smolensky, 1993:34, 92). If both faithfulness constraints (MAX and DEP) dominate NO-CODA, the optimal parsing is completely input-faithful (CVC). Yukaghir exhibits contrary characteristics: it prefers closed syllables even when they are not input-faithful, that is, when they emerge from underlying light syllables.

Under the analysis suggested here, such a situation is motivated by the conflict between the demands of syllabification and the demands of foot structure. The paper argues that codas are tolerated and even desirable because foot well-formedness requires heavy syllables. I suggested that this idea may be captured with the constraint FT=σ formulated as one of the family of alignment constraints. It states that both edges of the foot must align with two edges of the same syllable. Although, as far as I know, such an alignment constraint has not so far been considered, nothing to my knowledge precludes it from the theory. Prosodic constituents tend to align, and some alignment constraints are formulated as both edge alignment, that is, as the complete correspondence of the two categories. The format of FT=σ follows the pattern of another alignment constraint LxWd=PrWd (although obviously it can be formulated in a different way, for example, as a requirement on a maximal foot). The foot-syllable alignment requirement seems to be a natural extension of the already existing theory.

The constraint FT=σ is not immediately noticeable in most languages' grammar because, first, it can operate only in languages where Foot Binarity works at moraic level, second, it requires that output heavy syllables correspond to input light syllables (CVCV -> CVC). This results in a violation of both NO-CODA and faithfulness constraints (namely, MAX($_{\circ}$)). The relationship between NO-CODA and MAX($_{\circ}$), on the one hand, and FT=σ, on the other hand, can be described by one of the following four configurations:

(46) (a) FT=σ >> {NO-CODA, MAX($_{\circ}$)}

(b) {NO-CODA, MAX($_{\circ}$)} >> FT=σ

(c) MAX($_{\circ}$) >> FT=σ >> NO-CODA

(d) NO-CODA >> FT=σ >> MAX($_{\circ}$)

In order to be visible, FT=σ must dominate both NO-CODA and MAX($_{o}$), so only (46a) leads to the situation where coda-insertion for the sake of foot well-formedness is the optimal choice. Then foot well-formedness is satisfied at the expense of multiple violations of NO-CODA and MAX($_{o}$), and heavy syllables surface even when they are not included in the input representation. Apparently this situation is infrequent, however, one can expect to find grammars in which (46a) is operative.

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[1] Yukaghir is a paleosiberian language spoken in north-east Asia by approximately 200 people. It is traditionally regarded as genetically isolated, but in fact is distantly related to the Uralic and Altaic languages, although its exact relationship to them is not entirely clear (Collinder, 1965: Sauvageot, 1969; Nikolaeva, 1988; Fortescue, 1988, 1994). Two modern dialects (the so-called Kolyma and Tundra dialects) are significantly different in their lexicon, but less so in phonology. This paper is based on my own field material on the Kolyma dialect (1986-1990).

[2] The *p*-final plural is normally followed by the epenthetic *u* not discussed here. The vowel epenthesis prevents tautosyllabic consonant clusters. Verbs are cited as bare stems not augmented by inflectional affixes.

[3] Recent research has shown that Proto-Uralic must also have had consonant-final roots, and generally the situation is not as simple as has been stated in classical Uralistic study.

[4] In fact, Uralic *e*-final roots normally correspond to consonant-final roots in Yukaghir, while *a/ä*-final roots usually preserve the final vowel (Nikolaeva, 1988).

[5] Most of the 18th and early 19th century data (collected by occasional travelers and missionaries) was gathered and published by Schiefner (1871). I will cite this data here after Schiefner without

specifying the exact source. Abbreviations: J – Jochelson, 1900, KR – Kreinovich, 1982, SCH - Schiefner, 1871.

[6] This idea was advanced for the first time in Nikolaeva, 1986.

[7] In the 2Sg imperative, consonant-final verbs surface as a bare root, and in the 1Sg aorist transitive verbs appear on the surface as a bare root. However, there are reasons to think that underlyingly these forms end in a consonant (the imperative suffix *–k* and the 1Sg inflection *–ŋ* respectively). These cases are not examined here.

[8] I deal only with nouns and verbs, the latter including quantitative and qualificative stems. Adverbs and postpositions seem to follow the same patterns as nouns. Functional words and pronouns are normally cliticized and must be a subject for a special study. The types presented here do not cover recent borrowings and nominal compounds. There are other exceptional roots ignored here: for example, a few nouns CV:CV: (mostly kinship terms) which are likely to appear as a historical reduplication of the CV: base.

[9] The nominal roots (C)V:C exhibit alternations in vowel length discussed later in section 5.5.

[10] A few non-alternating Cə affixes all contain a voiced consonant (for example, the verbal derivational suffixes *–gə-, -γə-* and *–də-*). The voiced consonants have developed from consonant clusters (Nikolaeva, 1988) and can be analyzed as such on the synchronic level as well. Other exceptional cases comprise complex affixes.

[11] The vowel *ə* seems to be present in monosyllabic clitic words such as *mət* 'I' (SCH *mat, mot,* J *met,* KR *met*), *tət* 'thee' (SCH *tat, tot, tet,* J *tet*, KR *tet*), *pən, -bən* 'something, nature (also as a nominalizer)' (J *pen, pon*, KR *-ben, bon*), the subjunctive particle *ət,* and the auxiliary verb *l*ʸə- 'be'.

[12] In the recent development of the Prosodic Morphology framework (McCarthy and Prince, 1995: 323) this constraint was parameterized as MCat=PrWd, where MCat = Stem, Root, Lexical Word, etc.

[13] Here and hereafter foot parsing is shown with brackets. In the tableaux dashed lines mark the border between unranked constraints, and the exclamation mark indicates fatal violations.

[14] In some other cases the root-final consonant in CV:C roots is deleted before the consonant-initial suffix, for example, *ša:l-pə* --> *ša:-pə* 'tree' + plural *–pə*. The consonant deletion will not be discussed here, but is also clearly motivated by Foot Binarity.

[15] The format of (26) differs from that of (17) because it does not specify whether ♋ is right or left but simply requires that some edge of a foot be aligned with an opposite edge of another foot. FT1 and FT2 are understood here as two adjacent feet within a prosodic word.

[16] They are allowed at the leftmost word edge. The Optimality Theoretic account for this fact employs the alignment constraint ALIGN (Wd L Root L) which overranks both ONSET and DEP and therefore blocks both consonant epenthesis and the misalignment of the root and the word.

[17] Consonant epenthesis in the coda position is universally forbidden (Prince and Smolensky, 1993: 95-96).