CHAPTER 4

VOWEL DELETION IN FAIALENSE PORTUGUESE

In European Portuguese unstressed vowels variably delete. The word *bato* 'I beat' can therefore be pronounced as either [bátu] or [bát]. This deletion pattern is not random, but is strongly influenced by phonological considerations – certain prosodic contexts are associated with higher deletion rates than others, certain vowels delete more often than others, etc. (Mateus and d'Andrade, 2000:18, Silva, 1997, 1998). In this chapter I provide an analysis of this variable deletion pattern within the rank-ordering model of EVAL. In the discussion below I will assume familiarity with the rank-ordering model of EVAL and with how this model deals with variation. For a general discussion on this model, see Chapters 1 and 3.

European Portuguese, like many languages, allows only a subset of its full vowel inventory in unstressed syllables. The smaller vowel inventory observed in unstressed positions is achieved through vowel reduction. This vowel reduction process is categorical – that is, a particular input vowel either does or does not reduce. In addition to reduction, European Portuguese also has a variable process that deletes vowels from unstressed syllables.[1] The result of this is that many European Portuguese words have

---

[1] Brazilian Portuguese also has a reduced vowel inventory in unstressed syllables (Fails and Clegg, 1992, Mateus and d'Andrade, 2000:17-18, Thomas, 1974:4-7). However, unlike European Portuguese, Brazilian Portuguese does not apply vowel deletion (Mateus and d'Andrade, 2000:46, 134-135, Oliviera, 1993:9). Silva (1997:307, endnote 2) attributes this to the fact that European Portuguese is a "stress timed" language, while Brazilian Portuguese is syllable timed. (See also Parkinson (1988:141-142) for a classification of Brazilian Portuguese as syllable timed. However, see Major (1981, 1985, 1992) for some arguments to the contrary.) Stressed timed languages are much more likely to have vowel reduction and/or vowel deletion processes than syllable timed languages.

two possible pronunciations: One with a vowel in the unstressed syllable,[2] and another in which the vowel from the unstressed syllable has been deleted.

(1) **Examples of variation in European Portuguese**

/sɛlo/	[sɛ́lu] ~ [sɛ́l]	'stamp'
/idade/	[idádi] ~ [idád]	'age'
/muʎɛɾ/	[muʎɛ́ɾ] ~ [mʎɛ́ɾ]	'woman'

In the rest of this chapter I offer a detailed account of this variation pattern within the rank-ordering model of EVAL. Since there is no quantitative data available on vowel deletion in standard (Lisbon) European Portuguese, I will use data on vowel deletion in an Azorean dialect of Portuguese, namely that spoken on the island of Faial. Although there are differences between standard European Portuguese and Azorean Portuguese, the basic patterns observed in the vocalic phonology of these two varieties of European Portuguese are very similar.[3] In the discussion below, all references to Portuguese should

---

2 This vowel can be different from its input correspondent if the input vowel is one of the vowels subject to reduction. However, it can also be identical to the input vowel if the input vowel is not one of the vowels subject to reduction.

3 As far as possible I will rely on sources specifically about the phonology of Azorean Portuguese (Rogers, 1948, 1949, Silva, 1988, 1997, 1998). However, these sources do not always present us with enough information. The vocalic phonology of Azorean Portuguese is sufficiently similar to that of standard European Portuguese that it justifies the use of grammars on standard European Portuguese where the information on Azorean Portuguese is insufficient – see for instance Mateus and d'Andrade (2000:2) who claim that the phonological differences between dialects of European Portuguese occur mainly "in the fricative consonant system" and not in the vocalic system. Mateus and d'Andrade also claim that "the dialects on … the Azores, while they have their own peculiarities, share the general characteristics of the central-southern dialects" (2000:2). Lisbon Portuguese is a "central-southern" dialect. This provides more motivation for the use of grammars of standard European Portuguese to supplement information on Azorean Portuguese.

Even more motivation for using information on standard European Portuguese to supplement that on Faialense Portuguese comes from Rogers (1949:48): "It has been shown that the pronunciation of Portuguese on the Madeiran and eastern Azorean islands is quite different from that of the standard language heard on the European continent. This divergence from the standard language does not hold for the central and western Azores." Faial is a central Azorean island.

therefore be interpreted as referring equally to standard European Portuguese and Faialense Portuguese, unless otherwise stated.

The rest of this chapter is structured as follows. In §1 I will discuss the basics of the vocalic phonology of Faialense Portuguese, focusing on the processes that apply in unstressed syllables. In §2 I will present an OT account of the vowel reduction in unstressed syllables. Finally, in §3 and §4, I will give an OT account of variable vowel deletion, and show how this process interacts with vowel reduction. I postpone a discussion of alternative accounts of variation until the end of the section of the dissertation that deals with variable phenomena (Chapter 5 §3).

1. The basic vocalic phonology of Faialense Portuguese

1.1 The oral vowels of Faialense Portuguese

In (2) I give the vowel inventory of standard European Portuguese, which according to Silva (1997:298) "is also found in most Azorean varieties of the language, including that spoken on the island of Faial". The diphthongs are immune to the vowel lenition processes, and nasal vowels undergo a different kind of reduction than oral vowels (Silva, 1997:299).[4] I will limit myself here to only the oral monophthongs. The features that I will assume for the vowels in the rest of this discussion are given in (3). The table is followed by some discussion of the features.[5]

---

4 The nasal vowel inventory is already smaller than the oral vowel inventory. In post-tonic position, nasal vowels do reduce. However, in addition to "reduction" they also undergo a process of diphthongization in post-tonic position.

5 The vowel inventory given here, agrees with that proposed by Silva (1997:298) and Parkinson (1988). Mateus and d'Andrade (2000:17-18) agree on the inventories for the stressed vowels. However, they

(2) **Oral vowel inventory of Portuguese**

a. Stressed syllables

i								u
	e						o	
		ɛ				ɔ		
				ɐ				
				a				

b. Unstressed syllables

i		u
	ə	
	ɐ	

(3) **The features of the Faialense Portuguese vowels**

	i	u	e	o	ɛ	ɔ	ɐ	a	ə
High	+	+	-	-	-	-	-	-	-
Low	-	-	-	-	-	-	+	+	-
Front	+	-	+	-	+	-	-	-	-
Back	-	+	-	+	-	+	-	-	-
ATR	+	+	+	+	-	-	+	-	-

Height. I am making a three level height distinction. In particular, the vowels can be ordered from low to high as follows: [a, ɐ] > [e, o, ɛ, ɔ, ə] > [i, u]. The two low vowels [a, ɐ], the two mid front vowels [e, ɛ], and two mid back vowels [o, ɔ] are not formally distinguished from each other by a height feature, but rather by the feature ATR. In absolute acoustic terms the [+ATR] (or tense) vowels are all higher than their [-ATR] (or lax) counterparts. This is confirmed by a spectrographic analysis of the tonic vowels of European Portuguese performed by Martins (1964 and 1973). The average F_1 values that

---

do not recognize schwa in unstressed syllables. The vowels that Silva indicates as [ə] are considered to be [ɨ] by Mateus and d'Andrade. I follow Silva and Parkinson here, primarily because the data on vowel deletion in Faialense Portuguese are reported by Silva, and it is therefore easier to interpret his data if I assume same the vowel inventory that he assumes.

This difference between authors on the vowel inventory is not surprising. The high non-back unrounded vowels and schwa are not only acoustically quite similar, but they also do sometimes pattern together phonologically. For some discussion on the close phonological relationship between high non-back unrounded vowels and schwa in Tiberian Hebrew, see Coetzee (1996a, 1996b, 1999a:122-126) and Garr (1989).

Martins found for these sets of vowels are given in (4) below. An advanced tongue root is known to raise a vowel slightly. The fact that the [+ATR] vowels are higher than their [-ATR] counterparts is therefore not surprising.

(4) **F_1 values for low and mid vowels in European Portuguese**[6]

	F_1		F_1		F_1
e	403	o	426	ɐ	511
ɛ	501	ɔ	531	a	626

Frontness/Backness. I distinguish front [e, ɛ, i], central [a, ɐ, ə], and back vowels [o, ɔ, u]. This deviates from Mateus and d'Andrade (2000:30) who distinguish only front and back vowels, and who classify [a, ɐ] as back. However, it agrees with Silva (1988, 1997, 1998), Fails and Clegg (1992), and Parkinson (1988:132). The classification of [a, ɐ, ə] as central is also confirmed by the Martins's spectrographic analysis. The average F_2 values for the vowels of European Portuguese in the table in (5) are from *Figure 12* in her paper (p. 312). Since Martins investigated only vowels in stressed syllables, she does not report values for schwa, which occurs only in unstressed syllables in Portuguese.

6 Martins's study was done on standard peninsular Portuguese and not Azorean Portuguese. However, there is no reason to assume that Azorean and peninsular Portuguese would differ in the basic pattern. Additionally, even Brazilian Portuguese has the same F_1 relationships between these vowels. The F_1 values for Brazilian Portuguese vowels below are from Fails and Clegg (1992:36). Brazilian Portuguese does not have the vowel [ɐ] in tonic position, and comparison between [a] and [ɐ] is therefore not possible.

	F_1		F_1
e	383	o	399
ɛ	539	ɔ	545

(5) **F_2 values for low and mid vowels in European Portuguese**[7]

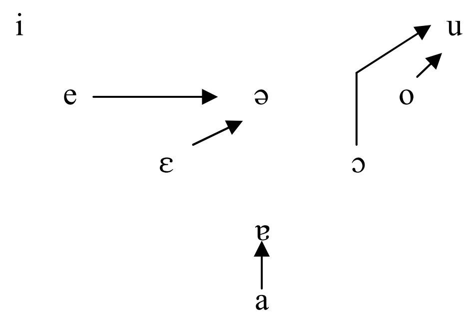
	F_2		F_2		F_2
i	2344	ɐ	1602	u	678
e	2084	a	1326	o	864
ɛ	1893			ɔ	994

Roundness. Roundness is completely redundant – all and only the back vowels are round. I therefore do not include a separate feature [round].

1.2 Vowel reduction and deletion in unstressed syllables

The schematic representation of the reduction process in (6) is adapted from Silva (1997:299, 1998:175).[8]

(6) **Vowel reduction in unstressed syllables**



[7] Again, Brazilian Portuguese shows the same pattern (Fails and Clegg, 1992:36).

	F_2		F_2		F_2
i	2149	a	1264	u	896
e	1936			o	780
ɛ	1659			ɔ	939

[8] Silva (1997:299, 1998:175) and Mateus and d'Andrade (2000:18) claim that /i/ reduces to schwa in post-tonic position. However, the stress placement rules of Portuguese are such that /i/ will never be parsed into a post-tonic position. Portuguese words are usually stressed on the penultimate syllable. However, when the final syllable contains one of the two high vowels /i, u/, stress is attracted to this final syllable (Silva, 1997:299, Thomas, 1974:3). The result is that it is not possible for an /i/ to occur in post-tonic position. The statement that post-tonic /i/ reduces is therefore a vacuous statement. Silva has also confirmed this to me in personal communication.

(7) **Examples of the reduction in unstressed syllables**[9]

/e/ → [ə]: *selo* [sé̲lu] "stamp" vs. *selar* [sə̲láɾ] "to stamp"

/ɛ/ → [ə]: *selo* [sɛ̲́lu] "I stamp" vs. *selar* [sə̲láɾ] "to stamp"

/a/ → [ɐ]: *paga* [pá̲gɐ] "s/he pays" vs. *pagar* [pɐ̲gáɾ] "to pay"

/ɔ/ → [u]: *forço* [fɔ̲́ɾsu] "I oblige" vs. *forçar* [fu̲ɾsáɾ] "to oblige"

/o/ → [u]: *força* [fó̲ɾsa] "strength" vs. *forçar* [fu̲rsáɾ] "to oblige"

(Mateus and d'Andrade, 2000:17, 20)

Crosswhite (2000a, 2000b, 2001) distinguishes two types of vowel reduction, namely *contrast enhancing* reduction and *prominence neutralizing* reduction. Contrast enhancing reduction is characterized by the avoidance of non-peripheral vowels in perceptually weak positions such as unstressed syllables. In these kinds of systems, the inventory of reduced vowels therefore often consists of the three peripheral vowels [i, u, a]. Prominence neutralizing vowel reduction is characterized by a drive to have elements with similar prominence characteristics co-occur. Vowels of lower sonority are less prominent than vowels of higher sonority, and unstressed syllables are less prominent than stressed syllables. These kinds of reduction processes therefore usually result in the replacement of high sonority vowels with lower sonority vowels in unstressed syllables.

The reduction process observed in Portuguese is prominence neutralizing reduction. Each of the reductions in unstressed syllables replaces a vowel of higher sonority with a vowel of lower sonority. This rests on two assumptions about the sonority

---

[9] In these examples I have replaced the [ɨ] of Mateus and d'Andrade with [ə]. For more on this, see footnote 5 above.

of vowels: (i) Schwa is the least sonorous vowel.[10] (ii) Lower vowels are more sonorous than higher vowels (Parker, 2002). Under these assumptions the Portuguese vowels can be ordered according to their sonority as in (8).

(8) **Sonority scale for Portuguese vowels**

a > ɐ > {ɛ, e, ɔ, o}[11] > u > i > ə

Aside from this positive evidence that Portuguese vowel reduction is of the prominence reduction kind, there is also negative evidence. If Portuguese vowel reduction was a contrast enhancing process, then two of the reduction mappings could not be explained. (i) The corner vowel /a/ maps onto the non-peripheral [ɐ]; (iii) each of /ɛ, e/ also map onto the central [ə]. Although /ɛ, e/ are not corner vowels, they are more peripheral than schwa. These two mappings reduces the contrast between vowels in unstressed syllables – rather than being pushed apart in the articulatory space, the vowels centralize, moving towards each other in the space. I will therefore analyze the vowel reduction in Portuguese as a prominence reduction process.

Aside from these reduction processes, European Portuguese also has variable vowel deletion in unstressed syllables. Vowel deletion is usually not treated in as much detail as vowel reduction in the literature on Portuguese grammar. Mateus and d'Andrade, for instance, devote only one paragraph to vowel deletion (2000:18), while vowel

---

10 Crosswhite (2000b:2) makes a similar claim. Schwa is usually very short and low in intensity in comparison to other vowels. Also, although schwa is usually classified as a mid vowel, Pettersson and Wood (1987) have found that, at least in Bulgarian, schwa is pronounced with a very close jaw position – similar to that seen in high vowels such as /i, u/.

11 I am classifying all of the mid, non-central vowels together. This is because there is no evidence that they are treated differently with regard to the vowel reduction or vowel deletion. Since these vowels are all contiguous on the sonority hierarchy, this is simply scale conflation or encapsulating (de Lacy, 2003a, 2003b, Prince and Smolensky, 1993).

reduction receives several sections. As far as the specific pattern of variation is concerned, Mateus and d'Andrade make only three remarks: (i) It is only schwa[12] and unstressed [u] that are subject to deletion; (ii) schwa is more prone to delete than [u]; and (iii) deletion is mostly limited to word final position.

Silva (1997, 1998) represents the first detailed study of the process of vowel deletion. For Faialense Portuguese he shows that: (i) Although schwa and [u] delete most frequently, other vowels in unstressed position can also delete; (ii) word-final vowels are more prone to deletion than non-word final vowels; (iii) a vowel is more likely to delete if the following syllable is unstressed than if the following syllable is stressed. In general then, Silva has shown that the deletion process is more wide spread than what has traditionally been assumed, and that the rate of deletion is at least partially determined by grammatical factors. I will report Silva's findings in more detail in §3 where I present an OT account of this process.

2. Vowel reduction in Faialense Portuguese

In this section I provide an account for vowel reduction in Faialense Portuguese within the theory of vowel reduction developed by Crosswhite (2000a, 2000b, 2001). This section is structured as follows: I first discuss the constraints that are necessary to account for the reduction process (§2.1). After that, I show how these constraints can be used to account for vowel reduction in Faialense Portuguese (§2.2 to §2.7).

---

[12] Of course, Mateus and d'Andrade do not recognize schwa as part of the vowel inventory of Portuguese. In the discussion here I have replaced all of their references to [ɨ] with [ə]. See footnote 5 above.

2.1 The constraints

Crosswhite offers an explanation of prominence neutralizing vowel reduction by appealing to the concept of harmonic alignment as formulated by Prince and Smolensky (1993). The basic idea behind harmonic alignment is that different types of prominence should be aligned with each other. Assuming two prominence scales, harmonic alignment requires prominent elements from one scale to co-occur with prominent elements from the other scale, and similarly for non-prominent elements on the two scales. Prominence neutralizing vowel reduction aims to have non-prominent (low sonority) vowels align with prosodically weak positions (unstressed syllables). This is therefore exactly the situation in which harmonic alignment can be called upon. In (9) I list the two prominence scales involved in Faialense Portuguese vowel reduction, and show their harmonic alignment.

(9) **Harmonic alignment of syllable strength and sonority**

Syllabic prominence scale:	σ́ > σ̆
Sonority scale for vowels:	a > ɐ > {o, ɔ, e, ɛ} > u > i > ə
Harmonic alignment for σ̆:	σ̆/ə ™ σ̆/i ™ σ̆/u ™ σ̆/{o, ɔ, e, ɛ} ™ σ̆/ɐ ™ σ̆/a
Harmonic alignment for σ́:	σ́/a ™ σ́/ɐ ™ σ́/{o, ɔ, e, ɛ} ™ σ́/i ™ σ́/u ™ σ́/ə

Since vowel reduction occurs in *unstressed* syllables, the harmonic alignment of these two scales in terms of σ́ is not relevant here, and it will not be discussed any further.[13] These harmonically aligned scales can now be converted into constraints. The

[13] Portuguese does not have the converse of vowel reduction in unstressed syllables, that is, vowel augmentation in stressed syllables – i.e. it is not the case that, for instance, an underlying /u/ that is parsed into a stressed syllable is replaced by a vowel of higher sonority such as [o]. Therefore, the

constraints will be in a fixed ranking relationship determined by the harmonic alignment. The members of the harmonically aligned σ̆-scale are ordered from the most to the least well-formed. The ranking between the constraints is therefore the opposite of the ordering between the elements on the harmonically aligned scale, so that the least well-formed member on the scale will violate the highest ranked constraint. In (10) I list the constraints that can be derived from the harmonically aligned σ̆-scale. Rather than listing the mid vowels individually, I refer to {o, ɔ, e, ɛ} together as "mid". Note that this group does not include schwa even though schwa is also a mid vowel. These vowels are therefore not really the mid vowels, but rather a group of vowels that occupy the same slot on the sonority scale.

(10) **Prominence alignment constraints**

||*σ̆/a o *σ̆/ɐ o *σ̆/mid o *σ̆/u o *σ̆/i||

An /a/ vowel in an unstressed syllable will violate the highest ranked constraint *σ̆/a, while an /i/ in an unstressed syllable will violate the lowest ranked constraint *σ̆/i. There is no constraint against parsing schwa into an unstressed syllable. This is in accordance with Gouskova (2003) who shows that there can be no constraints against the least marked member on a harmonically aligned scale. It is the interaction of these markedness constraints with faithfulness constraints on featural identity that determines which vowels are reduced and to what they reduce.

---

constraints that can be formed from the harmonic alignment on σ́ have to be ranked very low in the constraint hierarchy of Portuguese.

There are two ways in which featural identity constraints can be stated, namely as directional IDENT[±F] faithfulness constraints (Pater, 1999), or as the more traditional non-directional IDENT[F] constraints (McCarthy and Prince, 1994, 1995). The directional IDENT[±F] constraints differ from the non-directional IDENT[F] constraints in that they are able to distinguish between the mappings /+F/ → [-F], and /-F/ → [+F]. The definitions of these two versions of IDENT constraints are given in (11) and are based on Pater (1999) and McCarthy and Prince (1994, 1995).[14]

(11) **a. Non-directional**

IDENT[F]

If *x* is an output correspondent of an input segment *y*, then *x* must agree with *y* in its specification for the feature [F].

b. Directional

IDENT[+F]

If *x* is an output correspondent of an input segment *y* and *y* is specified as [+F], then *x* must also be specified as [+F].

IDENT[-F]

If *x* is an output correspondent of an input segment *y* and *y* is specified as [-F], then *x* must also be specified as [-F].

---

[14] There is actually a third way in which featural identity can be enforced, and that is through MAX[F]/DEP[F] constraints (Lombardi, 1998, 2001). These constraints are also violated by ordinary segmental deletion and epenthesis. Since Portuguese phonology needs to distinguish between featural change (reduction) and deletion, I will not use these MAX[F]/DEP[F] constraints here.

To illustrate the difference between these two approaches to featural faithfulness constraints, consider tableau (12) in which I use IDENT constraints for the feature [high].

(12) **Comparison between different kinds of featural faithfulness**

	Non-Directional	Directional	
	IDENT[high]	IDENT[+high]	IDENT[-high]
/e/ → [i]	*		*
/i/ → [e]	*	*	

The non-directional IDENT constraint cannot distinguish between raising and lowering, while the directional constraints can. The typology predicted by the non-directional constraints therefore forms a subset of the typology predicted by the directional constraints. In a grammar where the directional constraints for a feature [F] are ranked contiguously (no constraints intervening between them), the same output will be selected even if the directional constraints were replaced by a single non-directional constraint. It is only when the two directional constraints are separated by other constraints that the predictions of the two approaches diverge. A non-directional constraint can therefore be seen as shorthand for two directional constraints that are contiguously ranked.

Pater (1999) has shown with examples from nasalization and de-nasalization in Austronesian that directional constraints are necessary. I will therefore use directional constraints here. However, in the vocalic phonology of Portuguese, it is only for the feature [high] that it is necessary to rank constraints in between the two directional IDENT constraints. For all the other features, the directional constraints can be ranked contiguously. In order to simplify the exposition below, I will use non-directional constraints for all features except for [high]. For each of the other features, the non-directional constraints can be replaced with directional constraints ranked contiguously. I list the featural faithfulness constraints that I will use in (13).

(13) **Featural faithfulness constraints active in Portuguese vowel reduction**

IDENT[front]

IDENT[back]

IDENT[low]

IDENT[ATR]

IDENT[+high], IDENT[-high]

In §1.2 above I have already discussed the data that needs to be explained. However, I am repeating the essential aspects of the vowel reduction process again in (14) to facilitate the discussion in the following sections.

(14) **What needs to be explained**

a.	Low vowels:	/a, ɐ/ → [ɐ̆]
b.	Back vowels:	/o, ɔ, u/ → [ŭ]
c.	Schwa:[15]	/ə/ → [ə̆]
d.	High front vowel:	/i/ → [ĭ]
e.	Mid front vowels:	/e, ɛ/ → [ə̆]

[15] Schwa does not have phonemic status in Portuguese – the only surface schwa's are the result of vowel reduction. However, under richness of the base (Prince and Smolensky, 1993, Smolensky, 1996) we also have to consider how a schwa input will be treated. Since a schwa is the preferred unstressed syllable, there would not be any pressure on an underlying schwa to change if it is parsed into an unstressed syllable. I am therefore making the assumption that schwa will map faithfully onto the surface.

Before delving into the details of the vowel reduction process, I explain in §2.1.1 a basic assumption that I make about the ranking between markedness and faithfulness constraints. In the sections §2.2 to §2.7 I then discuss each of the classes of vowels mentioned in (14). I am making two simplifying assumptions in the discussion: (i) I am ignoring the deletion candidate; and (ii) I am not taking into account the possibility of variation. I will deal in detail with both of these issues in §3 and §4 below.

2.1.1 Ranking conservatism

Throughout the discussion here I follow the principle of "ranking conservatism" (Itô and Mester, 1999, 2003, Tesar and Smolensky, 1998, 2000) . This principle is based on the assumption that the original state of the grammar has the ranking ||Markedness o Faithfulness|| (Smolensky, 1996). I will therefore assume this ranking between any markedness constraint and faithfulness constraint unless if there is positive evidence to the contrary. This is not a necessary assumption – the vowel reduction and deletion process in Faialense Portuguese can be explained without this assumption. However, there are two reasons for making this assumption: First, it is in agreement with standard assumptions about grammar in the OT literature. Secondly, it results in a "neater" looking final grammar – a grammar that more closely approaches a total ranking of the constraints. One reason for this assumption is therefore aesthetical.

2.2 Low vowels

Both low vowels map onto the vowel [ɐ̆] in unstressed syllables, i.e. /a, ɐ/ → [ɐ̆]. Consider first the mapping /a/ → [ɐ̆]. This observed unfaithful mapping violates IDENT[ATR], while the faithful mapping violates *σ̆/a. In order for the unfaithful candidate to be preferred over the faithful candidate, we therefore need the ranking ||*ŏ/a o IDENT[ATR]||.

We still need to explain why /a/ maps onto [ɐ̆] rather than onto some other unfaithful candidate. The actually observed output [ɐ̆] violates the markedness constraint *ŏ/ɐ. If /a/ mapped onto any of the non-low vowels, it would have violate a lower ranked markedness constraint. This implies the mapping of /a/ onto any non-low vowel should violate a faithfulness constraint ranked higher than *ŏ/ɐ. The only constraint violated by the mapping /a/ → [ə̆] is IDENT[low], so that we need at least the ranking ||IDENT[low] o *ŏ/ɐ|| in order to prevent /a/ from mapping onto [ə̆]. It so happens that all other mappings of /a/ to non-low vowels will also violate IDENT[low]. This ranking alone is therefore sufficient to rule out all unfaithful mappings of /a/ except for the actually observed /a/ → [ɐ̆]. The full ranking required to explain the mapping /a/ → [ɐ̆] is therefore ||{*ŏ/a, IDENT[low]} o {*ŏ/ɐ, IDENT[ATR]}||. This is shown in the tableau in (15).

(15) **/a/ → [ɐ̆]**[16]

/a/	*ŏ/a	ID[low]	*ŏ/ɐ	ID[ATR]
ă	*!			
L ɐ̆			*	*
All other vowels		*!		(*)[17]

[16] The rankings ||*ŏ/a o IDENT[low]|| and ||*ŏ/ɐ o IDENT[ATR]|| are not necessary to explain the mapping /a/ → [ɐ̆]. I assume these rankings based on the principle of "ranking conservatism". See this discussion in §2.1.1 above.

[17] IDENT[ATR] is violated by all [+ATR] vowels and obeyed by all [-ATR] vowels. However, since all of these vowels also violate high ranking IDENT[low], their performance on IDENT[ATR] is not relevant. Throughout the discussion I will use a parenthesized asterisk (*) to indicate a constraint that is violated by some but not all candidates represented by a row in a tableau.

The faithful candidate [ă] fatally violates *σ̆/a. All unfaithful candidates except for [ɐ̆] fatally violate IDENT[low]. Consequently, [ɐ̆] is the observed output for an /a/-input.

Now consider /ɐ/ → [ɐ̆]. This mapping violates only the constraint *σ̆/ɐ. If /ɐ/ were to map onto its [-ATR] counterpart [ă] it will violate a higher ranked markedness constraint *σ̆/a. All mappings of /ɐ/ onto a non-low vowel will violate the constraint IDENT[low], which, as we have already established, outranks *σ̆/ɐ. No additional rankings are necessary to explain why /ɐ/ does not reduce. This is shown in tableau (16).

(16) **/ɐ/ → [ɐ̆]**

/ɐ/	*σ̆/a	ID[low]	*σ̆/ɐ	ID[ATR]
ă	*!			*
L ɐ̆			*	
All other vowels		*!		(*)

2.3 Back vowels

All back vowels map onto the high back vowel in unstressed syllables, i.e. /o, ɔ, u/ → [ŭ]. Consider first the mapping of the mid back vowels, /o, ɔ/ → [ŭ]. Had these vowels been mapped faithfully onto the surface, they would have violated the markedness constraint *σ̆/mid. The actually observed mappings violate *σ̆/u and either only IDENT[-high] (/o/ → [ŭ]) or both IDENT[-high] and IDENT[ATR] (ɔ/ → [ŭ]). This means that *σ̆/mid has to outrank *σ̆/u, IDENT[-high] and IDENT[ATR], i.e. ||*σ̆/mid o {*σ̆/u, IDENT[-high], IDENT[ATR]}||.[18] This explains why these inputs do not map faithfully onto themselves.

[18] The ranking ||*σ̆/mid o *σ̆/u|| was motivated in (10). Only the other two rankings are therefore new.

However, this alone still does not explain why /o, ɔ/ does not map onto [ĭ] or [ə̆]. Both of these vowels are lower in sonority than [ŭ], and therefore violate lower ranked markedness constraints from the hierarchy in (10) than does [ŭ]. The mapping /ɔ/ → [ə̆] violates only the faithfulness constraint IDENT[back]. This means that the ranking ||IDENT[back] o *ŏ/u|| is required to block this mapping. The mappings /o/ → [ə̆], and /ɔ, o/ → [ĭ] all also violate IDENT[back]. The ranking ||IDENT[back] o *ŏ/u|| is therefore sufficient to block all of these mappings.[19]

The following ranking is therefore necessary to explain the mappings /o, ɔ/ → [ŭ]: ||{*ŏ/mid, IDENT[back]} o *ŏ/u o {IDENT[-high], IDENT[ATR]}||. This is illustrated in the tableau in (17).[20]

(17) **/ɔ/ → [ŭ]**[21]

/ɔ/	*ŏ/mid	ID[ba]	*ŏ/u	ID[-hi]	ID[ATR]
ɔ̆	*!				
ŏ	*!				*
L ŭ			*	*	*
All other vowels		*!		(*)	(*)

[19] /o/ → [ə̆] also violate IDENT[ATR]. This mapping can therefore also be blocked by ranking IDENT[ATR] over *ŏ/u. Similarly /ɔ/ → [ĭ] also violates IDENT[ATR] and IDENT[front]. This mapping can therefore also be blocked by ranking either IDENT[ATR] or IDENT[front] over *ŏ/u. Lastly, the mapping /o/ → [ĭ] also violates IDENT[front], and can therefore also be blocked by ranking IDENT[front] over *ŏ/u. The ranking argued for in the text, ||IDENT[back] o *ŏ/u||, is therefore sufficient but not necessary. However, following the principle of ranking conservatism (see §2.1.1) I am opting for the ranking ||IDENT[back] o *ŏ/u||, since this ranking eliminates the need for any of IDENT[ATR] or IDENT[front] to be ranked above a markedness constraint. This ranking is the most conservative ranking that can explain the data.

[20] I do not include as candidates any vowels that are lower in sonority than /o, ɔ/ – i.e. I do not include the candidates [ă, ɛ̆]. Since they are higher in sonority than /o, ɔ/, they violate higher ranked markedness constraints than the faithful candidate – see (10) above. They can therefore not be selected as output candidates.

[21] The rankings ||*ŏ/mid o IDENT[back]|| and ||*ŏ/u o {IDENT[-high], IDENT[ATR]}|| are based on the principle of ranking conservatism – see §2.1.1 above.

The observed output [ŭ] violates *ǒ/u, IDENT[-high] and IDENT[ATR]. The faithful candidate [ɔ̆] violates only *ǒ/mid. However, because *ǒ/mid dominates all of the constraints violated by the observed candidate [ŭ], the faithful candidate is eliminated. All unfaithful candidates except for [ŭ] violate IDENT[back]. This is a fatal violation because IDENT[back] outranks *ǒ/u. The result is that [ŭ] is the optimal candidate. In this tableau I used /ɔ/ as input. However, the same point can be made also with an /o/-input. The only difference will be that [ɔ̆] rather than [ŏ] will violate IDENT[ATR].

Now consider the high back vowel that maps faithfully onto itself, /u/ → [ŭ]. Mapping onto any of [ă, ɐ̆, ŏ, ɔ̆, ĕ, ɛ̆] violates markedness constraints ranked higher than the markedness constraint *ǒ/u, which is violated by the faithful candidate [ŭ] – see (10) above. There are therefore only two candidates to worry about, namely [ə̆, ĭ]. Both of these candidates violate the faithfulness constraint IDENT[back] which has already been established to outrank *ǒ/u. No additional rankings are therefore necessary to explain why /u/ does not reduce. This is illustrated in (18).

(18) **/u/ → [ŭ]**

/u/	*ǒ/mid	ID[ba]	*ǒ/u	ID[-hi]	ID[ATR]
ɔ̆	*!				*
ŏ	*!				
L ŭ			*		
All other vowels		*!		(*)	(*)

The faithful candidate violates only *ǒ/u. All other candidates violate either *ǒ/mid or IDENT[back], both of which outrank *ǒ/u. The faithful candidate is therefore selected as output.

2.4 Schwa

Since schwa is the preferred vowel in an unstressed syllable, there is no pressure on an underlying schwa to change into any other vowel if it is parsed into an unstressed syllable. In fact, there is not even a markedness constraint in the markedness hierarchy in (10) that penalizes an unstressed schwa. The fully faithful mapping /ə/ → [ə̆] therefore violates none of the markedness constraints under consideration here. This means that no unfaithful candidate can improve in markedness on the fully faithful candidate. The principles of harmonic ascent (Moreton, 1999) and harmonic bounding (Samek-Lodovici and Prince, 1999) therefore assure that /ə/ will map faithfully onto [ə̆]. No tableau is given to illustrate this. The faithful candidate violates neither a markedness nor a faithfulness constraint. Each of the other candidates violates one markedness constraint and at least one faithfulness constraint. It is therefore clear that the faithful candidate will be optimal.

2.5 The high front vowel

The high front vowel /i/ maps faithfully onto itself, i.e. /i/ → [ĭ]. This faithful mapping violates the markedness constraint *σ̆/i. With the exception of [ə̆] all other possible candidates violate a markedness constraint that outranks *σ̆/i and are non-optimal. The mapping /i/ → [ə̆] is therefore the only mapping that needs to be ruled out by a faithfulness constraint. This mapping violates three faithfulness constraints, namely IDENT[+high], IDENT[front] and IDENT[ATR]. As long as one of these constraints ranks higher than *σ̆/i, the reduction mapping will be blocked. I will assume here that it is the constraint IDENT[+high] that is acting as the blocking constraint.[22] All other unfaithful mappings will violate markedness constraints that are ranked higher than *σ̆/i. They can therefore never beat the faithful candidate. The only new ranking required is ||IDENT[+high] o *σ̆/i||. This is shown in the tableau in (19). I do not include in this tableau any of the candidates that violate a markedness constraint from (10) ranked higher than *σ̆/i.

(19) **/i/ → [ĭ]**

/i/		ID[+hi]	*σ̆/i
L	ĭ		*
	ə̆	*!	

2.6 The mid front vowels

The mid front vowels /e, ɛ/ reduce to [ə̆] in unstressed syllables. The faithful candidates for these two vowels violate the markedness constraint *σ̆/mid. It is therefore necessary that all faithfulness constraints violated by the actual mapping /e, ɛ/ → [ə̆] be ranked lower than *σ̆/mid. The mapping /e/ → [ə̆] violates IDENT[ATR] and IDENT[front], while the mapping /ɛ/ → [ə̆] violates only IDENT[front]. The following ranking is therefore minimally necessary: ||*σ̆/mid o {IDENT[front], IDENT[ATR]}||.

22 This is not a necessary assumption. Any one or combination of these constraints could act as blocker. Under the conservative assumption that faithfulness constraints will be ranked as low as possible (§2.1.1), I will assume that only one of them actually ranks above *σ̆/i. Both IDENT[front] and IDENT[ATR] are violated elsewhere in Portuguese. IDENT[front] is violated in the reduction of the mid front vowels /e, ɛ/ to [ə̆] (see §2.6 below), and IDENT[ATR] is violated by several mappings, for instance /ɔ/ → [ŭ] (see §2.3 above). Since these constraints are at least sometimes violated while IDENT[+high] is never violated, the most conservative option is to let IDENT[+high] be the blocker.

The vowels [ă, ɛ̆, ŏ, ɔ̆] all violate a markedness constraint from (10) that is ranked as least as high as the markedness constraint *σ̆/mid violated by the faithful [ĕ, ɛ̆]. These candidates can therefore not be optimal. The vowels [ĭ, ŭ] violate *σ̆/i and *σ̆/u respectively. Both of these are ranked lower than *σ̆/mid – see (10). We can prevent /e, ɛ/ from mapping onto [ĭ, ŭ] by ranking the faithfulness constraint violated by /e, ɛ/ → [ə̆] lower than *σ̆/i and *σ̆/u. This ranking is also in accordance with the principle of raking conservatism – see §2.1.1.

The rankings necessary to explain the mapping /e, ɛ/ → [ə̆] is therefore ||*σ̆/mid o *σ̆/u o*σ̆/i o {IDENT[front], IDENT[ATR]}||. This is shown in the tableau in (20). This tableau does not include any of the candidates that are more marked than the faithful candidate.

(20) **/e/ → [ə̆]**[23]

/e/	*σ̆/mid	*σ̆/u	*σ̆/i	ID[ATR]	ID[fr]
L ə̆				*	*
ĕ	*!				
ŭ		*!			*
ĭ			*!		

The observed output [ə̆] violates only the faithfulness constraints IDENT[ATR] and IDENT[front]. The faithful candidate [ĕ] violates *σ̆/mid. Because *σ̆/mid ranks higher than IDENT[ATR] and IDENT[front], this violation is fatal. The vowels [ĭ, ŭ] violate *σ̆/i

23 When I discuss deletion later in this chapter, I will show that the situation with the /e, ɛ/ is more complicated than what is presented here. In particular, I will show that it is not the *σ̆/i that prevents /e, ɛ/ from mapping onto [ĭ], but rather the local conjunction of IDENT[-high] and *σ̆/i. However, the evidence for this comes from the variable deletion of /e, ɛ/, and since the data on deletion have not yet been presented, I cannot yet motivate this complication. See the discussion in §3.3.1 below.

and *σ̆/u respectively. Since these two constraints also outrank IDENT[ATR] and IDENT[front], [ĭ, ŭ] are ruled out as candidates. The illustration was here given in terms of an /e/-input. However, the same can be shown with an /ɛ/-input. The only difference will be that the observed output [ə̆] will not violate IDENT[ATR], and [ɛ̆] rather than [ĕ] will violate *σ̆/mid.

2.7 Summary

The rankings necessary to explain vowel reduction is Faialense Portuguese are summarized in the table in (21). In this table I indicate the ranking in the first column, and the motivation for the ranking in the second column. The third column indicates where in the preceding discussion that particular ranking is motivated. After the table, I give a graphic representation of these rankings.

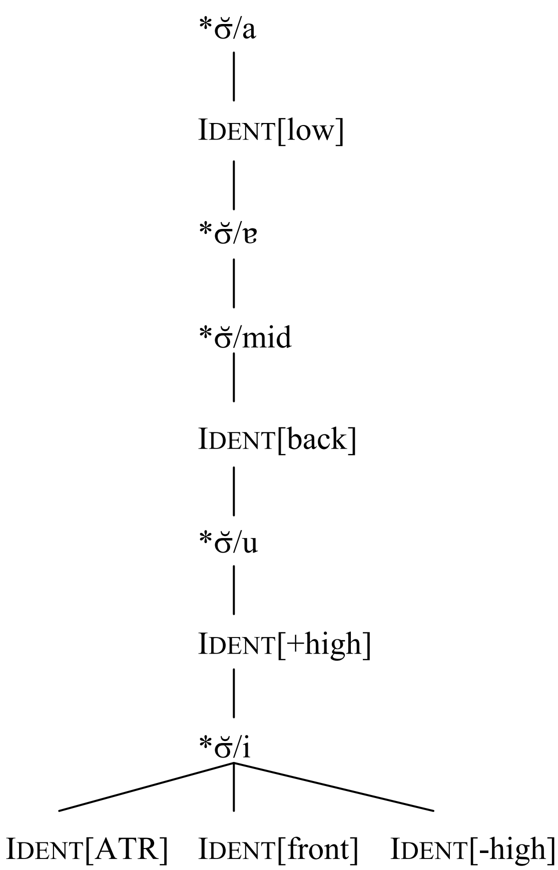
(21) **Summary of rankings necessary for vowel reduction**

Ranking	**Motivation**	**Where?**
*σ̆/a o*σ̆/ɐ o*σ̆/mid o *σ̆/u o*σ̆/i	Universal	§2.1 (10)
*σ̆/a o IDENT[ATR]	/a/ reduces to [ɐ̆]	§2.2 (15)
IDENT[low] o *σ̆/ɐ	/a, ɐ/ do not reduce to non-low vowels	§2.2 (15)
*σ̆/mid o IDENT[-high], IDENT[ATR]	/o, ɔ/ reduce to [ŭ]	§2.3 (17)
IDENT[back] o *σ̆/u	/o, ɔ, u/ do not reduce to [ĭ] or [ə̆]	§2.3 (17)
IDENT[+high] o *σ̆/i	/i/ does not reduce to [ə̆]	§2.5 (19)
*σ̆/mid o IDENT[front], IDENT[ATR]	/e, ɛ/ reduce to [ə̆]	§2.6 (20)
*σ̆/u, *σ̆/i o IDENT[front], IDENT[ATR]	/e, ɛ/ do not reduce to [ĭ] or [ŭ]	§2.6 (20)

((21) continued)

Ranking	Motivation	Where?
*σ̆/a o IDENT[low] *σ̆/mid o IDENT[back] *σ̆/u o IDENT[+high] *σ̆/i o IDENT[-high], IDENT[front], IDENT[ATR]	Ranking conservatism	§2.1.1

(22) **Graphic representation of the rankings for Faialense Portuguese vowel reduction**



3. The interaction of vowel reduction and deletion in Faialense Portuguese

Aside from vowel reduction, European Portuguese also applies a more severe form of vowel lenition in unstressed syllables, namely vowel deletion. However, unlike reduction, deletion is a variable process. A vowel in an unstressed syllable is sometimes pronounced and sometimes deleted. This means that a single word often has more than one possible pronunciation. There are two possibilities: (i) If the unstressed vowel is a vowel that is subject to reduction, then the variation will be between reduction and deletion. (ii) If the unstressed vowel is a vowel that resists reduction, then the variation will be between faithfully preserving the underlying vowel and deletion.

(23) **Variation between the faithful, reduction and deletion candidates**

Reduction ~ Deletion:	/peludo/	→	[pə̆lúdŭ]~[p_lúdŭ]	*peludo*	"hairy"
Faithful ~ Deletion:	/piloto/	→	[pĭlótŭ]~[p_lótŭ]	*piloto*	"pilot"

In this and the next section I will offer an OT account for this variable pattern within the rank-ordering model of EVAL. This section is structured as follows. In §3.1 I present that data on vowel deletion in Faialense Portuguese. In §3.2 I develop an OT account for the differential realization of each of the individual vowels. This is what I refer to as intra-contextual variation – any given input can be pronounced in more than one manner (see Chapter 1 §2.2.1). In the next section (§4), I account for gross patterns of the variable process that hold true across different vowels – in general vowels are more or less prone deletion based on the context in which they appear. This is what I refer to inter-contextual variation (see Chapter 1 §2.2.2).

3.1 The data

Mention of variable vowel deletion is found throughout the literature on European Portuguese (Crosswhite, 2001:104, Mateus and d'Andrade, 2000:18, Oliviera, 1993:9, Parkinson, 1988:142). However, the discussion of vowel deletion typically amounts to no more than an acknowledgement that the process exists. The only exceptions to this generalization are two papers by Silva. He reports on unstressed vowel deletion in two dialects of Azorean Portuguese, namely that spoken on the island of Faial (Silva, 1997) and that spoken on the island of São Miguel (Silva, 1998). In these two papers Silva shows that the pattern of deletion is not random, but that it is at least partially determined by grammatical factors. He offers an account of this process within the variable rule framework of Labov (Cedergren and Sankoff, 1974, Kay and McDaniel, 1979, Labov, 1972). In particular he employs the VARBUL software package (Sankoff and Rand, 1988) to determine which grammatical factors contribute significantly towards determining the observed pattern of deletion. I will not adopt Silva's variable rule analysis of vowel deletion, but I will use the data on the deletion process as he presents it. Although the deletion patterns in Faialense and São Miguel Portuguese are very similar, they are not identical. In the rest of this discussion I will focus only on Faialense Portuguese. I choose Faialense Portuguese over São Miguel Portuguese since Faialense Portuguese is very similar to standard (Lisbon) European Portuguese while São Miguel Portuguese differs much more from the European standard.[24]

---

[24] See footnote 3 about the just how similar Faialense Portuguese is to standard European Portuguese. In that footnote I explain that Faialense Portuguese agrees with standard European Portuguese in all respects relevant to vowel reduction and deletion.

São Miguel Portuguese, on the other hand, is more different from standard European Portuguese. For instance, Silva (1997:30, note 3) claims that São Miguel Portuguese has a different vowel inventory than standard European Portuguese. Also see Rogers (1949:48) who claims that the Portuguese of the eastern Azores is quite different in pronunciation from Lisbon Portuguese. São Miguel is an eastern Azorean island.

Silva collected his data on Faialense Portuguese from a 42 year old female native speaker of Faialense Portuguese.[25] He recorded a conversation between the subject and her mother, and selected a continuous block of 22 minutes for study. He transcribed this block, and then analyzed the realization of vowels in unstressed syllables.[26] This resulted in 861 unstressed syllables or potential sites for vowel deletion.[27] Silva reported the data without reference to the underlying form of the vowels. For instance, the data that he reports on deletion of [ŭ] includes [ŭ] that corresponds to underlying /o, ɔ, u/ (see §2.3 above on this). This is a little unfortunate, as it is at least conceivable that different underlying forms might be subject to different rates of deletion. However, because of the way in which Silva reports his data, I will make the assumption that the deletion rates reported for [ŭ] apply equally to [ŭ] derived from each of /o, ɔ, u/.

Silva coded his data according to several linguistic factors. These data were then submitted to the VARBUL program (Sankoff and Rand, 1988). From among all the factors that Silva considered, only three were selected by VARBUL as contributing significantly

---

25 The conclusions drawn here about Faialense Portuguese are therefore somewhat tentative, being based on the speech of a single speaker – this is also acknowledged by Silva (1997:307, endnote 7). However, under the assumption that the data presented by Silva reflect at least the grammar of this individual, it is necessary that our theory be capable of accounting for the data.

26 Since vowel deletion results in loss of a syllable, the term "unstressed syllable" should not be given a strictly phonetic meaning here. For each word, Silva determined which syllables would have been unstressed had all the vowels been pronounced. He counted as unstressed syllables therefore also those syllables that were destroyed by the deletion of the vowels that would have formed their nuclei.

27 Originally Silva assumed that there were 884 potential sites of vowel deletion. However, upon closer scrutiny of the data, he found that the vowel in the last syllable of the third person pronouns *elle*/*elles* and the vowel in the first syllable of the preposition *para* were never realized. Based on this he assumed that the underlying forms of the third person pronouns do not contain a vowel in the second "syllable", i.e. /el/ and /els/. And similarly he assumed that the underlying form of *para* does not actually contain a vowel in the first "syllable", i.e. /pra/. With regard to *para* there is additional evidence from Brazilian Portuguese that the underlying form is /pra/ – unlike European Portuguese, Brazilian Portuguese is not characterized by deletion of unstressed vowels, and even so *para* in Brazilian Portuguese is pronounced as [pra] (Thomas, 1974:15). The 23 occurrences of these three lexical items were excluded from the final analysis (Silva, 1997:303-304).

toward determining how likely vowel deletion is to apply. These three factors are: (i) vowel quality (i.e. some vowels are more likely to delete than others), (ii) position in prosodic word (word final vowels are more likely to delete), and (iii) stress of following syllable (vowels are more likely to delete if followed by an unstressed syllable). Table (24) summarizes the deletion pattern and is based on *Table 2* from Silva (1997:305).[28]

(24) **Vowel deletion patterns in Faialense Portuguese**

		Following syllable				
		Stressed		**Unstressed**		
		ω-final	**Elsewhere**	**ω-final**	**Elsewhere**	**Total**
[ə̆]	**Deleted**	12	23	20	13	68
	n	19	86	26	32	163
	% deleted	63%	27%	77%	41%	42%
[ŭ]	**Deleted**	23	7	25	9	64
	n	35	65	35	47	182
	% deleted	66%	11%	71%	19%	35%
[ĭ]	**Deleted**	—	5	—	—	5
	n	—[29]	75	—	—	75
	% deleted	—	7%	—	—	7%
[ɐ̆]	**Deleted**	1	3	1	2	7
	n	75	147	58	51	331
	% deleted	1%	2%	2%	4%	2%

28 Silva includes nasal vowels, but as explained earlier my focus is only on the oral vowels and therefore I will not include his data on the nasal vowels (cf. §1.1). He also includes another prosodic context, namely pre-pausal. However, this factor was never selected by the VARBUL program as a significant factor (Silva, 1997:304). I am therefore also not including the data on this prosodic position.

29 Silva lists 10 occurrences of [ĭ] in this cell. However, in personal communication to me Silva explained these 10 [ĭ]'s were all occurrences of the conjunction *e* 'and'. In his coding of the data he treated this word as a separate prosodic word. This is probably not correct. Function words are incorporated into the prosodic word headed by the following lexical word (see below). These 10 [ĭ]'s should rather be counted as [ĭ]'s occurring non-final in a prosodic word followed by a stressed vowel. This is indeed how I represent them in this table – i.e. the 75 [ĭ]'s in the next cell include 10 [ĭ]'s that in Silva's original table were in this cell. See also the discussion footnote 8 about post-tonic /i/.

Vowel quality. Not all vowels are equally likely to delete. The vowels are ordered as follows according to how likely they are to delete: [ə̆] > [ŭ] > [ĭ] > [ĕ].[30] The total deletion rates of [ə̆] and [ŭ] do not differ significantly, although it tends strongly towards significance ($\chi^2(1) = 3.21$, $p = .07$).[31] The deletion rates of [ŭ] and [ĭ] do differ significantly ($\chi^2(1) > 10^{307}$), as do deletion rates of [ĭ] and [ĕ] ($\chi^2(1) = 11.02$, $p = .0009$). The deletion rate of [ĕ] does differ significantly from zero ($p = .0008$).[32] However, since it is so close to zero, I will treat [ĕ] as if it is different from all the other vowels. All the other vowels I will treat as if variable deletion is indeed attested for them. However, [ĕ] will be treated as if it never deletes.

Position in prosodic word. Vowels that are final in a prosodic word are consistently more likely to delete than vowels that occur elsewhere in a prosodic word. The difference in deletion rates between these two contexts is significant. Of the 115 unstressed vowels that occurred in prosodic word final position 80 or 70% were deleted. However, of the 305 unstressed vowels that occurred elsewhere in the phonological word,

---

30 This pattern agrees with that found by Cedergren and Simoneau (1985) for Montréal French in which non-low vowels are more likely to delete than low vowels.

31 These statistics were calculated as follows: As observed frequencies I took the number of deletions and retentions of the vowel with the lower deletion rate. In the comparison between [ə̆] and [ŭ], I therefore took the number of deletions and retentions of [ŭ] as observed. The expected frequencies were then calculated by assuming that the vowel with the lower deletion rate actually had the same deletion rate as the vowel with the higher deletion rate – i.e. I assumed [ŭ] had a deletion rate of 42% rather than its actual rate of 35%. The frequencies used for the comparison between [ə̆] and [ŭ] were therefore the following:

	Observed	**Expected**
Deletion	64	(0.42)(182) = 76
Retention	118	(0.58)(182) = 106

32 This is the binomial probability of having 0 successes out of 331 trials if the probability of success on every trial is really 0.02.

only 57 or 19% were deleted ($\chi^2(1) > 10^{307}$).[33] Here it is relevant to know how Silva determined the boundaries of prosodic words. Following Selkirk (1986, 1987), he assumes that prosodic words are defined in part by reference to syntactic structure (Silva, 1997:297). In particular, he claims that every lexical word in a syntagmatic sequence corresponds to a prosodic word, and that it is the right edge of the lexical word that is used to delimit the boundary between prosodic words. This implies that functional words are incorporated into the prosodic word headed by a following lexical word. In a sentence such as *As mulheres de Coimbra cantavam um fado* 'The women from Coimbra sang a fado', there are then four prosodic words: [*As mulheres*]$_\omega$ [*de Coimbra*]$_\omega$ [*cantavam*]$_\omega$ [*um fado*]$_\omega$. With the expression "final in prosodic word", Silva indicates a vowel that is final in a prosodic word, not the final vowel in a prosodic word. The last vowel in *Coimbra* was coded as "final in prosodic word", but the last vowel of *mulheres* was coded as "elsewhere in prosodic word".

Stressed or unstressed following syllable. An unstressed vowel is more likely to delete when followed by an unstressed syllable than when followed by a stressed syllable. Of the 140 unstressed vowels followed by an unstressed syllable 67 (48%) deleted. Of the 280 unstressed vowels followed by a stressed syllable 70 (25%) deleted ($\chi^2(1) > 10^{307}$).[34]

There are two aspects to the variation that needs to be accounted for. (i) *Intra-contextual variation*. The relationship between deletion and reduction for individual vowels needs to be explained – e.g. why for a some vowel deletion or reduction is more

---

[33] In these calculations I include only the vowels that are subject to deletion (i.e. only potential sites for deletion). The low vowels are therefore not included in these counts.

[34] See the previous footnote.

or less frequent. This is the focus of the current section. (ii) *Inter-contextual variation*. But the differences between contexts across vowels also need to be accounted for – why is deletion more frequently for some vowels than others, why does deletion occur more in pre-unstressed than pre-stressed position, and why do the deletion rates differ for vowels that occur final in prosodic words and for vowels that occur elsewhere in prosodic words. This will be discussed in the section §4.

Although this section is dedicated to variation in the realization of individual vowels, the position of the vowel in the prosodic word will also be discussed. This is necessary because the relative frequency of deletion and retention differs for some vowels depending on where they occur in the prosodic word. For instance, final in a prosodic word [ŭ] is preferentially deleted (69%), but elsewhere in the prosodic word deletion is dispreferred (14%). Throughout the discussion below I will use the symbol ∅ to stand for a candidate in which the unstressed vowel has been deleted.

When I discussed the process of vowel reduction earlier in this chapter, I did not consider a deletion candidate. Since the deletion candidate is now added to the list of candidates, we need to add the anti-deletion constraint MAX. The discussion below will therefore focus on where MAX has to be ranked relative to the other constraints in the partial ranking established for Portuguese vowel reduction (see (22) in §2.7).

I also did not consider the possibility of variation. Therefore I did not discuss the location of the critical cut-off in the constraint ranking. (See Chapter 1 §2.2.3 and Chapter 3 §2.3). Locating the position of the critical cut-off will be another focus of the discussion below. In the rank-ordering model of EVAL, variation can only arise when the critical cut-off point occurs relatively high in the constraint ranking. If it occurred at the bottom of the hierarchy, all candidates will violate at least one constraint above the cut-off and then no variation will be observed. It is only as the cut-off moves up through the hierarchy that it will reach a point where more than one candidate can be included in the set of candidates disfavored by no constraints above the cut-off. Non-variation is the default situation – most phonological phenomena are categorical. I therefore assume that the critical cut-off point is located as low as possible on the constraint hierarchy.

This is just an extension of the principle of ranking conservatism that I already introduced above in §2.2.1. There I argued that faithfulness rank below markedness constraints by default. Now I am assuming that the critical cut-off ranks below both markedness and faithfulness constraints by default. Constraints are ranked above the cut-off unless if there is positive evidence to the contrary. This positive evidence would take on the following form: If two candidates both appear as outputs for some input, then all constraints that disfavor these two candidates have to rank lower than the cut-off.

3.2 Variation between [ŭ] and ∅

From the table in (24) the following can be calculated about the realization of [ŭ]: (i) *Final in prosodic word*. Silva's data contained 70 instances where [ŭ] could have appeared final in the prosodic word. In 48 of these instances the [ŭ] was deleted. The frequency of the two variants in this context is therefore: ∅ = 69%, [ŭ] = 31%. (ii) *Elsewhere in the prosodic word*. There are 112 instances in the data where [ŭ] could have appeared in a position elsewhere in the prosodic word. In only 16 of these did the [ŭ] delete. The frequency of the variants in this context is therefore: ∅ = 14%, [ŭ] = 86%. Final in the prosodic word the deletion candidate is preferred, while the retention candidate is preferred elsewhere. In prosodic word final contexts, EVAL therefore has to impose the ordering |∅# ™ ŭ#|[35] on the candidate set, and elsewhere in the prosodic word EVAL has to impose the opposite ordering |ŭ ™ ∅|. I will first discuss the "elsewhere" case, and then argue that the higher deletion rate in prosodic word final position is due to the fact that vowels in this position violate an additional markedness constraint.

3.2.1 Non-final in a prosodic word: |ŭ ™ ∅|

There are three different inputs that can result in an [ŭ] output, namely /ɔ, o, u/ (see §2.3 above). In order for the grammar to impose the ordering |ŭ ™ ∅| on the candidate set, it is necessary that the highest ranked constraint that favors [ŭ] over ∅ dominates the highest ranked constraint that favors ∅ over [ŭ]. The constraints violated by the each of the mappings /o/ → [ŭ], /ɔ/ → [ŭ], /u/ → [ŭ], and /o, ɔ, u/ → ∅ are listed in (25).

(25) **Violation profiles of mappings /o/ → [ŭ], /ɔ/ → [ŭ], /u/ → [ŭ], and /o, ɔ/ → ∅**

/u/ → [ŭ]	*σ̆/u
/o/ → [ŭ]	*σ̆/u, IDENT[-high]
/ɔ/ → [ŭ]	*σ̆/u, IDENT[-high], IDENT[ATR]
/o, ɔ, u/ → ∅	MAX

MAX therefore favors [ŭ] over ∅, while ∅ is favored by *σ̆/u, IDENT[-high] and IDENT[ATR]. The required ranking to ensure the ordering |ŭ ™ ∅| is given (26).

---

[35] In order to distinguish forms that occur in final position in a prosodic word, I will use the symbol # to indicate a prosodic word boundary. A vowel in prosodic word final position will therefore be indicated as /v#/, while a vowel occurring elsewhere in a prosodic word will be indicated simply as /v/.

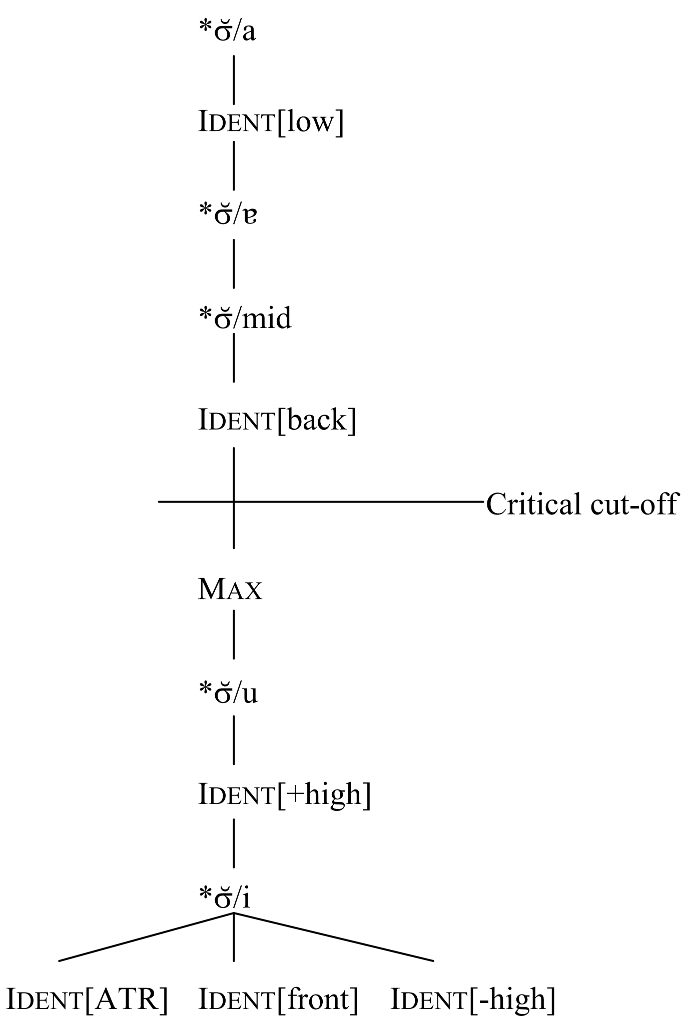
I will also include the symbol # in underlying representations, which is strictly speaking not correct. Prosodic structure is usually assigned by the grammar not part of the input. However, when I use the symbol # in an underlying representation, it should be interpreted as follows: A prosodic word boundary will be inserted by the grammar in this position in the underlying representation.

(26) **Ranking required for |ŭ ™ ∅|**

||MAX o {*ŏ/u, IDENT[-high], IDENT[ATR]}||

Comparison with the ranking in (22) shows that this is compatible with simply adding MAX to a position above *ŏ/u. Following the principle of ranking conservatism, MAX is ranked below all of the markedness constraints ranked higher than *ŏ/u – i.e. ||*ŏ/a o *ŏ/ɐ o *ŏ/mid o MAX||. Adding this information to the ranking from (22) therefore results in the new ranking in (27). In (27) I also indicate the position of the critical cut-off. The motivation for this location of the cut-off follows later in this section.

(27) **Adding MAX to the hierarchy of (22)**



The tableau in (28) shows that the ranking in (27) does indeed result in the rank-ordering |ŭ ™ ∅|. (On the typographical conventions used in this tableau see Chapter 1 §2.2.1 and §2.2.3.)

(28) **/ɔ/→ |ŭ ™ ∅|**

/ɔ/		MAX	*ŏ/u	ID[-hi]	ID[ATR]
2	ŭ		*	*	*
1	∅	*			

Output of EVAL

L ŭ *ŏ/u

L ∅ MAX

We still need to find where the critical cut-off point is. This is determined as follows: (i) No candidate that is observed as a variant should be disfavored by any constraint ranked higher than the cut-off. (ii) All candidates that are not observed as variants should be disfavored by at least one constraint ranked higher than the cut-off. As shown just above in (25), the observed variants violate the constraints {MAX, *ŏ/u, IDENT[-high], IDENT[ATR]}. All of these constraints are therefore ranked lower than the cut-off.

Recall the conservative assumption about the location of the cut-off – it is ranked as low as possible (see the discussion at the end of §3.1). Inspection of the hierarchy in (27) will show that this implies that the cut-off is located right between IDENT[back] and MAX, i.e. ||IDENT[back] o Cut-off o MAX||.

(29) **Location of the critical cut-off**

||IDENT[back] o Cut-off o MAX||

Of the candidates that are not observed as variants all but [ŏ, ɔ̆] violate IDENT[back]. With the exception of [ŏ, ɔ̆], all non-observed candidates do therefore violate a constraint ranked higher than the cut-off. The two candidates [ŏ, ɔ̆] both violate *ŏ/mid. Inspection of (27) will show that *ŏ/mid is also ranked higher than the cut-off. The candidates [ŏ, ɔ̆] therefore also violate a constraint ranked higher than the cut-off.

With these refinements to the constraint hierarchy of Portuguese, it is now true that: (i) except for ∅ and [ŭ], all candidates for the inputs /o, ɔ, u/ violate constraints above the critical cut-off; (ii) [ŭ] is rated as more harmonic than ∅. This is shown in the tableau in (30). This tableau considers only an /ɔ/ input, but is representative of the inputs /o, u/ also. The mappings /o, u/ → [ŭ] violate only a subset of the constraints violated by /ɔ/→ [ŭ]. Any ranking that allows the latter will therefore also allow the former.

(30) **/ɔ/→ |ŭ ™ ∅|**

/ɔ/		*ŏ/mid	ID[ba]	MAX	*ŏ/u	ID[-hi]	ID[ATR]
1	ŭ				*	*	*
2	∅			*			
	ŏ, ɔ̆	*!					(*)
	all other cands		*!				

Output of EVAL

L ŭ *ŏ/u

L ∅ MAX

Cut-off

··· *IDENT[back] or higher

Neither [ŭ] nor ∅ violates any constraints ranked higher than the cut-off. Both of these candidates will therefore be observed as variants for the input /ɔ/. Because of the ranking ||MAX o *ŏ/u|| EVAL imposes the rank-ordering |ŭ ™ ∅| on these two candidates. From this follows the prediction that [ŭ] will be the more frequent variant of the two. The candidates [ŏ, ɔ̆] violate *ŏ/mid. Since *ŏ/mid is ranked above the cut-off, [ŏ, ɔ̆] will never be accessed as outputs. All other candidates violate at least IDENT[back]. Since IDENT[back] is ranked above the cut-off, these "other candidates" will also never be selected as output. The correct prediction is therefore made: Only [ŭ] and ∅ are observed as variants, and of these two [ŭ] is the more frequent variant.

3.2.2 Final in a prosodic word: |∅# ™ ŭ#|

Unstressed /o#, ɔ#, u#/ that occur in final position in a prosodic word are also variably realized as either ∅# or [ŭ#]. However, in this position ∅# is the more frequent variant. It is therefore necessary that EVAL imposes the rank-ordering |∅# ™ ŭ#| on these two candidates. We know that with the constraints that we have been using up to now, EVAL imposes the opposite rank-ordering on these two candidates. We therefore have to call on an additional constraint. This additional constraint must be violated by [ŭ#] but not by ∅#. I propose that this constraint is a constraint against unstressed vowels in prosodic word final position. Call this constraint *v̆]$_{\omega}$.[36] The violations of the two variants for the inputs /o#, ɔ#, u#/ are listed below in (32).

---

[36] This constraint is probably closely related to final extrametricality (Hayes, 1982, 1995), and it can be restated in terms that will make this connection clearer – something like "do not allow any unfooted vowels" or "do not allow vowels that are not incorporated into prosodic structure".

Evidence for the existence of this (or a very similar) constraint can be found in the process of [ɹ]-intrusion in some dialects of English (Bakovic, 1999, Johansonn, 1973, Kahn, 1976, McCarthy, 1991,

(31) ***v̆]$_\omega$**

A prosodic word is not allowed in to end in an unstressed vowel.

(32) **Violation profiles of mappings /o#/ → [#ŭ], /ɔ#/ → [ŭ#], and /o#, ɔ#/ → ∅#**

/u#/ → [ŭ#]	*v̆]$_\omega$, *σ̆/u
/o#/ → [ŭ#]	*v̆]$_\omega$, *σ̆/u, IDENT[-high]
/ɔ#/ → [ŭ#]	*v̆]$_\omega$, *σ̆/u, IDENT[-high], IDENT[ATR]
/o#, ɔ#, u#/ → ∅#	MAX

In order for EVAL to impose the ordering |∅# ™ ŭ#| on these candidates, it is necessary that the highest ranked constraint that favors ∅# over [ŭ#] dominates the highest ranked constraint that favors [ŭ#] over ∅#. This means that at least one of the

---

1993, Pullam, 1976, Vennemann, 1972). In this phenomenon a vowel final prosodic word is avoided by insertion of an [ɹ], and it results in pronunciations such as *The spa*[ɹ] *is broken* for the sentence *The spa__ is broken*. McCarthy uses a constraint that is very similar to *v̆]$_\omega$ to account for this process (McCarthy, 1993).

Avoidance of final (unstressed) vowels is also attested as a historical change in several languages. Words that ended on /e/ in Old Galician have been reanalyzed lexically in present day Galician without the final /e/ (Martinez-Gil, 1997), so that Old Galician *papele* 'paper' corresponds to Modern Galician *papel*. This is a particularly relevant example, since Galician is closely related to Portuguese.

Several Semitic languages also underwent a process in which final unstressed vowels were deleted. For instance, in Proto-Semitic nouns ended in unstressed vowels /a, i, u/ that indicated the case of the noun. However, these case endings were lost in Hebrew and Aramaic (Moscati, 1964:94-96, O'Leary, 1969:137). This lead to developments such as the following in the word for 'book': Hebrew **sipru* > *sefer*, and Aramaic **sipru* > *səfar* – on the other changes in these words see *inter alia* Coetzee (1996a, 1996b, 1999a, 1999b) and Malone (1972, 1993).

The case endings were retained in Classical/Qur'anic Arabic, but in the dialects of Modern Arabic they have also been deleted (Haywood and Nahmad, 1965:498-499). This lead to differences such as the following between Classical Arabic and modern colloquial dialects: 'house' Classical Arabic *baitu* > modern colloquial Arabic *bait*.

There also seems to be a similar constraint defined on a morphological rather than prosodic domain. McCarthy and Prince (1990a, 1990b) have argued that *stems* in Classical Arabic are not allowed to end in vowels. The constraint FREE-V used by Prince and Smolensky (1993: Chapter 7, no. (152)) in their analysis of Lardil truncation can also be interpreted as a ban on (nominative noun) stems ending in vowels.

constraints violated by the three non-deletion mappings has to dominate MAX. I have argued just above MAX dominates {*ŏ/u, IDENT[-high], IDENT[ATR]}. This leaves only the new constraint $*\breve{v}]_{\omega}$ to dominate MAX. We therefore need the ranking ||$*\breve{v}]_{\omega}$ o MAX||. The relation between $*\breve{v}]_{\omega}$ and the critical cut-off still needs to be determined. Since the non-deletion candidate that does violate $*\breve{v}]_{\omega}$ is observed as one of the variant outputs, it follows that the cut-off has to be above $*\breve{v}]_{\omega}$, ||cut-off o $*\breve{v}]_{\omega}$||. All of the non-observed candidates will still violate either a markedness constraint ranked higher than the cut-off or the faithfulness constraint IDENT[back] which is ranked higher the cut-off. The only observed variants will therefore still be ∅# and [ŭ#].

The rankings required to account for the variation between ∅# and [ŭ#] are summarized in (33). The tableau in (34) shows that these rankings are indeed adequate to explain the variation. In this tableau I consider as before only an /ɔ#/ input – see the discussion above (30) for a motivation.

(33) **Ranking required for |∅# ™ ŭ#|**

||IDENT[back] o cut-off o $*\breve{v}]_{\omega}$ o MAX||

(34) **/ɔ#/→ |∅# ™ ŭ#|**

/ɔ#/		*ɔ̆/mid	ID[ba]	$*\breve{v}]_{\omega}$	MAX	*ŏ/u	ID[-hi]	ID[ATR]
2	ŭ#			*		*	*	*
1	∅#				*			
	ŏ#, ɔ̆#	*!						(*)
	all other cands		*!					

((34) continued)

Output of EVAL

L ∅# MAX

|

L ŭ# *v̆)ω

—|———— Cut-off

. . . IDENT[back] or higher

The only candidates that violate no constraint ranked higher than the cut-off, are [ŭ#] and ∅#. These two are therefore correctly predicted as the only variants. Because of the ranking ||*v̆]$_{\omega}$ o MAX||, EVAL imposes the harmonic ordering |∅# ™ ŭ#| on these two candidates. From this follows the prediction that the deletion candidate will be the more frequent variant in prosodic word final position.

3.3 Variation between [ə̆] and ∅

From (24) we can calculate the following about the realization of [ə̆]: (i) *Final in prosodic word*. Silva's data contained 45 instances where [ə̆] could have appeared final in the prosodic word. In 32 of these instances the [ə̆] was actually deleted, i.e. ∅ = 71%, [ə̆] = 29%. (ii) *Elsewhere in the prosodic word*. There are 118 instances in the data where [ə̆] could have appeared in a position elsewhere in the prosodic word, and [ə̆] deleted in 36 of these positions, i.e. ∅ = 31%, [ə̆] = 69%. The same relationship that holds between the retention and the deletion candidate in the [ŭ]~∅ alternation, also holds in the [ə̆]~∅ alternation. Final in a prosodic word, deletion is the preferred variant. Elsewhere in the prosodic word, retention is preferred. In prosodic word final contexts EVAL must impose the ordering |∅# ™ ə̆#|, and elsewhere the opposite |ə̆ ™ ∅|. As before, I will begin by considering the elsewhere environment.

3.3.1 Non-final in a prosodic word: |ə̆ ™ ∅|

There are three possible inputs that can result in a [ə̆] output, namely /e, ɛ, ə/ (see §2.4 and §2.6 above). It is necessary that the highest ranked constraint that favors [ə̆] over ∅ outranks the highest ranked constraint that favors ∅ over [ə̆]. In order to determine which constraints favor which of these candidates, I list the constraints violated by each of the following mappings in (35): /e/ → [ə̆], /ɛ/ → [ə̆], /ə/ → [ə̆], and /ə, e, ɛ/ → ∅.

(35) **Violation profiles of mappings /e/ → [ə̆], /ɛ/ → [ə̆], /ə/ → [ə̆], and /ə, e, ɛ/ → ∅**

/ə/ → [ə̆]	—
/ɛ/ → [ə̆]	IDENT[front]
/e/ → [ə̆]	IDENT[front], IDENT[ATR]
/ə, e, ɛ/ → ∅	MAX

MAX is the only constraint that prefers the retention candidate over ∅. In order for retention to be preferred over deletion, it is therefore necessary that MAX ranks above all the constraints violated by the other three mappings. Since we have not yet seen any evidence that required IDENT[front] or IDENT[ATR] to outrank any markedness constraints, both of them are still ranked right at the bottom of the hierarchy, and therefore below MAX. No additional rankings are required for EVAL to impose the ordering |ə̆ ™ ∅| on these two candidates. We also know that the critical cut-off is situated above MAX, and therefore above all constraints violated by the two variants [ə̆] and ∅. Both of these are therefore predicted as possible outputs.

However, we still need to ascertain that the cut-off point is situated sufficiently low on the hierarchy to eliminate all other vowels as variants – that is, the cut-off should be sufficiently low that all non-observed candidates violate at least one constraint ranked higher than the cut-off. In (36) I list one constraint ranked higher than the cut-off for each of the non-observed candidates (with the exception of [ɪ̆]). The fact that these constraints are ranked higher than the cut-off can be confirmed by inspecting (27).

(36) **Violations ruling out [ĕ, ɛ̆, ŏ, ɔ̆, ă, ɐ̆, ŭ]**

[ĕ, ɛ̆, ŏ, ɔ̆]	*σ̆/mid
[ă]	*σ̆/a
[ɐ̆]	*σ̆/ɐ
[ŭ]	IDENT[back]

The only non-observed candidate that presents us with a problem is [ɪ̆]. I propose that [ɪ̆] is prevented from surfacing as a variant by the local conjunction (Smolensky, 1995) of IDENT[-high] and *σ̆/mid.[37] The idea is that Portuguese is willing to tolerate [ɪ̆] in an unstressed syllable (/i/ does not reduce), but only if this [ɪ̆] is the result of a faithful mapping. Portuguese does not tolerate an [ɪ̆] that is the result of an unfaithful mapping.[38] I define this locally conjoined constraint in (37).

---

37 For a discussion of the local conjunction of markedness and faithfulness constraints, see Łubowicz (1998, 1999, 2002).

38 [ɪ̆] can also be ruled out as an alternative in a model of OT that relies on comparative markedness (McCarthy, 2002a). Portuguese is then willing to violate $*\breve{\sigma}/i_{Old}$ but not $*\breve{\sigma}/i_{New}$. The ranking $||*\breve{\sigma}/i_{New}$

(37) **[IDENT[-high] & *ŏ/i]$_{segment}$**

Do not violate IDENT[-high] and *ŏ/i in the same segment.

If we rank [IDENT[-high] & *ŏ/i]$_{segment}$ higher than the cut-off, then [ĭ] will violate a constraint ranked higher than the cut-off and will therefore be ruled out as possible variant.[39]

In (38) I list the rankings that are required to explain the variation between ∅ and [ə̆]. In (39) I show that this ranking is indeed sufficient. In the tableau I include only those candidates that do not violate a markedness constraint ranked higher than the cut-off. I use /e/ as a representative input. The mapping /e/ → [ə̆] violates a superset of the faithfulness constraints violated by the other two inputs. Any ranking that allows /e/ → [ə̆] will therefore also allow the other two.

(38) **Ranking required for |ə̆ ™ ∅ |**

||[IDENT[-high] & *ŏ/i]$_{segment}$ o Cut-off o MAX o {IDENT[front], IDENT[ATR]}||

---

o Cut-off o *ŏ/i$_{Old}$|| would then account for the pattern. The faithful mapping /i/ → [ĭ] will violate *ŏ/i$_{Old}$ and will surface unproblematically. However, an [ĭ] that is the result of an unfaithful mapping will violate *ŏ/i$_{New}$ and will be ruled out because *ŏ/i$_{New}$ is ranked above the cut-off.

39 The mappings represented by /ə, e, ɛ/ → [ĭ] also violate the constraints *ŏ/i, IDENT[front], IDENT[ATR] and IDENT[-high]. It is therefore at least potentially possible to block these mappings by ranking one of these constraints higher than the cut-off. However, this is for independent reasons not possible.

IDENT[front] and IDENT[ATR] are violated by the mappings /e, ɛ/ → [ə̆], and [ə̆] is one of the variants observed for these inputs. If either of these two constraints ranked higher than the cut-off, then [ə̆] could not surface as variant for these inputs. (See (35) just above.

IDENT[-high] is violated by the mappings /o, ɔ/ → [ŭ], and [ŭ] is one of the variants observed for the inputs /o, ɔ/. If IDENT[-high] ranked higher than the cut-off, then [ŭ] could not surface as variant for the inputs /o, ɔ/. (See §3.2.1 (30) above.)

We can also not rank *ŏ/i above the cut-off. In (10) above I argued for the universal ranking ||*ŏ/u o *ŏ/i||. Ranking *ŏ/i above the cut-off will therefore imply by transitivity of constraint ranking that *ŏ/u is also above the cut-off. This will again incorrectly imply that [ŭ] cannot be a variant output for the inputs /o, ɔ, u/. (See §3.2.1 (30) above.)

(39) **/e/→ |ə̆ ™ ∅|**[40]

/e/		*σ̆/mid	[ID[-hi] & *σ̆/i]$_{Seg}$	ID[ba]	MAX	*σ̆/u	*σ̆/i	ID[ATR]	ID[fr]	ID[-hi]
1	ə̆							*	*	
2	∅				*					
	ĕ	*!								
	ĭ		*!				*			*
	ŭ			*!		*				

Output of EVAL

L ə̆ IDENT[ATR], IDENT[front]

|

L ∅ MAX

—— cut-off

· · · IDENT[back] or higher

Only [ə̆] and ∅ violate no constraints ranked above the cut-off. It is therefore correctly predicted that these will be the only two observed variants. Because of the ranking ||MAX o {IDENT[ATR], IDENT[front]}|| EVAL imposes the harmonic ordering |ə̆ ™ ∅| on these two candidates. It is therefore also correctly predicted that the retention

[40] I am making the following assumption about local conjunctions between markedness and faithfulness constraints with regard to ranking conservatism (see §2.1.1 above): Let [M & F] be such a local conjunction. (i) Since one of the conjuncts of [M & F] is a markedness constraint, I am assuming that it ranks higher than any faithfulness constraint in the absence of evidence to the contrary. (ii) However, since one of the conjuncts of [M & F] is a faithfulness constraint, I assume that it will rank lower than any markedness constraint in the absence of evidence to the contrary. I therefore assume the following default ranking with regard to such local conjunctions: ||Markedness o [M & F] o Faithfulness||.

I am therefore assuming the ranking ||*σ̆/mid o [IDENT[-high] & *σ̆/i]$_{segment}$ o IDENT[back]|| here. This ranking is not necessary to account for the data, and it is assumed simply to make the exposition easier. For more on the decision to follow the principle of ranking conservatism, see §2.1.1 above.

candidate will be the more frequent variant of the two. The faithful candidate of an /e/ or an /ɛ/ input violates *ŏ/mid, which is ranked higher than the cut-off. It is therefore excluded from surfacing as variant. The candidate [ŭ] violates IDENT[back] which is also ranked above the cut-off. This candidate is therefore also not a possible variant. Lastly, consider the candidate [ĭ]. This candidate violates *ŏ/i and IDENT[-high], both of which rank below the cut-off. However, since it violates both of these constraints, it also violates the local conjunction of these two constraints. This locally conjoined constraint ranks higher than the cut-off, so that [ĭ] is prevented from surfacing as a possible variant.

3.3.2 Final in a prosodic word: |∅# ™ ə̆#|

Unstressed /e#, ɛ#, ə#/ are also variably realized as either ∅# or [ə̆#] when they occur in prosodic word final position. However, in this context the deletion candidate is the more frequent variant. EVAL therefore has to impose the following rank-ordering on the candidate set in this context: |∅# ™ ə̆#|. When the variation between ∅# and [ŭ#] was discussed in §3.2.2, I argued for the existence of the constraint *v̆]$_{\omega}$, violated by an unstressed vowel that occurs in prosodic word final position. The mappings /e#, ɛ#, ə#/ → [ə̆#] will also violate this constraint. I have also argued in §3.2.2 (33) that *v̆]$_{\omega}$ is ranked between the cut-off and MAX. This is what explains that the retention candidate that violates *v̆]$_{\omega}$ is less harmonic than the deletion candidate that violates MAX. Finally, in §3.3.1 (38) just above I argued for the locally conjoined constraint [IDENT[-high] & *ŏ/i]$_{segment}$, ranked above the cut-off. This constraint eliminates [ĭ#] as a possible variant. From just these constraints and the ranking already established for them, it follows that: (i) For the inputs /e#, ɛ#, ə#/, ∅# and [ə̆#] are the only candidates that do not violate any constraints ranked above the cut-off. These candidates are therefore the only two variants. (ii) The deletion candidate ∅# is more harmonic than [ə̆#], and is therefore the more frequently observed of the two variants. This is confirmed by the tableau below in (40). As before, I include only those candidates that do not violate a markedness constraint ranked higher than the cut-off. Also as before, I use /e#/ as a representative input. See the discussion above (38) for a motivation for this move.

(40) **/e#/→ |∅# ™ ə̆#|**

/e#/		*σ̆/mid	[ID[-hi] & *σ̆/i]$_{Seg}$	ID[ba]	*v̆]$_{\omega}$	MAX	*σ̆/u	*σ̆/i	ID[ATR]	ID[fr]	ID[-hi]
2	ə̆#				*				*	*	
1	∅#					*					
	ĕ#	*!			*						
	ĭ#		*!		*			*			*
	ŭ#			*!	*		*				

Output of EVAL

L ∅# MAX

L ə̆# *v̆]$_{\omega}$

cut-off

. . . IDENT[back] or higher

The only candidates that do not violate a constraint ranked higher than the cut-off are [ə̆#] and ∅#. These are correctly predicted as the only observed variants. Because of the ranking ||*v̆]$_{\omega}$ o MAX|| EVAL imposes the ordering |∅# ™ ə̆#| on these two candidates.

From this follows that the deletion candidate will be the more frequently observed variant in this context. For the inputs /e#, ɛ#/ the faithful candidates will violate *σ̆/mid. Since *σ̆/mid ranks higher than the cut-off, these candidates will not surface as variants. The candidate [ŭ#] violates IDENT[back], which ranks higher than the cut-off. It is also excluded as a possible output. Finally, [ĭ#] violates the locally conjoined [IDENT[-high] & *σ̆/i], which ranks higher the cut-off, and therefore eliminates [ĭ#] as a variant.

3.4 Interim summary

In the table in (41) I summarize all of the new rankings that have been argued for since the last summary in (21) in §2.7. As in (21) the first column lists the ranking, the second states the motivation for the ranking, and the last column states where in the text the ranking was introduced. In (42) I give a graphic representation of the Faialense Portuguese constraint hierarchy as it stands at this point in the discussion. In this graphic representation I do not include the hierarchy above *σ̆/mid. We have not encountered any evidence prompting a change in this part of the hierarchy since the last summary in (21). This part of the hierarchy therefore still looks exactly the same as in (21).

(41) **Summary of rankings thus far**

Ranking	**Motivation**	**Where?**
MAX o *σ̆/u, ID[-hi], ID[ATR]	More [ŭ] that ∅ for /o, ɔ, u/[41]	§3.2.1 (26) (28)
ID[ba] o Cut-off o MAX	[ŭ] and ∅ only variants for /o, ɔ, u/[42]	§3.2.1 (29) (30)

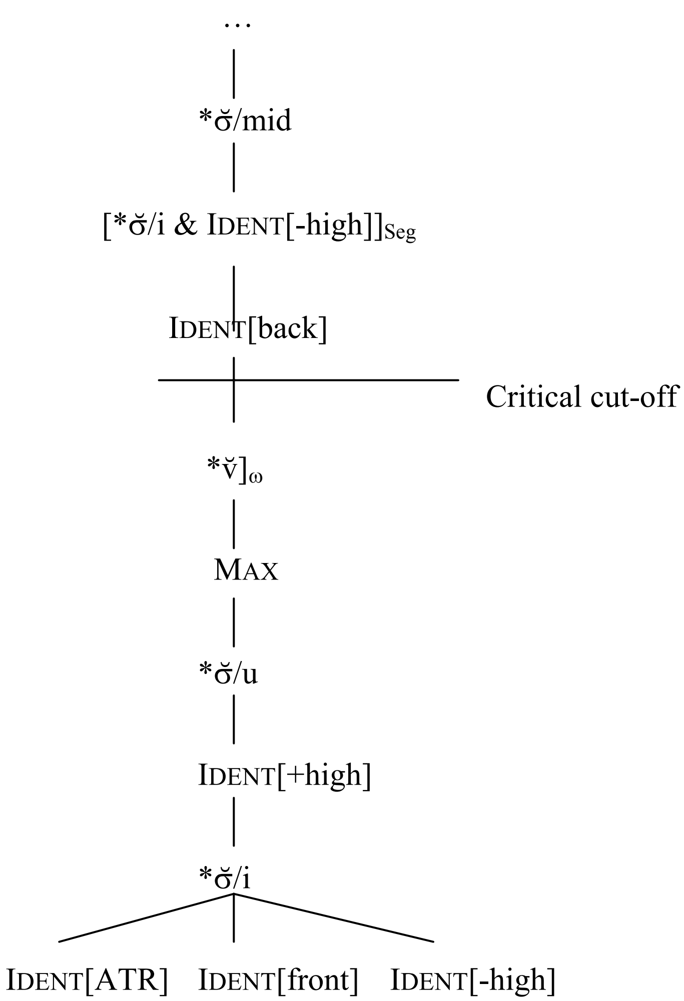
[41] The ranking argument used to motivate this ranking is different from the ranking arguments used in classic OT. The argument is not that the opposite ranking will result in selecting the wrong output. The argument is rather that the opposite ranking will result in the wrong relative frequency relation between the variants. See Chapter 3 §2.4 for a discussion of this.

[42] See previous footnote.

((41) continued)

Ranking	**Motivation**	**Where?**
Cut-off o*v̆$]_{\omega}$, MAX	∅# and [ŭ#] only variants for /o#, ɔ#, u#/	§3.2.2 (33) (34)
[ID[-hi] & *σ̆/i$]_{Seg}$ o Cut-off	[ĭ] not observed as variant for /e, ɛ, ə/	§3.3.1 (38) (39)
MAX o ID[fr], ID[ATR]	more [ə̆] than ∅ for /e, ɛ, ə/	§3.3.1 (38) (39)
*σ̆/mid o [*σ̆/i & ID[-hi]$]_{Seg}$ o ID[ba]	Ranking conservatism	§3.3.1 Footnote 40.

(42) **Graphic representation of the Portuguese hierarchy established thus far**



3.5 Variation between [ĭ] and ∅

Because of the stress placement rules of Portuguese, [ĭ] cannot appear final in a prosodic word (see footnote 8 in §1.2 and footnote 29 in §3.1). We therefore only have to account for the deletion pattern of [ĭ] that occurs in non-final position in the prosodic word. From the table in (24) we see that Silva's corpus contains 75 instances of [ĭ] that could have appeared in unstressed syllables in non-final position in a prosodic word. Of these 5 were deleted, i.e. [ĭ] = 93%, ∅ = 7%. The retention candidate is preferred over the deletion candidate, and we therefore need EVAL to impose the rank-ordering |ĭ ™ ∅| on these two candidates.

There is only one input that can result in an [ĭ] output, namely /i/. This is because no vowel reduces to [ĭ] – see §1.2 (6) above. In order for EVAL to impose the rank-ordering |ĭ ™ ∅| on the candidate set, it is necessary that the highest ranked constraint that favors [ĭ] over ∅ be ranked higher than the highest ranked constraint that favors ∅ over [ĭ]. I list the violations that each of the two observed mappings earns in (43).

(43) **Violation profiles of the mappings /i/ → [ĭ], and /i/ → ∅**

/i/ → [ĭ]	*σ̆/i
/i/ → ∅	MAX

Since MAX is the only constraint that favors [ĭ] over ∅, MAX has to outrank all constraints violated by [ĭ], i.e. ||MAX o *σ̆/i||. Comparison with (42) above shows that this is consistent with the rankings established thus far. Since these two candidates are observed as variants, it is also necessary that neither of them violate any constraints ranked higher than the cut-off. Again, comparison with (42) shows that both MAX and *σ̆/i are ranked lower than the cut-off. It therefore follows that [ĭ] and ∅ will be observed as variants, and that [ĭ] will be the more frequent variant of the two.

All that still needs to be determined is where the cut-off has to be ranked to assure that no other candidate will surface as a variant. Each of the non-observed candidates has to violate at least one constraint ranked higher than the cut-off. With the exception of [ə̆] each of the non-observed variants violate a constraint that is already ranked above the cut-off. In (44) I list one constraint ranked higher than the cut-off for each of the non-observed candidates (with the exception of [ə̆]). The fact that these constraints are ranked higher than the cut-off can be confirmed by inspecting (42) and (27).

(44) **Violations ruling out [ĕ, ɛ̆, ŏ, ɔ̆, ă, ɐ̆, ŭ]**

[ĕ, ɛ̆, ŏ, ɔ̆]	*σ̆/mid
[ă]	*σ̆/a
[ɐ̆]	*σ̆/ɐ
[ŭ]	IDENT[back]

The mapping /i/ → [ə̆] violates IDENT[+high], IDENT[ATR] and IDENT[front]. If any of these three constraints ranked higher than the cut-off, then we can prevent [ə̆] from surfacing as variant output for /i/. Of these three constraints, only IDENT[+high] can be ranked higher than the cut-off. The reason is that IDENT[ATR] and IDENT[front] are both violated by one of the observed variants for an /e/-input. An /e/-input is variably realized as either ∅ or [ə̆] (see §3.3.1 above). The mapping /e/ → [ə̆] violates both IDENT[ATR] and IDENT[front]. If either of these constraints were to rank higher than the cut-off, then [ə̆] would be blocked from surfacing as variant output for /e/. We can therefore not use IDENT[ATR] or IDENT[front] to prevent [ə̆] from surfacing as variant output for /i/.

IDENT[+high], on the other hand, is not violated by a variant output for any input. There are only two inputs that could violate IDENT[+high], namely /i, u/. Neither of these inputs has an observed variant that violates IDENT[+high]. There is therefore nothing that prevents us from ranking IDENT[+high] above the cut-off. Since IDENT[+high] is a faithfulness constraint, it will be ranked as low as possible with respect to markedness constraints – following the principle of ranking conservatism (see §2.1.1 and footnote 40 in §3.3.1 above). It will therefore be ranked below all of the markedness constraints (and markedness + faithfulness conjunctions) above the cut-off. In particular, this means that it will rank below [IDENT[-high] & *ŏ/mid]$_{\text{Segment}}$. The rankings required to account for the variation between [ĭ] and ∅ are stated in (45).

(45) **Ranking required for |ĭ ™ ∅|**

||[IDENT[-high] & *ŏ/mid]$_{\text{Segment}}$ o IDENT[+high] o cut-off o MAX o *ŏ/i||

With these rankings: (i) [ĭ] and ∅ are the only candidates that violate no constraints ranked higher than the cut-off. They are therefore predicted as the only two observed outputs for an /i/ input. (ii) [ĭ] is rated better than ∅, and retention is therefore predicted to be preferred over deletion. This is confirmed by the tableau in (46). In this tableau I do not consider any of the vowels that violate markedness constraints higher than the cut-off.

(46) **/i/→ |ĭ ™ ∅|**

/i/		ID[ba]	ID[+hi]	MAX	*ŏ/u	*ŏ/i	ID[ATR]	ID[fr]
1	ĭ					*		
2	∅			*				
	ə̆		*!				*	*
	ŭ	*!			*			*

Output of EVAL

L ĭ *ŏ/i

L ∅ MAX

cut-off

··· IDENT[+high] / IDENT[back] or higher

The only two candidates that are not disfavored by any constraint ranked higher than the cut-off are [ĭ] and ∅. These candidates are therefore correctly predicted as the only two variants for an /i/ input. Because of the ranking ||MAX o *ŏ/i||, EVAL imposes the rank-ordering |ĭ ™ ∅| on these candidates. From this follows the correct prediction that the retention candidate will be the more frequent variant. [ə̆] violates IDENT[+high] and [ŭ] violates IDENT[back]. Both of these constraints are ranked higher than the cut-off and these candidates are therefore blocked from being possible variants. The vowels not considered in (46) violate *ŏ/mid, *ŏ/a or *ŏ/ɐ, all of which also rank higher than the cut-off.

3.6 No variation: always [ɐ̆]

The vowel [ɐ̆] has a very low overall deletion rate. As can be seen in table (24), Silva's corpus contains 331 sites where an [ɐ̆] could have occurred, and in only 7 of these the vowel was deleted. This represents a total deletion rate of just over 2%.[43] Because the deletion rate of [ɐ̆] is so low, I will treat this vowel as if it categorically resists deletion.

When I discussed the critical cut-off in Chapter 1 §2.2.3 I explained that there are two situations in which no variation will arise in the rank-ordering model of EVAL. I repeat these two in (47).

(47) **No variation in a rank-ordering model of EVAL**

a. All candidates except for one violate at least one constraint above the cut-off. The single candidate that does not violate a constraint above the cut-off is then selected as the only "variant".

b. All candidates violate at least one constraint above the cut-off. In such a circumstance the single best candidate is chosen as output even though it does violate a constraint above the cut-off.

The observed output under consideration here is [ɐ̆]. This vowel violates the markedness constraint *σ̆/ɐ. Inspection of (42) and (22) will show that *σ̆/ɐ is ranked above the cut-off. This means that we are dealing here with the second of the scenarios in (47) above.

43 Since the number of deletions is so small, it is not possible to compare [ɐ̆] that occurs final in the prosodic word and [ɐ̆] that occurs elsewhere in the prosodic word.

There are two inputs that are realized as [ɐ̆] in unstressed syllables, namely /a, ɐ/ (see §1.2 above). In order to ensure that [ɐ̆] is the only observed output for these two inputs, the following is necessary: (i) The highest ranked constraint that favors [ɐ̆] over any other candidate outranks the highest ranked constraint that favors this other candidate over [ɐ̆]. (ii) All other candidates have to violate at least one constraint above the cut-off.[44] The violations incurred by each of the mappings /a/ → [ɐ̆] and /ɐ/ → [ɐ̆] are listed in (48).

(48) **Violation profiles of the mappings /a/ → [ɐ̆] and /ɐ/ → [ɐ̆]**

/a/ → [ɐ̆]	*σ̆/ɐ, IDENT[ATR]
/ɐ/ → [ɐ̆]	*σ̆/ɐ

Inspection of (22) and (42) will show that of the constraints *σ̆/ɐ and IDENT[ATR], *σ̆/ɐ ranks the highest. The highest ranked constraint that disfavors [ɐ̆] is therefore *σ̆/ɐ. This implies that it is crucial that all other candidates violate at least one constraint ranked higher than *σ̆/ɐ. This is not a problem for the other vowels. The other low vowel [ă] violates the constraint *σ̆/a, which universally outranks *σ̆/ɐ – since /a/ is higher in sonority than /ɐ/ (see (10) above). All other vowels violate the faithfulness constraint IDENT[low]. I have argued above for the ranking ||IDENT[low] o*σ̆/ɐ|| (see §2.2 (15) and (16)). This therefore eliminates all vowels except for [ɐ̆]. Only the deletion candidate still needs to be eliminated as possible output. Of the constraints that we have considered up to now, the deletion candidate violates only MAX. However, we cannot use

---

[44] This second requirement actually follows from the first, since [ɐ̆] does violate *σ̆/ɐ, which is ranked above the cut-off.

MAX to block the deletion candidate from surfacing as a variant output. The reason for this is that the deletion candidate does alternate as variant with [ŭ], [ĭ] and [ə̆]. If MAX ranked higher than the cut-off, the deletion candidate would wrongly be prevented from surfacing as variant in these contexts. We therefore need a different constraint to block the deletion candidate from surfacing as variant of [ɐ̆]. I propose that the constraint that is responsible for this is a MAX constraint indexed specifically to the low vowels.[45] This constraint is defined in (49).

(49) **MAX-a/ɐ**

/a, ɐ/ must have some output correspondent.

If MAX-a/ɐ is ranked above *ɐ̆/ɐ,[46] then ∅ will violate a constraint ranked higher than the constraint violated by the actually observed output [ɐ̆]. This will then result in a situation where [ɐ̆] is the only predicted output. The crucial rankings to ensure that /a, ɐ/ maps only onto [ɐ̆] are given in (50). The tableau in (51) shows that this ranking does indeed result in selecting only [ɐ̆] as output. In this tableau the input /a/ is used as example. Since this input violates a superset of the violations of /ɐ/, any ranking that will allow the mapping /a/ → [ɐ̆], will also allow the mapping the /ɐ/ → [ɐ̆].

45 See Hartkemeyer (2000) and Tranel (1999) for arguments in favor of MAX constraints indexed to specific vowels. Their idea is that vowels of higher sonority are protected by higher ranking MAX-constraints than vowels of lower sonority. Since the low vowels /a, ɐ/ are the highest in sonority of the Portuguese vowels (see §1.2 (8) above), the MAX-constraint for these vowels ranks higher than the MAX constraints for the other vowels. The MAX-constraints for the other vowels can therefore be ranked lower than the cut-off. In fact, it is possible to replace the general MAX that I currently use with the MAX-constraints indexed to the non-low vowels. See Gouskova (2003:240) for an argument against vowel-specific MAX-constraints.

46 Since MAX-a/ɐ is a faithfulness constraint, I am ranking it as low as possible in accordance with the conservative ranking principle (§2.1.1). Since we have no evidence that MAX-a/ɐ should rank above *ɐ̆/a, I am ranking MAX-a/ɐ between *ɐ̆/a and *ɐ̆/ɐ.

(50) **Ranking requirement for /a, ɐ/ → [ɐ̆]**

||*ŏ/a o {MAX-a/ɐ, IDENT[low]} o *ŏ/ɐ o IDENT[ATR]||

(51) **/a/ → [ɐ̆]**

/a/		*ŏ/a	MAX-a/ɐ	ID[low]	*ŏ/ɐ	MAX	ID[ATR]
1	ɐ̆				*		*
2	ă	*!					
	∅		*!			*	
	All other cands			*!			(*)

Output of EVAL

——————— cut-off

L ɐ̆ *ŏ/ɐ

|

… *ŏ/ɐ or higher

All candidates are disfavored by at least one constraint ranked higher than the cut-off. When this happens, only the single best candidate will be selected as output. The candidate [ɐ̆] violates *ŏ/ɐ. All non-low vowels violate IDENT[low] which is ranked higher than *ŏ/ɐ. The other low vowel [ă] violates *ŏ/a which is also ranked higher than *ŏ/ɐ. The deletion candidate violates MAX-a/ɐ which also dominates *ŏ/ɐ. It is therefore correctly predicted that [ɐ̆] will be the only observed output.

I am not discussing [ɐ̆] that occurs in prosodic word final position separately. There are two reasons for this. First, [ɐ̆] resists deletion, irrespective of where it occurs in the prosodic word. Secondly, inspection of tableau (51) shows that the same pattern is indeed predicted for the inputs /a#, ɐ#/. The only difference between tableau (51) and one with /a#/ as input, is that all of the non-deletion candidates will receive a violation in terms of $*\breve{v}]_{\omega}$. However, all candidates already violate a constraint that is ranked higher than $*\breve{v}]_{\omega}$. This violation therefore will have no influence on the selection of the output.

3.7 Final summary

In the table in (52) I summarize all of the new rankings that have been argued for since the last summary in (41) in §3.4. As before, I also give a graphic representation of the Faialense Portuguese constraint hierarchy in (53). This hierarchy represents the grammar that is required to account for vowel reduction and deletion in unstressed syllables in Portuguese.

(52) **Summary of rankings thus far**

Ranking	Motivation	Where?
ID[+hi] o Cut-off	To exclude [ə̆] as a possible variant of /i/	§3.5 (45) (46)
[ID[-hi] & $*\breve{\sigma}$/i]$_{Seg}$ o ID[+hi]	Ranking conservatism	§3.5 (45) (46)
MAX-a/ɐ o $*\breve{\sigma}$/ɐ	To exclude ∅ as possible variant for /a, ɐ/	§3.6 (50) (51)
$*\breve{\sigma}$/ɐ o MAX-a/ɐ	Ranking conservatism	§3.6 (50) (51)

This concludes the basic account of Portuguese vowel reduction and deletion. I have argued that:

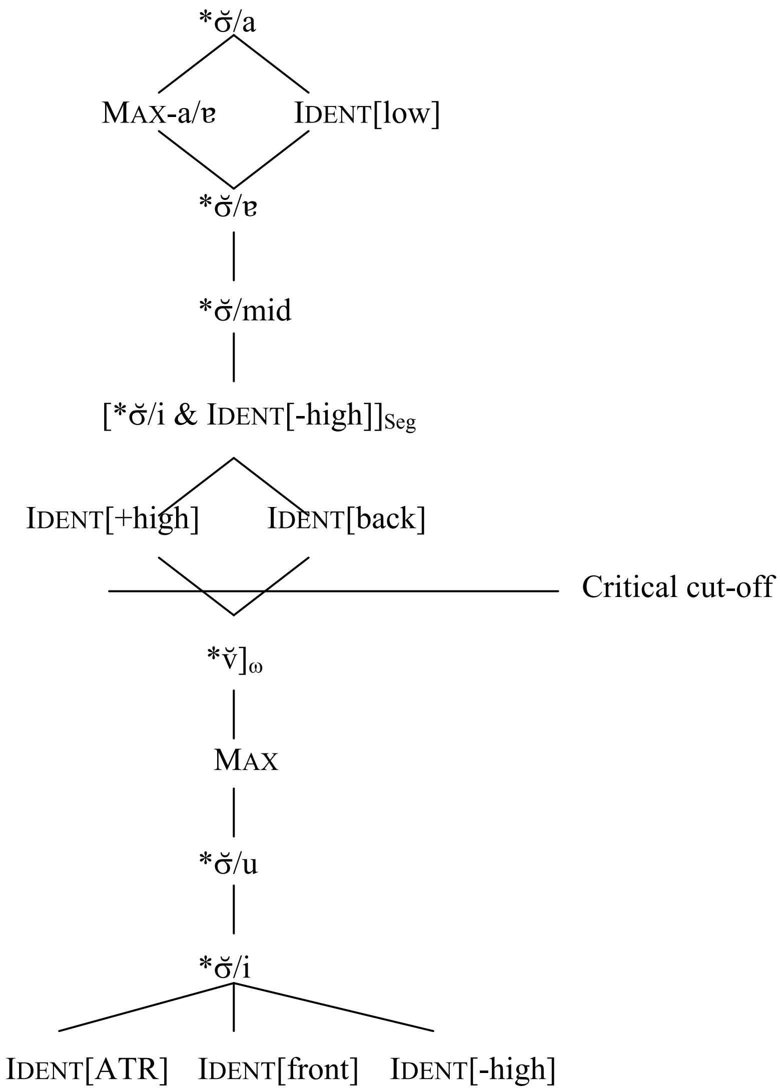
(i) EVAL rank-orders the full candidate set, and does not simply distinguish between the best candidate and the mass of losers.

(iii) There is a critical cut-off in the constraint hierarchy. Candidates that violate constraints ranked above the cut-off, are eliminated as possible variants.

(iv) When all candidates violate constraints above the cut-off, then only the single best candidate is selected as output (= a categorical process).

With these assumptions I was able to present a coherent account of the vowel reduction, and variable vowel deletion in Faialense Portuguese. In the rest of this chapter I will show how we can also account for variation patterns across different inputs by allowing EVAL to compare candidates that are not related via the same input.

(53) **Graphic representation of the Portuguese constraint hierarchy**



4. Variation across contexts

In the previous section I presented an account of why variation is encountered in the realization of individual vowels. In that section I dealt with questions such as: Why is the input /o#/ sometimes realized as [ŭ#] and sometimes as ∅#, and in particular, why is it more often realized as ∅#? This is what I refer to as intra-contextual variation (see Chapter 1 §2.2.1). However, there is also the inter-contextual variation that need to be accounted for (see Chapter 1 §2.2.2). It is often the case that a variable process applies more frequently in one context than another. For instance, for both /i/ and /e, ɛ, ə/ in non-prosodic word final position the retention candidate is the more frequent variant (/i/ → |ĭ ™ ∅| and /e, ɛ, ə/ → |ə̆ ™ ∅|). This fact has been accounted for in §3 above. However, deletion is observed much more frequently for /e, ɛ, ə/ (31%) than for /i/ (7%). There are more such patterns that can only be identified by generalizing over different input forms. To account for these patterns, it is necessary to compare candidates that are not related to each other via the same input, i.e. by considering non-generated comparison sets (see Chapter 1 §1.2). In this section I offer an account for these cross-input patterns by appealing to such non-generated comparison sets.

Silva coded the data in his corpus for several linguistic features, and then subjected the data to analysis within the variable rule framework of Labov (Cedergren and Sankoff, 1974, Kay and McDaniel, 1979, Labov, 1972). In particular, he employs the VARBUL software package (Sankoff and Rand, 1988) to determine which grammatical factors contribute significantly towards determining the observed pattern of deletion. Only three of the factors for which Silva coded his data were selected as significant. I have already discussed these three factors when I initially presented Silva's data on deletion in §3.1. I briefly mention each of them again. However, for more detailed discussion, refer to §3.1 and the table in (24).

(i) *Vowel quality*. Some vowels are more susceptible to deletion than others. In particular, the vowels can be ordered as follows with regard to how likely they are to delete: [ə̆] (42%) > [ŭ] (35%) > [ĭ] (7%) > [ɐ̆] (2%).[47] (ii) *Position in the prosodic word.* For all inputs, deletion applies more frequently in prosodic word final position (70%), than elsewhere in the prosodic word (19%). (iii) *Stress of the following syllable*. For all inputs, a vowel is more likely to delete if followed by an unstressed syllable (48%) than if followed by a stressed syllable (25%). In the rest of this section I will discuss each of these three observations.

4.1 Vowel quality

There are three forces that co-determine how likely a specific process is to apply: (i) *Markedness of the input*. The more marked the input is, the more likely it is that a process will apply to decrease its markedness. (ii) *Cost of application of the process*. In OT terms application of a process translates into violation of a faithfulness constraint. The faithfulness constraints therefore militate against application of a process. The more faithfulness constraints violated by application of a process, the less likely that process is to apply. Similarly, the higher the ranking of the faithfulness constraint(s) violated by the application of some process, the less likely that process is to apply. (iii) *Markedness of the output*. The more marked the form that results from the application of the process, the less likely the process is to apply.

---

[47] Strictly speaking, it is of course not the surface vowels [ə̆, ŭ, ĭ, ɐ̆] that delete, but their underlying correspondents. It would be most correct to replace each of the vowels in this statement with its possible underlying correspondents as follows: [ə̆] = /e, ɛ, ə/, [ŭ] = /o, ɔ, u/, [ĭ] = /i/, [ɐ̆] = /a, ɐ/.

In order to determine how likely a process is to apply, there are therefore two relevant non-generated comparison sets to consider. First, the non-generated comparison set comprising of candidates, from each of the relevant classes, in which *the process has not applied* ("non-undergoers" of the process). By comparing these forms, it can be determined how they relate to each other in terms of markedness. The prediction is that the most marked of these candidates corresponds to the context where the process is most likely to apply.

Secondly, we need to consider the non-generated comparison set that contain candidates in which *the process has applied* ("undergoers" of the process). We can compare these candidates in terms of their markedness and faithfulness violations. The least marked amongst these will correspond to the context in which the process is most likely to apply. Similarly, from among these candidates that one that does best on the faithfulness constraints, is predicted to correspond to the context in which the process applies most frequently. I consider each of these two non-generated comparison sets below.

4.1.1 The non-undergoers

For each of the possible vowel inputs, the set of non-undergoers will contain a candidate in which the vowel has not deleted. For vowels that are not subject to reduction, the candidate will be the faithful candidate. However, for vowels that are subject to reduction, the candidate will be the reduced vowel.

(54) **The non-generated comparison set of non-undergoers**

Non-undergoers = { /i/ → [ĭ];

/a/ → [ɐ̆]; /ɐ/ → [ɐ̆];

/ɔ/ → [ŭ]; /o/ → [ŭ]; /u/ → [ŭ];

/ɛ/ → [ə̆]; /e/ → [ə̆]; /ə/ → [ə̆] }

Consider first the mappings /a, ɐ/ → [ɐ̆]. These mappings violate the constraint *σ̆/ɐ which is ranked higher than the markedness constraint violated by each of the other mappings. The drive to delete is therefore predicted to be the strongest in this context, and we expect the highest deletion rate associated with this context. However, this is not correct. In fact, the vowel [ɐ̆] has such a low rate of deletion that it was treated above as if it is categorically retained (see §3.6). The prediction here is counter to the facts. However, recall how the deletion candidate was ruled out in for the low vowels. There is faithfulness constraint that specifically militates against deletion of the vowels /a, ɐ/, namely MAX-a/ɐ, and this faithfulness constraint is ranked higher than the critical cut-off. Although the candidate [ɐ̆] is the most marked of all the retention candidates, and although the drive to delete is therefore strongest for this vowel, deletion is categorically blocked by a special faithfulness constraint. In the rest of this section I will not consider [ɐ̆] any further.

Now consider the mappings /ɔ, o, u/ → [ŭ] and /i/ → [ĭ]. The mappings /ɔ, o, u/ → [ŭ] violate the markedness constraint *σ̆/u, while /i/ → [ĭ] violates *σ̆/i. Since /u/ is more sonorous than /i/, *σ̆/u universally outranks *σ̆/i (see (9) and (10) in §2.1). The mappings /ɔ, o, u/ → [ŭ] therefore violate a higher ranked constraint than the mapping

/i/ → [ĭ], and it is predicted that the drive to delete in the [ŭ]-context should be stronger than the drive to delete in the [ĭ]-context. This corresponds to the observed deletion pattern.

Now consider the mappings /ɔ, o, u/ → [ŭ] and /ɛ, e, ə/ → [ə̆]. The mappings represented by /ɔ, o, u/ → [ŭ] violate the markedness constraint *σ̆/u. However, since schwa is the most harmonic unstressed syllable, there is no constraint *σ̆/ə – see §2.1 (9) above and Gouskova (2003). The mappings /ɛ, e, ə/ → [ə̆] therefore violate none of the markedness constraints considered thus far. According to this, there is no markedness constraint that would drive deletion in the [ə̆]-context, while the constraint *σ̆/u drives it in the [ŭ]-context. A higher deletion rate is therefore expected in the [ŭ]-context than in the [ə̆]-context. However, this is counter to the facts. [ə̆] is associated with a higher deletion rate than [ŭ]. In fact, [ə̆] has the highest deletion rate of all vowels in Faialense Portuguese.

If there truly were no markedness constraint violated by [ə̆], then it would be extremely hard to explain why it would ever delete. I propose that [ə̆] violates a general constraint against associating a syllabic nucleus with schwa – i.e. irrespective of whether the relevant syllable is stressed or not. This is just a member of the peak-affinity constraint family of Prince and Smolensky (1993:129). Their argument for the existence of this constraint family can be stated as follows: The syllabic peak (nucleus) is more prominent than the syllabic margins (onset/coda). More sonorous segments are more prominent than less sonorous segments. Prominent elements prefer to co-occur, and therefore a syllabic peak is more well-formed the more sonorous the segment is that is associated to the syllabic peak. This is again an example of harmonic alignment – see (9) and (10) in §2.1 above. In fact, this is one of the examples that Prince and Smolensky used when they introduced the concept of harmonic alignment. The harmonic alignment of the peak/margin scale and the sonority scale can be represented as in (55).

(55) **Harmonic alignment of peak/margin and sonority**

Syllabic position prominence:	Peak > Margin
Sonority scale:	a > ɐ > {o,ɔ,e,ɛ} > u > i > ə > {y,w} > {r,l} … > {t, p, k}
Harmonic alignment on Peaks:	P/a ™ P/ɐ ™ P/{o, ɔ, e, ɛ} ™ P/u ™ P/i ™ P/ə … ™ P/{t, p, k}
Constraint hierarchy:	‖*P/{t, p, k} o … *P/ə o *P/i o *P/u o … *P/ɐ‖

Here the sonority scale is harmonically aligned not with a prominence scale on different nuclei (more prominent = stressed nuclei vs. less prominent = unstressed nuclei). The sonority scale is aligned with a scale in which all peaks qualify as prominent. The constraints that are formulated based on this harmonic alignment therefore do not distinguish between stressed and unstressed syllables. These constraints are violated by a vowel irrespective of whether it occurs in a stressed or an unstressed syllable.

Since schwa is the least sonorous vowel, the constraint from this family that penalizes schwa (*P/ə) is ranked higher than the constraint that penalizes any of the other vowels. This is the constraint that is responsible for driving deletion of [ə̆] in Faialense Portuguese. Where should *P/ə be ranked? Since [ə̆] is associated with higher deletion rates than [ŭ], it is our expectation that [ə̆] should be more marked than [ŭ]. Therefore, the constraint violated by [ə̆], should rank higher than the constraint violated by [ŭ], i.e. ||*P/ə o *ŏ/u||.[48] With this additional ranking, we can now account for the relative deletion rates associated with each of the [ŭ], [ə̆] and [ĭ]. This is shown in the tableau in (56). In this tableau I only include the constraints actually violated by at least one candidate.

(56) **Comparing non-deletion candidates from different inputs**

		*P/ə	*ŏ/u	*ŏ/i	ID[ATR]	ID[fr]	ID[-hi]
1	/i/ → [ĭ]			*			
2	/ɔ/ → [ŭ]		*		*		*
2	/o/ → [ŭ]		*				*
2	/u/ → [ŭ]		*				
3	/ɛ/ → [ə̆]	*				*	
3	/e/ → [ə̆]	*			*	*	
3	/ə/ → [ə̆]	*					

Output of EVAL

/i/ → [ĭ] *ŏ/i

|

/ɔ, o, u/ → [ŭ] *ŏ/u

|

/ɛ, e, ə/ → [ə̆] *P/ə

In this tableau I simplify somewhat by ignoring the relationships between the different candidates in the last two groups. However, the general pattern is clear. The mapping /i/ → [ĭ] is preferred over all of the mappings onto [ŭ], which is again preferred

[48] See discussion just below in §4.1.1.1 about the relation between MAX and *P/ə.

over all of the mappings onto [ə̆]. Since the mapping /i/ → [ĭ] is most preferred (= least marked), the drive to delete is the lowest here and we predict the lowest deletion rate associated with /i/. This is indeed correct. Since the mappings /ɛ, e, ə/ → [ə̆] is least preferred (= most marked), the drive to delete is strongest for the inputs /ɛ, e, ə/. We therefore correctly predict the highest deletion rate for these inputs.

By allowing EVAL to compare forms from different inputs, we can capture the intuition that certain forms are more marked and therefore more likely to undergo some process. We can order the three vowels [ĭ], [ə̆] and [ŭ] as follows in terms of their markedness: |ĭ ™ ŭ ™ ə̆|. This explain why [ə̆] deletes most, then [ŭ], and then [ĭ].

4.1.1.1 The peak-affinity constraints in general

In the previous section I argued for the inclusion of a member of the peak-affinity constraints into the set of constraints active in vowel deletion process of Portuguese. It is now necessary to answer two questions about these constraints: (i) Does the introduction of *P/ə influence any of the predictions with regard to reduction and deletion of /e, ɛ, ə/ as discussed above in §3.3? (ii) What about the other members of the peak-affinity hierarchy?

Consider first the influence of *P/ə on the realization of the inputs /e, ɛ, ə/. When any of these vowels are parsed into an unstressed syllable that is not final in a prosodic word, variation between [ə̆] and ∅ is observed with [ə̆] as the most frequent variant. It is therefore necessary that EVAL imposes the following rank-ordering on these two candidates: |ə̆ ™ ∅|. For this to happen, to highest ranked constraint that favors ∅ over [ə̆] must rank below the highest ranked constraint that favors [ə̆] over ∅. The violation profiles of the mappings /e, ɛ, ə/ → [ə̆] and /e, ɛ, ə/ → ∅ are listed in (57).

(57) **Violation profiles of the mappings /e, ɛ, ə/ → [ə̆] and /e, ɛ, ə/ → ∅**

/ə/ → [ə̆]	*P/ə
/ɛ/ → [ə̆]	*P/ə, IDENT[front]
/e/ → [ə̆]	*P/ə, IDENT[front], IDENT[ATR]
/e, ɛ, ə/ → ∅	MAX

MAX is the only constraint that favors the retention candidates over the deletion candidate. MAX must therefore outrank all of the constraints violated by the retention candidates. The ranking ||MAX o {IDENT[front], IDENT[ATR]}|| has already been established (see (53) in §3.7). All that we need to add now is the ranking ||MAX o *P/ə||. Together with ||*P/ə o *ə̆/u|| argued for just above in 4.1.1, we therefore know exactly where *P/ə ranks, namely: ||MAX o*P/ə o *ə̆/u||. With this ranking *P/ə will not interfere with the predictions that the theory makes about the realization of the inputs /e, ɛ, ə/.

Now we can consider the rest of the peak-affinity hierarchy. Can the other *P/-constraints cause problems? Only if they rank too high. In particular, if the *P/-constraint for some vowel ranks higher than the *ə̆/-constraint for that same vowel. But since *P/ə ranks highest of all the *P/-constraints, we can claim that the other *P/-constraints rank lower than *P/ə, and in particular low enough that they will not have an influence on the observed output patterns.

4.1.2 The undergoers

We still need to consider the set of undergoers – i.e. a candidate for each possible output where the vowel was indeed deleted. All deletion candidates violate the constraint MAX. The inputs /a, ɐ/ violate, in addition to the general MAX constraint, also the special constraint MAX-a/ɐ. The tableau in (58) compares the members of the non-generated comparison set of undergoers. Since MAX and MAX-a/ɐ are the only constraints violated by these candidates, only these two constraints are included in the tableau.

(58) **Comparing deletion candidates from different inputs**

		MAX-a/ɐ	MAX
1	/i/ → ∅		*
1	/ɔ/ → ∅		*
1	/o/ → ∅		*
1	/u/ → ∅		*
1	/ɛ/ → ∅		*
1	/e/ → ∅		*
1	/ə/ → ∅		*
2	/a/ → ∅	*	*
2	/ɐ/ → ∅	*	*

Output of EVAL

/i, ɔ, o, ɛ, e, ə/ → ∅

|

/a, ɐ/ → ∅ $_{\text{MAX-a/ɐ}}$

What this comparison shows is that deletion of /a, ɐ/ comes at a higher faithfulness cost than deletion of /i, ɔ, o, ɛ, e, ə/. Faithfulness will therefore militate stronger against the deletion of /a, ɐ/, with the result that we expect lower deletion rates associated with these two inputs than with the other vowels. This is confirmed by the data

– in fact, /a, ɐ/ deletes so infrequently that I have claimed above that MAX-a/ɐ ranks above the critical cut-off, thereby ruling out deletion as a variant for these inputs.

4.2 Position in the prosodic word

Averaging across all inputs, it can be seen that deletion applies more in prosodic word final position (70%) than elsewhere in the prosodic word (19%). Inspection of the table in (24) shows that this pattern is also individually true for the vowels that are realized as [ə̆] (/e, ɛ, ə/) and as [ŭ] (/o, ɔ, u/). The vowel [ĭ] does not occur in prosodic word final position (footnote 8 §1.2 and footnote 29 §3.1), and we can therefore not compare the deletion rate for this vowel in the two different positions in the prosodic word. For the vowels realized as [ɐ̆] (/a, ɐ/), this generalization does not hold. However, /a, ɐ/ in general resists deletion, irrespective of whether it occurs final or elsewhere in the prosodic word. In the rest of this section, I will therefore deal only with the inputs /e, ɛ, ə/ and /o, ɔ, u/.

We can again consider the set of deletion undergoing mappings and the set non-undergoing mappings as non-generated comparison sets. However, in this instance the comparison between the undergoers will be uninformative. All of the mappings represented by /e, ɛ, ə, o, ɔ, u/ → ∅ violate only one constraint, namely MAX, irrespective of whether the deletion occurs in prosodic word final position or elsewhere in the prosodic word. The faithfulness cost of deletion is the same everywhere in the prosodic word. The drive not to delete is therefore equally strong for all these vowels.

However, it is informative to compare the set of non-deletion-undergoers. For any given input vowel, a non-undergoing candidate will violate different markedness constraints, depending on whether it is occurs in final position of a prosodic word or elsewhere in a prosodic word. To make this more concrete, consider as an example the vowel /o/. This vowel reduces to the high back vowel in unstressed syllables. When the reduced vowel occurs in prosodic word final position, it will violate the markedness constraints *σ̆/u and *v̆]$_{\omega}$. However, when it occurs elsewhere in the prosodic word, it violates only *σ̆/u. In prosodic word final position, deletion will avoid two markedness violations, while it will avoid only one elsewhere in the prosodic word. The drive to delete is therefore stronger final in the prosodic word than elsewhere, and a higher rate of deletion is predicted for this position. This is illustrated in the tableau in (59). Since the faithfulness violations incurred by the reduction candidate is the same irrespective of where in the prosodic word the vowel occurs, only the markedness violations are relevant here. In this tableau I include only markedness constraint actually violated by one of the candidates under consideration.

(59) **Non-deletion candidates from different positions in the prosodic word**

			*v̆]$_{\omega}$	*σ̆/u
Elsewhere:	1	/o/ → [ŭ]		*
Prosodic word final:	2	/o#/ → [ŭ#]	*	*

Output of EVAL

Retention elsewhere /o/ → [ŭ]

|

Retention final in prosodic word: /o# → [ŭ#] *v̆]$_{\omega}$

The discussion has been in terms of the input /o/. However, the same can be shown for the vowels /e, ɛ, ə, ɔ, u/. For every input vowel, non-deletion is more marked in prosodic word final position than elsewhere. For each of these vowels, the drive to delete is therefore stronger in prosodic word final position, and we predict a general higher deletion rate in prosodic word final position.

This prediction also follows from the analysis of the deletion process presented above in §3 where ordinary generated comparison sets were discussed. Consider first the vowels that are realized as [ŭ]. In §3.2.1 I have shown how EVAL imposes for any one of the vowels /o, ɔ, u/ the following rank-ordering on the possible outputs when not in prosodic word final position: |ŭ ™ ∅|. Since [ŭ] is predicted to occur more than ∅ when not final in a prosodic word, and since these are the only two variants predicted as possible, it follows that deletion is predicted to occur less than 50% of the time. In §3.2.2, however, we have seen that EVAL imposes the opposite ordering on the retention and the deletion candidates when final in the prosodic word, i.e. |∅# ™ ŭ#|. Again, these are predicted to be the only two variants, and since the deletion candidate is the more frequent variant, deletion is predicted to occur more than 50% of time. When non-final in the prosodic word, deletion is predicted to happen less than half of the time; when final in the prosodic word, deletion is predicted to happen more than half time. This implies more deletion in prosodic word final position than elsewhere in the prosodic word. The same explanation can be given with regard to the deletion rate associated with [ə̆]. The fact the prediction based on generated comparison sets (§3) and the prediction based on non-generated comparison sets (the current section) are in agreement, is strong evidence in favor of the analysis.

4.3 Stress of the following syllable

A vowel in an unstressed syllable is more likely to delete if it is followed by an unstressed syllable (48%) than if it is followed by a stressed syllable (25%). In this section I will argue that this follows form general principles of rhythmic well-formedness. There is a very strong universal tendency for rhythmic structure to be alternating – i.e. contiguous unstressed syllables are avoided, as are contiguous stressed syllables. In order to express this generalization, two constraints have been defined in OT, namely *LAPSE against contiguous unstressed syllables, and *CLASH against contiguous stressed syllables (Alber, 2002, Elenbaas and Kager, 1999, Kager, 2001, Kenstowicz and Green, 1995, Pater, 2000). In this section I will argue that it is these constraints that lead to higher deletion rates in pre-unstressed syllables. As in the preceding two sections, there are two non-generated comparison sets to consider, the undergoers and the non-undergoers. I will first discuss the non-undergoers.

4.3.1 The non-undergoers and *LAPSE

When an unstressed syllable is followed by an unstressed syllable, two contiguous unstressed syllables is the result. Such a form will violate the constraint *LAPSE against rhythmic lapses. However, when an unstressed syllable is followed by a stressed syllable, there is an alternating rhythmic structure, and therefore *LAPSE is not violated. In addition to general constraints against vowels in unstressed syllables, a candidate in which an unstressed vowel is followed by yet another unstressed syllable also violates *LAPSE. In such a form both *LAPSE and the markedness constraint against unstressed vowels will favor deletion, predicting higher deletion rates in such a context.

As an example, consider the vowel /e/ in two contexts: (i) Where both /e/ and the following vowel will be realized as unstressed, i.e. /e…v/ → [ə̆ … v̆]; and where /e/ will be realized as unstressed but the following vowel a stressed. /e…v/ → [ə̆…v́]. There exists a non-generated comparison set that contains these two mappings. The tableau in

(60) compares these two mappings. Since both mappings violate the same faithfulness constraints, the tableau includes only markedness constraints. I am also not considering the violations that the vowel in the following syllable might receive.[49]

(60) **Non-deletion in pre-stressed and pre-unstressed contexts**

			*P/ə	*LAPSE
Pre-unstressed:	2	/e…v/ → [ə̆ … v̆]	*	*
Pre-stressed:	1	/e…v/ → [ə̆…v́]	*	

Output of EVAL

Pre-stressed retention: /e…v/ → [ə̆…v́]

|

Pre-unstressed retention: /e…v/ → [ə̆ … v̆] *LAPSE

The comparison has been done for the vowel /e/ here, but the same comparison can be done for any of the vowels. For all vowels, non-deletion before an unstressed vowel will result in a more marked output than non-deletion before a stressed vowel. Deletion before an unstressed vowel can therefore avoid violation of two markedness constraints, *LAPSE and the markedness constraint against the unstressed vowel. However, deletion before a stressed vowel avoids violation of only one markedness constraint, namely against the unstressed vowel. The drive to delete is stronger before unstressed vowels, and the prediction is that this context should be associated with higher deletion rates. This is in agreement with the actual pattern observed in Silva's corpus.

4.3.2 The undergoers and *CLASH

Deleting an unstressed vowel violates MAX, irrespective of whether the vowel was followed by a stressed or an unstressed syllable. The faithfulness cost is therefore the

[49] About where *LAPSE should be ranked, see §4.3.3 below. For now I do not rank it relative to *P/ə.

same for both contexts under consideration here. However, deleting a vowel before a stressed vowel can result in bringing two stressed syllables into contact, therefore creating a *CLASH-violation. This will not always happen, but only when the deleting vowel is flanked by two stressed syllables, i.e. /σ́ v̆ σ́/ → [σ́ σ́].[50] When the deleting vowel is preceded by an unstressed vowel, then its deletion does not create a *CLASH-violation, i.e. /σ̆ v̆ σ́/ → [σ̆ σ́]. On the other hand, deletion of a vowel followed by an unstressed syllable can never cause a *CLASH violation, /σ́ v̆ σ̆/ → [σ́ σ̆] and /σ̆ v̆ σ̆/ → [σ̆ σ̆].[51] When the preceding syllable is stressed, then the markedness cost of deletion in a pre-stressed context is higher than the markedness cost of deletion in a pre-unstressed context. In addition to the faithfulness constraint MAX, *CLASH also militates against deletion in (some) pre-stressed contexts, with the result that deletion will apply less frequently before stressed syllables.

As an example, consider the input /ɔ/. There is a non-generated comparison set for this vowel that contains a mapping where it is deleted between two stressed syllables (/σ́ ɔ σ́/ → [σ́ σ́]), and a mapping where it is deleted between a stressed and an unstressed

---

50 Since stress assignment in Portuguese is for the most part predictable, it is probably not correct to indicate stress on underlying representations. Therefore, whenever I indicate stress (or the lack of stress) on underlying form it should be interpreted as follows: This syllable will receive stress (or not) according to the rules of stress assignment of Portuguese.

51 /σ̆ v̆ σ̆/ → [σ̆ σ̆]: The output form here does contain a *LAPSE violation. However, had deletion not applied, then the form would have had two violations of *LAPSE. In addition to avoiding the violation of the constraint against the unstressed vowel, deletion also avoids one *LAPSE-violation here.

/σ̆ v̆ σ́/ → [σ̆ σ́]: This is the corresponding mapping with a following stressed syllable. The output here does not violate *LAPSE. On the face of it, this seems to predict that deletion should apply more in pre-stressed position. However, had deletion not applied in this situation *LAPSE would have been violated once. Deletion therefore avoids violation of the constraint against the unstressed syllable, and one *LAPSE-violation.

When the syllable preceding the deleting vowel is unstressed, there is no difference between the two contexts in what is gained by deletion. The drive to delete is therefore equally strong when the preceding syllable is unstressed.

syllable (/σ́ ɔ σ̆/ → [σ́ σ̆]). The tableau in (61) compares the members of this non-generated comparison set.[52]

(62) **Comparing deletion candidates in pre-stressed and pre-unstressed contexts**

			MAX	*CLASH
Pre-stressed:	2	/σ́ ɔ σ́/ → [σ́ σ́]	*	*
Pre-unstressed:	1	/σ́ ɔ σ̆/ → [σ́ σ̆]	*	

Output of EVAL

Pre-unstressed deletion: /σ́ ɔ σ̆/ → [σ́ σ̆]

|

Pre-stressed deletion: /σ́ ɔ σ́/ → [σ́ σ́] *CLASH

This illustration has been in terms of the vowel /ɔ/. Since the constraints involved are independent of the input vowel, the same point can be made for any input vowel. When a vowel is preceded and followed by a stressed syllable, then deletion of that vowel will result in a *CLASH-violation. However, when it is preceded by a stressed syllable and followed by an unstressed syllable, then deletion of that vowel will not result in the creation of a *CLASH-violation. In these contexts, there are more constraints that militate against deletion before a stressed syllable. This therefore predicts higher deletion rates in pre-stressed position, which is in agreement with the patterns observed in Silva's corpus.

By taking into consideration the rhythmic well-formedness constraints *LAPSE and *CLASH, we can account for the fact that deletion is observed more frequently in pre-unstressed than in pre-stressed position. There are two reasons: (i) Non-deletion in a pre-unstressed position can result in a form that violates *LAPSE, while non-deletion in a pre-stressed position cannot. The drive to delete is therefore stronger in pre-unstressed

[52] About where *CLASH should be ranked, see §4.3.3 below.

position. (ii) Deletion in pre-stressed position can create a *CLASH-violation, while deletion in pre-unstressed position cannot. The drive not to delete is stronger in pre-stressed position than in pre-unstressed position.

4.3.3 *LAPSE, *CLASH and the deletion of individual vowels

In the previous two sections I have shown that *LAPSE and *CLASH can influence the deletion rate. In §3 above, I have offered an account of the variable deletion of the Portuguese vowels without taking into consideration the contribution of these two constraints. Addition of *LAPSE and *CLASH can cause problems for the earlier account. In §3 the ranking between MAX and the markedness constraints determines whether deletion or retention is preferred. If the markedness constraint violated by the retention candidate ranks above MAX, then deletion is preferred. If the markedness constraint violated by the retention candidate is ranked below MAX, then retention is preferred.

(63) **The structure of the argument from §3**

a. Markedness o MAX = Deletion preferred
||*v̆]$_{\omega}$ o MAX|| = more deletion than retention when final in prosodic word.

b. MAX o Markedness = Retention preferred
||MAXo*P/əo*ŏ/u|| = for [ə̆], [ŭ] more retention than deletion elsewhere.

If *CLASH and *LAPSE rank too high, they can override the effects of MAX and the constraints against unstressed vowels. They can do this in particular if they are allowed to rank above MAX. I illustrate this here with *LAPSE and an input /u/ followed by an unstressed syllable in a non-prosodic word final context. In this context, the retention candidate should be the more frequently observed output. However, under the ranking ||*LAPSE o MAX||, the opposite is predicted. This is shown in the tableau in (64).

(64) **The wrong predictions with ||*LAPSE o MAX||**

/u ŏ/	*LAPSE	MAX	*ŏ/u
2 ŭ ŏ	*		*
1 ∅ ŏ		*	

Output of EVAL

L ∅ ŏ MAX

|

L ŭ ŏ *LAPSE

———— Cut-off

The illustration here was in terms of *LAPSE and /u/. However, similar examples could be constructed with the other vowels and with *CLASH. We therefore need these two constraints to be ranked below MAX.

4.4 Final summary

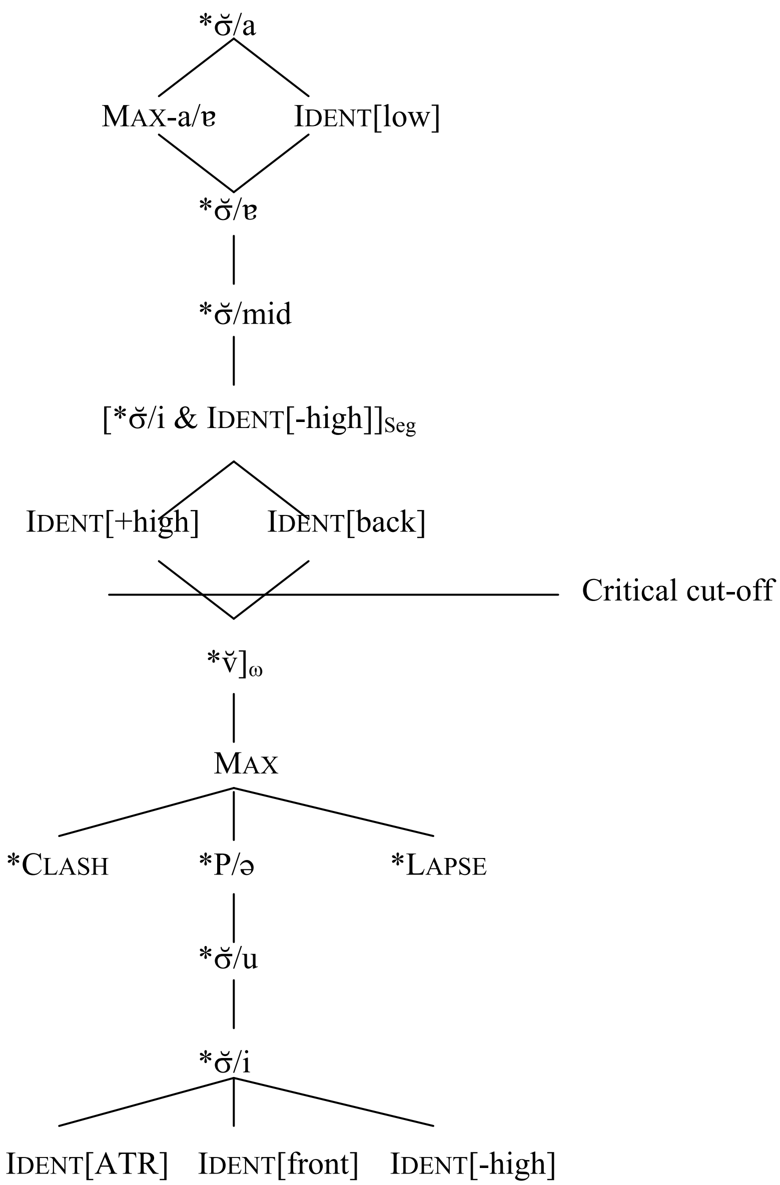
In the table in (65) I summarize all of the new rankings that have been argued for in §4. As before, I also give a graphic representation of Faialense the Portuguese constraint hierarchy. This is the final hierarchy for Faialense Portuguese.

(65) **Summary of new rankings**

Ranking	**Motivation**	**Where?**
*P/ə o *ŏ/u	[ə̆] deletes more than [ŭ]	§4.1.1 (55) (56)
MAX o*P/ə	In general [ə̆] is preferred over deletion	§4.1.1.1 (57)
MAX o {*CLASH, *LAPSE}	*CLASH, *LAPSE cannot override effect of MAX and markedness against unstressed vowels	§4.3.3

With these additional rankings, and by allowing EVAL to compare candidates that are not related to each by the same input (selected comparison sets), we can account for the following generalizations about vowel deletion in Faialense Portuguese: (i) some vowels are more prone to delete than others; (ii) vowels in prosodic word final position are more prone to delete than vowels elsewhere; and (iii) vowels before an unstressed syllable are more prone to delete than vowels before a stressed syllable.

(66) **Graphic representation of the Faialense Portuguese constraint hierarchy**



5. Summary: vowel reduction and deletion in Faialense Portuguese

In this chapter I have presented an account of vowel reduction and deletion in Faialense Portuguese within a rank-ordering model of EVAL. A rank-ordering model of EVAL differs in two respects from the classic OT conception of EVAL: (i) In the rank-ordering model, EVAL does more than to distinguish the optimal candidate from the losers. EVAL imposes a harmonic ordering on the complete candidate set. (ii) EVAL is allowed to compare candidates that are not related to each other via the same input. The rank-ordering model of EVAL can be used to account for variable phenomena in the following way:

(i) The language user can potentially access all candidates in the rank-ordering that EVAL imposes on the candidate set. However, the likelihood of a candidate being accessed depends on the position it occupies in this rank ordering. The higher position a candidate occupies in the rank-ordering, the more likely it is to be accessed. In a variable phenomenon the language user therefore accesses more than just the best candidate. However, the best candidate is most likely to be accessed and is therefore predicted to be to the preferred variant. The second best candidate is second most likely to be accessed, and is therefore the second most frequent variant, etc.

(ii) There is an absolute cut-off on the constraint hierarchy of every language. When given a choice a language user will not select as output a candidate that is disfavored by a constraint ranked higher than the critical cut-off. This places a strict limit on the number of variants that will be observed in a variable process, and it also accounts for categorical phenomena.

(iii) A variable process often applies with different frequency in different contexts. By allowing EVAL to compare candidates from different contexts (candidates that are not related to each other via a shared input), we can account for the relative frequency with which a variable process applies in different contexts.

Deletion of unstressed vowels applies variably in Faialense Portuguese. In this chapter I have shown how the variable deletion pattern in Faialense Portuguese can be accounted for within such a rank-ordering model of EVAL. In particular, I have shown how this model accounts for the following facts about vowel deletion in Faialense Portuguese:

(i) In non-prosodic word final position the unstressed vowels [ŭ, ə̆, ĭ] are retained more often than they are deleted. The grammar developed for Faialense Portuguese in this chapter rates the retention candidate best and the deletion candidate second best in non-prosodic word final position.

(ii) In prosodic word final position the unstressed vowels [ŭ, ə̆, ĭ] are deleted more often than they are retained. In this context the grammar rates the deletion candidate best and the retention candidate second best.

(iii) All other candidates for these vowels are eliminated by constraints ranked above the critical cut-off, and are therefore never selected as possible variants.

(iii) The unstressed vowel [ɐ̆] is categorically retained. All candidates for this output are disfavored by constraints above the cut-off. Only the single best candidate is therefore selected as output. The grammar rates [ɐ̆] as best.

(iv) [ə̆] deletes most frequently, then [ŭ], and then [ĭ]. Comparison between non-deletion candidates for these vowels show that [ə̆] is more marked than [ŭ] which is again more marked than [ĭ]. A higher deletion rate is predicted with more marked forms.

(v) Comparison between unstressed vowels in prosodic word final position and unstressed vowels from elsewhere in the prosodic word, show that the vowels in prosodic word final position are more marked. This explains why this position is associated with higher deletion rates.

(vi) Unstressed vowels followed by an unstressed syllable are more prone to delete than unstressed vowels followed by a stressed syllable. Comparison between candidates from these two contexts show that deletion in pre-unstressed position leads to more well-formed rhythmical structures, while deletion in pre-stressed syllables could create rhythmically more marked structures. This explains why pre-unstressed vowels are more prone to deletion.