CHAPTER 2

PROMINENCE AND METRICAL CONSTITUENCY IN SEGMENTAL PHONOLOGY

2.1 Introduction

While situations where there is a clearly seen mismatch between the placement of stress and foot structure are rare, they are possible, mostly due to diachronic stress shifts that did not affect foot boundaries since the latter were marked by some alternation.

We start with the case that, I claim, shows that the "stress only reference" hypothesis cannot be sustained. The case study is of the Uralic Samoyedic language Nganasan. I argue that Nganasan has an alternation (consonant gradation) that is restricted by foot structure. Furthermore, the foot structure that is marked by gradation **does not match** the stress pattern, namely the placement of the primary stress and its shifts from [ə] and [ɨ] leftwards. I analyze the pattern as one affected by several sonority constraints on stressed vowels and a NonFinality constraint that outrank Prominence Alignment constraints. The pattern of consonant gradation is perfectly predictable from foot structure, but cannot be accounted for by making reference only to the stressed/stressless opposition.

Similarly, the second case study I present in this chapter discusses another demonstrable stress placement/foot structure mismatch. The language I discuss is a dialect of Eastern (Meadow) Mari. First, I discuss the pattern of stress assignment in the language that depends on vowel quality and other principles, but not on binary foot structure. Next, I demonstrate that the language's foot structure is strictly binary, as evidenced by a pattern of full/reduced vowel alternations. The Eastern Mari mismatch between foot structure and stress placement is analyzed as vowel sonority and stress-to-Phonological Word alignment outranking constraints on stress alignment to foot boundaries. Another segmental alternation, rounding harmony, is demonstrated to be conditioned by stress, and not by metrical structure, thus showing that the "metrical boundaries only" hypothesis falls short of accounting for the full range of facts as well.

What Nganasan and Eastern Mari cases have in common is a demonstrable mismatch between the foot structure and stress, so we can be sure to which of these prosodic categories the grammar must refer in generalizations about segmental alternations. In order to account for cases like these, we need to reject both limitation hypotheses.

2.2 Case Study: Nganasan[1]

Nganasan, also known as Tawgy (Tavgy), or Tawgy Samoyed, is a Uralic Samoyedic language spoken on Taimyr Peninsula. Nganasan is split into two very close dialects, Avam (Abam) (spoken in the western and central parts of the ethnic territory by about 75% of all Nganasans) and Vadey (spoken in its eastern part). The data presented in this chapter is from the Avam dialect.

Nganasan has two phenomena that are sensitive to metrical structure: stress assignment and consonant gradation. Especially interesting, in the context of the discussion in this chapter, is the mismatch between consonant gradation and stress placement in the language.

First, we will see the distribution of primary and secondary stress in the language, with obligatory and optional stress shifts from 'less sonorous' vowels [ə] and [ï]. Next, we discuss the consonant gradation in the language and establish that it is restricted by foot structure.

Importantly, however, the foot structure that we need to predict the appearance of consonant gradation reflexes does not match the location of stress. Due to this mismatch, it is easy to see that in order to account for restrictions on consonant gradation, the

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[1] The Nganasan data in this chapter are partly taken from source grammars (Helimsky (1998), Tereshenko (1979), Prokofjev (1937)) and subsequently checked with native speakers, and partly comes from fieldwork on the language in March and October 2000. All the discrepancies between grammars and my fieldwork are noted.

grammar of the language has to make reference to foot structure, and crucially not to the stressed/stressless opposition.

2.2.1 Stress

2.2.1.1 Basic Facts

Nganasan has both primary and secondary stress. Correlates of stress in Nganasan are fundamental frequency, duration and amplitude. Normally, primary stress is assigned to the final syllable if it is heavy (CVV), and to antepenultimate syllable if the final is light:

(4)
a. bakúnu 'salmon'   bàkunú-mə 'my salmon'
    ɟémɲi 'salary'   ɟemɲí-mə 'my salary'
    tïrími 'caviar'   tïrimí-mə 'my caviar'
    káðar 'light'   kaðár-mə 'my light'

b. kümáa 'knife'   kümáa-mə 'my knife'
    biríə 'wound'   biríə-mə 'my wound'
    k̀itaráa 'only cup'   k̀itaráa-mə 'my only cup'
    lehúa 'board'   lehúa-mə 'my board'

As the data shows, long vowels are bimoraic. Adjacent vowels are never stressed, presumably due to the clash restriction that we discuss in detail below, as for example in words for 'wound' *biríə*, 'caviar' *tïrími*, 'knife' *kümáa*, and others. When the 1st singular possessive suffix /-mə/ is added, the stress shifts to the penultimate syllable of the derived word, i.e. derived words are evaluated as a whole for the purposes of stress assignment.

Secondary stress, on the contrary, is left-aligned: it is assigned to odd vowels, starting from the beginning of a word. Similar to primary stress assignment, when a word starts with a CV.CVV sequence, secondary stress is assigned to the CVV syllable, leaving the leftmost light syllable unstressed:

(5)
a. bakúnu 'salmon'   bàkunù-mənú-mə 'my salmon (Prol.)'
    ɟémɲi 'salary'   ɟèmɲi-mənú-mə 'my salary (Prol.)'
    tïrími 'caviar'   tïrimì-mənú-mə 'my caviar (Prol.)'
    káðar 'light'   kàðar-mənú-mə 'my light (Prol.)'

b. kümáa 'knife'   kümàa-mənú-mə 'my knife (Prol.)'
    biříə 'wound'   biřìə-mənú-mə 'my wound (Prol.)'
    ǩitaráa 'only cup'   ǩitaràa-mənú-mə 'my only cup (Prol.)'
    lehúa 'board'   lehùa-mənú-mə 'my board (Prol.)'

It appears, therefore, that while primary stress assignment is concerned with the right edge of a word, in that it is the penultimate mora that gets stressed (except situations where either schwa or [ï] is penultimate), secondary stress is assigned 'from the left': aside from CV.CVV-initial words and clash restrictions, secondary stress is placed on the odd-numbered moras of a word.

We can notice that, regardless of the foot structure that is marked by consonant gradation to be discussed below, stress is never on the last syllable. This fact, when taken by itself, can be attributed to either a prohibition on degenerate feet, or to the NONFINALITY constraint. Given that we know (from the gradation data) that monosyllabic feet are allowed, the former possibility must be discounted. Thus, the first case of mismatch between footing and stress assignment we discuss must be attributed to the NONFIN constraint that bans prominent final syllables:

Tableau 1

/ŋuhu/-/-/Tu/ 'his/her/its mitten'	ALIGN-L (FT, PWD)	NONFIN	ALIGN-L (GRID$_2$, FT)
☞ a. (ŋuhú)-(ðu)			*
b. (ŋùhu)-(ðú)		*!	

The foot alignment constraint is irrelevant for these candidates, since they are footed the same way and neither of them violates the constraint. NONFINALITY, on the other hand, competes with the Prominence Alignment constraint: the word is trisyllabic and its last syllable is also a foot-initial syllable. Candidate (b) is eliminated since it violates

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NONFINALITY, and candidate (a) is selected as optimal despite its two violations of the lower-ranked Prominence Alignment constraint[2].

(6) *Interim ranking of primary stress assignment in Nganasan*

      ALIGN-L (FT, PWD); NONFIN $>$ ALIGN-L (GRID$_2$, FT)

The situation we observe here, therefore, conforms to our schema of a higher-ranking constraint (NONFIN) causing a mismatch between the footing and prominence assignment.

2.2.1.2 Penultimate and/or Antepenultimate [ə] or [ï]

The general pattern of Avam Nganasan stress assignment we have just outlined is complicated by several stress shifts that take place if the penultimate vowel of a word is [ə] or [ï]. Stress does not shift away from the rest of Nganasan vowels, ([a], [e], [o], [u], [i], and [ü])[3].

To account for the range of patterns of stress assignment where [ə] and/or [ï] is penultimate and/or antepenultimate, we will follow Kenstowicz's (1994b) insight that less sonorous vowels are worse stress-bearers than more sonorous ones. In particular, we need constraints that ban stress on less sonorous vowels[4], notably schwa and [ï]. A partial scale of constraints with universally fixed ranking is given below:

(7) *Scale for Vowels with Prominence*

    *GRID$_n$/ə $>>$ * GRID$_n$/i, u $>>$ * GRID$_n$ /ɛ, ɔ $>>$ * GRID$_n$ /e, o $>>$ * GRID$_n$ /a

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[2]A candidate such as *(ŋùhú)-(ðu)*, while having only one violation of the prominence alignment constraint, is eliminated by CLASH constraint to be discussed shortly.

[3] In de Lacy's (2004, 2006) data, there are also cases of stress shift from [u] and [i], but I have found no such shifts in the dialect of Nganasan with which I worked.

[4] For theories of the phonetic interpretation of sonority, see Parker (2002) and references therein.

Each of the constraints in this scale should read as, for example, 'there must not be a vowel [ə] with a gridmark on Level$_n$', i.e. a schwa must bear no prominence. As we will see shortly, however, the Nganasan stress assignment pattern necessitates certain a more relaxed theory than the universally fixed constraints allow us.

Under de Lacy's (2004, 2006) Markedness Conflation theory, stringent constraints allow all attested types of conflation between members of a sonority scale, while universally ranked constraints in (7) above (cf. Kenstowicz (1994b)) do not. De Lacy's Stringency Hierarchy sonority constraints are given below:

(8)

a. *HD$_{FT}$/ɨ   b. *NON-HD$_{FT}$/a

   *HD$_{FT}$/ɨ,ə   *NON-HD$_{FT}$/a, e •o

   *HD$_{FT}$/ɨ,ə,i•u   *NON-HD$_{FT}$/a, e •o, i•u

   *HD$_{FT}$/ɨ,ə,i•u,e •o   *NON-HD$_{FT}$/a, e •o, i•u, ə

   *HD$_{FT}$/ɨ,ə,i•u,e •o,a   *NON-HD$_{FT}$/a, e •o, i•u, ə, ɨ

The constraints in the hierarchy above are not universally ranked. Thus, a constraint such as *HD$_{FT}$/ɨ,ə would require that ə or ɨ be the head of a foot. Since the Nganasan primary stress assignment pattern requires, in some cases, conflation of sonority of ə and ɨ, de Lacy's (2002, 2004) proposal will be the one that is utilized in analyses in this thesis[5], with the following minor adjustments:

First, given the Nganasan data presented throughout this chapter, we must reverse the relative sonority of ə and ɨ (i) at least with respect to their stressability, because while schwa and ɨ can be of equal sonority in the language, schwa can also be the least

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[5] An alternative to the Stringency Hierarchy constraints would be to propose that constraints of the form in (7) above can be unranked, though crucially not reranked with respect to each other. Thus, a constraint banning stressed e and o can be unranked in a given language with respect to a constraint banning stressed i and u, which would result in the four vowels having the same stressability; however, the former constraint may not outrank the latter, to exclude a grammar which stresses i and u preferentially to e and o.

sonorous vowel in the system, whereas *ï* cannot. The distinction can be seen in optional penult/antepenult stress assignment, when conflation of sonority is optional (see the discussion of the pattern below). The opposition between schwa and other vowels can depend on the representation of schwa universally or in any given grammar. In particular, Oostendorp (1995), among others, relies on the idea that schwa lacks phonological features, which, combined with other factors, renders it the least desirable stress-bearing vowel. In Nganasan, schwa is very short: at a roughly constant rate of speech, schwa duration was c.25 ms, while short [a] was c.60 ms, and long [aa] c. 90 ms.

Secondly, since one of the main proposals of this dissertation is that prominence and foot structure are two distinct entities in the grammar, we must revise the form of de Lacy's constraints that refer to heads of feet and stress-bearing vowels synonymously. In particular, we must consider the possibility that a trochaic (i.e. left-headed) foot is subject to FTFORM constraints forcing trochaic shortening, while stress falls on the rightmost vowel (for a similar idea, see Hewitt (1992), who posits "flat feet" at some point of derivation to account for stress and quantitative adjustments in Alutiiq). A related possibility is that a there can be feet where there is no stressed vowel (as is the case in Nganasan), which does not necessarily mean that such feet are headless. Whether there is a grammar with disparity between foot-headedness and prominence, and not just foot boundaries and prominence is an empirical question that I will leave for future research.

With the above modifications, and given the representation of prominence we developed in Chapter 1, the Stringency Hierarchy sonority constraints for stressed vowels will have the following form:

(9)

*GRID$_n$/*ə*	There must not be *ə* with a gridmark on Level$_n$
*GRID$_n$/*ə,ï*	There must not be *ə* or *ï* with a gridmark on Level$_n$
*GRID$_n$/*ə,ï, i•u*	There must not be *ə*, *ï* or *i•u* with a gridmark on Level$_n$
*GRID$_n$/*ə,ï, i•u, e •o*	There must not be *ə*, *ï*, *i•u* or *e •o* with a gridmark on Level$_n$
*GRID$_n$/*ə,ï, i•u, e •o,a*	There must not be *ə*, *ï*, *i•u*, *e •o* or *a* with a gridmark on Level$_n$

With this theoretical apparatus, we now turn to the formal analysis of Nganasan primary stress assignment that depends on vowel sonority. Primary stress obligatorily shifts one syllable to the left if the penultimate vowel is schwa[6] and the antepenult is a vowel other than schwa or [ï]:

(10)

a. bakúnu 'salmon'   bàkunú-ⁿtənu 'salmon (Loc)'
    ɟémɲi 'salary'   ɟemɲí-təni 'salary (Loc)'
    tïrími 'caviar'   tïrimí-ⁿtənï 'caviar (Loc)'
    ɟűhü 'sledge'   ɟübű-təni 'sledge (Loc)'
    ɟǎte 'stone'   ɟäðé-tənu 'stone (Loc)
    sátu 'clay'   saðú-tənu 'clay (Loc)'
    ɲorúmu 'copper'   ɲòrumú-ⁿtənu 'copper (Loc)'
    ɟamáða 'animal'   ɟàmaðá-ⁿtənu 'animal (Loc)'
    kó 'ear'   kó-ⁿtənu 'ear (Loc)'

b. kümáa 'knife'   kümáa-tənï 'knife (Loc.)'
    biríə 'wound'   biríə-təni 'wound (Loc.)'
    kìta-ráa 'only cup'   kìtaráa-tənï 'only cup (Loc.)'
    lehúa 'board'   leᵐbúa-tənu 'board (Loc.)'
    ɟàmaða-ráa 'only animal'   ɟàmaða-ráa-ⁿtənu 'only animal (Loc)'
    sòŋïl-ɟə́ə 'former[7] pillow'   sòŋïl-ɟə́ə-ⁿtənu 'former pillow (Loc)'

Even though, at this point in our analysis, we are only trying to account for the stress shifts from the penultimate schwas, we will see later on that both schwa and [ï] are 'weaker' than the rest of the vowels in the language. Hence, we will utilize the more general constraint that bans primary (Level 2) stress on schwa and [ï]:

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[6]The Locative suffix /-NtənV/ surfaces as -ⁿtənV or -tənV, depending on principles of consonant gradation to be discussed in the next subsection. The quality of the final vowel of the suffix is determined by vowel harmony that is greatly morphologized in the language: the stems are divided according to which allomorph of this and similar suffixes they take. This division does not always depend on the shape of the stem itself, but has to be specified lexically.

[7] The suffix /-ɟəə/ is a denominal suffix with the meaning 'what used to be N', 'former N'

(11)

      $*\textsc{Grid}_2/ə,ï$ There must not be a schwa or an [ï] with a gridmark on Level$_2$

This constraint outranks the Prominence Alignment constraint responsible for the default (trochaic, in this case) stress, without changing the footing shown by the consonant gradation:

Tableau 2

/ɟühü/-/rəKV/ 'similar to a sledge'	ALIGN-L (FT, PWD)	$*\textsc{Grid}_2/ə,ï$	ALIGN-L (LEV$_2$ GRID, FT)
☞ a. (ɟühǘ)-(rəgu)			*
b. (ɟühü)-(rə́gu)		*!	

Similarly to the previous Tableau 1, Tableau 2 only contains candidates that are footed 'correctly' (for presentational purposes), so none of the candidates violates the footing constraint. Candidate (b), however, violates the $*\textsc{Grid}_2/ə,ï$ constraint, since it has a Level$_2$ gridmark on the schwa vowel in the second syllable. This sonority constraint, therefore, eliminates candidate (b). Both of the candidates in the Tableau violate the Prominence Alignment constraint, since candidate (a) does not have a gridmark aligned with the left edge of the second foot, and candidate (b) does not have a gridmark aligned with the left edge of either of the feet.

Note, also, that the stress surfaces on the antepenult rather than on the final syllable, i.e. while we cannot yet rank the NONFINALITY constraint and the $*\textsc{Grid}_2/ə,ï$ constraints, we know that the latter does not outrank the former. In order to rank these constraints definitively, we can take a look at an example with a schwa in the antepenult as well as penult, but where the final vowel a vowel other than schwa:

(12)

    (kì^{n}tə)-(rə́kï)   *(ki^{n}tə́)-(rəkï)   'similar to smoke'
    (kàmə)-(rə́ku)   *(kamə́)-(rəku)   'similar to blood'
    (gə̀tə)-(rə́ku)   *(gətə́)-(rəku)   'similar to a swan'
    (tə̀rə)-(tə́nu)   *(tərə́)-(tənu)   'hair (Loc)'
    (màɟə)-(tə́nu)   *(maɟə́)-(tənu)   'house (Loc)'
    (gə̀ðə)-(tə́nu)   *(gəðə́)-(tənu)   'swan (Loc)'

Tableau 3

/kamə/-/rəKV/ 'similar to blood'	ALIGN-L (FT, PWD)	NONFIN	*GRID$_2$/ə,ï	ALIGN-L (LEV$_2$GRID, FT)
☞ a. (kàmə)-(rə́ku)			*	
b. (kamə́)-(rəku)			*	*!
c. (kamə)-(rəkú)		*!		*

As we can see, the main stress is **not** word-final and surfaces on the penultimate syllable despite its containing a schwa as a nucleus. In other words, it is more important that the stress is not word-final than that schwas do not carry stress. Candidate (c), therefore, is eliminated by the Word Finality constraint. The remaining two candidates tie on the *GRID$_2$/ə,ï constraint, because candidate (a) has a stressed schwa penult, and in candidate (b), it is the schwa-headed antepenult that bears primary stress. The decision, therefore, is passed to the Prominence Alignment constraint that is violated by candidate (b), but satisfied by candidate (a) that has primary stress aligned with the left edge of a foot. Below is an interim ranking of relevant constraints:

(13)
      ALIGN-L (FT, PWD), NONFIN > *GRID$_2$/ə,ï > ALIGN-L (LEV$_2$GRID, FT)

Primary stress can also shift from penultimate schwa even if the antepenult is also a schwa. This shift, however, only happens if the antepenult is foot-initial, according to the foot structure that we will justify in the next subsection:

(14)

a.   (hïa)(ɟə́-rə)(gï) 'similar to a thumb'   b.   (hïa)(ɟə́-ⁿtə)(nï) 'thumb (Loc)'
    (kàta)(rə́-rə)(gï) 'similar to light'   (kàta)(rə́-ⁿtə)(nï) 'light (Loc)'
    (bàar)(pə́-rə)(gï) 'similar to a master, chief'   (bàar)(pə́-ⁿtə)(nï) 'master, chief (Loc)'
    (čìsa)(rə́-rə)(gï)[8] 'similar to benefit'   (čìsa)(rə́-ⁿtə)(nï) 'benefit' (Loc)

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[8] The antepenultimate schwa in this word, but not in the previous examples, is epenthetic. With regard to stress assignment and consonant gradation epenthetic schwas behave in the same manner as underlying schwas.

The examples above, (14a) with the similative suffix, and examples in (14b) with one of the Locative suffixes, illustrate the pattern where antepenultimate schwas are stressed, but only if the antepenult is foot-initial, not foot-final as in the example we have in the Tableau 3 above (from the data in (13)). In fact, to account for the pattern we observe in (14), we do not need to refer to any constraints other than the ones we have already used:

Tableau 4

/kaTar/-/Ntənï/ 'light' (Loc)	ALIGN-L (FT, PWD)	WDFIN	*GRID$_2$/ə,i	ALIGN-L (LEV$_2$GRID, FT)
☞ a. (kàta)(rə́-ⁿtə)(nï)			*	
b. (kàta)(rə-ⁿtə́)(nï)			*	*!
c. (kàta)(rə̀-ⁿtə)(nḯ)		*!	*	

The situation is very similar to the one in the Tableau 3: candidate (c) violates the WORD FINALITY constraint, while the other two candidates satisfy the constraint. The remaining candidates (a) and (b) tie with respect to *GRID$_2$/ə,i constraint: candidate (a) has a gridmark on its antepenult, and candidate (b) on its penultimate syllable, both of which are headed by schwas. Once again, therefore, the decision is passed on to the Prominence Alignment constraint. In this case, however, in contrast to what we saw in Tableau 3, it is the candidate with the stress on the **antepenult** rather than penult that emerges as a winner: while both of the candidates violate the Prominence Alignment constraint (no gridmark aligned with the left edge of the final foot), only candidate (b) has the second violation of this constraint, since its primary stress is not aligned with the left edge of the second foot. This example also shows that the left-to-right footing plays a crucial role in seating the primary stress[9].

Note that the situation we have just modelled, when both antepenultimate and penultimate syllables are schwas, i.e. of equal sonority, shows us the Prominence Alignment constraint in action, since it is the constraint that distinguishes between two candidates with stressed schwas, and selects the one where stress is aligned with the left

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[9] De Lacy (2004, 2006) assumes a moraic trochaic foot at the right edge of the word, an assumption that is contradicted by the above pattern of optionality as well as by the pattern of consonant gradation to be discussed in the next subsection.

edge of a foot. Table below shows the pattern of stress assignment where both penult and antepenult are either [ə] or [ï]:

(15) *Primary stress assignment with the vowels [ə] and [ï]*

antepenult	penult	penult is foot-initial	penult is foot-final
ə	ə	penultimate	antepenultimate
ï	ə	variable penultimate ~ antepenultimate	antepenultimate
ə	ï	penultimate	variable penultimate ~ antepenultimate
ï	ï	penultimate	antepenultimate

We will now consider cases where either the penult, or the antepenult, or both is the high central vowel [ï] (IPA [ɨ]).

Primary stress shifts if the penultimate vowel of the word is [ï] (IPA [ɨ]); this 'shift' is obligatory when the preceding vowel is a full vowel, whether the antepenultimate vowel is foot-final (16b) or foot-initial (16a):

(16)
a. (bìtï)-(báⁿhï)-(rə)   * bìtï-baⁿhí-rə   'you (sg.) are said to drink'
    (bìðïr)-(nǎⁿtï)-(báⁿhï)-(rə)   * bìðïr-nǎⁿtï-baⁿhí-rə 'you (sg.) are said to be thirsty'

b. (jìləb)(tï-bá)(hï-rə)   *(jìləb)(tï-ba)(hí-rə)   'you (sg.) said to rise'
    (bùa)(tə-bá)(hï-rə)   *(bua)(tə-ba)(hí-rə)   'you (sg.) are said to look up'
    (hìi)(ʎə-bá)(hï-rə)   * (hìi)(ʎə-ba)(hí-rə)   'you (sg.) are said to spin'

Given the data above, we can see that behavior of penultimate [ï] with an antepenultimate vowel that is any vowel other than [ə] or [ï], is exactly the same as behavior of schwa:

primary stress obligatorily falls on the antepenult. Following our analysis, the tableau for this pattern should be the same as Tableau 2 above, with the relevant constraint banning both primarily stressed [ï] and [ə]:

Tableau 5

/buaNtə/-/HaNhï/-/rə/ 'you (sg.) are said to look up'	ALIGN-L (FT, PWD)	*GRID$_2$/ə,ï	ALIGN-L (LEV$_2$ GRID, FT)
☞ a. (bùa)(tə-há)(hï-rə)			*
b. (bua)(tə̀-ba)(hí-rə)		*!	

Since the sonority constraint on stressed [ï] and [ə] outranks the Prosodic Alignment constraint, candidate (b) is not viable, having primary stress on the high central vowel. The Prosodic Alignment constraint, even though it is violated twice by the winning candidate (a), does not play a role here.

So far, we have not taken into account the relative sonority of [ə] and [ï]. According to de Lacy's (2004, 2006) theory, these vowels can either be of equal sonority, when conflation occurs, or the high central vowel can be of lesser sonority than [ə]. As the data below will show, however, schwa is the least sonorous vowel in the language, though, as de Lacy's theory predicts, the two can be of equal sonority. For the purposes of Nganasan, however, schwa is the 'least stressable' vowel, the fact that necessitated our slight revision of de Lacy's constraints.

If the antepenultimate syllable has [ï] as a nucleus, and schwa is penultimate, there is a certain variation: primary stress can be assigned to antepenult, but also to the penult if the penult is foot-initial (17a). If the penult is foot-final, the only option for the primary stress is to surface on the antepenultimate [ï] (17b):

(17)

a. (bïnï)-(ⁿtə́nï) ~ (bïnî)-(ⁿtənï)   'rope (Loc.)'
    (ɲïnï)-(ⁿtə́nu) ~ (ɲinî)-(ⁿtənu)   'brother (Loc.)'
    (bïðï)-(tə́nï) ~ (bïðî)-(tənï)   'water (Loc)'
    (kòlï)-(tə́nu) ~ (kolî)-(tənu)   'fish (Loc)'

(ɟàlï)-(tə́nï) ~ (ɟalḯ)-(tənï) 'day (Loc)'
(cèbï)-(tə́nu) ~ (cebḯ)-(tənu) 'nail (Loc)'
(sòŋï)-(ⁿtə́nï) ~ (soŋḯ)-(ⁿtənï) 'pillow (Loc)'
(mï̀ⁿdï)-(tə́nu) ~ (mïⁿdḯ)-(tənu) 'load (Loc)'

b. (nḯ-ⁿtə)(nï)   *(nï-ⁿtə́)(nï)   'wife (Loc.)'
  (kə̀ə)(lḯ-ⁿtə)(nu) *(kə̀ə)(lï-tə́)(nu)   'tear (Loc.)'
  (sìr-ha)(ᵐbḯ-ⁿtə)(nï) *(sìr-ha)(ᵐbï-ⁿtə́)(nï) 'ice (Loc), evidently'
  (bàŋ-ha)(ᵐbḯ-ⁿtə)(nï) *(bàŋ-ha)(ᵐbï-ⁿtə́)(nu) 'dog (Loc), evidently'
  (kò-ba)(ᵐbḯ-ⁿtə)(nï) *(kò-ha)(ᵐbï-ⁿtə́)(nï) 'ear (Loc), evidently'
  (tìri)(mì-ba)(ᵐbḯ-ⁿtə)(nï) *(tìri)(mì-ba)(ᵐbï-ⁿtə́)(nï) 'caviar (Loc), evidently'
  (çiə)(ɟə̀-ba)(ᵐbḯ-ⁿtə)(nï) *(çiə)(ɟə̀-ba)(ᵐbï-ⁿtə́)(nï) 'tongue (Loc), evidently'

Two main factors seem to play a role in determining whether there is an option of penultimate main stress in word or not: first, the relative sonority of [ə] and [ï], and second, foot structure of the language.

Following that reasoning, one of the options should have the Prominence Alignment constraint select the winner, with the other vowel sonority constraint ranked lower than Prominence Alignment:

Tableau 6

/kolḯ/-/NtənV/ 'fish (Loc)'	ALIGN-L (FT, PWD)	*GRID$_2$/ə,ï	ALIGN-L (LEV GRID, FT)	*GRID$_2$/ə
a. (kolḯ)-(tənu)		*	*!	
☞ b. (kòlï)-(tə́nu)		*		*

In case where the Prominence Alignment constraint outranks the *GRID$_2$/ə constraint, the winner is candidate (b), even though its primary stress falls on schwa. The candidates tie on the *GRID$_2$/ə,ï constraint, and Prominence Alignment constraint eliminates candidate (a).

If the Prominence Alignment constraint and the *GRID$_2$/ə constraint are reranked, however, it is always the candidate with primary stress on [ï] that emerges as the winner, regardless [ï]'s position with respect to foot structure:

Tableau 7

/kolï/-/NtənV/ 'fish (Loc)'	ALIGN-L (FT, PWD)	*GRID$_2$/ə,ï	*GRID$_2$/ə	ALIGN-L (LEV$_2$ GRID, FT)
☞ a. (kolḯ)-(tənu)		*		*
b.(kòlï)-(tə́nu)		*	*!	

The optionality of (17a), therefore, is explained by the optional reranking of the two sonority constraints, where one of the rankings (Tableau 6) puts the decision between the candidates on the Prominence Alignment constraint, and the other ranking makes the candidate with primary stress on [ï] the optimal one. This analysis crucially depends on the stringency hierarchy in (9) allowing the two candidates tie on the constraint that conflates [ï] and schwa and allows the lower ranking constraints to decide the winner.

With the same optional reranking of the Prominence Alignment and *GRID$_2$/ə constraint, however, the examples in (17b) will receive obligatory antepenultimate stress, either because the deciding constraint is the Prominence Alignment constraint:

Tableau 8

/nï/-/NtənV/ 'wife (Loc)'	ALIGN-L (FT, PWD)	*GRID$_2$/ə,ï	ALIGN-L (LEV$_2$ GRID, FT)	*GRID$_2$/ə
a. (nï-ⁿtə́)(nï)		*	*!	*
☞ b. (nḯ-ⁿtə)(nï)		*		

or because the candidate with the stressed schwa is eliminated by the *GRID$_2$/ə constraint:

Tableau 9

/nï/-/NtənV/ 'wife (Loc)'	ALIGN-L (FT, PWD)	*GRID$_2$/ə,ï	*GRID$_2$/ə	ALIGN-L (LEV$_2$ GRID, FT)
a. (nï-ⁿtə́)(nï)		*	*!	*
☞ b. (nḯ-ⁿtə)(nï)		*		

When the antepenultimate vowel is [ï], (and the penult is also [ï]), the location of the primary stress does depend on the foot structure: the primary stress surfaces on the penult (18b) or antepenult (18a), depending on which one of the vowels is foot-initial:

(18)
a. (mí^{m}tï)-(mə)   *(mi^{m}tí)-(mə)   'my load'
   (bínï)-(mə)   *(biní)-(mə)   'my rope'
   (bítï)-(rə)   *(bití)-(rə)   'you (sg.) drink'(intr)
   (bìðï-p)(tí-tï)-(rə)   *(bìðï-p)(tï-^{n}tí)-(rə)   'you (sg) are drinking' (tr)
   (làŋï-p)(tí-tï)-(rə)   *(làŋï-p)(tï-^{n}tí)-(rə)   'you (sg) are burning' (tr)
   (hìɲï-p)(tí-tï)-(rə)   *(hìɲï-p)(tï-^{n}tí)-(rə)   'you (sg) are cooking' (tr)

b. (bìðï)-(tí-rə)   *(bìðí)-(tï-rə)   'you (sg) are drinking' (intr)
   (kònï)-(^{n}tí-rə)   *(koní)-(^{n}tï-rə)   'you (sg) are going'
   (làŋï)-(^{n}tí-rə)   *(laŋí)-(^{n}tï-rə)   'you (sg) are burning' (intr)
   (hìɲï)-(^{n}tí-rə)   *(hiɲí)-(^{n}tï-rə)   'you (sg) are cooking' (intr)
   (làŋï)-(^{n}tí-rə)   *(laŋí)-(^{n}tï-rə)   'you (sg) are yelling'
   (ɲìlï)-(tí-rə)   *(ɲilí)-(tï-rə)   'you (sg) are living'

In (18a) we see examples of two types: nouns with both root vowels being [ï] with the 1st person possessive suffix *-mə*, which constitutes trisyllabic words with stress on the antepenult that is foot-initial, and verbs with three suffixes, transitivizing /-PTU-/, continuous action suffix /-NTU-/, and non-alternating suffix *-rə*, which signifies 2nd person singular verb. Here, we also see the primary stress on the antepenult, which is foot-initial.

In (18b), on the other hand, we see verbs with the same continuous action suffix /-NTU-/ and personal suffix *-rə*, but without the suffix that makes transitive verbs out of intransitive. Since all the verbal roots here are disyllabic, the penultimate [ï] of the continuous action suffix surfaces with primary stress, because it is foot-initial. The antepenult in the examples in (18b) is always foot-final, and thus never receives primary stress. As the data shows, the primary stress assignment clearly depends on the foot structure, since constraints on vowel sonority are irrelevant, because candidates violate them equally:

Tableau 10

a.

/bïnï/-/-/mə/ 'my rope'	A$\textsc{lign}$-L ($\textsc{Ft}$, $\textsc{PWd}$)	*$\textsc{Grid}_2$/ə,ï	*$\textsc{Grid}_2$/ə	A$\textsc{lign}$-L ($\textsc{Lev}_2\textsc{Grid}$, $\textsc{Ft}$)
☞ a. (bǐnï)-(mə)		*		
b. (bïnǐ)-(mə)		*		*!
b.				
/ɲilï/-/-/Ntï/-/-/rə/				
☞ a. (ɲìlï)-(tǐ-rə)		*		
b. (ɲilǐ)-(tï-rə)		*		*!

In both tableaux 10a and 10b above, all the candidates violate the *$\textsc{Grid}_2$/ə,ï constraint, and none of them violate the *$\textsc{Grid}_2$/ə since primary stress is assigned to [ï], whether it is penultimate or antepenultimate. The Prominence Alignment constraint, therefore, is the one that chooses the optimal candidate: it is the candidate with the antepenultimate stress in Tableau 10a, and the candidate with penultimate stress in Tableau 10b, since these are the candidates with primary stress aligned with the left edge of a foot.

In the situation where the penultimate [ï] is preceded by the antepenultimate schwa, there can be some optionality, just as in the situation we saw in (17) above, where schwa is the penult and [ï] is antepenult, i.e. the mirror situation to the data in (19) below. In (19a), we see that if the penult is foot-final, the primary stress can be assigned to the antepenult as well as to the penult. In (19b), on the other hand, all the examples have foot-initial penult, and the primary stress cannot be optionally assigned to the antepenultimate schwa, but only shows up on the penultimate [ï]:

(19)
a. (bìnï)-(^{n}tənǐ)-(mə) ~ (bìnï)-(tə́nï)-(mə)   'my rope (Loc.)'
    (ɲìnï)-(^{n}tənǐ)-(mə) ~ (ɲìnï)-(tə́nï)-(mə)   'my brother (Loc.)'
    (kü)(màa)-(^{n}tənǐ)-(mə) ~ (kǘ)(maa)-(^{n}tə́nï)-(mə) 'my knife (Loc.)'
    (kǐta)-(ràa)-(tənǐ)-(mə) ~ (kǐta)-(raa)-(tə́nï)-(mə) 'my only cup (Loc.)'
    (cèbï)-(tənǐ)-(mə) ~ (cèbï)-(tə́nï)-(mə)   'my nail (Loc)'
    (ɟàlï)-(tənǐ)-(mə) ~ (ɟàlï)-(tə́nï)-(mə)   'my day (Loc)'

b. (nì-^{n}tə)(nǐ-mə)   *(nï-^{n}tǝ́)(nï-mə)   'my wife (Loc.)'
    (kə̀ə)(lì-^{n}tə)(nǐ-mə)   *(kə̀ə)(lï-^{n}tə́)(nï-mə)   'my tear (Loc.)'

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(nìlu)(ɟi-rə́)(gɪ́-mə)	*(nìlu)(ɟi-rə́)(gɪ-mə)	'similar to my life'
(sɪ̀-rə́)(gɪ́-mə)	*(sɪ̀-rə́)(gɪ-mə)	'similar to my ice'
(ɟòrə)-(tɪ́-rə)	*(ɟorə́)-(tɪ-rə)	'you (sg) are crying'
(ɟùlə)-(tɪ́-rə)	*(ɟulə́)-(tɪ-rə)	'you (sg) are lifting'
(hòðə)-(tɪ́-rə)	*(hoðə́)-(tɪ-rə)	'you (sg) are writing'

The above pattern is predicted by the constraints with the ranking we have already developed. The optionality of (19a) is predicted by the two options of ranking the *GRID$_2$/ə constraint with respect to the Prominence Alignment constraint:

Tableau 11

/bïnï/-/Ntənï/-/mə/ 'my rope (Loc)'	ALIGN-L (FT, PWD)	*GRID$_2$/ə,ï	ALIGN-L (LEV$_2$ GRID, FT)	*GRID$_2$/ə
☞ a.(bïnï)-(ⁿtə́nï)-(mə)		*		
b. (bïnï)-(ⁿtənḯ)-(mə)		*	*!	*

With this ranking of the Prominence Alignment and *GRID$_2$/ə constraints, the decision between the candidates is made by the Prominence Alignment constraint. If, however, *GRID$_2$/ə outranks the Prominence Alignment constraint, the candidate with higher-sonority [ï] is the optimal one:

Tableau 12

/bïnï/-/Ntənï/-/mə/ 'my rope (Loc)'	ALIGN-L (FT, PWD)	*GRID$_2$/ə,ï	*GRID$_2$/ə	ALIGN-L (LEV$_2$ GRID, FT)
a.(bïnï)-(ⁿtə́nï)-(mə)		*	*!	
☞ b. (bïnï)-(ⁿtənḯ)-(mə)		*		*

In case of the above ranking, the Prominence Alignment is irrelevant, because the candidate with antepenultimate primary stress on the schwa is eliminated by the *GRID$_2$/ə constraint. The optional stress assignment disappears, however, if the [ï] in the penult is also foot-initial, since both rankings of the sonority constraints give us the same winner:

Tableau 13

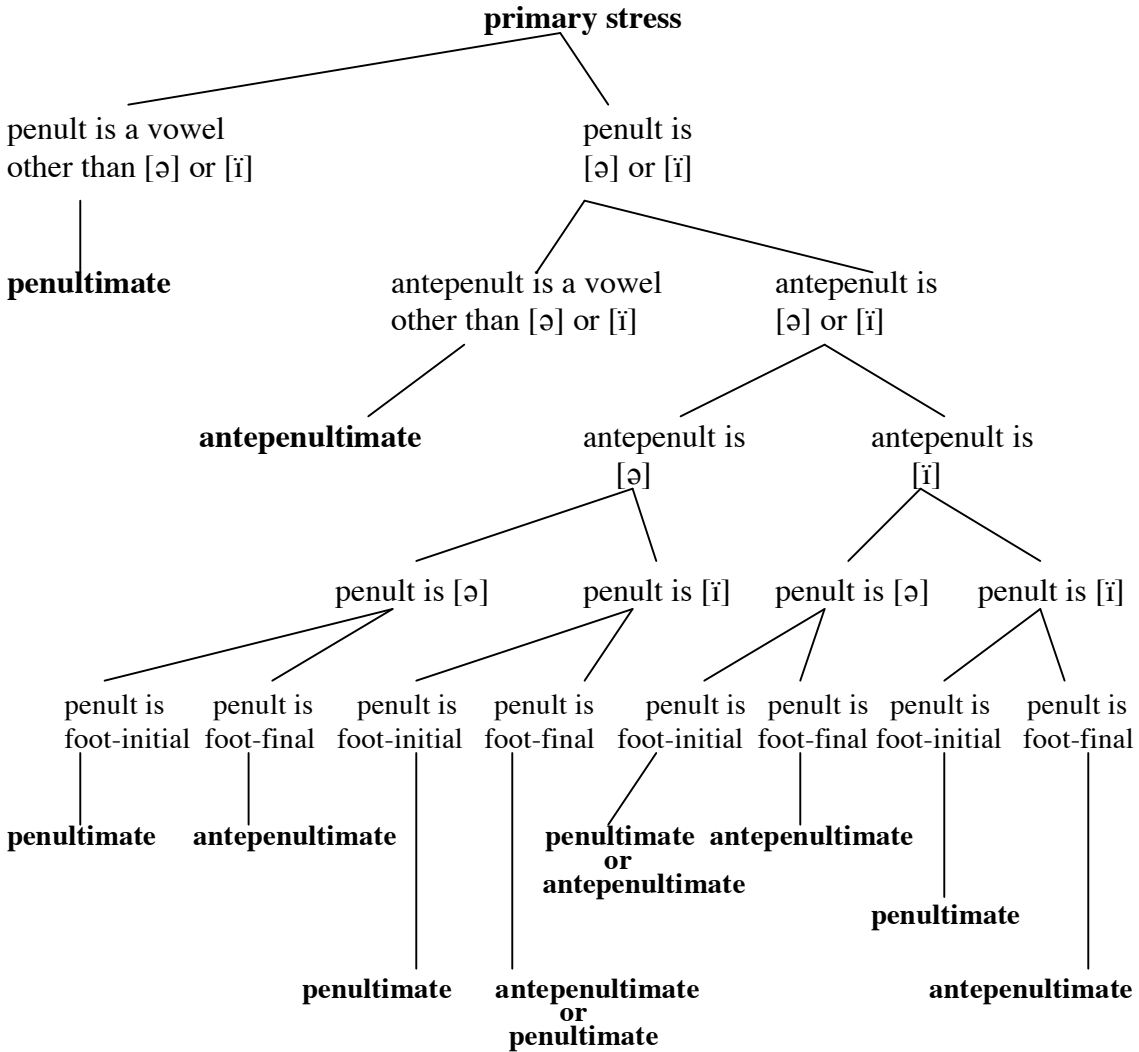| /nï/-/Ntənï/-/mə/ 'my wife (Loc)'	ALIGN-L (FT, PWD)	*GRID$_2$/ə,ï	ALIGN-L (LEV$_2$ GRID, FT)	*GRID$_2$/ə
☞ a. (nì-ⁿtə)(nɨ́-mə)		*		
b. (nï-ⁿtə́)(nï-mə)		*	*!	*

In the above tableau, candidate (b) is eliminated by the Prominence Alignment constraint, since its primary stress is assigned to the rightmost syllable of a foot. The penultimate stress is optimal here.

Tableau 14

/nï/-/Ntənï/-/mə/ 'my wife (Loc)'	ALIGN-L (FT, PWD)	*GRID$_2$/ə,ï	*GRID$_2$/ə	ALIGN-L (LEV$_2$ GRID, FT)
☞ a. (nì-ⁿtə)(nɨ́-mə)		*		*
b. (nï-ⁿtə́)(nï-mə)		*	*!	

To summarize, the intricate stress pattern of the Avam dialect of Nganasan is assigned according to the following principles: a) secondary stress is assigned to the odd-numbered vowels, starting from the left, with restrictions imposed by avoidance of clash; b) primary stress is always the rightmost prominent syllable in a word; it is assigned to the penultimate vowel of the word if the penult is a vowel other than [ə] or [ï]; it obligatorily shifts to antepenult if the penultimate vowel is [ə] or [ï] and the antepenult is a vowel other than [ə] or [ï]; if both of penult and antepenult are [ə] or [ï], primary stress assignment depends on foot structure that we will justify in a moment, and in certain cases varies between penult and antepenult. The variation is explained by ranking the less inclusive *GRID$_2$/ə either above or below the Prominence Alignment constraint, thus making the sonority conflation optional.

(19) *Summary of Nganasan primary stress assignment*

primary stress

- penult is a vowel other than [ə] or [ï] → **penultimate**
- penult is [ə] or [ï]
  - antepenult is a vowel other than [ə] or [ï] → **antepenultimate**
  - antepenult is [ə] or [ï]
    - antepenult is [ə]
      - penult is [ə]
        - penult is foot-initial → **penultimate**
        - penult is foot-final → **antepenultimate**
      - penult is [ï]
        - penult is foot-initial → **penultimate**
        - penult is foot-final → **antepenultimate or penultimate**
    - antepenult is [ï]
      - penult is [ə]
        - penult is foot-initial → **penultimate or antepenultimate**
        - penult is foot-final → **antepenultimate**
      - penult is [ï]
        - penult is foot-initial → **penultimate**
        - penult is foot-final → **antepenultimate**

2.2.2 Consonant Gradation

2.2.2.1 Basic Facts

Nganasan has another phenomenon besides stress that is sensitive to prosody, namely consonant gradation. Consonant gradation is the process that establishes the foot structure we have been assuming for Nganasan up to this point. The gradation establishes that Nganasan words are parsed into binary moraic feet from left to right, with degenerate foot allowed at the left edge of a word.

The grade alternation, or gradation, of consonants is a phenomenon of the alternative appearance of two grades, traditionally called strong and weak, depending on some phonological or morphophonological environment. For Nganasan, consonant grade alternations are alternations between voiceless ("strong" in traditional terminology) and voiced ("weak") obstruents. The reflexes of gradation are given in the table below:

(21) *Gradation reflexes* (cf. Helimsky 1998, Tereshenko 1968a)

strong grade	h	t	k	s	ç	c	^{ŋ}h	^{n}t	^{ŋ}k	^{n}s	^{ɲ}ç	^{n}c
weak grade	b	ð	g	ɟ	ɟ	ɟ	h	t	k	s	ç	c

We will first examine the distribution of voicing in obstruents that are not intervocalic. Nganasan obstruents after another consonant are always voiceless. In (22) we see the 3rd person possessive suffix. Its obstruent always surfaces as voiceless [t] after consonant-final stems below:

(22)

tə́r-**t**u 'his/her/its hair'	kám-**t**u 'his/her/its blood'
kaðár-**t**u 'his/her/its light'	máʔ-**t**u 'his/her/its house'
bíʔ-**t**ï 'his/her/its water'	sír-**t**ï 'his/her/its ice'
he^{n}ɟír-**t**ï 'his/her/its shaman's drum'	nilúʔ-**t**u 'his/her/its life'
húəʔ-**t**u 'his/her/its fur overcoat'	sóŋïl-**t**u 'his/her/its pillow'
ðörúʔ-**t**u 'his/her/its cry'	báŋ-**t**u 'his/her/its dog'

The same is true of coda obstruents: they are always voiceless in the language. In addition to appearing in their 'strong' (i.e. voiceless) grade, coda obstruents in the language are neutralized to glottal stop[10]. The underlying place of articulation, however, is clear in forms where the obstruent is intervocalic, like the Accusative singular forms below:

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[10] Interestingly enough, the only obstruents that do not get neutralized to glottal stop in the coda are labials. They are also invariably voiceless in the coda position and therefore comprise the alternation [h$^{(w)}$] ~ [b] ~ [p].

(23)

bïʔ (cf. Acc Sg *bïðïm* with suffix –*m* and epenthesis) 'water'

huəʔ (cf. Acc Sg *huəɟum* with suffix –*m* and epenthesis) 'fur coat'

maʔ (cf. Acc. Sg *maɟəm* with suffix –*m* and epenthesis) 'house'

níluʔ (cf. Acc. Sg *niluɟim* with suffix –*m* and epenthesis) 'life'

ðőruʔ (cf. Acc. Sg *ðörugum* with suffix –*m* and epenthesis) 'cry'

kéguʔ (cf. Acc. Sg *kekuðum* with suffix –*m* and epenthesis) 'fog'

sínüʔ(cf. Acc. Sg *sïnügüm* with suffix –*m* and epenthesis) 'memory'

hiaʔ (cf. Acc. Sg *hiaɟim* with suffix –*m* and epenthesis) 'oak'

The two non-intervocalic positions, therefore, are never contrastive as far as obstruent voicing (and weak/strong gradation reflexes of prenasalized obstruents) are concerned, the obstruents in postconsonantal and coda positions are uniformly voiceless.

Word-initial voicing of the obstruents is not predictable from any principle of consonant gradation, or any other principle for that matter. The data in (24) illustrate this point: a word can start with either a voiced or a voiceless obstruent:

(24)

ɟűhü 'sledge'	**ɟ**áte 'stone'
céhï 'nail'	**ç**úəɟə 'tongue'
sátu 'clay'	**s**ïr 'ice'
baŋ 'dog'	**b**ása 'iron'
hᵘaa 'tree'	**h**óðür 'letter'
kíta 'cup'	**k**ásu 'bark'
gə́tə 'swan'	**g**úla 'crow'
tər 'hair'	**t**úrku 'lake'
ðőruʔ 'cry'	**ð**ájpu 'dry wood'

While in non-intervocalic positions we see no grade (voicing) alternations, obstruents in the language lenite intervocalically. However, and this is the most important aspect of the alternations in question for the discussion of this chapter, this lenition is prosodically restricted. Intervocalically, obstruents can surface as both voiced and voiceless, depending on their prosodic position. The data in (25) below illustrate this distribution, with the foot structure we need to predict the distribution of obstruent voicing. The words in (25) are examples with the 3ʳᵈ person possessive singular suffix:

(25)

    (ɟütű)-(ðü) 'his/her/its hand'   (táa)-(ðu) 'his/her/its deer'

    (suu)(ðə́ə)-(ðu) 'his/her/its lung'   (cimí)-(ði) 'his/her/its tooth'

    (kəə)(lí-**t**ï) 'his/her/its tear'   (kə́i)-(ði) 'his/her/its side'

    (ɟálï)-(ðï) 'his/her/its day'   (ɲòru)(mú-**t**u) 'his/her/its copper'

    (ŋuhú)-(ðu) 'his/her/its mitten'   (ci^{n}té)-(ði) 'his/her/its hill'

    (ɟàma)(ðá-**t**u) 'his/her/its animal'   (moo)(ɟá-**t**u) 'his/her/its stub'

As the alternation above illustrates, the appearance of voiced and voiceless intervocalic obstruents is predictable from the foot structure of the language as it is marked above. The footing has to be binary and start from the left. The CVV syllables are heavy, and are always footed by themselves. Stray syllables are footed into degenerate monomoraic feet.

The distribution of voicing is the same whether the gradating consonant starts a suffix or is inside a suffix. In (26) there is another example of the same voicing distribution with a similative suffix, where the gradating consonant ([k]/[g]) is in the second syllable of the suffix. The generalization about voicing (grade) distribution still holds: when the obstruent of the suffix is foot-initial, it is voiced, and when it is foot-internal, it is voiceless.

(26)

a.   (ɟütű)-(rə**k**ü)   'similar to a hand'

       (bìnï)-(rə́**k**ï) ~ (bïní)-(rə**k**ï) 'similar to a rope'

       (suu)(ðə́ə)-(rə**k**u) 'similar to a lung'

       (taá)-(rə**k**u)   'similar to a deer'

       (ŋuhú)-(rə**k**u)   'similar to a mitten'

b.   (ní-rə)(**g**ï)   'similar to a woman'

       (bàku)(nú-rə)(**g**u) 'similar to salmon'

       (t̀ïri)(mí-rə)(**g**ï)   'similar to caviar'

       (kəə)(lí-rə)(**g**ï)   'similar to a tear'

       (ɟàma)(ðá-rə)(**g**u) 'similar to an animal'

The data in (27) below gives us yet another example of intervocalic obstruent voicing distribution, but in verbs rather than nouns, with a participial suffix with [s]/[ɟ]

alternation. Despite the morphological (nouns vs. verbs) difference, the generalization about consonant gradation is exactly the same: when an intervocalic [s] is foot initial, it voices, and when it is foot-internal it stays voiceless.

(27)

    (bítï)-(ɟu) 'drinking'   (búaʔ)(tə-sï) 'looking up'
    (ɟúlə)-(ɟu) 'lifting'   (bə)(ðúaʔ)(tə-sa) 'growing'
    (ɟórə)-(ɟa) 'crying'   (hóðəʔ)(tə-sa) 'writing'
    (hótə)-(ɟa) 'writing out'   (ɟórə)(lə-sa) 'starting to cry'

It seems clear that intervocalic lenition in Nganasan is prosodically restricted: the obstruents are only allowed to lenite iff they are foot-initial, and the lenition is blocked otherwise.

Importantly, however, the foot structure that we need in order to predict the reflexes of consonant gradation correctly differs from the foot structure that we would posit if we only considered the stressed/stressless syllable opposition in the language. Recall that stress assignment in Nganasan does not exactly match the foot structure as marked by consonant gradation. Primary stress in the language is penultimate, regardless of whether the penultimate vowel is even or odd-numbered when counting from the left. In other words, a stressed vowel in the language can equally be foot-initial and foot-final because of the requirement that the penultimate vowel is stressed.

In addition, the same situation arises when the stress assignment is influenced by the quality of the vowel (stress shifts from [ə] and [ï]): the stressed vowel can be foot-initial or foot-final. Consider the following examples with similative suffix *-rəkV/-rəgV*, and foot structure marked as required by consonant gradation alternations:

(28)

a.   (ní-rə)(gï)   'similar to a woman'
     (hïa)(ɟə́-rə)(gï)   'similar to a thumb'
     (kó-rə)(gu)   'similar to an ear'

(hʷáa)-(rəku)   'similar to a tree'
(ɲòru)(mú-rə)(gu)   'similar to copper'
(là)(təə)-(rə́ku)   'similar to a bone'
(bi)(ríə)-(rəkï)   'similar to a wound'

b.   (bïní)-(rəkï) ~ (b̀ïnï)-(rə́kï)   'similar to a rope'
      (kə̀rï)(gəʎi)-(rəkï)   'similar to a march'
      (bopkú)-(rəku)   'similar to a coast'
      (hiŋhí)-(rəkï)   'similar to night'
      (koĺí)-(rəkï) ~ (kòlï)-(rə́kï)   'similar to a fish'
      (kǐⁿtə)-(rə́kï)   'similar to smoke'

Note that, due to the stress shift from the penultimate schwa of the suffix, stress can be placed on the foot-initial syllable (28a), and on the foot-final syllable, as in (28b), unless, as in the word for 'similar to a fish' *(koĺí)-(rəkï) ~ (kòlï)-(rə́kï)*, there is variation in whether the primary stress falls on the penult or antepenult. Consonant gradation, nevertheless, clearly makes reference to foot structure, regardless of the position of stress. Any reference to stress instead of to foot structure would render the pattern of consonant gradation alternations unpredictable.

Similarly, in forms without stress shifts due to the quality of the penultimate vowel, the stress (i.e. penultimate vowel) can be in foot-initial and foot-final position, while obstruents are only allowed to lenite foot-initially, as in the following examples with the 2nd person dual suffix *-ti/-ði*:

(29)

a.   (kó-ti)   'your (du.) ear'
      (bàku)(nú-ti)   'your (du.) salmon'
      (hai)(mú-ti)   'your (du.) fur boots'
      (hia)(ðá-ti)   'your (du.) ermine'
      (ɟàka)(ðá-ti)   'your (du.) smell'
      (ní-ti)   'your (du.) wife'
      (ɲòru)(mú-ti)   'your (du.) copper'

b.   (bahí)-(ði)   'your (du.) wild deer'
      (béi)-(ði)   'your (du.) period of time'

(düŋhá)-(ði)	'your (du.) soft ground'
(kərï)(gəʎî)-(ði)	'your (du.) march'
(koʎ)(sǔo)-(ði)	'your (du.) worm'
(le)(húa)-(ði)	'your (du.) board'

In (29a) the consonant of the suffix is always foot-final, and thus is not allowed to lenite, but is required to surface in its 'strong' grade, as voiceless [t]. In (29b), on the other hand, the same suffix is concatenated with stems that have an even number of vowels, and thus the consonant of the suffix is in foot-initial position, and surfaces in its 'weak' grade, i.e. as a voiced obstruent [ð]. Note that the suffix is stressed in neither case, as it is the word-final syllable, and the grammar therefore cannot refer to stressed/unstressed position to determine whether or not the consonant of the suffix is allowed to lenite. In both (29a) and (29b) the stress can precede the syllable with the suffix consonant, but the presence or absence of stress on the preceding syllable cannot predict the grade of the suffix consonant.

Note that the phenomenon of consonant gradation in pervasive in Nganasan: it applies also to compound words:

(30)

ciipsinəðə 'wrist' + hʷasa 'iron'	(ciip)(sinə)(ðəhʷa)(ɟa) 'bracelet'
hïaɟə 'thumb' + kita 'cup'	(hïa)(ɟəki)(ða) 'glove'
ɟamaðа 'animal' + ŋoka 'numerous'	(ɟama)(ðaŋo)(ga) 'insect'
bïʔ 'water' + ɟühü 'sledge'	(bïtï)(ɟühü) 'boat'
ko 'ear' + hʷasa 'iron'	(kohʷa)(ɟa) 'earring'
hiⁿhi 'night' + taabu 'tail'	(hiⁿhi)(taa)(bu) 'dawn'

Note that footing is persistent throughout the compounds, so that the first syllable of the second part of the compound can be footed with the last syllable of the first part of the compound, as in the word for 'glove' *(hïa)(ɟəki)(ða)*.

Borrowings into Nganasan, both fairly recent and older, are also subject to consonant gradation:

(31)

(ðoro)(ga) 'paved road'	from Russian	/doroga/ 'road'
(pəko)(ða) 'nasty weather'	from Russian	/pogoda/ 'weather'
(hʷapri)(ga) 'factory'	from Russian	/fabrika/ 'factory'
(kəɲi)(gulï) 'holidays'	from Russian	/kanʲikulï/ 'school break'
(səha)(ga) 'small, show dog'	from Russian	/sobaka/ 'dog'
(çiro)(ða) 'orphan'	from Russian	/sʲirota/ 'orphan'

We can see from the data above that while the word-initial consonant can appear as either voiced or voiceless, word-internal consonant voicing is distributed according to principles of consonant gradation, exactly as the voicing of consonants in native words.

2.2.2.2 The Analysis

The essence of consonant gradation seems to be intervocalic lenition restricted by metrical structure, and the conditions on prosody regulate the distribution of grades in certain prosodic positions. More specifically, gradation is a condition on appearance of **weak** grades: they are allowed only if they are aligned with the left edge of a foot. More formally, this generalization can be expressed as an interaction of a lenition constraint and an alignment constraint:

(32)　　*Constraints (preliminary formulation, to be revised)*

LENITION *V C$_{(strong)}$ V　　No strong grade consonants intervocalically

ALIGNWEAK　　Align the left edge of a weak grade segment with the left edge of a foot

IDENT$_{[voice]}$　　The value of the feature [voice] in the out has to be the same as the value of this feature in the input[11]

In the analysis of consonant gradation throughout this thesis I will maintain that underspecification versus prespecification of segments for certain features plays a crucial role in accounting for the facts. Those segments with predictable surface alternates are

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[11] In this thesis, I am using privative voicing to account for the data, that is, the value for [voice] can be either present or absent in a segment.

underspecified (segments that are underspecified for some feature in the input are written with capital letters), while unpredictable information is encoded with prespecification in the input. In using this kind of underspecification I follow, most notably, Inkelas (1994).

Tableau 15

/ nï-rəKV/ 'similar to a wife'	IDENT [voice]	ALIGNWEAK	LENITION
☞ a. (nî-rə)(gï)			
b. (nî-rə)(kï)			*!
/ bïnï-rəKV/ 'similar to a rope'			
a. (bìnï)-(rə́gï)~ (bïnî)-(rəgï)		*!	
☞ b.(bìnï)-(rə́kï)~ (bïnî)-(rəkï)			*

In Tableau 15, the main insight about gradation is formalized: in the upper part of the tableau, the two candidates under consideration differ in that candidate (a) has a weak grade of the suffix consonant, and candidate (b) has the strong grade. Neither candidate violates the IDENT[voice] constraint (leaving aside momentarily the issue of word-initial voicing), since the grade of the relevant consonant is underspecified in the input /nï-rəKV/. Neither candidate incurs an ALIGNMENT violation, either: candidate (a) has its weak grade consonant aligned correctly with the left edge of a foot, and candidate (b) has no weak grade consonant to align. The decision, therefore, is passed on to the LENITION constraint, which favors the candidate (a) since it has a weak consonant [g] intervocalically.

In the second part of Tableau 15 the situation is slightly different. While none of the candidates violate the IDENT[voice] constraint (underspecified input is /bïnï-rəKV/), candidate (a) is ruled out by the ALIGN constraint: weak grade consonant [g] in [bïnï-rəgï] is not aligned with the left edge of any foot. Thus, even though candidate (a) satisfies the LENITION constraint while candidate (b) violates it (due to a strong grade

between vowels), the candidate with the strong grade of the consonant (candidate (b)) emerges as optimal.

The above tableau, therefore, gives us the generalization about gradation that we need: the appearance of the two grades is a product of intervocalic lenition interacting with an alignment condition.

What, however, determines the grade of the consonants that are not positioned between vowels? Initial consonants do not participate in consonant gradation, the initial position is the only position with contrastive voicing.

It appears necessary to prespecify the grade of a word-initial consonant in the input, which, at least in some cases, amounts to specifying a consonant for presence of voice feature. We can prespecify the initial consonant of the word for 'his/her/its salmon' *bakunu-tu* with a [voice] feature (weak grade), while leaving the initial consonant of the word for 'his/her/its caviar' *tïrimi-tï* underspecified. There is one additional constraint we need to give us the default absence of voicing, other conditions permitting:

(33)
      *C$_{[+voice]}$ No voiced consonants are allowed.

This constraint can be viewed as part of universal markedness hierarchy that favors voiceless consonants over voiced ones (*C$_{[+voice]}$ >> *C$_{[Øvoice]}$).

Tableau 16

/ **baKunu-TV** /	IDENT $_{[voice]}$	**ALIGNWEAK**	**LENITION**	***C$_{[+voice]}$**
☞ a.(bàku)(nú-tu)			**	
b. (pàku)(nú-tu)	*!		**	
c.(bàku)(nú-ðu)		*!	*	
d.(pàku)(nú-ðu)	*!	*	*	
/ **Tïrimi-TV**/				
☞ a. (tïri)(mí-tï)			*	
b. (ðïri)(mí-tï)			*	*!
c.(tïri)(mí-ðï)		*!		
d.(ðïri)(mí-ðï)		*!		

As Tableau 16 illustrates, for the input **/baKunu-TV/,** where the initial consonant is prespecified for the [voice] feature, the two candidates that do not have this feature in the output (candidates (b) and (d)) are ruled out by the IDENT constraint that requires the voicing in the input and output to be the same. The two remaining candidates, (a) and (c), are identical as far as initial voicing is concerned, but they differ in the grade of the suffixal consonant. The choice between these candidates is made by the alignment constraint: candidate (c)'s weak grade is not aligned with a foot edge, which is a fatal violation. The winner, therefore, is candidate (a), with the voicing of the initial consonant identical to the voicing in the input (voiced, weak grade), and the suffixal consonant in its strong grade.

In the lower part of Tableau 16 the situation is slightly different: the initial consonant is not prespecified for voicing in the input. The IDENT constraint, therefore, is inactive, as neither of the candidates violates it. Candidates (c) and (d), with the weak grade of the suffix consonant, are ruled out by the ALIGN constraint, since the weak grade is not aligned properly. The remaining two candidates, (a) and (b) tie on the LENITION constraint: they both violate it, having a strong-grade consonant intervocalically in the suffix. Note that the constraint is indifferent to the initial voicing (it refers only to intervocalic consonants), and the initial strong grade of the consonant in candidate (a) does not cause a violation of this constraint. The decision, therefore, is passed on to the constraint that disallows voiced consonants. The constraint is violated by candidate (b), where initial consonant is voiced. Candidate (a), on the other hand, passes this constraint and becomes a winner.

The grade of the initial consonant, hence, is a matter of specifying it for grade/voicing in the input. Initial consonants that are prespecified for [voice] are going to surface as voiced, while the ones that are not specified, will show up voiceless.

Consonants in another non-intervocalic position, which appear after another consonant, will get similar treatment under the present analysis: since they are not prespecified for

grade in the input, they surface with default grade, strong (voiceless), due to the lower-ranked constraint that forbids voiced consonants.

As we have observed before, after another consonant, a consonant appears in the strong grade (voiceless), regardless of whether it is foot-medial or foot-initial:

Tableau 17

/KaTar-TV/[12] 'his/her/its light'	IDENT[voice]	ALIGNWEAK	LENITION	*C[+voice]
☞a.(kaðár)-(tu)				
b.(kaðár)-(ðu)				*!

As there are no consonants prespecified for voicing in the input[13], the IDENT constraint is inoperative in this case. There is no violation of the ALIGN constraint by any of the candidates, either: candidate (a) satisfies the constraint vacuously, since it does not have a weak grade consonant to be aligned, and candidate (b) has its weak grade consonant of the suffix correctly aligned with the edge of a foot. LENITION is inoperative as well: in both candidates, initial and suffixal consonants do not appear in intervocalic position. The voicing of the postconsonantal suffixal consonant, therefore, is determined by the *C[+voice] constraint, which is violated by candidate (b), since its suffixal consonant is voiced.

The analysis, as a result, insures that a consonant that appears after another consonant invariably surfaces in its strong grade (voiceless).

The same type of analysis should apply for gradation of prenasalized consonants. They differ from all the other gradating consonants at which we have looked so far in that the alternation between strong and weak grade in this case is the alternation between a prenasalized and simple obstruent. The obstruent of the weak grade, as well as of the strong grade, is voiceless. Lenition in this case, therefore, is manifested as a simplification of complex prenasalized consonant in the relevant position (intervocalic

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[12] The voicing of the second consonant of the stem depends on another type of gradation, Closed Syllable gradation, discussed in the appendix.
[13] See previous footnote

and aligned with the left edge of a foot). Let us now illustrate the basic contrast with the suffix **-tənu/-ⁿtənu/-tənï/-ⁿtənï**:

(34)

a.
       kubú-**t**ənu   (Locative singular, non-possessive) 'skin, fur'
       ɟübű-**t**ənu   (Locative singular, non-possessive) 'sledge'
       kiðá-**t**ənï   (Locative singular, non-possessive) 'cup'
       hʷáa-**t**ənu   (Locative singular, non-possessive) 'tree'

b.
       baarpə́-**ⁿt**ənu   (Locative singular, non-possessive) 'master, chief'
       cïïpsìnəðə́-**ⁿt**ənï   (Locative singular, non-possessive) 'wrist'
       hïaɟə́-**ⁿt**ənu   (Locative singular, non-possessive) 'thumb'
       kəəlḯ-**ⁿt**ənï   (Locative singular, non-possessive) 'tear'

The consonant in the suffix shows up in its weak grade in (34a), and in its strong grade in (34b). This difference is due to the position in the prosody of the consonant in question: in (34a) it is foot-initial, and in (34b) it is foot-internal. The condition on grade distribution, therefore, is identical to the rest of the cases we have discussed, what differs here is only the form of the gradation reflexes. The data above, consequently, should receive treatment parallel to the rest of the gradation facts:

Tableau 18

/ɟüHü-NTənV/	IDENT$_{[voice]}$	ALIGN WEAK	LENITION	*C$_{[+voice]}$
☞ a. (ɟübű)-(tənu)				
b. (ɟübű)-(ⁿtənu)			*!	
/ Kəəlï-NTənï/				
a. (kəə)(lḯ-tə)(nï)		*!		
☞ b. (kəə)(lḯ-ⁿtə)(nï)			*	

The tableau for dealing with these reflexes is virtually identical to the one for voiceless/voiced reflexes, owing to the fact that the two operative constraints in this case (ALIGNWEAK and LENITION) refer to grades of consonants rather than specifically to voicing. In the upper part of Tableau 18, both of the candidates satisfy the alignment constraint: candidate (b) satisfies it vacuously with no weak grade to align, and candidate

(a) has its weak-grade [t] properly aligned with the left edge of the foot. The crucial constraint here is the LENITION constraint, which is fatally violated by candidate (b), since it has strong-grade [^{n}t] intervocalically.

In the lower part of the tableau, on the other hand, candidate (a) violates the ALIGN constraint, since its weak-grade [t] is foot-medial, leaving candidate (b) a winner, even though candidate (b) fails to have a weak grade of the suffixal consonant intervocalically.

Grade, in accordance with the analysis we have developed so far, emerges as a diacritic property: the grammar appears to have two *t*'s, one of which is the 'strong grade' consonant of the alternation *t/ð*, and the other is the 'weak grade' of the consonant in the alternation *^{n}t/t*. The same has to be said about the alternation *j/Ø*, where the strong grade is voiced and the weak grade is no consonant at all. The notion of grade, therefore, is not defined theoretically in the constraints above. It seems that these constraints have to be reformulated so, on the one hand, there is no direct reference to 'grades' in the grammar, and on the other hand, to capture the intuition that the language has the opposition of 'weak' and 'strong grades'.

First, let us consider the alignment constraint we have posited in (32): the **ALIGNWEAK** constraint serves to limit the appearance of 'weak grades' to the left edge of a foot. It eliminates all the candidates that have 'weak-grade' consonants that are not aligned correctly. We will break this constraint into two conjoined constraints, first of which will take on the alignment part:

(35)

a.　　　**ALIGN-L C, FT**　　　　　　　　Align a consonant with the left edge of a foot

and the second will define what 'weak' grade is for the purposes of Nganasan consonant alternations:

b.　　　**DEP**$_{[voice]}$ **or MAX**$_{[+nasal]}$ **or MAX**$_{[+sonorant]}$

This disjunction defines what the weak grade of a consonant is: it is a consonant that has either introduced voicing that is not in the input, or lacks nasalization that is in the input, or deletes the feature [+sonorant] that is in the input. The disjoint constraint is violated if any of the three disjuncts is violated.

Note that this type of definition of what the weak/strong opposition is depends heavily on underspecifying predictable surface alternates in the input: it is not the presence of voicing in an output consonant that makes it 'weak grade' (and thus subject to alignment constraints), but the faithfulness violation of introducing voicing that is not present in the input form. Similarly, it is not the absence of prenasalization that makes a consonant 'weak grade', but deletion of the prenasalization that is present in the input.

To achieve the effect the **ALIGNWEAK** constraint has (limiting weak grades of a consonant to the left edge of a foot), we need to conjoin the constraint that aligns a consonant to the left edge of a foot (**ALIGNC**) with the constraint that determines what a weak grade is (our disjunction $DEP_{[voice]}$ or $MAX_{[+nasal]}$ or $MAX_{[+sonorant]}$).

Conjunction of these two constraints will give the effect that all the consonants that are featurally distinct in a certain way from their inputs will have to be aligned with the left edge of a foot. Candidates that are not changed from the input ('strong grades') will pass automatically, and so will candidates that have irrelevant featural changes such as place neutralization in the coda, whether they are aligned or not. Candidates that are changed in the relevant way, on the other hand, ('weak grades') will satisfy the conjunction only if they are aligned correctly:

Tableau 19

/bïnï-rəKV/	**ALIGNC**	**&**	$DEP_{[voice]}$ or $MAX_{[+nasal]}$ or $MAX_{[+sonorant]}$
☞ a. (bìnï)-(rə́kï)~ (bïní)-(rəkï)	*	✓	
b. (bìnï)-(rə́gï)~ (bïní)-(rəgï)	*	*!	*

Candidate (a) in Tableau 19, with the strong-grade voiceless consonant [k], violates ALIGNC, since [k] is foot-medial, but it is not changed featurally from the input, that is, it does not violate the disjunction. As a result, the candidate passes the conjunction.

Candidate (b) also has a violation of the ALIGNC constraint: its weak-grade consonant [g] is also foot-medial. However, in contrast with candidate (a), candidate (b) violates DEP[voice], since it has the voicing that is not in the input, and thus violates the disjunction. This way, candidate (b) violates both ALIGNC and the disjunction, and, as a result, the whole conjoined constraint.

Note that the conjunction of **ALIGN-L C, FT, DEP[voice] or MAX [+nasal] or MAX [+sonorant]** above, responsible for restricting weak-grade consonants to foot-initial positions has a logical equivalent like the following:

(36)
      [ALIGN C & DEP [voice]] **or** [ALIGN C & MAX [+nasal]] **or** [ALIGNC & MAX [+son]]

The alignment constraint is conjoined with each of the faithfulness constraints (each determining a type of weak-grade reflexes), and the three conjunctions are disjoint, so that if a candidate violates one of the disjuncts, it violates the whole disjunction.

For example, the candidate (b) in the tableau above *(bïnï)-(rəgï)* would violate the first of the disjuncts above, since its consonant [g] violates both DEP [voice] – due to the presence of voicing that is not in the input – and ALIGNC, because it is not aligned with the left edge of a foot. Since one of the disjuncts is violated, the whole disjunction is violated, and the candidate is dismissed.

Let us now turn to a more precise definition of the LENITION constraint, which is the other constraint that exploits the notion of 'weak' versus 'strong' grade opposition in our preliminary formulation. The constraint is repeated below for convenience:

(37)   **LENITION**   No strong-grade consonants intervocalically

LENITION is, in fact, a scale of constraints: $*VNC_{[\text{Øvoice}]}V$ (no prenasalized voiceless consonants intervocalically[14]) **>>**$*V^NCV$(no complex – prenasalized – consonants intervocalically) >> $*VC_{[\text{Øvoice}]}V$ (no voiceless consonants intervocalically) >> $*VC_{[\text{-sonorant}]}V$ (no obstruents intervocalically) >> $*VC_{[\text{+sonorant}]}V$ (no intervocalic sonorants)[15].

The Lenition scale of constraints determines what the weak reflex of a certain strong input really is:

Tableau 20

/K/	$*V^NC_{[\text{Øvoice}]}$ V	$*V^NCV$	$*VC_{[\text{Øvoice}]}V$	MAX$_{[\text{-son}]}$	$*VC_{[\text{-son}]}V$	$*VC_{[\text{+son}]}$ V
a. k			*!		*	*
☞b. ɡ					*	*
c. C[16]				*!		
/j/						
a. j						*!
☞b. C[17]						

In the Tableau 20 above, an input like /K/ has three relevant candidates. Candidate (a) is the completely faithful one, candidate (b) is unfaithful in that it introduces voicing, and candidate (c) lacks the feature [-sonorant] that is present in the input.

Neither of the candidates violates the first two lenition constraints, since do not have prenasalization. Candidate (a) has a fatal violation of the $*VC_{[\text{Øvoice}]}V$ (no voiceless

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[14] This constraint is actually is a conjunction of two: $*V$ ^NC V (no prenasalized consonants intervocalically) and $*VC_{[\text{Øvoice}]}$ V (no voiceless consonants intervocalically) The conjoined constraint is violated iff both of its conjuncts are violated, that is, iff the intervocalic consonant is both prenasalized and voiceless.

[15] The scale goes from a 'weaker' requirement (no intervocalic consonants that are both prenasalized (complex structure) and voiceless) to the strongest requirement that there be no intervocalic consonants even if it is a sonorant. It is possible that this scale is more detailed universally, that is, it includes constraints like $*VC_{[\text{-continuant}]}V$ (no stops intervocalically), or $*VC_{[\text{-son, -nasal}]}V$ (no liquids intervocalically), but here I am using only those constraints that have effect in the language.

[16] here C means that there is a consonant root node that has only the feature [+consonantal] and no other features. Even though this node is a part of the surface phonological representation, it is not read off by phonetics that is unable to supply some essential missing features. See more on that in the section on 'ghosts' below.

[17] See previous footnote

consonants intervocalically) constraint, and candidate (c) violates the $\text{MAX}_{\text{[-sonorant]}}$ constraint. Candidate (b) is the most harmonic one, with lenition taking the consonant from underlying voiceless stop to surface voiced stop.

For input like [j] that is [+sonorant], on the other hand, candidate (b), that is phonetically a zero, is the most harmonic one, because it does not violate any of the lenition constraints (it does not have any consonantal features intervocalically, except the consonantal node itself). Candidate (a), on the other hand, has a violation of the lowest-ranking constraint in the scale, that is nevertheless a fatal one.

A problem with accounting for Nganasan consonant gradation with this scale of lenition arises when we consider the reflexes of prenasalized stops. Consonant gradation reflexes of prenasalized stops are voiceless stops, while the reflexes of underlying voiceless stops are voiced stops[18]. This is a chain shift that needs to be accounted for in our system.

The basic facts of the chain shift in consonant gradation of Nganasan are the following:

(38)
> ^{n}t → t and t → ð in the same environment
> ^{ŋ}h → h and h → b in the same environment
> ^{ŋ}k → k and k → g in the same environment
> ^{ɲ}c → c and c → ɟ in the same environment

This chain shift occurs in all the dialects of the language, as far as I know. The only difference is that there is a small dialectal variation in that the output of the last link is [d] instead of [ð]. This dialect (Vadey) also has no *ð*'s at all, just as the dialect I am working with here (Avam) has no *d*'s except the prenasalized ones.

The main challenge in handling this kind of chain shift in OT is to prevent the prenasalized consonant going all the way to a single voiced segment, while the single

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[18] or a voiced fricative in case of t ~ ð alternation, since the language does not have any voiced dental stop anywhere but word-initially and after nasals.

voiced segment is the most harmonic one for the single voiceless input. Essentially, the problem is in defining 'one step' in OT.

The idea of how to deal with this kind of chain shifts in OT here comes from the combination of Orgun's (1995) analysis of chain shifts (for chain shifts where one of the links contains deletion) and Kirchner's (1995) analysis.

Orgun exploits difference between deleting a feature and deleting a segment. Kirchner (1995) uses notion of **distantial faithfulness**, i.e. minimization of distance between underlying and surface values along the phonetic scale. Constraints enforcing distantial faithfulness can in turn be derived from ordinary featural faithfulness constraints by local conjunctions (Green 1993, Smolensky 1995)[19]. Assuming some phonetic scale, the output cannot be more than a certain distance from its input value along this scale.

(39)   *The distantial faithfulness constraint:*

$MAX_{[+nasal]}$ **&** $DEP_{[voice]}$ All the instances of the feature [+nasal] present in the input must be present in the output **&** All instances of voicing present in the output must be present in the input

The conjunction is violated if and only if both of the conjuncts are violated, i.e. if a candidate both lost prenasalization and introduced voicing. (Green (1993), Smolensky (1995)).

Tableau 21

/NT/	$*V^N C_{[Øvoice]}$ V	$Max_{[+n]}$& $Dep_{[v]}$			$*V^N CV$	$*VC_{[Øvoice]}V$	$MAX_{[-son]}$	$*VC_{[-son]}V$	$*VC_{[+son]}$ V
a. ⁿt	*!	✓	✓	✓	*	*		*	
b. ⁿd		✓	✓	*	*!			*	
☞c. t		*	✓	✓		*		*	
d. ð		*	*!	*				*	
/T/									
a. t		✓	✓	✓		*!		*	
☞b. ð		✓	✓	*				*	
c. C		✓	✓	*			*!		

[19] Cf. Crowhurst and Hewitt (1997) for a different notion of conjunctions and disjunctions of constraints in Optimality Theory.

The result is that underlying /NT/ does not go all the way to [d] (or [ð] in dialects that have [d] only if the consonant is prenasalized), and underlying /T/ surfaces as [d] ([ð]). In the upper part of the tableau, there are three candidates that are harmonic enough to pass the conjoined constraint: candidate (a) that is most faithful to the input, candidate (b) that keeps the prenasalization while introducing voicing, and candidate (c) that does not introduce voicing but gets rid of the prenasalization. Candidate (d), on the other hand, violates the conjunction because it both introduces voicing **and** does not have underlying prenasalization, and this violation is fatal for the candidate.

Candidate (a) is discarded by the first 'mild' lenition constraint that requires that there are no prenasalized voiceless stops intervocalically. Ranking of the $*V^NCV$ constraint (no prenasalized stops intervocalically) above the $*VC_{[Øvoice]}V$ constraint (no voiceless consonants intervocalically), makes candidate (c) the optimal one.

In the lower part of the tableau we have an input without prenasalization. All of the candidates, thus, pass the conjoined constraint, and candidate (b) is selected as the most harmonic one by the lower-ranked lenition constraints.

The problem of the chain shift, therefore, is solved in this analysis: the conjunction of the two faithfulness constraints prohibits the candidates to be distinct more than one step along the lenition scale from the input.

Let us now summarize the analysis of consonant gradation from this section:

(40)

   a) The alternations are caused by intervocalic lenition that requires that there be no strong grade consonants between vowels;

   b) Gradation in itself is an alignment requirement on weak grades: any weak grade consonant must be aligned with the left edge of a foot.

c) Word-initial consonants show up in the output with the same voicing for which they are specified in the input. In case a word-initial consonant is not specified for voicing, it surfaces as voiceless as a default

d) Since consonants appearing after consonants are not forced to have a weak grade consonant by the Lenition constraints, they also surface voiceless as a default

e) Consonant gradation depends on the foot structure of the language that is (i) moraic with CVV syllables heavy and CVC and CV light; (ii) maximally binary; (iii) degenerate feet are allowed at the right edge of a word; and (iv) stress can deviate from the foot structure in certain cases, without changing the foot structure itself.

The grade alternation pattern is only predictable from foot structure, and crucially not from position of stress in the word. Thus, though theoretically appealing, the theory of restriction of reference to prominent/non-prominent opposition cannot be maintained, and there are clear mismatches between prominence and constituency in Nganasan.

2.3 Case Study: Eastern Mari[20]

The second case we discuss in detail in this chapter is the interaction of three patterns of alternations in Eastern (Meadow) Mari. Mari is a Finno-Ugric Uralic language that has two major literary dialects, Eastern (Meadow) Mari and Western (Hill, Mountain) Mari, each of which has considerable dialectal variations. The dialect from which the data in this chapter is drawn is spoken on the boarder of Nizhni Novgorod region and Mari El republic, in Russia.

Eastern Mari alternations we discuss in this chapter are the following: stress assignment pattern, the full/reduced vowel alternation, and two types of vowel harmony,

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[20] The Eastern Mari data in this chapter is from fieldwork during the summer of 2002. I owe a debt of gratitude to the Center of Finno-Ugric peoples in Moscow, and to Dmitriy Solovjev, Marina Illarionova and Vladislav Makarov for their invaluable organizational help and moral support.

backness/frontness harmony and rounding harmony. Eastern Mari has the following vowel inventory:

(41)

i ü			u
e ö		ə	o
ä			a

Schwa ([ə]) is the vowel to which I will refer as 'reduced' and the rest of the vowels are called 'full', a distinction that is important for the discussion in this thesis. The front low vowel [ä] is restricted to non-initial syllables, and surfaces only as a result of frontness harmony. There are no such vowels underlyingly. The rest of the vowels appear underlyingly, as well as on the surface, according to the analysis I present in this chapter.

With respect to phonological behavior, there are five types of suffixes in Eastern Mari that are discussed in this chapter:

(42)

	single-consonant suffixes	suffixes with underlying /e/	suffixes with underlying /a/	suffixes with underlying /´/	suffixes with underlying full mid vowel
attract stress	no	from stems in which all underlying vowels are /ə/	from all stems except stems with all underlyingly full vowels	no	no
subject to frontness harmony	____	no	yes	yes	yes
subject to rounding harmony	____	no	no	yes	yes

As can be seen from the table above, the absence or presence of a vowel, as well as the quality of the vowel is the difference between the five types of suffixes, i.e. they are classified here on phonological basis, not morphological categories.

With this essential background, we turn to the discussion of several phenomena in Eastern Mari. First, we discuss the pattern of stress assignment in the language. We show that the placement of stress depends on the quality of the underlying vowels, and exhibit the so-called 'default-to opposite' pattern of stress assignment.

Next, we present the full/reduced vowel alternation, which marks the foot structure of the language. The alternation is analyzed as one of unidirectional neutralization, where underlyingly reduced vowels are converted into full vowels under certain conditions, one of which is prosodic.

Of the two types of vowel harmony that we discuss in subsection 2.3.3 one, namely the rounding harmony, is prosody-sensitive. We will show that the trigger of rounding harmony is a stressed vowel.

Given the mismatch between the placement of stress and foot structure that is marked by the full/reduced vowel alternation, the fact that the trigger of rounding harmony must be stressed allows us to see that the generalization in this case must crucially refer to stress, and not to metrical boundaries.

2.3.1 Stress

In the dialect of Eastern (Meadow) Mari that I am investigating in this chapter, there is only one stress per word. The correlates of stress are fundamental frequency, amplitude, and especially duration. At a constant rate of speech, stress adds c.120 ms. to a 70 ms. long unstressed vowel. In underived words, the stress falls on the rightmost full (non-schwa) vowel, as illustrated in (43):

(43)

/koŋga/	koŋgá	'oven'
/šerge/	šergé	'comb'
/šudo/	šudó	'hay'
/kəʎa/	kəʎá	'mouse'
/čijä/	čijá	'paint'

/čödrä/	čödrä́	'forest'
/šüzär/	šüzä́r	'sister'
/aβam/	awám	'mother'
/murɲa/	murɲá	'tube, pipe'
/paša/	pašá	'work'
/kuβa/	kuβá	'old woman'
/olma/	olmá	'apple'
/muča/	mučá	'end'

Since all of the examples above are underived nouns consisting of two syllables, both of which have unreduced vowels underlyingly, as well as on the surface, the stress in (43) always falls on the second syllable, i.e. on the rightmost vowel in the word. When the second syllable of a word contains an underlying[21] schwa, the stress falls on the first syllable, since it is the 'rightmost' full-vowelled syllable in these words:

(44)

/šörtɲə/	šő́rtɲö	'gold'
/pörtə/	pő́rtö	'pine forest'
/kürtɲə/	kű́rtɲö	'iron'
/teŋgəz/	téŋgəz	'sea'
/olək/	ólək	'meadow'
/kində/	kínde	'bread'
/waštər/	wáštər	'maple'
/serəš/	sérəš	'letter'
/šüšpək/	šű́špək	'nightingale'
/šorək/	šórək	'sheep'
/pünčə/	pű́ncö	'pine'
/šuldər/	šúldər	'wing'
/jüksə/	jű́ksö	'swan'
/šoŋšə/	šóŋšo	'hedgehog'

While most synchronically underived roots in Eastern Mari are mono- and disyllabic, there are a few trisyllabic roots that exhibit the same stress pattern: the rightmost underlyingly full vowel is stressed:

---

[21] An underlying reduced vowel becomes a full vowel under certain conditions we discuss later in the chapter. For the purposes of stress assignment, however, the underlying reduced vowels count as such, whether or not they become full vowels on the surface.

(45)

/joŋələš/	jóŋələš	'mistake'
/pušaŋgə/	pušáŋgə	'tree'
/üremə/	ürémə	'street'
/kögörčen/	kögörčén	'dove'
/pareŋə/	paréŋə	'potato'

As we can observe from the data above, any syllable in a trisyllabic word can be the stressed one: it is the first syllable in the word for 'mistake' *jóŋələš*, the second syllable in the words for 'tree', 'street' and 'potato', and the final third syllable in the word for 'dove'. The generalization, therefore, still stands, the stress is uniformly placed on the rightmost full vowel in the word, regardless of the number of syllables.

The dialect under discussion also has roots that consist entirely of reduced vowels underlyingly. In these roots, the stress is placed on the **leftmost** syllable:

(46)

/βəɲər/	βə́ɲər	'canvas'
/jəšəŋ/	jə́šəŋ	'joint'
/əškəl/	ə́škəl	'step'
/čərkə/	čə́rke	'church'
/rəβəž/	rə́wəž	'fox'
/təlzə/	tə́lze	'moon, month'
/kəlmə/	kə́lme	'cold'
/jəlmə/	jə́lme	'tongue; language'
/kəzət/	kə́zət	'now'
/ləβə/	lə́βe	'butterfly'
/pərəs/	pə́rəs	'cat'
/čəβə/	čə́βe	'chicken, hen'

The language, as is evident from the data, exhibits the 'default-to-opposite' pattern[22],

[22] Dobrovolsky (1999) in his study of Chuvash, suggests that the default initial syllable stress in the language is a mistranscription, since the initial syllable bears high tone rather than appears with such correlates of stress in other positions such as fundamental frequency, duration and amplitude. Such an analysis, however, cannot be extended to the dialect of Eastern Mari under discussion, where stressed initial vowels exhibit the same characteristics as other stressed vowels.

discussed in Walker (1996), Zoll (1997) and Gordon (2000), among others[23]: the rightmost full vowel is stressed, otherwise the letftmost (see also Itkonen (1955), Ristinen (1960), Sebeok and Ingemann (1961) for generalizations about Eastern Mari stress, and Ivanov and Tuzharov (1970) on Northwest Mari stress).

In the next subsection of this chapter, we will show that the dialect of Mari under discussion has binary foot structure. The stress assignment pattern, however, does not seem to take the foot structure into account, but is rather based on different principles: preference for edges of the Phonological Word, and sonority of the vowels. Let us now turn to investigating the stress assignment pattern within roots, and later expand our analysis to derived words.

Let us start with sketching an analysis of underived words that contain only full vowels, and then turn to examples with all surface schwas, as well as words with segmental alternations between schwa and full vowels. Constraints, following (with slight modifications) the model established in Zoll (1997) for Selkup, are formulated below:

(47)

a.   **ALIGN-RIGHT (ǿ, PWd)**   Stressed syllables must be word-final

∀ ǿ ∃ Prosodic Word such that the stressed syllable coincides with the rightmost syllable in the Prosodic Word

b.   ***GRID$_n$/ə**   Gridmark Level$_n$ must not be
                                        assigned to a schwa-headed
                                        syllable

Assign one violation for every syllable that is headed by [ə] that is assigned prominence

c.   **ALIGN-LEFT (ǿ, PWd)**   Stressed syllables must be word-
                                        initial

∀ ǿ ∃ Prosodic Word such that the stressed syllable coincides with the leftmost syllable in the Prosodic Word

---

[23] Notably, however, the familiar 'default-to-opposite' pattern is peculiar in Eastern Mari (see Kenstowicz (1995) and Zoll (1997) for more discussion on this and similar patterns): the difference here is not between heavy and light syllables, or long and short vowels, but rather between short full and short reduced vowels.

We diverge from Zoll's model somewhat in that we have two constraints (47 a, c), one of which requires a stressed syllable to be word-final, and the other word-initial. We also have a markedness constraint in (47b), which picks out a marked configuration. We have already used this constraint in the analysis of Nganasan primary stress.

For the purposes of the dialect of Mari under discussion, the marked stressed schwa has to be licensed, which we do by conjoining the $*\text{GRID}_n/\text{ə}$ constraint with the ALIGN-LEFT constraint in (47c). Thus, without adding a separate group of licensing constraints to the CON component of the grammar, we achieve the licensing effect of a marked configuration (a stressed schwa in this case).

The conjoined licensing constraint ranked above the more general constraint in (47a), which itself outranks the Prominence Alignment constraint, derives the Mari pattern. Note that because the footing constraints outrank the Prominence Alignment constraint, the foot structure stays always binary, regardless of the position of the stress:

Tableau 22

/šudo/ 'hay'	ALIGN-L (FT, PWD)	$*\text{GRID}_n/\text{ə}$ & ALIGN-LEFT (ǿ, PWd)		ALIGN-RIGHT (ǿ, PWd)	ALIGN-L (LEV$_n$GRID, FT)
☞ a. (šudó)		✓	*		*
b. (šúdo)		✓		*!	

As there are no schwas in the word above, in either underlying representation or the candidates, the conjoined licensing constraint is irrelevant here: there are no schwas to license. Both candidates pass this constraint, and the decision is passed on to the ALIGN-RIGHT constraint, which is violated by candidate (b) with the stress assigned to the leftmost syllable. Note that the Prominence Alignment constraint is inactive here: it is ranked below the alignment to Prosodic Word group of constraints. Even though candidate (a) violates the Prominence Alignment constraint by not having prominence on its foot-head syllable, it still emerges as a winner.

The situation where there are only [ə] vowels in candidates and the stress is assigned to the leftmost syllable is also accounted by the above constraints with their ranking:

Tableau 23

/pərəs/ 'cat'	ALIGN-L (FT, PWD)	*GRID$_n$/ə	**&**	ALIGN-LEFT (ɔ́, PWd)	ALIGN-RIGHT (ɔ́, PWd)	ALIGN-L (LEV$_n$GRID, FT)
☞ a. (pə́rəs)		*	✓			*
b. (pərə́s)		*	*!	*		

In the case above, we see the licensing constraint in action: both candidates have stressed schwas, but it is only in candidate (a) that the stressed schwas are licensed: it is aligned with the left edge of the Prosodic Word, hence passing the conjunction. In contrast, candidate (b)'s stressed schwa violates both the sonority constraint *GRID$_n$/ə and the ALIGN-LEFT constraint, thus violating the whole licensing conjunction. Candidate (a) thus emerges as the optimal one.

Mari also presents a somewhat more challenging situation, when an underlying schwa is vocalized on the surface. We also have to account for the fact that an underlying schwa, even if it is vocalized on the surface, behaves as a non-vocalized schwa with respect to stress. In other words, such an interaction would be handled by opaque ordering of rules in a serial-based framework. The stress assignment rule would be ordered before the vocalization rule, thus deriving the pattern we see, for example, in /šörtɲə/ 'gold' surfacing with initial stress *šŏrtɲö* or /kində/ 'bread' similarly showing up as *kínde*, and not **kindé* as our analysis developed so far predicts.

It has been pointed out many times (see, for example Vaux (2003) and references therein) that an output-oriented theory like OT has trouble modeling 'an opaque' phenomenon. Here, however, we will maintain that the interaction of vocalization and stress assignment is a variation on what Kirchner (1995) dubs **distantial faithfulness**, i.e. minimization of distance between underlying and surface values along some phonetic scale. We will argue that adding vocalic features such as [±back] or [±round] at the same time as adding a degree of prominence is too much of a departure of an underlyingly non-prominent schwa that has only root features. In essence, an underlying schwa can either violate DEP constraints on relevant features by showing up as a full vowel, or violate DEP/LEV$_n$GRID by showing up with a positive degree or prominence, but crucially not both. More

formally, the notion of distantial faithfulness can be expressed as a conjunction of the two constraints[24]:

(48)

DEP/LEVₙGRID & DEP[±back, ±round]

The constraint in (48) is violated if a segment violates both of the conjuncts, i.e. if it shows up with a positive degree of prominence and features that are not in the input.

Tableau 24

/šörtṇə/[25] 'gold'	DEP/LEVₙ GRID	&	DEP[±back,±round]	*GRIDₙ/ə	&	ALIGN-L (ó, PWd)	ALIGN-RIGHT (ó, PWd)	ALIGN-L (LEVₙGRID, FT)
☞ a. (šŏrtṇö)	✓		*	✓			*	
b. (šörtṇő)	*	*!	*	✓		*		*

As the tableau above illustrates, the decision in this case is made by the conjoined distantial faithfulness constraint: candidate (b) enhanced the underlying schwa in both assigning it prominence and adding features, so it fails the constraint. Candidate (a), on the other hand, passes the constraint essentially because of the locality requirement on the conjunction: one segment in the Prosodic Word is enhanced by adding features, while the other one is enhanced by assigning prominence to it. As a result, candidate (a) passes the distantial faithfulness conjunction, and it is the optimal one. Thus, a vocalized (surfacing as a full vowel) schwa is treated the same way as a non-vocalized schwa for the purposes of stress assignment.

Consider a candidate where a schwa does not vocalize because of its position within a binary foot (see the next subsection for the illustration of this pattern):

---

[24] This type of opacity, counterfeeding, can also be easily handled with McCarthy's (2007) model OT-CC.

[25] We do not consider any candidates with non-vocalized schwa here. Vocalization of the word-final vowel here is ensured by a vowel harmony constraint that is ranked above the constraints on distantial faithfulness, and outranked only by (a number of) Ident constraint(s). For a model of vocalization, see the next subsection that discusses the pattern of vowel vocalizations.

Tableau 25

/pušaŋgə/ 'tree'	DEP/LEV$_n$ GRID	&	DEP$_{[\pm back, \pm round]}$	*GRID$_n$/ə	&	ALIGN-L (ó, PWd)	ALIGN-R (ó, PWd)	ALIGN-L (LEV$_n$GRID, FT)
☞ a. (pušáŋ)gə	(*)	✓			✓	*	*	*
b. (pušaŋ)gó	*	✓		*	*!	*		*
c. (púšaŋ)gə	(*)	✓			✓		**!	

All three of the candidates above have a word-final schwa that is not vocalized. In this case, the distantial faithfulness constraint is not relevant, since all three candidates satisfy it. Candidate (b) is eliminated by the licensing constraint, because its stressed schwa is not in the only licensed position (aligned to the left edge of a Prosodic Word). ALIGN-RIGHT makes the choice between candidates (a) and (c): the latter violates the constraint once (the stress is one syllable away from the right edge of a Prosodic Word), while the former violates ALIGN-RIGHT twice, and the second violation is fatal. Candidate (a) becomes optimal in this case.

Note that the Prominence Alignment constraint is inactive here once again, thus creating the illusion that the language has no binary constituency within a Phonological Word. However, the data from the schwa vocalizations prove just the opposite: the language does have binary constituency that regulates, and is marked by, the schwa vocalizations. The dialect of Mari under consideration, therefore, presents a case at the edge of the spectrum of constituency/prominence assignment interaction continuum: its prominence is subject to constraints that outrank Prominence Alignment in such a way that the latter is rendered inactive.

So far, we have only had to consider the separation of schwa from all other vowels along the sonority scale. Next, however, we demonstrate that other sonority constraints, as well as morphological constraints, have to play a role in the stress assignment pattern whenever derived forms are considered.

At the first glance, the stress assignment in the language appears to be strictly cyclic, i.e. the stress assigned on the root cycle does not get reassigned when more morphemes are added, as the following forms with the Dative suffix /-lan/ (49a) and Commitative suffix /-ge/ (49b) suggest:

(49)
a. pašá 'work'   pašá-lan 'work (Dat.)'   * paša-lán
    olmá 'apple'   olmá -lan 'apple (Dat.)'   * olma-lán
    kornó 'road'   kornó-lan 'road (Dat.)'   *korno-lán
    kawún 'pumpkin'   kawún-lan 'pumpkin (Dat.)'   * kawun-lán
    keŋéž 'summer'   keŋéž-län 'summer (Dat.)'   * keŋež-lán
    meráŋ 'hare'   meráŋ-län 'hare (Dat.)'   * meraŋ-lán

b.
    pašá 'work'   pašá-ge 'work (Com.)'   * paša-gé
    olmá 'apple'   olmá-ge 'apple (Com.)'   * olma-gé
    kornó 'road'   kornó-ge 'road (Com.)'   *korno-gé
    kawún 'pumpkin'   kawún-ge 'pumpkin (Com.)'   * kawun-gé
    keŋéž 'summer'   keŋéž-ge 'summer (Com.)'   * keŋež-gé
    meráŋ 'hare'   meráŋ-ge 'hare (Com.)'   * meraŋ-gé

Both the Dative and the Commitative suffixes have full vowels, and these vowels are the rightmost ones in all of the examples in (49); yet, they do not attract stress from the root.

Similarly, the same suffixes added to the following monosyllabic roots surface unstressed[26]:

(50)
a.
    šör   'milk'   šőr-län 'milk (Dat.)'
    mü   'honey'   mű-län 'honey (Dat.)'
    pel   'half'   pél-län 'half (Dat.)'
    üšt   'belt'   űšt-län 'belt (Dat.)'
    tam   'taste'   tám-lan 'taste (Dat.)'
    lum   'snow'   lúm-lan 'snow (Dat.)'
    šot   'sense'   šót-lan 'sense (Dat.)'
    ij   'year'   íj-län 'year (Dat.)'

b.
    šör   'milk'   šőr -ge 'milk (Com.)'
    mü   'honey'   mű-ge 'honey (Com.)'

---

[26] Cf. the monosyllabic root with reduced schwa:
    šəž 'fall, autemn'   šəž-lán 'fall (Dat.)'

pel	'half'	pél-ge	'half (Com.)'
üšt	'belt'	űšt-ge	'belt (Com.)'
tam	'taste'	tám-ge	'taste (Com.)'
lum	'snow'	lúm-ge	'snow (Com.)'
šot	'sense'	šót-ge	'sense (Com.)'
ij	'year'	íj-ge	'year (Com.)'

The monosyllabic roots above also keep the initial stress and do not have stress shift to the full vowels of the suffixes. If the stress is always assigned on the root cycle and does not get reassigned on later cycles, it predicts that the suffixes above (and, indeed, all the suffixes in the language) never bear stress. This prediction turns out to be wrong, however, if we consider the following forms:

(51)
a.

rə́wəž	'fox'	rəwəž-lán	'fox (Dat.)'
tə́lze	'moon, month'	təlzə-lán	'moon (Dat.)'
jə́lme	'tongue; language'	jəlmə-lán	'tongue (Dat.)'
lə́βe	'butterfly'	ləβə-lán	'butterfly (Dat.)'
pə́rəs	'cat'	pərəs-lán	'cat (Dat.)'
čə́βe	'chicken, hen'	čəβə-lán	'hen (Dat.)'

b.

rə́wəž	'fox'	rəwəž-gé	'fox (Com.)'
tə́lze	'moon, month'	təlzə-gé	'moon (Com.)'
jə́lme	'tongue; language'	jəlmə-gé	'tongue (Com.)'
lə́βe	'butterfly'	ləβə-gé	'butterfly (Com.)'
pə́rəs	'cat'	pərəs-gé	'cat (Com.)'
čə́βe	'chicken, hen'	čəβə-gé	'hen (Com.)'

Unlike the examples in (49) and (50), where the stress uniformly stays on the root, all the forms in (51), when suffixed, shift stress to the suffixes. Note that all of the roots in (51) contain only reduced vowels underlyingly, the fact that determines the default initial position of stress in the underived forms.

The third type of roots in the language, the roots with initial stress that is due to the first vowel being the full one and the second vowel the reduced one underlyingly, exhibit yet another pattern. These roots treat the Dative suffix differently from the Commitative one:

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(52)

a. ímɲe   'horse'   imɲə-lãn   'horse (Dat.)'
    múno   'egg'   munə-lán   'egg (Dat.)'
    wáštər   'maple'   waštər-lán   'maple (Dat.)'
    sérəš   'letter'   serəš-lãn   'letter (Dat.)'
    jǔksö   'swan'   jüksə-lãn   'swan (Dat.)'
    kǔzö   'knife'   küzə-lãn   'knife (Dat.)'

b. ímɲe   'horse'   ímɲə-ge   'horse (Com.)'
    múno   'egg'   múnə-ge   'egg (Com.)'
    wáštər   'maple'   wáštər-ge   'maple (Com.)'
    sérəš   'letter'   sérəš-ge   'letter (Com.)'
    jǔksö   'swan'   jǔksə-ge   'swan (Com.)'
    kǔzö   'knife'   kǔzə-ge   'knife (Com.)'

While the Dative suffix always receives stress in the forms in (52a), the Commitative suffix (52b) fails to attract the stress, which stays on the first syllable of the word.

It seems clear that sonority of the vowels effect stress assignment: full vowels behave differently from the reduced ones, and, as we see with the Dative and Commitative suffixes, the low vowel [a] of the Dative suffix appears to be 'stronger', more sonorous, than the mid vowel [e] of the Commitative.

This hypothesis is sustained when we consider that other suffixes with the vowels in question exhibit identical behavior: Modal (or Comparative) suffix /-la/ behaves like the Dative suffix as far as stress assignment is concerned, as do the 1st and 2nd person animate possessive suffixes /-na/ and /-da/; and Ablative suffix /-eč/ and Caritive suffix   /-de/ behave exactly like the Commitative. Similarly, verbal suffixes containing [a] behave differently from verbal suffixes containing [e]. In fact, the only two types of suffixes that **never** attract stress regardless of the type of root to which they attach are the suffixes a) with an underlying schwa, and b) with a full alternating vowels [o]/[ö]/[e], quality of which depends on vowel harmony discussed below. When such a suffix is attached, the stress stays on the vowel of the root.

To summarize, the following factors determine stress placement in the dialect in question:

(53)

a) (Underlyingly) reduced vs. full vowels. In an underived word, the stress falls on the rightmost full vowel; if there is no full vowel in the word, the stress defaults to the leftmost vowel. A suffix with an underlyingly reduced vowel never attracts stress from the root.

b) Low vs. mid vowels. In **derived** environment, suffixes with a low vowel [a] appear to be 'stronger' (more sonorous) than suffixes with a mid vowel [e]: when combined with roots of a certain type, the suffixes with [a] attract the stress away from the roots while the suffixes with [e] do not.

c) Finally, whether the root vowels are underlyingly reduced or full plays a role in derived environment as well as in underived words: roots with all schwas in them lose the stress when there are full-voweled suffixes attached to them.

We will start our analysis by showing how morphological constraints affect stress assignment pattern. One constraint that we need to account for this pattern is a constraint that aligns a stressed syllable to the right edge of the root, rather than the Prosodic Word:

(54)

        ALIGN-RIGHT (ó, Root)   Stressed syllables must be root-final

It appears that the above constraint is ranked above ALIGN-RIGHT (ó, PWd). When dealing with underived words, there is no difference in the effect of these two constraints, since, by definition, the right edge of a Prosodic Word always coincides with the right edge of the root. In derived words, however, the ranking of the two is crucial:

Tableau 26

/meraŋ/-/lan/ 'hare (Dat.)'	$*\text{GRID}_n/\text{ə}$ **&**	ALIGN-LEFT (ó, PWd)	ALIGN-RIGHT (ó, Root)	ALIGN-RIGHT (ó, PWd)	ALIGN-L (LEV$_n$GRID, FT)
☞ a. (meráŋ)-län	✓			*	*
b. (meraŋ)-lä́n	✓	*	*!		*

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Since neither of the candidates contain a schwa, the conjoined licencing constraint is not relevant here: both candidates pass it. The decision is made by the ALIGN-RIGHT (ó, Root) constraint, which candidate (b) violates because it has its stress on the suffix. Even though candidate (a) violates the lower-ranked ALIGN-RIGHT (ó, PWd) constraint, it is nevertheless the optimal candidate.

Note that the addition of the ALIGN-RIGHT (ó, Root) constraint does not change the analysis of underived words, and, without any further additions, the constraints that we have with their respective rankings, account for the pattern where a suffix with [a] is added to a root with only schwas:

Tableau 27

/rəwəž/-/lan/ 'fox' (Dat)	*GRID$_n$/ə	&	ALIGN-LEFT (ó, PWd)	ALIGN-RIGHT (ó, Root)	ALIGN-RIGHT (ó, PWd)	ALIGN-L (LEV$_n$GRID, FT)
☞ a. (rəwəž)-lán		✓		*		*
b. (rə́wəž)-lan	*	✓		*	*!	
c. (rəwə́ž)-lan	*	*!	*		*	*

The tableau above illustrates the derivation of the pattern where the root contains only schwas and the suffix has a full vowel. Candidate (c) is eliminated by the licensing conjunction, since its stressed schwa is not word-initial. Both candidates (a) and (b) violate the ALIGN-RIGHT (ó, Root) constraint, since the prominent syllable in either of the candidates is not root-final. Hence, the decision is made here by ALIGN-RIGHT (ó, PWd), which eliminates candidate (b), where stress is not word-final.

The pattern where a suffix with a [-low] full vowel is concatenated with roots, however, does require us to consider constraints other than we already have. First, the pattern clearly shows that, even though there seems to be no difference in sonority of low and non-low vowels in roots, there is such a difference in suffixes. The suffix with the [+low] vowel is stressed with the roots that end in an (underlying) schwa, while the Commitative suffix, that has a [-low] vowel, is not stressed. There are at least two factors, therefore, that we have to consider: relative sonority of [e] and [a] (or [ä]), and the difference between roots and affixes. Let us start with the following constraint:

(55)

$*\text{GRID}_n/\text{e}_{\text{suffix}}$ There must be no suffix [e] that is assigned any
                        degree of prominence

Now, we also know that the constraint in (55) must be outranked by some other constraint, since both of the full vowels are stressed in the suffixes concatenated with roots with schwas only. We already have a licensing constraint for stressed schwas, which outranks a more general ALIGN-R (ó, Root) constraint. Another general constraint that is outranked by the licensing conjunction would be the constraint on the stressed schwas in general, whether licensed or not. In other words, the constraint in (55) should be outranked by $*\text{GRID}_n/\text{ə}$ to ensure that even if the vowel in the suffix is [-low], it is still assigned stress if the root contains only schwas, even if one of the schwas is licensed:

Tableau 28

/rəwəž/-/ge/ 'fox (Com.)'	$*\text{GRID}_n/\text{ə}$	**&**	ALIGN-L (ó, PWd)	ALIGN-R (ó, Root)	$*\text{GRID}_n/\text{ə}$	$*\text{GRID}_n/\text{e}_{\text{suffix}}$	ALIGN-R (ó, PWd)	ALIGN-L (LEV$_n$GRID, FT)
a. (rə́wəž)-ge	*	✓		*	*!		*	*
☞ b. (rəwəž)-gé		✓	*	*		*		
c. (rəwə́ž)-ge	*	*!	*				*	*

In the root meaning 'fox', there are two schwas, one of which is licensed to receive stress by the licensing constraint, while the other one cannot be licensed. Thus, the licensing conjunction eliminates candidate (c), where the stressed schwa is not in a word-initial syllable. Candidates (a) and (b), while tying on the ALIGN-R (ó, Root) constraint, differ with respect to the other general constraint that bans stressed schwas. Candidate (a), therefore, is eliminated, and candidate (b), with the stress on the [e] that belongs to the suffix, emerges as a winner.

Now, if a root has initial full vowel (any vowel other than a schwa, even a [-low] one as in example below, our $*\text{GRID}_n/\text{e}_{\text{suffix}}$ constraint becomes active:

Tableau 29

/serəš/-/ge/ 'fox' (Com)	*GRID$_n$/ə	&	ALIGN-L (ó, PWd)	ALIGN-R (ó, Root)	*GRID$_n$/ə	*GRID$_n$/e$_{suffix}$	ALIGN-R (ó, PWd)
☞ a. (sérəš)-ge		✓		*			*
b. (serəš)-gé		✓	*	*		*!	
c. (seróš)-ge	*	*!	*		*		*

Candidate (c) in the above tableau is eliminated by the licensing conjunction, but candidates (a) and (b) tie with respect to licensing: neither of the candidates has a stressed schwa. The candidates also tie on the ALIGN-R (ó, Root) constraint, since the stressed syllable is not root-final in either of the candidates. Candidate (b), however, violates the *GRID$_n$/e$_{suffix}$ constraint, and candidate (a) does not: even though an [e] is stressed in both cases, only in candidate (b) [e] belongs to the suffix rather than the root.

Note that, under the present analysis, more sonorous than [e], [a] or [ä] of the suffix do get assigned the stress:

Tableau 30

/serəš/-/lan/ 'fox' (Dat)	*GRID$_n$/ə	&	ALIGN-L (ó, PWd)	ALIGN-R (ó, Root)	*GRID$_n$/ə	*GRID$_n$/e$_{suffix}$	ALIGN-R (ó, PWd)	ALIGN-L (LEV$_n$GRID, FT)
☞ a. (serəš)-lä́n		✓		*				*
b. (sérəš)-län		✓	*	*			*!	
c. (seróš)-län	*	*!	*		*		*	*

Once again, candidate (c) with the stressed schwa that is not word-initial is eliminated by the licensing conjunction. Both candidates (a) and (b) tie on the two more general constraints: in neither candidate the stressed syllable is root-final, and neither of them has a stressed schwa. Neither of the candidates violates the *GRID$_n$/e$_{suffix}$ constraint, either: candidate (b)'s [e] does not belong to the suffix, and it is the more sonorous [ä] that is stressed in candidate (a). Thus, the constraint that requires that a stressed syllable must be aligned with the right edge of a Prosodic Word is the deciding one here. In contrast with a suffix with [e], as in previous tableau, it is the suffix with [ä] that surfaces stressed in this situation.

We have, therefore, accounted for the influence of morphological conditions on the stress assignment in this dialect of Mari. There are, in fact, two different types of morphology-

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based constraints: the difference in alignment of a stressed syllable to root vs. Phonological Word, and a sonority constraint against stressed [-low] vowels that effects only affixes and not roots.

Note that the decision in the case of Mari stress assignment is never made by the constraint(s) that align prominence with the binary foot structure of the language, thus creating the illusion that the languages simply does not have foot structure, or has foot structure that is in complete alignment with prominence. In fact, however, Mari has a segmental alternation that we will refer to as schwa vocalization, or full/reduced vowel alternation, that shows that the language has binary foot structure. To see the misalignment of prominence and foot boundaries, we discuss the schwa vocalization next.

2.3.2 Full/Reduced Vowel Alternations

Besides two types of vowel harmony that we discuss in the subsection 2.3.3, the dialect of Eastern Mari in question also has full vowels alternating with the reduced vowel [ə]. It is this phenomenon that allows us to see the principles of parsing the words in the language into binary feet: the parsing is from left to right, with a ban on degenerate feet. An underlying schwa surfaces as a full vowel at the absolute end of a word:

(56)
/bočkə/	bóčko	'tub'
/suskə/	súsko	'scoop'
/kütə/	kűtö	'herd'
/šürə/	šűrö	'soup'
/pöršə/	pőršö	'frost'
/šošə/	šóšo	'spring'
/imɲə/	ímɲe	'horse'
/munə/	múno	'egg'
/pirə/	píre	'wolf'
/jeŋə/	jéŋe	'human'
/jümə/	jűmö	'thirst'
/küzə/	kűzö	'knife'
/oɲə/	óɲo	'father-in-law'

In this alternation, which is opposite to vowel reduction, a schwa turns to a full vowel, the quality of which is determined by vowel harmony. There are several important restrictions on this alternation. First, all of the words in (56) above, in which the final vowel turns into a full vowel, end in a vowel. In contrast, if a word ends in a consonant, the schwa in its final syllable remains reduced:

(57)

/waštər/	wáštər	'maple'
/serəš/	sérəš	'letter'
/šüšpək/	šűšpək	'nightingale'
/šorək/	šórək	'sheep'
/šuldər/	šúldər	'wing'
/üdər/	űdər	'daughter'
/joŋələš/	jóŋələš	'mistake'

All of the stems in (57) are consonant-final stems, and the reduced vowel in their final syllables does not surface as a full vowel: in order to turn into a full vowel, the schwa has to be at the absolute edge of a word.

Note that there are two sets of facts that argue that this alternation is not a vowel reduction alternation (that would reduce full vowels to schwas unless they are at the end of the word), as, for example, Majors (1998) analyzes the alternation, but quite the opposite process that turns reduced vowels into full ones. First, there are the stress facts that we discussed in the previous subsection: the underlyingly reduced vowels, even if they are converted into full vowels on the surface, behave differently from the vowels that are full underlyingly, in that they do not attract stress if there is another full vowel in the root, as in the examples in (63). Second, the vowels that are underlyingly full (and thus attract the stress), do not, in fact, get reduced to schwas when not in the end of the word. Consider the following examples with the Accusative singular suffix /-m/ and the Lative singular suffix /-ž/:

(58)

	Nom.sg.	Acc.sg. /-m/	Lat sg. /-ž/	Gloss
/čödrä/	čödrǻ	čödrǻ-m	čödrǻ-ž	'forest'
/kəʎa/	kəʎá	kəʎá-m	kəʎá-ž	'mouse'
/kutko/	kutkó	kutkó-m	kutkó-ž	'ant'
/korno/	kornó	kornó-m	kornó-ž	'road'
/kəʎmo/	kəʎmó	kəʎmó-m	kəʎmó-ž	'shovel'
/paša/	pašá	pašá-m	pašá-ž	'work'
/ola/	olá	olá-m	olá-ž	'city'
/awa/	awá	awá-m	awá-ž	'mother'
/parɲa/	parɲá	parɲá-m	parɲá-ž	'finger'
/upša/	upšá	upšá-m	upšá-ž	'cap'
/tünä/	tünǻ	tünǻ-m	tünǻ-ž	'world'
/una/	unǻ	unǻ-m	unǻ-ž	'guest'

In contrast, roots with underlying schwas in the final syllable still have the reduced vowel when suffixed:

(59)

	Nom.sg.	Acc.sg. /-m/	Lat sg. /-ž/	Gloss
/bočkə/	bóčko	bóčkə-m	bóčkə-ž	'tub'
/suskə/	súsko	súskə-m	súskə-ž	'scoop'
/kütə/	kűtö	kűtə-m	kűtə-ž	'herd'
/šürə/	šűrö	šűrə-m	šűrə-ž	'soup'
/pöršə/	pőršö	pőršə-m	pőršə-ž	'frost'
/šošə/	šóšo	šóšə-m	šóšə-ž	'spring'
/imɲə/	ímɲe	ímɲə-m	ímɲə-ž	'horse'
/munə/	múno	múnə-m	múnə-ž	'egg'
/pirə/	píre	pírə-m	pírə-ž	'wolf'
/jeŋə/	jéŋe	jéŋə-m	jéŋə-ž	'human'
/jümə/	jűmö	jűmə-m	jűmə-ž	'thirst'
/küzə/	kűzö	kűzə-m	kűzə-ž	'knife'

Moreover, consonant-final stems with a full vowel in the final syllable also keep the full vowel on the surface:

(60)

/šüzär/	šüzár	'sister'
/ojləmaš/	ojləmáš	'story'
/pükšer/	pükšér	'hazel tree'
/aβam/	awám	'mother'
/joltaš/	joltáš	'friend'
/kugužan/	kugužán	'princess'
/kučem/	kučém	'handle'
/peledəš/	pelédəš	'flower'
/waštar/	waštár	'maple'
/kaβun/	kaβún	'pumpkin'
/keŋež/	keŋéž	'summer'
/korak/	korák	'crow'
/kögörčen/	kögörčén	'dove'
/mardeš/	mardéš	'wind'
/meräŋ/	meráŋ	'hare'

Thus, it seems clear that what we are dealing with here is not vowel reduction, but rather a process of conversion of a reduced vowel into a full one at the end of the word, subject to some restrictions. It appears that these alternations are also a type of vowel harmony. Using somewhat antiquated terminology, we can identify the phenomenon as a 'feature-filling', rather than a 'feature-changing' harmony, that can also be called a DEP-violating type of harmony, and not an IDENT-violating one.

It is the restrictions on this phenomenon that are of the utmost importance for us here, since they manifest that the language has metrical structure that is distinct from the position of stress. One restriction that we determined is that a reduced vowel surfaces as full only if it **immediately** precedes the word boundary, i.e. if there is no intervening consonant. There is, however, an additional restriction that is manifested in the following forms:

(61)

/pušaŋgə/	pušáŋgə	'tree'
/üremə/	ürémə	'street'
/pareŋə/	paréŋə	'potato'

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The above (synchronically) underived forms all have a reduced schwa in the final syllable underlyingly, and the final syllable is open, i.e. the schwas immediately precede the word boundary. Those underlying schwas, therefore, satisfy the condition on reduced to full vowel conversion, and should surface as full vowels. However, they surface as schwas. We encounter the same problem if we look at the alternations with the suffix /-lə/, which forms adjectives from nouns:

(62)a. lüm 'name'　　　　　　lűm-lö 'famous'
　　　　tam 'taste'　　　　　　tám-le 'sweet'
　　　　tüŋ 'beginning'　　　　tűŋ-lö 'initial'
　　　　jük 'voice'　　　　　　jűk-lö 'loud'
　　　　tür 'edge, border'　　　tűr-lö 'final'
　　　　lum 'snow'　　　　　　lúm-lo 'snowy, cold'
　　　　šot 'sense'　　　　　　šót-lo 'sensitive'
　　　　jür 'rain'　　　　　　　jűr-lö 'rainy, wet'
　　　　kü 'stone'　　　　　　kű-lö 'hard'
　　　　taŋ 'friend, partner'　　táŋ-le 'friendly'
　　　　čən 'truth'　　　　　　čə́n-le 'true'
　　　　šor 'mud'　　　　　　　šór-lo 'dirty'

　b.　　pő́ršö 'frost'　　　　　pő́ršə-lə 'frosty'
　　　　šő́rtɲö 'gold'　　　　　šő́rtɲə-lə 'golden'
　　　　tűrö 'edge'　　　　　　tűrə-lə 'final'
　　　　šóšo 'spring'　　　　　šóšə-lə 'spring (adj.)'
　　　　kűrtɲö 'iron'　　　　　kűrtɲə-lə 'iron (adj.)'
　　　　jéŋe 'human'　　　　　jéŋə-lə 'human (adj.)'
　　　　jűmö 'thirst'　　　　　jűmə-lə 'thirsty'
　　　　čijá 'paint'　　　　　　čijá-lə 'colorful'
　　　　téŋgəz 'sea'　　　　　téŋgəz-lə 'naval'
　　　　olá 'city'　　　　　　　olá-lə 'urban'
　　　　oksá 'money'　　　　　oksá-lə 'expensive'
　　　　keŋéž 'summer'　　　　keŋéž-lə 'summer (adj.)'
　　　　mardéž 'wind'　　　　　mardéž-lə 'windy'
　　　　ə́škəl 'step'　　　　　　ə́škəl-lə 'gradual'
　　　　tə́lze 'moon, month'　　tə́lzə-lə 'monthly'

c.   ürémə 'street'   ürémə-le 'street (adj.)'
   šóŋgələk 'old age'   šóŋgələk-lo 'senile'
   jóŋələš 'mistake'   jóŋələš-lo 'wrong'
   ojləmáš 'story, fable'   ojləmáš-lo 'fictional, apocryphal'
   kugužán 'princess'   kugužán-lo 'spoilt (about a woman)'
   pelédəš 'flower'   pelédəš-le 'flowery, embellished'

In all of the forms in (62a), where the suffix /-lə/ attaches to monosyllabic stems, its final vowel surfaces as a full one, and its exact quality depends on the other types of vowel harmony, which we will discuss below. In (62b), in contrast, the same suffix is put together with a disyllabic stem, and in this case we see no reduced to full vowel conversion. In (62c), on the other hand, the suffix appears with the full grade of the vowel yet again, i.e. forms in (62a) and (62c) pattern together as far as the full/reduced vowel alternation in the attached suffix is concerned, while (62b) points to yet another condition on the alternation in question. Given that both stems in (62a) and (62c) are odd-voweled stems, while the stems in (62b) contain even number of vowels, the restriction on schwa conversion into a full vowel seems to be a prosodic restriction: it is allowed to vocalize (be converted to a full vowel on the surface) if starts a foot, while the conversion is blocked if the vowel of the suffix is foot-final. The fact that it is clearly the number of vowels of the stems that is taken into account for this restriction leads us to conclude that the feet in the language are binary, left-adjacent, and consonants are not moraic, since they seem to have no bearing on the foot assignment. This phenomenon of reduced/full vowel alternations, therefore, **marks the foot structure** of the language, while the stress assignment is independent of the footing, but follows its own set if principles we investigated earlier in this dissertation.

In support of the generalization that the alternation in question is showing us the foot structure, let us consider the conversion of a reduced vowel into a full vowel with another suffix. This suffix, or clitic[27] /-sə/, can be concatenated with nouns already inflected for case, number, possessivity and containing a large number of derivational suffixes, and

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[27] Whether it is a suffix or a clitic morphologically has no bearing on the alternations I discuss here; one might be tempted to classify it as a clitic as it always appears word-finally. Its phonology, however, is no different that phonology of the suffix /-lə/, except that stems to which it attaches can be much longer.

has the meaning 'the one who is N' or 'the one that is N'. When attached to an uninflected form of the noun (Nominative singular of the noun), it exactly matches the behavior of the adjective-forming /-lə/ in (62a-c):

(63)　a.　taŋ 'friend, partner'　　(táŋ-se) 'the one who is a friend'
　　　　　mü 'honey'　　　　　　　(mű-sö) 'the one that is honey'
　　　　　üj 'butter'　　　　　　　　(űj-sö) 'the one that is butter'
　　　　　čən 'truth'　　　　　　　　(čə́n-se) 'the one that is the truth'

　　　b.　jéŋə 'human'　　　　　　　(jéŋə)-sə 'the one who is human'
　　　　　olá 'city'　　　　　　　　　(olá)-sə 'the one that is a city'
　　　　　oksá 'money'　　　　　　　(oksá)-sə 'the one that is money'
　　　　　érgə 'boy'　　　　　　　　　(érgə)-sə 'the one who is a boy'

　　　c.　jóŋələš 'mistake'　　　　　(jóŋə)(ləš-so) 'the one that is a mistake'
　　　　　pušáŋgə 'tree'　　　　　　(pušáŋ)(gə-so) 'the one that is a tree'
　　　　　pelédəš 'flower'　　　　　(pelé)(dəš-se) 'the one that is a flower'
　　　　　kögörčén 'dove'　　　　　(kögör)(čén-se) 'the one that is a dove'

With the foot structure of the derived nouns that we see in (63), the generalization of the prosodic restriction on full/reduced vowel alternation can be stated in a straightforward fashion as one that blocks the surfacing of underlyingly reduced vowel as a full one if that vowel is not right-aligned to the foot boundary. Importantly, this generalization does not take the location of stress into account: the words in (63c), for instance, have stress respectively on the first (*jóŋələš-so* 'the one that is a mistake'), second (*pušáŋgə-so* 'the one that is a tree' and *pelédəš-se* 'the one that is a flower'), and third (*kögörčén-se* 'the one that is a dove') syllables, yet the vowel of the suffix uniformly surfaces as the full one in all of the words in (63c).

The generalization that the restriction on full/reduced vowel alternation marks the prosodic structure of the language becomes even clearer if we consider longer stems with the same suffix /-sə/ attached to them:

(64)

	Nom.sg (non-poss) no suffix	Nom.sg (3ʳᵈ p.pl. poss) suffix /-na/ (inanimate)	'the one who is N' suffix/-sə/
a.	mü 'honey'	mű-nä 'our honey'	(mű-nä)-sə
	šə 'fall, autemn'	šəž-ná 'our fall'	(šəž-ná)-sə
	tam 'taste'	tám-na 'our taste'	(tám-na)-sə
	šot 'sense'	šót-na 'our sense'	(šót-na)-sə
	ij 'year'	íj-nä 'our year'	(íj-nä)-sə
b.	múno 'egg'	munə-ná 'our egg'	(munə)-(ná-so)
	jǔksö 'swan'	jüksə-nǎ 'our swan'	(jüksə)-(nǎ-se)
	pə́rəs 'cat'	pərəs-ná 'our cat'	(pərəs)-(ná-se)
	tünǎ 'world'	tünǎ-nä 'our world'	(tünǎ)-(nä-se)
c.	pušáŋgə 'tree'	pušaŋgə-ná 'our tree'	(pušaŋ)(gə- ná)-sə
	kögörčén 'dove'	kögörčén-nä 'our dove'	(kögör)(čén-nä)-sə
	ürémə 'street'	üremə-nǎ 'our street'	(üre)(mə-nǎ)-sə
	paréŋə 'potato'	pareŋə-ná 'our potato'	(pare)(ŋə-ná)-sə

The roots in (64) above have two suffixes attached to them: first, 1ˢᵗ person possessive suffix /-na/, followed by already familiar /-sə/. Notice that it is clear from this data that the restriction on the schwa conversion into a full vowel takes into account all the syllables (prosodic structure) of the derived stem, i.e. of the [root + suffix /-na/]. Again, using our mechanism of footing (left-aligned binary feet) predicts where the underlying schwa is allowed to surface as a full vowel (64b), and where it stays the reduced vowel because it is not at the right edge of a foot. No matter how many suffixes we add between the root and the underlyingly reduced vowel of the suffix, iterative binary footing, that is crucially a different phenomenon than stress assignment, will determine the full or reduced quality if the underlying schwa. We will return to accounting for the quality of the full vowels converted from an underlying schwa in the next subsection of this chapter and in Chapter 3. A more formal analysis of the schwa/full vowel alternations, however, is in order here.

It appears that the nature of the alternation in question is vowel harmony that is restricted by metrical constituency. While sonority of vowels clearly plays an important role in the

language, we can reasonably rule it out as a driving force for schwa vocalizations: schwas are, according to any sonority scale, ideal vowels to constitute the nucleus of a syllable in the non-head position of a foot, but it is precisely in this position and only in this position that schwas are converted into full vowels. Our analysis of the alternation, therefore, should be more along the lines of some positions (like foot-head position) being more resistant to mismatch between input and output than other positions, i.e. non-head position in our case. Positional Faithfulness (Beckman (1998)), thus, appears to be the nature of the restriction on the schwa vocalizations. For the purposes of this analysis, we will consider schwas to be vowels that are only specified for the root features in the input, and lacking any other specification. A Positional Faithfulness-like constraint, therefore, must have an effect of disallowing any DEP violations in foot-head positions[28]:

(65)

DEP$_{[feature]}$	Any feature present in the output must be present in the input
ALIGN-R, S$_{[-cons]}$**, FT**	Every vowel must be aligned with the right edge of a foot

By conjoining the two constraints in (65) above, we are saying that a vowel can either have features in the output that are not present in the input, or be in non-final position within a foot, but crucially not both.

A constraint that forces schwas to vocalize would be a (more general) constraint that triggers vowel harmony:

(66)

AGREE-R [±high], PRWD	For every segment n, assign one violation for every segment without the same specification for the feature [±high][29] as n, in the same PrWd, that is to the right of n.

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[28] For the reasons that are outside the scope of this dissertation, I will use constraint conjunction rather than a true Positional Faithfulness constraint as formulated in Beckman (1998).

[29] It is at least the [±high] feature that is relevant for the harmony. Other features, such as [±ATR], [±round] etc. might be relevant as well, but are omitted here for the purposes of illustration. I also assume that higher-ranking constraint(s) will prevent consonants from having these features.

I am not specifying the position of the trigger: every full vowel triggers this requirement for agreement in principle, and every full vowel starts its own domain for agreement. In practice, it would mean that a schwa must copy the relevant features of a preceding full vowel.

Tableau 31

/jüksə/ 'swan'	DEP[feature] &		ALIGN-R, S[-cons], FT	AGREE-R, PRWD
a. (jüksə)		✔		*!
☞ b. (jüksö)	*	✔		

The underlying form in Tableau 31 above has two vowels, the second of which is schwa. Both outputs are footed according to the principles we have discovered above in this thesis, and I skip the constraint responsible for such footing, because they are never violated in the language, and outrank any constraints that are in competition with them. Both of the candidates pass the conjoined constraint: they tie on the alignment conjunct, since both have one vowel that is not aligned with the right edge of a foot. Candidate (b) violates the DEP conjunct, but passes the whole conjunction, because of the locality requirement of the conjunction: violations of both of the conjuncts should be incurred in the same domain, a segment in this case[30].

The decision between the two candidates, consequently, is made by a lower-ranking AGREE-R constraint that is violated by candidate (a), which is a fully faithful candidate with a final schwa, and is satisfied by candidate (b). Candidate (b), with the schwa vocalization, emerges as optimal in this case.

Let us now compare the situation in Tableau 31 with the potentially vocalizable schwa in a trisyllabic word:

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[30] On local conjunction, see Green (1993), Smolensky (1995), Crowhurst and Hewitt (1997), Nathan (2002).

Tableau 32

/üremə/ 'street'	DEP[feature]	&	ALIGN-R, S[-cons], FT	AGREE-R, PRWD
☞a. (üre)mə		✔	*	*
b. (üre)me	*	*!	*	

In contrast with the Tableau 31, both candidates in the Tableau 32 above are trisyllabic. The meaningful difference is in footing: a trisyllabic word is parsed into one binary foot, leaving a stray final syllable unparsed. Candidate (a) passes the conjoined constraint: there are no (relevant) features in the output that not in the input, and that is enough to satisfy the conjunction, regardless of Alignment violation(s). Candidate (b), on the other hand, violates the conjunction, since it both has feature(s) that are not in the input, and the same vowel is not in the rightmost position within a foot. Thus, even though candidate (a) violates the agreement constraint, it still emerges as the optimal one.

The contrast, with the same constraint and their respective ranking, between Tableaux 31 and 32 shows us the main condition for the schwa vocalization in the language: binary foot structure, and crucially not the position of the prominent syllable, is responsible for the restriction on this type of vowel harmony.

To summarize this subsection, we have investigated an alternation that marks the foot structure of the language. Foot structure, as marked by the full/reduced vowel alternation, is binary, left-aligned, and crucially does not depend on the position of stress, in that either right or left syllable of a foot can be stressed, or there might be no stressed syllable in a foot. An underlying schwa surfaces as a full vowel if: 1) it immediately precedes a word boundary; and 2) it is the second part of a binary foot, i.e. it is aligned to the right boundary of such a foot.

We have established, therefore, that the dialect of Meadow Mari under discussion has two distinct and independent potential points of reference for a segmental alternation: binary metrical structure and prominent/non-prominent opposition. Metrical boundaries and position of stress do not match. The DEP-violating harmony (full/reduced vowel alternations), crucially have to refer to the foot structure to be predictable.

2.3.3 IDENT-violating Vowel Harmony

In the previous subsections we have identified two types of potential prosodic points of reference for a segmental alternation: stress and metrical structure, which crucially do not match. Metrical structure restricts and is marked by the reduced/full vowel alternations, while stress is assigned according to a different set of principles and can be assigned to any syllable in a foot.

At this point we come to the phenomenon of a different type of vowel harmony in Meadow Mari. One of the IDENT-violating types of vowel harmony is influenced by prosody, and thus a principle that regulates it has to refer to prosody in some fashion.

Mari has two types of IDENT-violating vowel harmony: backness/frontness harmony and rounded/unrounded harmony. Backness/frontness harmony is conditioned by the quality of the first vowel of the word, regardless of whether it is stressed or unstressed:

(67)

	Nom.sg. non-poss. no suffix	Nom.sg. 2nd p.pl. possessive suffix /-ta/
a.	ém 'medicine'	ém-dä[31] 'your (pl.) medicine'
	tűrö 'edge'	türə-tá 'your (pl.) edge'
	čödrǎ 'forest'	čödrǎ-tä 'your (pl.) forest'
	čijá 'paint'	čijǎ-tä 'your (pl.) paint'
b.	uβér 'news'	uβér-ta 'your (pl.) news'
	ólək 'meadow'	olək-tá 'your (pl.) meadow'
	aβám 'mother'	aβám-ta 'your (pl.) mother'
	kutkó 'ant'	kutkó-ta 'your (pl.) ant'

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[31] Underlying suffix /-ta/ has voiced [d] after a nasal as in this word.

c. čə́rke 'church'   čərke-tá 'your (pl.) church'
    pə́rəs 'cat'   pərəs-tá 'your (pl.) cat'
    rə́wəž 'fox'   rəwəž-tá 'your (pl.) fox'
    tə́lze 'moon, month'   təlze-tá 'your (pl.) moon, month'

In the roots in (67a), the first vowel is front, and it triggers fronting of the vowel of the suffix[32]. If the first vowel of the word is a back one, as in (67b), the vowel of the suffix also surfaces as a back [a]. Note that it is crucially the first, and not the stressed vowel of the root that causes the fronting: the root *uβér* 'news' is disharmonic, its stressed vowel [e] is front. The vowel of the suffix, however, surfaces as back.

In (67c) we see the same suffix attached to roots with all reduced vowels underlyingly. In this case, the vowel of the suffix is not fronted, even though, under appropriate conditions discussed in the previous subsection, the word-final vowel of the underived word surfaces as a front [e] in these roots.

Eastern Mari suffixes of the second type, with the underlying front mid vowel /e/, do not exhibit any frontness/backness harmony alternations, and always surface with [e] in the suffix[33]. Similarly, when underlying vowel of the suffix is a schwa, and its conversion into a full vowel is blocked, the schwas appear as such, without fronting or backing:

(68)

Nom.sg. no suffix	Denominal adjective suffix /-lə/	Ablative sg suffix /-leč/
šóšo 'spring'	šóšə-lə 'spring (adj.)'	šóšə-leč
kǘrtṇö 'iron'	kǘrtṇə-lə 'iron (adj.)'	kǘrtṇə-leč
jéŋe 'human'	jéŋə-lə 'human (adj.)'	jéŋə-leč
šúldər 'wing'	šúldər-lə 'light, weightless'	šúldər-leč
téŋgəz 'sea'	téŋgəz-lə 'naval'	téŋgəz-leč
olá 'city'	olá-lə 'urban'	olá-leč
kutkó 'ant'	kutkó-lə 'tiny, ridiculous'	kutkó-leč

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[32] Since, to the best of my knowledge, there is no front low vowel [ä] in first syllables of Eastern Mari words in the dialect I discuss, the [a]/[ä] alternation is allophonic. Front vowels of the first syllable front /a/ to [ä] within roots, as well: see, for example, words for 'paint' and 'forest' in (19). However, I will still keep [ä] in the inventory for the purposes of this discussion.

[33] Recall also, that it is this set of suffixes that attracts stress in some cases (see (7b)), but not the suffixes with underlying schwa.

As seen in (68), suffixes containing an underlying schwa and the ones with the underlying /e/ behave identically with respect to frontness/backness harmony, but that only happens when a schwa is not allowed to be converted to a full vowel. In cases when the underlying schwa surfaces as a full vowel, the front or back nature of that full vowel is determined by the quality of the first vowel in the word:

(69)
a. kit 'hand'   kít-se 'the one that is a hand'
    mü 'honey'   mű-sö 'the one that is honey'
    šör 'milk'   šő̃r-sö 'the one that is milk'
    peléдəš 'flower'   peléдəš-se 'the one that is a flower'
    ner 'nose'   nér-se 'the one that is a nose'

b. šor 'mud'   šór-so 'the one that is mud'
    šuk 'worm'   šúk-so 'the one that is a worm'
    kož 'spruce'   kóž-so 'the one that is a spruce'
    jóŋələš 'mistake'   jóŋələš-so 'the one that is a mistake'
    pušáŋgə 'tree'   pušáŋgə-so 'the one that is tree'

c. šəž 'fall'   šə́ž-se 'the one that is fall'
    čən 'truth'   čə́n-se 'the one that is truth'
    šəl 'meat'   šə́l-se 'the one that is meat'
    tam 'taste'   tám-se 'the one that is taste'
    taŋ 'friend, partner'   táŋ-se 'the one that is a friend'

The words with the front first vowel (69a), when concatenated with the suffix /-sə/, (or any suffix with an underlying schwa, for that matter), determine the front nature of the suffix vowel, which also surfaces as front mid vowel (rounded or unrounded, depending on the rounding harmony we will discuss next).

The initial vowels of the examples in (69b) are back, and consequently the vowel of the suffix surfaces back as well.

Examples in (69c) contain initial vowels of two types: it is either [-front] [-back] vowel schwa, or a back low vowel [a]. The suffix in these cases, however, uniformly surfaces

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with a front [e]. It appears, therefore, that neither [ə] nor [a] trigger backness harmony, and the front vowel is the default that surfaces when the initial vowel is neutral, i.e. does not require that the target be either back or front. Note, in addition, that since all the roots in (69c) are monosyllabic, the potential intervention of the vowels between the initial vowel and the vowel of the suffix is not an option here: it is necessary to recognize both schwa and [a] as neutral vowels for the purposes or backness harmony.

Finally, there is the fourth type of suffix in Eastern Mari, namely suffixes with an underlying full mid vowel that alternates between [e], [o] and [ö] on the surface. These suffixes behave identically to suffixes with the underlying schwa, with the obvious exception that the vowel in these suffixes never surfaces as reduced, regardless of its position in prosody, and whether or not it immediately precedes the word boundary. We will talk more about the alternations in these suffixes when we discuss the second type of vowel harmony in this dialect of Mari.

To summarize, the generalization about backness/frontness harmony in Eastern Mari are as follows: the harmony is triggered by the first vowel in the word; the harmony spreads throughout the word; underlying [ə] harmonizes if allowed to surface as full, as do vowels that are underlyingly full, but are not specified for [front] and [back] features; the low vowel [a] gets fronted if the trigger is front; and the underlying vowel [e] does not harmonize. In addition, [ə] and [a] do not trigger this type of harmony.

Now that we have dealt with the backness/frontness harmony in Eastern Mari, we will start to discuss the rounding harmony that is particularly interesting for the present study.

Recall that we have identified two potential points of reference that are prosodic: stressed/stressless opposition and metrical boundaries, which do not coincide, as we demonstrated in previous subsections of this chapter. The vowel harmony, therefore, can refer to either metrical boundaries, or stress, and alternation in the language clearly show us to which notion the segmental phenomenon refers, if at all.

The second type of vowel harmony, the roundness harmony, is prosodically restricted in Eastern Mari. The trigger of this type of harmony crucially has to be **stressed**, as the following data demonstrate:

(70)

a. šóšo 'spring'   šóšə-šo 'his/her/its spring'
    érge 'boy'   érgə-še 'his/her/its boy'
    šűrö 'soup'   šűrə-šö 'his/her/its soup'
    kínde 'bread'   kíndə-še 'his/her/its bread'
    kűrtŋö 'iron'   kűrtŋə-šö 'his/her/its iron'
    pőrtö 'pine forest'   pőrtə-šö 'his/her/its pine forest'

b. šüzár 'sister'   šüzár-še 'his/her/its sister'
    pükšermé 'walnut tree'   pükšermé-še 'his/her/its walnut tree'
    ürémə 'street'   ürémə-še 'his/her/its street'
    kəʎmó 'shovel'   kəʎmó-šö 'his/her/its shovel[34]'
    čödrá 'forest'   čödrá-še 'his/her/its forest'
    kögörčén'dove'   kögörčén-še 'his/her/its dove'

While in the examples in (70a) above the initial vowel **is** the stressed vowel (these are the words where the second vowel of the root is the underlying schwa, as shown by stress and the vowel surfacing as [ə] before the suffix), we cannot be sure what the condition on the trigger is, the examples in (70b) disambiguate the situation. In these words, the stressed syllable is either the second one, as in words for 'sister', 'street', 'shovel' and 'forest', or the third, as in 'walnut tree' and 'dove'. It is crucially the quality of the **stressed** vowel, and not the initial vowel, that determines whether the vowel of the 3rd singular possessive suffix is rounded or unrounded.

Note that in all the examples in (70b), the initial and the stressed vowel do not agree in roundness. The roundness of the suffix vowel, however, only depends on whether or not the stressed vowel is round, and does not take into account the roundness of the initial vowel, only its frontness/backness.

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[34] The fronting of the suffix vowel in this example is due to the palatal lateral.

The set of suffixes vowels of which harmonize for roundness includes all suffixes with underlying full vowels that are specified only for height, and all suffixes that have underlying reduced schwa. In the latter case, the underlying schwa shows up as a full vowel with the rounding specifications according to the rounding specifications of the stressed vowel if it is in the left part of a foot and immediately precedes the word boundary (see the subsection on the full/reduced vowel alternations), and as non-harmonic reduced vowel if it is not allowed to be converted into a full vowel[35]. For illustration of these alternations see the data in (63) and (64) above.

We previously saw that suffixes with underlying low vowel /a/ in them show harmonic alternations between back [a] and front [ä] on the surface, the front/back alternation conditioned by the word-initial vowel. The same suffixes, however, do not show any rounding harmony, and neither do suffixes with underlying /e/:

(71)	Nom.sg no suffix	Caritive sg. suffix /-de/	Nom.sg 1p.pl.poss suffix /-na/
a.	súsko 'scoop'	súskə-de	suskə-ná
	ólək 'meadow'	ólək-de	olək-ná
	šudó 'hay'	šudó-de	šudó-na
	jük 'voice'	jük-te[36]	jük-nä
b.	kué 'birch'	kué-de	kué-na
	kəʎá 'mouse'	kəʎá-de	kəʎa-ná
	îmne 'horse'	îmnə-de	imnə-nâ
	murɲá 'tube, pipe'	murɲá-de	murɲá-na

We can see that while in examples in (71a) the stressed vowel of the root is rounded, and in (71b) the stressed vowel is unrounded, the rounding in the suffix vowels stays constant, and does not harmonize, regardless of whether or not it attracts the stress.

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[35] Isanbaev (1975) transcribes schwas with diacritics for 'more round' and 'less round' schwas, as well as for 'more front' and 'less front' schwas for Standard Literary Eastern Mari. I do not know if the difference in presence or absence of these secondary roundings or reduced vowels is due to dialectal variation or historical change, but I could not observe any such harmony on schwas.

[36] This suffix shows progressing devoicing after voiceless obstruents.

Besides the 3rd person singular possessive suffix we saw in (70), suffixes that harmonize in roundness with the stressed vowels include Inessive suffix [-šte]/[-što]/[-štö]; Illative suffix [-ške]/[-ško]/[-škö]; adjective-forming suffix [-lə]/[-le]/[-lo]/[-lö], suffix /-sə/ with the meaning "the one that/who is N", and many others. Suffixes that do not harmonize in roundness include Dative suffix [-lan]/[-län]; Modal (Comparative) [-la]/[-lä]; Ablative [-leč], Caritive [-de]/[-te], etc.

This difference between the suffixes with an alternating vowel, on the one hand, and suffixes with a non-alternating one, on the other hand, is captured straightforwardly within Optimality Theory with the difference between DEP and IDENT constraints, combined with the theory of underspecification like the one proposed in Inkelas and Cho (1993), Kiparsky (1993), Goldsmith (1985), among others.

With the (partial) ranking of IDENT$_{[round]}$ >> AGREE$_{[round]}$ >> DEP$_{[round]}$ the resulting suffix will get a harmonizing (alternating for roundness) suffix vowel if it is not specified for roundness underlyingly, i.e. if the [round] feature is added, violating lower-ranking DEP. A suffix would have a non-alternating vowel if its underlying representation contains specification for roundness, since this specification cannot be changed due to the highly ranked IDENT constraint.

The condition on targets of rounding harmony, therefore, becomes clear: in order to harmonize, a vowel must have no underlying specification for rounding, and vowels that have such a prespecification fail to harmonize.

The condition on trigger of the rounding harmony appears to be quite simple as well: the trigger vowel must be stressed. The problem, however, arises if we consider this prosodic condition on the trigger in light of the hypothesis that asserts that segmental phenomena can only appeal to metrical structure, not to the stressed vs. stressless opposition.

Recall that we know independently from the full/reduced vowel alternations that metrical structure of the language is binary and aligned to the left edge of a PrWd. The stress placement, however, does not depend on these metrical boundaries, but follows its own set of principles. The result is that stress can be placed on either right or left syllable of a foot, and there are feet without a stressed syllable in them at all. Consider the following alternations with the Illative singular non-possessive[37] suffix /-škV$_{[-high,-low]}$/, with the previously determined binary foot boundaries marked:

(72)
a.   šűšpək 'nightingale'[38]   (šűšpə)(k-əškö)
      íge 'young animal'   (ígə)-ške
      ə́škəl 'step'   (ə́škəl)-ške
      kínde 'bread'   (kíndə)-ške
      wáštər 'maple'   (wáštər)-ške
      jűksö 'swan'   (jűksə)-škö

b.   šergé 'comb'   (šergé)-ške
      kornó 'road'   (kornó)-ško
      ürémə 'street'   (üré)(mə-ške)
      kaβún 'pumpkin'   (kaβú)(n-əš)ko
      meráŋ 'hare'   (merá)(ŋ-əš)ke
      pušáŋgə 'tree'   (pušáŋ)(gə-ške)

c.   ojləmáš 'story'   (ojlə)(máš-əš)ko
      kugužán 'princess'   (kugu)(žán-əš)ko
      kögörčén 'dove'   (kögör)(čén-əš)ke

It is obvious from the forms above that the prosodic condition on the trigger cannot be reduced to a reference to metrical boundaries: in (72a) the trigger of the rounding harmony (the stressed vowel) is foot-initial and in the first foot in a word; in (72b) the trigger is, in contrast, foot-final, also in the leftmost foot; and in (72c) the trigger is foot-initial yet again, but in the second foot of the word. Given these facts, the generalization could not be clearer: in order to formulate a uniform condition on the triggering vowel,

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[37] Illative suffix with possessive forms is shortened to /-š/.

[38] When a stem ends in a consonant, an epenthetic schwa is inserted before suffixes that start with [š] to avoid a complex coda/onset; there is no epenthesis when a suffix starts with a liquid or a stop.

we have to refer to stress, and crucially **not to metrical structure** of the word. We will develop a more formal analysis of this type of vowel harmony in Mari in the next chapter.

In conclusion, we demonstrated in this analysis that the hypothesis of limiting the prosodic references to metrical boundaries falls short of explaining the relevant facts of Eastern Mari. Foot structure in this language is established to be independent from the placement of stress, and is marked by full/reduced vowel alternation. In order to account for the pattern of rounding harmony in the language, we specifically have to make reference to stressed vowels. It appears that this pattern is undergenerated by our second hypothesis of limiting prosodic references to metrical structure.

2.4   Local Conclusions

We started the discussion of this chapter with outlining two important hypotheses of limiting reference of segmental generalizations to prosodic categories. While in practice of formulating generalizations about segmental alternations there is unrestricted reference to both metrical boundaries and stressed/stressless opposition in the literature, the two extreme proposals suggest that such references should be limited to one of those prosodic notions.

In our two case studies of this chapter we presented evidence that neither of these extremes can be maintained. The Nganasan case shows that in order to account for restrictions on consonant gradation, the grammar of the language has to make reference to prosodic boundaries and crucially not to stressed/stressless opposition, since this opposition does not always coincide with, or determine, the foot structure of the language. The fact that Nganasan consonant gradation is accountable for with reference to metrical boundaries, but not to stress, renders the 'reference to the stressed/stressless opposition only' hypothesis incorrect.

The Eastern Mari case study, in fact, proves both of the extreme hypotheses wrong. In addition to falsifying the 'reference to stress only' proposal, it provides evidence that the opposite logical extreme, the 'reference to metrical boundaries only' hypothesis cannot be sustained either. The language has a pattern of stress assignment that differs from the foot structure, which is marked by the alternation of full and reduced vowels. This alternation becomes unpredictable if we are only allowed to make reference to stress, and not to metrical boundaries.

Another segmental phenomenon that is sensitive to prosody in Eastern Mari is rounding harmony. In contrast with full vs. reduced vowel alternations, the generalization about rounding harmony, in order to account for the full range of the facts, crucially has to refer to stress, and cannot be predicted with reference to metrical boundaries only.

It appears, therefore, that both of the logically possible ways of limiting segmental generalizations' reference to prosody fall short of predicting one or both of patterns discussed in this chapter. Limiting reference of segmental generalizations to stressed/stressless opposition fails to predict the pattern of Nganasan consonant gradation, as well as the full/reduced vowel alternations of Eastern Mari, and limiting such references to metrical boundaries is unsuccessful in generating the pattern of Eastern Mari rounding harmony.

Though logically appealing, these hypotheses cannot be sustained in their extreme formulations, and the solution for limiting reference of segmental generalizations to prosodic notions should take into account the typology of patterns that make such a reference, making this one of the major questions I address in this thesis. It is clear at this point that prominence and constituency within a Phonological Word are two different entities in the grammar. However, it is also true that in the majority of languages that have prosody-dependent segmental alternations it is impossible to empirically distinguish which of the notions (foot structure or the position of accent) is relevant for such an alternation since foot boundaries and prominence assignment coincide. We investigate

the relationship between these two notions, and what kinds of constraints can cause misalignment of prominence and foot structure throughout this thesis.

If foot structure and prominence are two distinct entities in the grammar, they may affect foot-dependent and stress-dependent phenomena differently. In the next two chapters of this thesis, therefore, we will investigate this possibility, as well as the question of what kinds of constraints can outrank Prominence Alignment constraints. We will concentrate on stress-influenced phenomena in Chapter 3 and on foot-structure influenced phenomena in Chapter 4.