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On the interplay of morphology, prosody and faithfulness in Portuguese pluralization

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1 Introduction

In this paper we demonstrate that, in spite of its surface array of manifestations, Portuguese pluralization is systematic and unitary at its root. That is, we shall show that the plural of *papel* 'paper', for example, is *papeis* because there is a change of underlying /l/ to surface [j] and because the plural morpheme is concatenated to the stem. However, this work does not aim to provide yet another analysis in which a base form is mapped to a surface form through a set of unrelated rules. Instead, we adopt the constraint-based Optimality Theory (Prince and Smolensky 1993), and focus on explaining the surface phonological alternations related to pluralization as the logical result of keeping morphology and prosody as simple as possible.

Our central assertion is that the morphology involved in pluralization is as simple as it can be: the plural morpheme must be realized segmentally as /s/ and must occur at the right edge of the word. Most of the alternations arise when these demands of morphology must be upheld while meeting other prosodic restrictions. Morphology requires the presence of the plural morpheme /s/, and prosody requires the well-formedness of syllabic and metrical constituents. In this paper we show how this specific case of conflict between morphology and prosody is resolved at the expense of segmental faithfulness to the input form.

There are a number of interesting aspects of Portuguese plural formation that have launched a considerable amount of investigation from different theoretical approaches (see section 3 for a review). The first area of debate is the determination of the underlying forms. Are *-s* and *-es* allomorphs? If this is not a case of lexicalized alternation, then the alternation between *-e* and *-es* must be

either a case of synchronic epenthesis or lenition. In Portuguese, plural formation intersects with consonant gliding and nasalization—with concomitant deletion of the nasal (e.g. /papel+s/[1] → [papejš] and /irman+o+s/ → [irmãw̃]). Moreover, in different previous analyses, many processes have been considered in relation to pluralization. These are, among others, denasalization, tensing, centralization, deletion, epenthesis, softening, analogy, and diphthongization. Our view is that this proliferation of processes is the result of approaching the problem from within a procedural framework. When considered from a constraint-based perspective, the relationship between the different surface realizations emerges, and a greater level of explanation is attained. The processes intersecting with pluralization do not stem from independent or unrelated rules, as previously proposed, but are the result of striving to accommodate, at the expense of faithfulness, morphological and prosodic constraints.

2 Data

We begin this section with a presentation of the basic data under consideration. First are words that end in a vowel or (nonnasal) glide, which present the simplest case of pluralization:

(1) Words with a final vowel- and nonnasal glide:

casa	*casa+s*	'house(s)'
coisa	*coisa+s*	'thing(s)'
pau	*pau+s*	'stick(s)'
rei	*rei+s*	'king(s)'

Here we see that the plural marker /-s/ is concatenated to the singular form, with no further changes taking place that concern us here.

Next are words that end in a consonant:

(2) Words ending in /s/ with penultimate stress:

simples	*simples*	'simple'
ourives	*ourives*	'goldsmith(s)'
lápis	*lápis*	'pencil(s)'
pires	*pires*	'saucer(s)'

íris	*íris*	'iris(es)'
gratis	*gratis*	'free'
caos	*caos*	'chaos(es)'
oásis	*oásis*	'oasis/oases'
ônibus	*ônibus*	'bus(es)'

This is a near exhaustive list of words of this type, which have identical surface forms for both the singular and plural.

In (3) are words ending in /s/ that are stressed on the ultimate syllable. Here we see that the plural forms surface with [eš], not simple [š]:

(3) Words ending in /s/ with final stress:

português	*português+es*	'Portuguese'
mês	*mês+es*	'month(s)'
gas	*gas+es*	'gas(es)'

Words ending in /-r/ behave like the forms in (3), showing final [eš]:

(4) Words ending in /-r/:

mar	*mar+es*	'sea(s)'
bar	*bar+es*	'bar(s)'
favor	*favor+es*	'favor(s)'
cor	*cor+es*	'color(s)'
flor	*flor+es*	'flower(s)'
lar	*lar+es*	'home(s), hearth(s)'
luar	*luar+es*	'moonlight(s)'

Words ending in /l/ constitute another class. The /l/ is velarized to [ɬ] in Continental Portuguese in syllable-final position, as in the singular forms, but is vocalized to [j] word-finally before the plural morpheme /-s/. Additionally, we observe three types of alternations in the plural:

For words ending in stressed *-al*, *-el*, *-ol*, *-ul*, /l/ becomes a glide. The plural form ends in [jš]:

(5) Words ending in stressed *-al*, *-el*, *-ol*, *-ul* ([ɬ ~ j]):

hospital	/ospital/	[os.pi.táɬ]	‘hospital’
hospitais	/ospital+s/	[os.pi.tájš]	‘hospitals’
hotel	/otel/	[o.téɬ]	‘hotel’
hoteis	/otel+s/	[o.téjš]	‘hotels’
farol	/farol/	[fa.róɬ]	‘headlight’
farois	/farol+s/	[fa.rójš]	‘headlights’
paul	/paul/	[pa.úɬ]	‘swamp’
pauis	/paul+s/	[pa.újš]	‘swamps’

If the final vowel is /i/, however, there are two possible further alternations. In (6) we see that there is lowering of unstressed /i/ to [e], and that a falling diphthong surfaces (only a representative example is shown in full phonetic form):

(6) Unstressed /-il/ is realized in the plural as [ejš] ([iɬ ~ ejš]):

fácil	/fásil/	[fá.siɬ]	‘easy’
fáceis	/fásil+s/	[fá.sejš]	‘easy pl.’
lábil	*lábeis*		‘labile’
fóssil	*fósseis*		‘fossil(s)’
frágil	*frágeis*		‘fragile’
dócil	*dóceis*		‘docile’
ágil	*ágeis*		‘agile’

Note, however, that when the final /i/ is stressed this change is not possible:

(7) Stressed /-il/ realized in the plural as [íš] ([íɬ ~ íš]):

subtil	/subtil/	[subtíɬ]	‘subtle’
subtís	/subtil+s/	[subtíš]	‘subtle pl.’
fuzil	*fuzís*		‘rifle(s)’
funil	*funís*		‘funnel(s)’
canil	*canís*		‘kennel(s)’
imbecil	*imbecís*		‘imbecile(s)’

The last major class of data is those words that end in the nasal diphthong [ãw̃] in the singular. The principal difficulty in analyzing these cases is that in the plural they show one of three forms, which depend both historically and synchronically on the Latin etymological root. The need to posit input forms that are identical or similar to the Latin etyma has been established by Saciuk (1970), Brasington (1971), St. Clair (1971), Mira Mateus (1975) and Brakel (1979), and is due to the numerous alternations that require the original morphological form be present. Below are the relevant data:

(8) Morphological alternations requiring positing of underlying nasal consonant (representative samples):

a. [ãw̃] ~ [ãw̃š] (<Lt. -anu(s))

irmão	*irmãos*	'brother(s)'	(cf. *irmanar* 'link')
cristão	*cristãos*	'Christian(s)'	

b. [ã] ~ [ãš] (< Lt. -ana(s))

irmã	*irmãs*	'sister(s)'
alemã	*alemãs*	'German(s), fem.'
cristã	*cristãs*	'Christian(s), fem.'

c. [ãw̃] ~ [õj̃š] (< Lt. -one(s))

patrão	*patrões*	'patron(s)'	(cf. *patronato* 'patronage')
limão	*limões*	'lemon(s)'	
leão	*leões*	'lion(s)'	

d. [oa] ~ [oas] (< Lt. -one(s))

leoa	*leoas*	'lioness(es)' (cf. [bõ] ~ [boa], [leãw̃] ~ [leoa])

e. [ãw̃] ~ [ãj̃š] (< Lt. -ane(s))

pão	*pães*	'bread(s)'	(cf. *panificar* 'make bread')
cão	*cães*	'dog(s)'	
capitão	*capitães*	'captain(s)'	

3 Previous analyses

3.1 Unmarked pluralization

The data in (1) are unproblematic since we see the simple concatenation of the plural marker /-s/. All previous accounts agree on this much, and so this will not be addressed further.

3.2 Identical forms

Beginning with the data in (2), those words with identical forms in both the singular and plural like *simples*, there is disagreement in analysis among previous authors. For instance, Williams (1962:126) cites historical evidence that these are cases of haplology, while the earliest synchronic analyses of these forms is given by the structuralist Mattoso Câmara (1970, 1972). He proposed that there is a zero plural allomorph that is added to words that end in an atonic syllable already ending in /s/. This quite unexplanatory account is bettered by Andrade (1977). Andrade argues that the plural marker /-s/ is uniformly added to all base forms, with a concomitant degemination rule for the forms in (2). This is shown below:

(9) simples + /s/ → simpless → simples

For analogous data in Spanish, Harris (1980) proposes a similar approach. Adapting work done in templatic morphology, Harris posits the following general template for the plural forms of nouns and adjectives:

(10) $[[...]_{\text{Root}}\ \text{V C}\ ]_{\text{Word}}$

Thus, a noun or adjective of the type Sp. *dosis* ‘dose’ has the identical plural form because of its morphological structure [[dos] i s] (cf. *dosificar* [[[dos] ifik]ar]), and the V C portion of the template in (10) is satisfied by the exceptional Terminal Element /is/. As in Andrade’s analysis, the plural morpheme is concatenated to the base form, but is then merged under identity with the stem-final /s/.

An analysis using the template in (10) does not seem able to account for all of the Portuguese data above in (2). *Simples*, *caos* and *gratis* do arguably have morphological structure that would satisfy the template in (10) (cf. *simpleza*

[[[simpl]ez]a], *caótico* [[[kao]tik]o], *gratuito* [[[grat]uit]o]), but for the majority of the above forms we cannot reasonably posit such morphological structure. Finally, Lipski (1973) notes that these words are quite exceptional, and assumes that native speakers would have difficulty in pronouncing *[V́…Vsis], since the final syllable of Portuguese paroxytones is very weakly articulated and is often dropped. Furthermore, he assumes that these forms already sound like plurals, so no plural ending is added.

3.3 Apocope versus epenthesis

Next, for the class of words exemplified in (3) and (4), those that show [eš] in the plural, many previous accounts have assumed that these base forms underlyingly possess the /e/ seen in the plural form (cf. for example, Hensey 1968, Mattoso Câmara 1970, Saciuk 1970, St. Clair 1971, Brasington 1971, Andrade 1977). Then, /e/ is either apocopated in the singular forms, or surfaces when the plural marker *-s* is added. These authors assume the Latin Stress Rule, so this /e/ also serves to regularize the stress of consonant-final words as underlyingly penultimate. Lipski (1973:76) argues against the apocope hypothesis, reasoning that such an analysis is undesirably abstract. Instead, he assumes that there is epenthesis of /e/ in the plural forms, because the simple addition of *-s* would yield the impermissible sequences **-ls* **-rs* **-zs* **-ss*. He states (p. 77) that this epenthesis is merely part of a general tendency toward making Portuguese a CV language (Brazilian Portuguese is the case Lipski addresses, but this is also true of Continental Portuguese). As for stress assignment, he assumes that the generalization native speakers make is that words ending in a consonant take final stress.

3.4 /l/-final words

For words ending in /l/, those in (5)-(7), early accounts (Mattoso Câmara 1970, St. Clair 1971:94, Andrade 1977) assumed that these forms underlyingly end in /e/, which is either apocopated in the singular forms as in (3) and (4) or provides the structural environment for a rule of intervocalic loss of /l/. Such accounts assume that it is the underlying /e/ that undergoes glide formation once the /l/ is lost and is in contact with another vowel. This crucially requires the extrinsic ordering of the apocope rule after the intervocalic /l/-deletion rule, and such ordering should be eliminated if possible, given the lack of independent

evidence for it. Likewise, an analysis that does not posit an underlying /e/ that never surfaces in the singular is preferable to an analysis that does. Furthermore, for the singular/plural pairs under discussion, the /e/ would *always* surface in the plural as the palatal glide [j], so there is really *no* evidence that supports an analysis requiring /e/ in the base forms.

Lipski (p. 78) notes that aside from playing a crucial role in the analysis these authors give of pluralization, this supposedly general rule of 'lateral loss' does not occur in Portuguese. In fact, there are thousands of words with intervocalic /l/, and even the type of words under discussion here contain /l/ intervocalically in forms other than the plural, such as *canal ~ canículo* '(little) canal', *papel ~ papelão* 'paper ~ cardboard', etc. Both Lipski (1973) and Agard (1984) assume that /l/ directly becomes [j] in the plural, and not that there is intervocalic loss of /l/ with concomitant glide formation of /e/.

The gliding of /l/ to [j] in Continental Portuguese is usually not related in the literature to the processes of vocalization and velarization of /l/ in syllable-final position. We note in passing that Lipski (p. 76) cites *[-ls] as an impermissible sequence, a restriction he uses to motivate epenthesis, as in *males* and *cônsules*, the only two exceptions to the loss of /-l-/, but not as motivation for gliding. On his account then, we would expect forms like **papeles* instead of *papeis*.

One author who does propose an explicit analysis of the vocalization of /l/ in the plural in Brazilian Portuguese (BP) (not Continental Portuguese, CP) to both [w] and [j] is Girelli (1988). Although his proposal employs an elaborate and quite unorthodox X'-theory of syllable structure, many of his ideas are fairly readily translated into the constraint-based approach adopted here. His principal claim relevant to the current discussion of /l/ is that in BP, syllable-final /l/ is realized within the nucleus, and so surfaces either as [w], before a pause or some consonant other than [š], or as [j], when the liquid is a sister to [š] within the nucleus (p. 147). He also assumes that those features whose values vary depending on the realization of /l/ as [w] or [j] are unspecified, and only filled in by other marking conventions. Though not identical, this general approach is consistent with the proposal of Inkelas (1995) with regard to underspecification and lexicon optimization in Optimality Theory.

Other facts that must be accounted for are the other alternations seen in (6) and (7). For (6), e.g. *fácil ~ fáceis*, both Mattoso Câmara and Andrade assume that from the base form /fasile/ there is loss of /l/, raising of /e/, dissimilation of

/i/ to [e], and then glide formation of [i] to [j]. For (7), e.g. *subtil ~ subtís*, Mattoso Câmara assumes that from /subtile/ the /l/ is suppressed in the plural (/subtil/: *subti(l)s = [subtíš]), while Andrade argues that there is elision of /l/, raising of /e/ to [i], and subsequent merger. The interaction of these rules is complex, and their relative ordering is simply stipulated. Since the rules and rule interaction posited above for (6) are so problematic, Lipski (p. 78) claims that these forms are "completely irregular...for obvious reasons, no attempt has ever been made to derive them in a principled way." In spite of the limited number of examples and Lipski's warning, we will later present our analysis, which will account for the regularity of the /-il/ ~ [ej] alternation, even if the number of words is reduced.

3.5 The nasals

There has been a long debate, at least since the early 1940s, regarding the phonological status of nasal vowels in Portuguese. The discussion centers around whether these vowels are underlyingly /Ṽ/ or /VN/ sequences. Proponents of the phonemic status of nasal vowels[2] prefer this non abstract analysis of the phonology of these vowels. On the other hand, advocates of the /VN/ analyses[3] prefer this proposal on morphological grounds. That is, a common underlying form containing /VN/ is attributed to the root in related forms such as *som* [sõ] 'sound', *sonoro* [sunoru] 'sonorous', *origem* [oriʒẽj] 'origen', *originar* [oriʒinar] 'originate' (Mira Mateus 1975:46, cited in Parkinson 1983).

Other evidence also supports the VN analysis.[4] First, with respect to the distribution of the allophones of /r/, the same variant that occurs after a heterosyllabic consonant also occurs after a nasal vowel: Is[X]ael 'Israel', pal[X]ar 'to chat', gen[X]o 'son-in-law' (Mattoso Câmara 1953:93, 1977:70). Second, prefinal heavy syllables are never skipped by the stress rule, and nasalized vowels in penultimate position followed by a consonant pattern the same way; that is, *rápido* 'rapid' is perfectly normal, but nonce **rápindo* is impossible (Reighard and Almeida 1983). This suggests that the rhyme in question is heavy. Third, nasal vowels do not occur in syllables closed by an oral consonant (Cintra 1962:26-31), which can be explained by assuming that only one rhyme consonant is allowed in Portuguese (Wetzels 1991:82, Mattoso Câmara 1953, 1972, Mascherpe 1970:68-9, López 1979:111, Azevedo 1981:38, 90; see also the appendix). Fourth, word-final nasal vowels are resistant to deletion or contraction (Mattoso Câmara 1953), which follows from their

underlying VN, not Ṽ, status, since only after further rules changed VN to VṼ would the nasal vowel meet the description for sandhi phenomena to take place (Wetzels 1991:81; this argument is challenged by Parkinson 1983:168-71). Fifth, the diphthongization of final /-ẽ/ to [ẽj̃], as in *bem* [bẽj̃] 'well', is more straightforwardly explained as a process that alters the final segment of a two-segment sequence (Parkinson 1983:161). Sixth, the variable realization of nasality, e.g. *finca* 'farm' [fĩĩka ~ fĩñka ~ fĩŋka] (Cagliari 1981:85, cited in Wetzels p. 81) is easily explained by the VN analysis as either the loss of the consonantality of the nasal or as its assimilation to a neighboring segment. Lastly, phonetic studies indicate that the nasal vowels of Portuguese are different from those found in French, for instance. That is, there is nasalization mainly on the second half of the vowel, which according to the VN analysis, corresponds to the slot occupied by the underlying nasal (Trigo 1993:388-89 cites Lacerda and Strevens 1956, Lacerda and Head 1952, Morais Barbosa 1965, Mira Mateus 1975:94 and Stevens, Andrade and Viana 1988; Morais Barbosa 1965 cites Louro 1954-55:242).

Given the various phonetic realizations of the underlying sequence, the issue arises as to the exact nature of this nasal segment. Early accounts assumed it was the neutralized nasal archiphoneme /-N/ (e.g. Mattoso Câmara 1970); others assumed that it is some sort of transitional element (Lacerda and Hammarström 1962:123, Louro 1954-55:242, both cited in Morais Barbosa 1983:84-85) or a 'relaxed *n*...like a glide, a transition sound from the vowel to the following occlusive' (translated from Morais Barbosa 1983:87). In generative accounts, this segment has received many names: it is the *mora-nasal* with no place of articulation of McCawley (1968:84), the *anusvara* of Trigo (1988:123), and is an 'incomplete segment' lacking a Place of Articulation (PA) according to Wetzels (1991:77); Girelli (1988:133) assumes that this segment is unspecified for the feature [consonantal]. The ultimate phonetic realization of the nasal consonant depends on what processes affect this segment (loss, assimilation, etc.). When the preceding vowel in nasalized, it is often assumed that the nasal element has undergone nucleation, forming a complex nucleus analogous to the structure of a diphthong (Parkinson 1983:158). Similar structure is proposed by Girelli (p. 133). Wetzels (p. 88) comments that it should not be surprising to see nasal consonants in the nucleus given the relative ease with which they become syllable peaks (though they do not in Portuguese). Trigo (1988:123), though discussing Gbe, in the spirit of de Chene and

Anderson (1979) also assumes that the change from V+N to Ṽ results from the shifting of the nasal glide from coda to nuclear position (this then triggers monophthongization in Gbe from ṼṼ to Ṽ).

Evidence supporting the nucleation of /n/ comes from the data concerning the breaking of hiatus (Parkinson 1983:163): e.g., *sim, é*, 'yes, it is', is pronounced [sĩ ˀ̇ ɛ], analogous to *é, é* [ɛ ʲɛ] 'it is, it is'. Thus, there is no evidence to show that the nasal is in coda position, since if it were, we would expect *sim, é* to be realized as *[si.nɛ], contrary to fact. The resyllabification data is thus consistent with the proposal that the nasal comes to be part of the syllable nucleus, having moved from the coda position that other consonants occupy.

Lastly, there is additional data cited from Brandão de Carvalho (1988) that is consistent with nucleation: compare the pairs *pesco* 'I fish' [pɐš kº] / *pescar* 'to fish' [pəš 'kar] and *meto* 'I put into' ['me tº] / *meter* 'to put into' [mə 'ter] with the pairs *deito* 'I lay, spread' [dɐy tº] / *deitar* 'to lay, spread' [dɐy 'tar] and *sento* 'I sit' [sẽn tº] / *sentar* 'to sit' [sẽn 'tar]. Here we see that both atonic open syllables and atonic syllables closed by /-s/ undergo reduction, while in those syllables closed by a glide or nasal there is no such reduction. This may be attributed to their both having a complex nucleus. See further discussion in section 3.4, and fn. 12.

4 A constraint-based analysis

In this section we elucidate the analysis we propose, showing that the various surface realizations are the result of the interaction of a set of morphological, prosodic and faithfulness constraints.

4.1 Theoretical preliminaries

Optimality Theory ('OT', Prince and Smolensky 1993) posits that a grammar is a set of ranked 'soft' or violable constraints. A component called the Generator (GEN) produces a set of candidate output forms whose satisfaction of the constraints is determined in parallel by the Evaluator (EVAL). The optimal output form *minimally violates* the set of constraints that define the grammar under study; that is, a surface form may not satisfy all the constraints of a language, yet still be optimal or preferable to others that violate higher-ranked constraints.

Sample tableaux are given in (11) and (12) that visually illustrate how an

OT grammar functions. The assumed underlying form is given in the upper left cell of the tableau and potential output forms are listed as candidates in the first column. Across the top of the tableau are the universal constraints whose relative importance in a given language is indicated by the ranking they are given; the more dominant a constraint the further left it appears in the tableau. An asterisk indicates a violation of a constraint, and an exclamation point indicates that a violation is 'fatal', that is, that this particular violation is the reason the candidate output is eliminated from consideration when compared to the optimal output. ☞indicates the optimal candidate, i.e., the actual output for the language.

(11)

/input/	Constraint 1	Constraint 2
Candidate output 1	*!	
☞ Candidate output 2		**

(12)

/input/	Constraint 1	Constraint 2
Candidate output 1	*	**!
☞ Candidate output 2	*	*

In (11) Candidate output 1 violates Constraint 1, and because Candidate output 2 does not violate Constraint 1, Candidate 1 is eliminated from consideration. For (11) then, Candidate output 2 is optimal, as indicated by ☞, even though it incurs two violations of lower-ranked Constraint 2. In (12) both Candidates violate Constraint 1, and the determination of optimality is effected by the satisfaction of Constraint 2. Here, Candidate 1 twice violates Constraint 2, while Candidate 2 only violates it once. Hence, the fatality of the second violation of Constraint 2 is indicated with '!'. Optimal Candidate 2 is likewise indicated by ☞.

An important group of constraints that comprise the grammar of a language is the faithfulness family of constraints, which regulates the relation of features and structures between underlying representations and their surface manifestations.

Here we will assume a Correspondence interpretation of the faithfulness constraints. In a Correspondence-based approach to faithfulness the familiar PARSE constraint may be redefined as follows:

(13) MAX-IO (INPUT-OUTPUT):

Every element of the input has a correspondent in the output.
(McCarthy and Prince 1995:264)

This constraint is satisfied when all the elements in the input correspond to elements in the output. In derivational terms this would amount to the requirement that no information from the input be lost, deleted, unparsed, transformed or destroyed.

Similarly, a Correspondence-based version of FILL is that in (14):

(14) DEP(ENDENCY)-IO:
Every element of the output has a correspondent in input.
(McCarthy and Prince 1995:264)

As with FILL, this constraint is violated when there are elements in the output that are not part of the input. In derivational terms this would mean no epenthesis or insertion of elements.

Finally, the IDENTITY family of constraints enforces identity between the feature values in the two corresponding strings:

(15) IDENT(ITY)-IO [F]
Output correspondents of an input [γF] are also [γF].
(McCarthy and Prince 1995:264)

Apart from these constraints demanding faithfulness between input and output, we wish to introduce morphological constraints that directly affect the realization of the plural morpheme. We will employ the cover term MORPHOLOGY for these constraints, but will not enter into precise formalization here.[5] One of these constraints controls the phonological form of the plural morpheme and establishes a correspondence relation between the morpheme and the segment /s/; another determines the location of this morpheme as the right edge of the Prosodic Word.

(16) MORPH(OLOGY) (informal definition):
The plural morpheme is /s/ and is realized at the end of the word.

4.2 The unmarked case of pluralization

As mentioned in sections 2 and 3.1, all previous studies assume that for words ending in a vowel or nonnasal glide, /-s/ is simply concatenated to the singular form to form the plural. In OT, this concatenation is not the result of a rule, but is instead one of the possible outputs of GEN. Then, EVAL must select the candidate with an /-s/ concatenated at the right edge of the word as the optimal candidate for a plural form. For our analysis, it is the effect of MORPH that selects the correct candidate in cases of unmarked pluralization. With the constraints presented we can account for the first set of data in (1):

(17) Vowel- and nonnasal glide-final words:

casa casa+s 'house(s)'

/casa + s/	MORPH	MAX	DEP
☞casas			
casaes			*!
casa	*!	*	
casap	*!		
cassa	*!		

For the unmarked examples all relevant prosodic constraints are satisfied in the optimal candidate, so no further complication needs to be noted in this regard. It is worth indicating that regardless of the ranking of these three constraints the optimal candidate is always *casas*. This set of data was unproblematic for all previous accounts and it is still unproblematic on our account.

4.3 Identical singular/plural pairs

Why is the plural of *simples* 'simple' *simples*, rather than *simpless*? Obviously, what is "wrong" with this expected "regular" output is the sequence of two identical segments. The Obligatory Contour Principle (OCP) (see, among others, Goldsmith 1976) disallows such a sequence.

(18) OCP

Identical adjacent elements are disallowed at the melodic level.

Still we might expect that the result of concatenating *-s* to a word-final /s/ would be the long segment ([š:]). In this case, there would be no OCP violation

since all the melodic nodes are shared and only the two mora units remain in the output.

(19) simples + s → simple s
… | | ∧
μ μ μ μ

This kind of candidate would violate *LONG (see Rosenthall 1994, and others, for the more specific *LONG-V)**.***

(20) *LONG
Long segments are not allowed.

Since the output is neither long nor a sequence of identical segments we can assume that *LONG and OCP are dominant constraints.

The simplification of *s*+*s* → [š] could also be a case of tier merger up to the level of the mora; alternatively, it could be argued that since inflectional morphemes are ignored by the stress system, they do not carry a mora. In any of these cases, the output would neither be long nor would violate the OCP. In this case, the constraint affected is *MULTIPLE CORRESPONDENCE:

(21) *MULTIPLE CORRESPONDENCE (*MC)
Elements of the input and output must stand in a one-to-one correspondence relationship with each other.
(Lamontagne and Rice 1995:218)

The kind of structure that this constraint targets is exemplified in (22):

(22) simples + s INPUT
\ /
simples OUTPUT

Finally, there are two further possibilities that need to be considered: (i) the plural morpheme is not parsed; (ii) the final /s/ of the stem is not parsed.

Graphically, these last two options can be depicted as in (23):

(23) Option (i) Option (ii)
simples + s simples + s
… | | … | |

simples O simpleO s

On our analysis, the first option is a violation of MAX and MORPH because the plural morpheme does not have a correspondent in the output string. The second option violates MAX but satisfies MORPH.

Because all plurals end in /s/ in Portuguese, we will assume that MORPH is undominated. Next, the ranking posited between Max and DEP follows from the observation that in general the language favors epenthesis over deletion to avoid problems of syllabification (e.g., /piknik/ → [pi.kə̲.nikə̲]). Vowel length, which had been contrastive in Latin, was lost in Late Latin due to a constraint reranking by which *LONG became stronger than MAX. Finally, the ranking of DEP with respect to *MC seems problematic, however, because in order to account for identical singular and plural pairs we would need to posit that DEP dominates *MC.

(24)

/simples + s/	OCP	MORPH	*LONG	MAX	DEP	*MC
simpleses					*	
☞ simples (s s)						*
simplesO		*!		*		
simpleOs				*!		
simples:			*!			
simpless	*!					
simplest		*!				
simplesi		*!				

However, it is obvious that the same set of constraints with the same ranking could not derive the data in (3), where we have cases of words ending in /-s/ with final stress. *Português* has the plural form *portuguêses* not **português*. In order to get plural *portuguêses*, we would need a ranking reversal of DEP and *MC. This possibility is to be rejected for two reasons: (i) allowing constraint reversals considerably weakens the OT machinery, since it forces us to give up assumptions central to the theory (see Inkelas, Orgun and Zoll 1995); and, (ii) treating this problem as a reversal for exceptional cases would miss the generalization that all of these exceptions, apart from ending in

/s/, also have final stress.[6]

The key difference between the examples in (2) and those in (3) is the location of stress. We have then, a peculiar situation were the plural form is predictable from stress. However, since stress is not underlyingly specified, there must be some difference in the lexical entry able to predict both the difference in stress pattern and the concomitant difference in pluralization. As mentioned above, an analysis based on morphological structure (along the lines of what Harris 1980 proposes for Spanish) is not viable in Portuguese. Our position here is that coda consonants in Portuguese are moraic, meaning that they are included in the computation of stress assignment. This accounts for the fact that in consonant-final words the unmarked pattern is ultimate stress, as Lipski says (see the end of section 3.3). In this setting, a word such as *simples* has a marked stress pattern. Our contention is that this markedness has to do with the fact that the final /s/ fails to project a mora. Then, the situation we want to explain is that the merging of the final /s/ with the plural *-s* is preferred only when the final /s/ is not associated to a mora in the singular. The plural morpheme is arguably never associated to a mora, since it never alters the location of stress of the singular form. This fact can be interpreted as the result of a constraint specifically banning the association of the plural morpheme to a mora. We will refer to this constraint as *MORA-PL. This allows us to solve the problem of the ranking between DEP and *MC. In agreement with general tendencies of the language, we postulate that merger of compatible segments is the preferred option. However, when the result of merger is not well-formed, epenthesis (or some featural change) has the opportunity to apply. This is reflected in the ranking *MORA-PL » DEP » *MC.

(25)[7]

/portuges +s/	MORPH, OCP	*MORA-PL	*LONG	MAX	DEP	*MC
☞portug[é]ses					*	
portug[é]s /\ s s		*!				*
portug[é]Os				*!		
portug[é]sO	*!			*		
portug[éš:]			*!			
portug[é]ss	*!					
portug[é]set	*!				*	
portug[é]si	*!					

In the case of *simples*, *MORA-PL does not have a bearing on any of the candidates, and the effect of the normal setting of the language that favors fusion emerges.

(26)

/simples + s/	MORPH, OCP	*MORA-PL	*LONG	MAX	DEP	*MC
s[í]mpleses					*!	
☞s[í]mples /\ s s						*
s[í]mpleOs				*!		
s[í]mplesO	*!			*		
s[í]mple[s:]			*!			
s[í]mpless	*!					
s[í]mplesi	*!					*
s[í]mplest	*!					

The data in (4) (words ending in /r/ taking the plural [eš], e.g., *favor* ~ *favores*) are identical to the data in (3), and so nothing needs to be added to the order of the constraints. The final consonant is moraic and distinct from the morpheme /s/ that is added, and consequently merger is not possibile. Nonetheless, in the following tableau we add a new constraint. A suboptimal candidate such as *favors* shows that there are syllabic constraints dominating DEP and MAX. This is confirmed by the general tendency of Portuguese to solve syllabification problems by epenthesis (e.g., *club* borrowed in CP as [klúbə],

picnic as [pikəníkə] etc.; BP shows epenthetic [i]). It is clear that we are dealing here with limitations on what segments Portuguese allows in coda position.[8] Nevertheless, the correct implementation of coda limitations is again tangential to our concern here. We will refer to these limitations with the general label SYLL. Candidates that receive a mark for SYLL contain ill-formed syllables.

(27)

/favor + s/	MORPH	SYLL, *MORA -PL	*LONG	MAX	DEP	*MC
☞favores					*	
favors		*!				
favort	*!	*				
favori	*!					
favorO	*!			*		
favoOs				*!		

So far, the stated constraints and the proposed ranking account for the data in (1)-(4). To simplify the exposition of the illustrations, we omit MORPH from further discussion and tableaux, given that we do not have evidence that it is ever dominated in Portuguese (i.e., plurals end without exception in [š]). Accordingly, we will no longer take into account candidates that violate MORPH since they cannot be optimal. We will further tend to omit from discussion constraints not playing a direct role in the computation of the optimal candidate.

4.4 Vocalization and velarization of /l/

The set of data in (5)-(6) contains examples of plurals of words that end in /l/. We repeat here one example of each group for ease of reference.

(28)	*hotel*	/otel/	[o.téɬ]	'hotel'
	hoteis	/otel+s/	[o.téjš]	'hotels'

Notice the alternations between /l/ and [ɬ] word-finally, and more importantly, between /l/ and [j] in the plural. We need to explain what eliminates candidates such as [o.télš] or [o.téɬš] from contention. As we shall see, this follows from syllable structure constraints.

(29) Words ending with unstressed /il/ realized in the plural as [ejš]:

fácil	/fasil/	[fá.siɬ]	'easy'
fáceis	/fasil+s/	[fá.sejš]	'easy pl.'

Here the question is why [ijš] should be suboptimal. Clearly, the answer has to make reference to the OCP.

(30) Words ending with stressed /il/ realized in the plural as [íš] (not [éjš]):

fuzil	/fusil/	[fu.zíɬ]	'rifle'
fuzís	/fusil+s/	[fu.zíš]	'rifles'

Here again we have an OCP-related problem. However, in this case, the optimal candidate merges the sequence [íj] to [í] instead of lowering the first element ([éjš]). Why in this case is merging better than lowering?

For each of these questions our analysis will provide an explanation. First, though, we need to discuss what the observed alternations have in common.

4.4.1 Velarization and gliding as nucleation

The possibilities of alternation of final /l/ may seem unrelated if we see them as transformations (/l/ → [j] and /l/ → […]). However, these two processes begin to converge when we realize that behind the names *velarization* and *gliding* what we have is two different manifestations of nucleation (Colman 1983, Parkinson 1983, Girelli 1988). For the present analysis we want to show that a tendency toward nucleation results in [j] or […] depending on the phonological context.

Let us start by stating that the vocalization of /l/ is not an uncommon process. Within the family of Romance languages, examples are abundant. Walsh (1995) gives Balearic Catalan as an example, and cites the alternation between Standard Catalan *alba* 'sunrise' with Balear Catalan *aube* (from Alcover and Moll 1968). Von Essen (1964) cites the change from Late Latin /l/ to [u] in Provençal when final; Portuguese syllable-final /l/ acquires a strong velar component and approaches [u] in CP, and actually is [w] in BP; the same change occurs in French, e.g. Lat. *caballo* 'horse' > Fr. *cheval, chevaux*;

ascultat 'listen' > *écoute*; *alba* > *aube*, etc.[9] Syllable-initially, /l/ may also become [j], as in the change in Italian of Latin *Cl* sequences: *plenu* 'full' > *pieno*, *clave* 'key' > *chiave*, *glande* 'acorn' > *ghiande*, *flamma* 'flame' > *fiamma*, etc. Expanding our view beyond Romance, we see the change from /l/ > /i/ in syllable-final position as well, as in the Bavarian dialect of German: *Holz* 'wood' is [hoits], and in the Munich dialect /l/ has been completely changed to [i], e.g. *foisch* 'false' and *hoib* 'half' (Sütterlin 1916:121, cited in von Essen 1964). This occurs synchronically in Cibaeño Spanish as well (see Guitart 1989), where *él* 'he', e.g., is pronounced [ey] in all contexts. In West Polish [w] is traced to [ɬ], as in [ɬan] > [wan] 'field', and a similar phenomenon occurs in the Low German dialect of Vierlanded, where, for instance, *hell* 'clear, light' was pronounced [hew], *School* 'school' is [šewʊ], *kalf* 'calf' is [kawf] (von Essen 1964). Finally, Walsh (1995) gives further examples from Polish, where /l/ > /w/ in all positions (Walsh cites Carlton 1991), and Trigo (1988:69) cites /kšaɬt/ → [kštawt] 'shape', and other examples. This same alternation occurs in Mehri (southern Arabian Semitic) in coda position: [ɬo:leθ] 'third (masc.)' vs. [ɬ ewθe:t] 'third (fem.)' (Johnston 1975, cited by Walsh). The Portuguese data, then, represent neither a surprising nor isolated case.

We follow Lipski (1973) in assuming that the loss of /l/ in the Portuguese cases is not 'intervocalic', and so we reject the claim that the input contains a final /e/, which would then be either apocopated (in the singular) or glided (in the plural).

To account for this vocalization we adopt here an assumption tacitly made by Girelli (1988), and explicitly made by Colman (1983:32-33). That is, 'vocalization' is to be understood as the loss of consonantal properties, a consonantal sound thus becoming a (more) vocalic one. Colman assumes that vocalization is really 'nucleation', whereby a (possibly lenited) consonantal (now approximant) allophone moves into the nucleus. The restructuring created by the nucleation brings about vocalization. Colman further assumes (p. 34) that if the nuclear pattern that results does not match an existing template, and the vocalized element cannot remain in the coda, it may be lost. Evidently, this is only sometimes the case in Portuguese since the segment is either velarized, vocalized or lost.

We assume that /l/ is forced into the nucleus when it is followed by a tautosyllabic consonant (the [l] and the following consonant in *maldad* 'evil', *palrar* 'to chat', etc. are heterosyllabic) because in this situation it cannot

occupy coda position.[10] For BP, it appears that the limitations on the coda may be formulated quite generally, simply disallowing any consonant in the coda, as Girelli explicitly assumes, since in syllable-final position /l/ is always vocalized to [w] or [j]. This stronger limitation on the possibilities of the coda also explains why nearly all consonant clusters in BP are eliminated by epenthesis, as in *obter* 'to obtain' [ob i téX], *enigma* 'enigma' [enig i ma], *admirar* 'to admire' [ad i miráX], etc. For CP, /l/ is merely strongly velarized to […] in syllable-final position, but is vocalized to [j] when it occurs next to the plural /-s/ (showing that the CP coda is just slightly more permissive). Velarization of /l/ may be viewed as an intermediate realization between [l] and [w]. As Sproat and Fujimura's (1993) experimental phonetic data show, all [l]s contain both coronal and dorsal articulations. The difference between the so-called 'light' and 'dark' [l]s is the position each occurs in syllable structure, with the vocalic dorsal component having an affinity with the syllable nucleus.[11] This velarization is particularly strong in CP because the secondary dorsal PA is actually incorporated into the nucleus. This is the preliminary stage Colman discusses before complete nucleation occurs. This next step is the realization of /-l/ in BP as [w], since fewer coda consonants are permitted, and so the primary CPlace coronal node is eliminated. In both BP and CP, however, the coronal Place of Articulation of plural /-s/ must be maintained (as a result of MORPH). Our position is, then, that [ɬ] is a case of partial nucleation that follows from coda avoidance. While in CP this partial nucleation seems to be enough when [ɬ] is the only segment in the coda, it is clearly not sufficient in BP, or in CP when the /s/ from the plural can only dock to the same coda position. In that sense we can say that the presence of the plural morpheme pushes the /l/ into the nucleus.[12]

4.4.2 Analysis of lateral nucleation

In order to keep our representations simple, we will subsume the previous discussion of syllable structure constraints under the label SYLL. Again, examples that would violate constraints that govern syllable well-formedness (specifically coda constraints) are assigned a mark under this constraint. Likewise, the following examples include the constraints IDENT introduced above in (15). Below we show how the data in (5) (words ending in stressed *-al, -el, -ol, ul*) is accounted for with the same constraint ranking, provided that

IDENT is ranked below DEP:

(31)

/otel + s/	SYLL	MAX	DEP	IDENT
(h)otelš	*!			
(h)ote…š	*!			*
☞(h)otejš				*
(h)oteOš		*!		
(h)oteleš			*!	

Thus, we now can explain why *hot*[elš] and *hot*[e…š] are not optimal: these candidates violate Portuguese coda well-formedness constraints. Other candidates still competing for optimality are eliminated by the faithfulness constraints, ranked in Portuguese as MAX » DEP » IDENT. In this situation, the change of value for the feature [lateral] turns out to be the least marked option. Without the feature [+lateral] the segment is able to be realized as a glide in the nucleus.[13]

Next, for the set of data in (6), where we see that unstressed *-il* is realized as [ejš] in the plural, it is obvious that candidate [facijš] is discarded by the OCP.

(32)

facil + s	OCP	SYLL	*LONG	MAX	DEP	*MC	IDENT
facilš		*!					
faci…š		*!					*
☞facejš							**
faci:š			*!				*
facijš	*!						*
faciOš				*!			
facileš					*!		
faciš i ⌒ l						*!	*

As with the words in (5), here the morphological requirements (MORPH) can only be upheld when /l/ is realized in the nucleus as a glide. The special situation here is that this glide clashes with the high vowel that has nowhere else to dock but to the same nucleus. In this example, IDENT must be crucially ranked below *MC, implying that changing feature values of the underlying form is a preferred strategy to fusion even when the outcome of the fusion

would be well formed.

Finally, the special case of words ending in stressed *-il* (the data in (7)) must be taken into account. As it stands, the proposed set of constraints fails to select the correct plural form [fuziš] (from /fuzil+s/) over the competing candidate [fuzeiš]. Again, the key difference between [fá.si…] ~ [fá.sejš] and [fu.zí…] ~ [fu.zíš] is stress location. It has been repeatedly observed in the phonological literature that stressed vowels are more resistant to any kind of alternation than their non-stressed counterparts. Evidence for this observation can be found within the language in the pattern of reduced and full vowels that correspond to stressed and unstressed vowels. One way to interpret vowel reduction is to assume that, in general, vowels have a tendency to be reduced (to be mid and central). However, this process of reduction is blocked when the vowel carries main stress. The blocking of this tendency to reduce vowels, and the blocking of the /i/ ~ [e] alternation at hand, can be seen as the result of a constraint of the HEAD-CORRESPONDENCE family, (for related discussion of the tendency for the head to resist change, see Alderete 1995, Kenstowicz 1995, Itô, Kitagawa and Mester 1995, McCarthy 1995; for vowel reduction, see Alderete 1995):

(33) HEAD(PRWD)-IDENT[F]
Correspondent segments in the head[14] of the PrWd agree in value for the feature (α). (Adapted from Alderete 1995:14)

This is an identity type of faithfulness constraint that requires that the features in the input agree with the features in the output. However by ranking HEAD-IDENT constraints above all other IDENT constraints we can account for the fact that the head features are more resistant to alteration. Again, since we do not have evidence in our data showing that the features of the head are altered we will represent HEAD(PRWD)-IDENT(α) as undominated. Now we can demonstrate that [fuzíš] is better than [fuzeiš]. Furthermore, since fusion is preferred to epenthesis, [fuzíš] is better than [fuzileš]:

(34)

fuzil + s	H-IDENT, OCP	*LONG, SYLL	MAX	DEP	*MC	IDENT
fuzílš		*(S)!				
fuzí…š		*(S)!				*
fuzéjš	*(H)!					*
fuzí:š		*(L)!				*
fuzíjš	*(OCP)!					*
fuzíOš			*!			
☞ fuzíš /\ i l					*	*
fuzíleš				*!		

4.5 Nasals

Vowel nasalization is quite systematic when a stressed vowel is followed by a nasal.[15] We assume that nasalization is a process of assimilation of the vowel to a following nasal. This assimilation is limited to stress vowels because nasal vowels are not allowed in unstressed position. In many cases, nasalization of the vowel is complemented by apparent deletion or gliding of the nasal. As discussed in section 3.5, we argue that nasal loss and gliding should be interpreted as nucleation. This puts /n/ gliding or loss and /l/ gliding or velarization at the same level. This is a desired result because now the relation between these processes and pluralization emerges quite naturally, and is entirely consistent with the data from Brandão de Carvalho discussed in section 3.5 and fn. 12. It simply makes sense that if the grammar reacts to the concatenation of /s/ to a word ending in /l/ by pushing the lateral into the nucleus, the tendency should be the same when /s/ is concatenated to any other word-final consonant. Nasal loss, nasal gliding, lateral gliding and lateral velarization are examples of the grammar resorting to nucleation. However, as we saw above, when /-s/ is concatenated to /r/ (or some instances of /s/) at the end of a word, the optimal result shows epenthesis instead of nucleation (*mar* ~ *mares*). This can be explained in OT if the nucleation of /r/ and /s/ (and any other consonant other than /n/ and /l/ as well) entails stronger violations than epenthesis, while at the same time epenthesis is worse than the adjustments required for the nucleation of /n/ and /l/.

As we saw in the previous section when discussing lateral gliding, nucleation can be readily related to a lateral not being able to be parsed into a

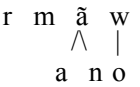
well-formed coda. Similarly, nasals not allowed in a coda are better realized as glides in the nucleus (e.g., /pans/ → [pãȷ̃s]). However, the role of coda conditions is not evident in examples such as /irman+o/ → [irmãw̃] or /irman+o+s/ → [irmãw̃š]. Here syllabification should be able to assign the nasal to an onset that would form a syllable with the following vowel. Nonetheless, we interpret this alternation as the result of nucleation, instead of as deletion as in traditional accounts.[16]

4.5.1 Nucleation of onset nasals

To explain /irman+o/ → [irmãw̃] we need to posit a constraint, other than coda limitations, that can push the coronal nasal towards the preceding syllable. Our contention is that *STRUCTURE (see Prince and Smolensky 1993:25, fn. 13) is the constraint behind this kind of nucleation.

(35) *STRUCTURE (*STRUC)
Structure should be constructed minimally.
(Prince and Smolensky 1993:25, fn. 13)

Up to this point, nucleation has surfaced as gliding or velarization (for laterals). However, it is not clear that the glide in [irmãw̃] is the surface manifestation of the nasal. Instead, we posit that the nasal is totally merged with the vowel, allowing for the gliding of the final /o/. The following figure illustrates the correspondence relationship between input and output elements in a similar fashion to the representations we are using in the tableaux.

(36)


Since Portuguese has nasal vowels, the merging of the nasal with the previous vowel is a possibility that avoids unnecessarily adding an extra syllable. Thus, as long as *STRUC is ranked above *MC we obtain the kind of merging in (36).

However, with just *STRUC we would not be able to explain why merging does not take place if the preceding vowel is unstressed (cf. *irmanar*). Furthermore, there are a number of other peculiarities about the merging of nasals that deserve some consideration. For instance, merging does not happen if the nasal is not coronal (cf. /cam+a/ → [kãma], *[kãa], *[kã] 'bed'; /puŋ+o/

→ [pũŋo], *[pũo] ‘fist’). This limitation to coronal nasals is expected if only coronals are unspecified for PA. It is true that there are a handful of exceptions to the generalization that coronal nasals are always totally merged into the nucleus (e.g. *cana* [cãna], *[cãa] ‘sugar cane’). However, most of these exceptions derive from Latin geminate /nn/, and may be handled in a manner similar to that discussed in fn. 8. Moreover, nucleation may be blocked if the coronal nasal is followed by a consonant (cf. /kaNp+o/ → [kãmpo] ~ [kãpo] ‘field’). Here, the variability indicates resistance to nucleation effected by interference of nasal assimilation. Assimilation and nucleation may enter in conflict, canceling out each other and giving rise to free variation. The interplay of nucleation and assimilation is made evident by the specific array of possibilities of variation for *finca* ‘farm’ [fĩĩka ~ fĩñka ~ fĩŋka] (Cagliari 1981:85, cited in Wetzels p. 81).

A peculiarity of nasals that is not easy to explain is that in their tendency to group with the preceding vowel they may be totally merged or surface as a glide. If nucleation can trigger either gliding or total merging we must be able to predict under what circumstances one or the other is optimal. In the following figure we illustrate the context of gliding and merging:

(37) *Gliding*

a.	/pan/	[pãw̃]	‘bread’
	/pan+s/	[pãj̃š]	‘breads’
	Total Merging		
b.	/irman+o/	[irmãw̃]	‘brother’
	/irman+o+s/	[irmãw̃š]	‘brothers’

The generalization is that gliding takes place only at the end of the word and before the plural morpheme.

Our claim here is that what controls whether gliding or total merging is optimal is the constraint WEIGHT-TO-STRESS.

(38) WEIGHT-TO-STRESS (Σ=μμ)
The head of the PrWd must be bimoraic.

Several authors (Repetti 1989, Morales-Front 1994, Holt (in preparation), among others) have noticed that there is a tendency in Romance languages for a tonic nucleus to be bimoraic. In some Italian dialects this tendency may give rise to long vowels, and in Spanish it may be responsible for diphthongization. This

kind of correlation between stress and complex nuclei is also at the base of nasal nucleation in Portuguese when a tonic nucleus attracts a following nasal.

As noted in fn. 14, we assume that the head of the PrWd is the vocalic nucleus. Consequently, a moraic coda would not satisfy WEIGHT-TO-STRESS; only a long vowel or a diphthong in the nucleus does. As formulated, Σ=μμ explains why the attraction of the nasal to the previous nucleus happens only when that nucleus carries the main stress. This constraint must be ranked below *LONG since we do not want all tonic vowels to be long. Similarly, it must rank below DEP to avoid generalized diphthongization. As shown in the following tableau, the glide surfaces when merging would not satisfy WEIGHT-TO-STRESS.

(39)

/pan/	SYLL	*LONG	MAX	Σ=μμ	IDENT
pan				*!	
pã /\ an				*!	
pãã		*!			
☞pãw̃					*

WEIGHT-TO-STRESS favors the nasal surfacing as a glide because in that realization it contributes to the weight of the nucleus. However, this gliding is not always possible. With an input such as /irman+o/, if the nasal were realized as a glide and parsed with the nucleus of the preceding syllable ill-formed syllable structure would ensue (*[ir.mãw.o]). Parsing the glide into the onset would not help because it would still clash with Portuguese syllable structure (or sonority) restrictions that disallow a glide as the only member of an onset. Likewise, in words such as /kamp+o/, gliding would conflict with assimilation (*[kãw̃.po]).[17] Since an assimilated nasal and not a glide is what surfaces we have to conclude that assimilation is more important. Finally, a word such as /kam+a/ does not have the kind of nasal (unmarked PA) that can be realized as a glide. Gliding can take place at the end of a word because in this position there is no lexical nasal assimilation and therefore no conflict. It can also arise before the palatal segment of the plural since in this case there is no conflict between assimilation and gliding. That is, both constraints can be satisfied simultaneously, as in, e.g., [pãj̃š].

4.5.2 Nucleation of onset nasal: the analysis

Having argued that WEIGHT-TO-STRESS and *STRUC are the constraints behind what we have termed "onset nucleation", we provide here an explanation of the data that falls under this label. For masculine plurals the following set of alternations has to be accounted for: (repeated from (8))

(40)	[ãw̃]	~	[ãw̃š]:	(< Lt. -anu(s))	
(=(8a))	*irmão*		/irman+o/	[irmãw̃]	'brother'
	irmãos		/irman+o+s/	[irmãw̃š]	'brothers'
(41)	[ãw̃]	~	[õj̃š]	(< Lt. -one(s))	
(=(8c))	*patrão*		/patron/	[patrãw̃]'patron'	
	patrões		/patron+s/	[patrõj̃š]'patrons'	
(42)	[ãw̃]	~	[ãj̃š]	(< Lt. -ane(s))	
(=(8e))	*pão*		/pan/	[pãw̃]	'bread'
	pães		/pan+s/	[pãj̃š]	'breads'

Synchronically, each group has a different plural form but an unexpected uniform ending [ãw̃] for the masculine singular. As indicated, each of the groups can be traced to different Latin endings: *-anu, -one, -ane*. In Late Latin those endings were arguably *-ano, -on* and *-an,* which are the underlying forms posited for our analysis.

From these underlying forms the correspondences between base and surface form are as represented in (43):

(43)

We first illustrate how Σ=μμ triggers nucleation in examples such as /irrman+o/ → [irmãw̃].

(44)

/irman+o/	SYLL, *LONG	MAX	DEP	Σ=μμ	*MC	IDENT
ir.mã.n o | | | a n o				*!		
ir.mã. o /\ | an o	*!			*	*	
☞ ir.mãw̃ /\ | an o					*	*
ir.mãã.n o | | | a n o			*!		*	
ir.mã. O /\ | an o		*!		*	*	

The most faithful candidate to the input (*irmano*) fails because the stressed nucleus is not heavy. Additionally, this tableau shows that Σ=μμ must crucially outrank *MC. Among the candidates that do not violate Σ=μμ, the one with total merging of the nasal into the previous vowel and gliding of the final /o/ results optimal. We follow here Girelli's assumption with regard to the underspecification of nasals that they are unspecified for the feature [consonantal] because of the morphological alternations given in (8). As previously mentioned, this is consistent with Inkelas' (1995) arguments that only features that alternate are underspecified.

The alternation of the corresponding feminine form can be accounted for in similar terms. The difference here is that the final vowel cannot form a glide. Instead, since it is identical to the vowel preceding the nasal it can be merged. As argued above, *STRUC is ranked above *MC.

(45)

/irman+a/	SYLL, *LONG	MAX	DEP	Σ=μμ	*STRUC	*MC	IDENT
ir.mã.n a | | | a n a				*	*!		
ir.mã.w̃a | | | a n a	*!			*	*		*
ir.mã n O | | | a n a		*!		*			
ir.mãã.n a \\\| | | a n a	*!		*		*		
☞ ir.mã /|\\ ana				*		*	

Both [irmãna] and [irmã] violate Σ=μμ; consequently, what determines the outcome is that the former has an extra syllable (*STRUC), while for the latter the next violation is the more lowly-ranked *MC.

For the plural, the addition of /s/ to the coda does not affect the number of marks incurred by each candidate.

(46)/irman+o+s/ [irmãw̃s̃] 'brothers'

/irman+o+s/	SYLL, *LONG	MAX	DEP	Σ=μμ	*STRUC	*MC	IDENT
ir.mã.n o s | | | | a n o s				*!	*		
ir.mã. o s /\\ | | an o s	*!			*	*	*	
☞ ir.mã w̃s /\\ | | an o s						*	*
ir.mãã.n o s \\\| | | | a n o s	*!		*		*		
ir.mã O s /\\ | | an o s		*!		*		*	

(47)

/irman+a+s/	SYLL, *LONG, OCP	MAX	DEP	Σ=μμ	*STRUC	*MC	IDENT
ir.mã.n a s | | | | a n a s				*	*!		
irmã.w̃a s | | | | a n a s	*!			*	*		*
irmã.n O s | | | | a n a s		*!					
irmãã.n a s \\| | | | a n a s	*		*!		*	*	
ir.m ã a s |\ | | ana s	*!		*			*	
☞ ir.mã s /|\ | ana s				*		*	*

4.5.3 Nucleation of coda nasals

One detail that must be discussed before moving on to additional tableaux illustrations is the realization of the nasal as a back or front glide. This alternation can be observed in (37) where we have the same underlying nasal realized as [w̃] in the singular and [j] in the plural. Consider also the following set of examples from Trigo (1993:380):

(48)	*fin	>	f[ĩ]	‘end’
	*atún	>	at[ũ]	‘one’
	*pan	>	p[ɐ̃w̃]	‘bread’
	*ándan	>	ánd[ɐ̃w̃]	‘they go’
	*montón	>	mont[ɐ̃w̃]	‘heap’
	*también	>	tamb[ɐ̃ỹ]	‘also’
	*vírgen	>	vírg[ɐ̃ỹ]	‘virgin’
	*ánden	>	ánd[ɐ̃ỹ]	‘they go (subjunctive)’

If [ĩ] and [ũ] are contractions from [iỹ] and [uw̃], then, we can make the generalization that when there is no assimilation to a following consonant, a nasal not specified for PA assimilates to the preceding vowel. That is, it is realized as a front glide when preceded by a front vowel, and as a back glide

when preceded by a back vowel.[18] We do not want to have this assimilation apply to any preceding vowel because nasals in an onset do not become dorsal following dorsal vowels (i.e. *fo[ŋ]ema). The domain where assimilation to the vowel occurs is the nucleus.

(49) VOWEL-AGREEMENT (V-AGR):
Members of a complex nucleus share Place of Articulation features.

However, this alternation between front and back realizations is not maintained when the nasal is followed by the consonant of the plural morpheme [š]. In this context, the nasal systematically surfaces with a palatal place of articulation that agrees with the consonant:

(50)a. /patron+s/ [patrõj̃š] 'patrons'
b. /pan+s/ [pãj̃š] 'breads'

We mentioned above that (50) is the only context where nasal assimilation and gliding are compatible. The fact that a front glide emerges even if preceded by a back vowel (50b) is an indication that assimilation to the consonant has a higher ranking than V-AGR. Assimilation to the following consonant can be formalized as follows:

(51) CONSONANT-AGREEMENT (C-AGR):
Two adjacent consonants must share Place of Articulation features.

We know that V-AGR cannot dominate IDENT (cf. /pan+s/ → p[ãj̃š], *p[ẽj̃š]); we also know that C-AGR dominates V-AGR (cf. /pan+s/ → p[ãj̃š], *p[ãw̃š]) and that C-AGR dominates Σ=μμ (cf. [kãmpo] *[kãw̃po]).

(52) /pan+s/ [pãj̃š] 'breads' (= data in (8e))

/pan+s/	SYLL	C-AGR	Σ=μμ	IDENT	V-AGR
p[ãnš]	*!		*		
p[ãš]			*!		
☞ p[ãj̃š]				*	*
p[ãw̃š]		*!		*	
p[ẽj̃š]				**!	

The singular form has the crucial difference that since there is no consonant following the nasal, C-AGR is not relevant.

(53)/pan/ [pãw̃] 'breads'

/pan/	SYLL	C-AGR	Σ=μμ	IDENT	V-AGR
p[ãn]			*!		
p[ã]			*!		
p[ãj̃]				*	*!
☞ p[ãw̃]				*	
p[ẽj̃]				**!	

The proposed ranking can also account for /patron+s/ → [patrõj̃š]:

(54)

/patron+s/	SYLL	C-AGR	Σ=μμ	IDENT	V-AGR
patr[õnš]	*!		*!		
patr[õš]			*!		
☞ patr[õj̃š]				*	*
patr[õw̃š]		*!		*	
patr[ẽj̃š]				**!	

For the masculine singular we must recall that the first vowel of a nasal diphthong is pronounced as a central low vowel ([patrɐ̃w̃] instead of [patrõw̃]). This is an unexpected result because our constraints would predict [patrõw̃] as the optimal output:

(55)

/patron/	SYLL	C-AGR	Σ=μμ	IDENT	V-AGR
patr[õn]			*!		
part[õ]			*!		
patr[õj̃]				*	*!
☞ patr[õw̃]	*!			*	
patr[ãw̃]				**!	
patr[ẽj̃]				**!	

Of the candidates given above [patrõw̃] is optimal. However, as mentioned in the discussion of the data in (48), the final phonetic output is a diphthong with a centralized version of the back vowel, [ɐ̃w̃]. An additional option given by many previous accounts is that the alternations /on/ → [ɐ̃w̃] and /an/ → [ɐ̃w̃] are a result of analogical influence from the most frequent alternation /ano/→ [ɐ̃w̃]. In either case, the analysis proposed above may be maintained. This completes the discussion of this complex data[19]

5 Conclusion

We hope to have fulfilled the initial goal of reaching a deeper understanding of how the realizations of the plural result from contrasting demands within the grammar. We have shown that there is no need to complicate the lexicon with allomorphs. We have also seen that the morphological process of pluralization is a simple and transparent process of concatenation: without exception /-s/ is concatenated to the end of a singular word to create the plural. Nor does the heavy load of our analysis fall on the grammar, as was the case for previous analyses where there was a proliferation of rules; if all the constraints employed in our analysis are universal, then there is no added complexity. Finally, we have been able to accommodate all of the intersecting processes without having to appeal to any kind of amendment of the basic assumptions of Optimality Theory. It is only the interaction of contrasting demands from morphology, prosody and faithfulness that account for the surface alternations that take place in Portuguese when the plural marker /-s/ is concatenated to the end of a word.

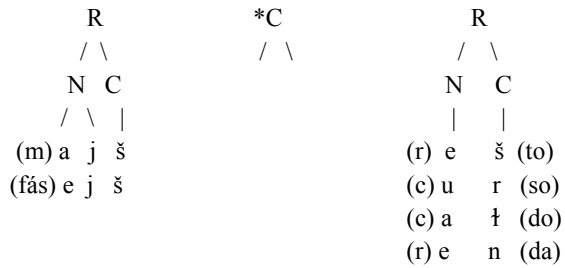
Appendix

Portuguese syllable structure. In this section we outline the structure of the syllable in Portuguese, or more specifically the rhyme constituent, since the onset is not pertinent to the pluralization alternations analyzed here.

While in Latin any consonant (stop, fricative, nasal or liquid) could appear post-vocalically, and /s/ could follow this consonant, Portuguese (and other Romance languages) had a tendency to reduce and/or eliminate closed syllables through a variety of historical processes such as palatalization, affrication, simplification of geminates and consonant groups, vocalization, monophthongization, etc. (Mattoso Câmara 1972:46, Porzio Gernia 1976, Lloyd 1994, etc.). The result is that in Modern Portuguese consonant clusters do not occur syllable- or word-finally (Mascherpe 1970:68-9, cited in Girelli

1988:93; Azevedo 1981:90). Any CC group will necessarily be heterosyllabic, with the C closing the syllable limited to *r, n, l, s* (López 1979:114, Mattoso Câmara 1972:49, Azevedo 1981:38, etc.), or making a generalization, only by sonorants and *s* (Wetzels 1991:82).[20] This has led to the following syllable template, which maximally allows one coda position, which must be filled by either a sonorant or a sibilant (Wetzels, p. 82; López, p. 111):

a)



This template also provides an explanation for why nasal vowels in Portuguese do not occur in syllables closed by an oral consonant, of the type *[kõp.tar], since there are not sufficient structural positions for the /VN/ necessary to yield [ɐ̃].[21] In a word like /transporte/, we would have both /n/ and /s/ in the coda, which is impermissible according the template in (a), and so the [nasal] specification is parsed in the nucleus. In the case of /kampo/, assimilation yields variable results. Likewise, /-l/ is either velarized to [ɫ] as a result of partial incorporation into the nucleus (as in CP), or is completely absorbed into the nucleus, i.e. is vocalized, yielding [w] (as in BP). These cases, then, are better described as complex nuclei.[22]

With regard to the vowels and glides that may occupy the nucleus, we note that the vastly predominant type of diphthong is of falling sonority, VG, whose first member may be of any quality:[23]

(b) diphthongs		example		gloss	
iw	-	*riu*	-	‘laughed/3p sg’	-
ew	ɐj	*deu*	*dei*	‘gave/3p sg’	‘I gave’
ɛw	ɛj	*céu*	*anéis*	‘sky’	‘rings’
aw	aj	*mau*	*pai*	‘bad’	‘father’
-	ɔj	-	dói	-	‘hurt/3p sg’
ow	oj	*sou*	*boi*	‘be/1p sg’	‘steer’
-	uj	-	*fui*	-	‘we went’

(from Mattoso Câmara 1972:53)

Rising, GV, diphthongs are unstable in Portuguese, and may always be pronounced in hiatus (Azevedo, p. 68); that is, for such sequences there is free variation between [V.V] and [GV] (Mattoso Câmara 1972:55).

Finally, nasal diphthongs are one of three types, always VG (listed in decreasing order of frequency):

(c)	*ão* [ãw̃]	*pão*	'bread'
	ãe [ãj̃]	*mãe*	'mother'
	õe [õj̃]	*põe, limões*	'put/3p sg', 'lemons'

Notes

1 At the end of a word /s/ is pronounced [š] in Portuguese. Since this palatalization affects all words ending in /s/, and not only the plural morpheme, we posit /s/ as the underlying form.

2 Hall 1943a,b; Sten 1944, Rogers 1954, Hammarström 1954, 1962a,b; Head 1965, Pontes 1965, Back and Mattos 1971-72, Back 1973, Tláskal 1980.

3 Trager 1943a,b; Reed and Leite 1947, Mattoso Câmara 1953, 1970, 1972; Morais Barbosa 1962, 1965, 1983; Malmberg 1971, and from within generative accounts, Saciuk 1970, Brasington 1971, St. Clair 1971, Mira Mateus 1975, Brakel 1979, Parkinson 1983, Girelli 1988, Brandão de Carvalho 1988, Wetzels 1991, Trigo 1993. Parkinson 1983 actually maintains a hybrid position that nasal vowels are underlyingly of the form /VN/, which is subsequently transformed to a diphthong on the surface. Given his acceptance of the underlying /VN/ status of nasal vowels, for our present purposes we can classify his approach with the second groups of authors. Girelli 1988 takes a similar approach, which will be discussed further below. For more detailed discussion of the issues involved, the reader is referred to Vandresen 1975, Parkinson 1983 and Wetzels 1991.

4 Much of the following discussion is based on Wetzels 1991:81-82, with additional arguments from Parkinson 1983:171-72, Brandão de Carvalho 1988:245-46, and the authors they cite.

5 For the time being, until an elaborate version of how to treat allomorphy and morpheme concatenation in OT is available, we will appeal to (16). One likely formalization would be to state the phonological form of a morpheme as a correspondence constraint and its position as an alignment constraint; this would be in agreement with the general functioning of OT and has the potential advantage of predicting some cases of phonologically controlled allomorphy just when these constraints are dominated. In any case, nothing in the present analysis crucially relies on the correct formalization of (16). All we need for the present analysis to hold is any constraint, set of constraints, rule or stipulation with the same results as (16). For

treatments of allomorphy in OT, see Mester 1994, Tranel 1996, Russell 1995 and Yip 1995.

6 The option of considering these examples with identical singular and plural forms as completely irregular has been adopted in previous analyses. As mentioned, Lipski 1973:79 has the following to say about these cases: "words ending in *-s* with unstressed final syllable, are quite exceptional, constituting at most half a dozen examples. Historically, these words once had a regular ending in *-es*, losing the ending through a process of haplology to yield the present forms (cf. Williams, 1962:126). Synchronically, there has been no attempt at restoring a regular plural form, for the final syllable of a Portuguese proparoxytone is very weakly articulated, often dropped; thus, an ending such as * *V́...Vsis* would ordinarily reduce to *V́...Vs*."

7 We omit from discussion candidates such as [simpléses], with penultimate stress, given that such plural forms alter the stress pattern of the singular form. This is something that never happens and may be due to prespecification. If prespecification is involved, then a high ranking of Max(Σ) would disqualify candidates that do not show the stress in the same syllable where it is prespecified.

8 See the appendix for a discussion of Portuguese syllable structure.

9 Sletsjöe 1971 dates this change in French to the 8th and 9th centuries.

10 *Solsticio*, *perspectiva*, and a handful of other words are apparent exceptions to this statement. However, as Mattoso Câmara 1972:49 notes, these are cases of morpheme concatenation to a bound stem with initial 'impure' /sC/: [sol + stisio], [per + spektiva].

11 For a more thorough discussion of all factors that influence the realization of /l/, the reader is referred to Sproat and Fujimura 1993.

12 There is additional evidence that lends support to the claim that /l/ (at least the vocalic dorsal element) occupies the nucleus, not the coda. (Interestingly, the same evidence extends to /N/, as well.) The data come from Brandão de Carvalho 1988:244-245, and lend credence to the vocalization-as-nucleation hypothesis ([ᵒ] represents a reduced high back vowel):

(a)	meto = ['me tᵒ]	/	meter = [mə 'ter]	'I put (into) / to put (into)'
	levo = ['lɛ vᵒ]	/	levar = [lə 'var]	'I raise / to raise'
	cozo = ['ko zᵒ]	/	cozer = [kᵒ 'zer]	'I cook / to cook'
	voto = ['vɔ tᵒ]	/	votar = [vᵒ 'tar]	'I vote / to vote'
(b)	desço = ['deš sᵒ]	/	descer = [dəš 'ser]	'I descend / to descend'
	pesco = ['pɛš kᵒ]	/	pescar = [pəš 'kar]	'I fish / to fish'
	gosto = ['goš tᵒ]	/	gostar = [gᵒš 'tar]	'I like / to like'
	gosto = ['gɔš tᵒ]	/	gostar = [gᵒš 'tar]	'like (noun) / to like'
(c)	verto = ['ver tᵒ]	/	verter = [vər 'ter]	'I pour / to pour'
	perco = ['pɛr kᵒ]	/	perder = [pər 'der]	'I lose / to lose'

	mordo = [‘mor dº]	/	morder = [mºr ‘der]	‘I bite / to bite’
	corto = [‘kɔr tº]	/	cortar = [kºr ‘tar]	‘I cut / to cut’
(d)	deito = [‘dɐy tº]	/	dietar = [dɐy ‘tar]	‘I lay, spread / to lay, spread’
	coimo = [‘koy mº]	/	coimar = [koy ‘mar]	? / ?
(e)	relva = [‘Rɛɬ vɐ]	/	relvar = [Rɛɬ ‘var]	grass, lawn / ?
	volto = [‘vɔɬ tº]	/	voltar = [vɔɬ ‘tar]	‘I return / to return’
(f)	sento = [‘sẽn tº]	/	sentar = [sẽn ‘tar]	‘I sit / to sit’
	conto = [‘kõn tº]	/	contar = [kõn ‘tar]	‘I count / to count’

If we compare (a-c) with (d-f), we observe that the mid vowels in a syllable closed by /-s/, /-r/ are reduced in atonic position, as are simple vowels in open syllables ((a) above), while the mid vowels closed by glides, /-l/ and /-n/ are maintained. Brandão de Carvalho attributes the like behavior of syllables ending in /-l/, /-n/ and diphthongs as evidence suggesting that in (e,f), just as in (d), there is a complex nucleus. Parkinson 1983:159 reaches the same conclusion (with the exception of /-l/, which he does not address): oral diphthongs, nasal monophthongs and nasal diphthongs all have the structure of a diphthong or complex syllable nucleus.

13 We are aware of the discussion concerning the possibly privative status of the feature [lateral] (Steriade 1995), and of Walsh’s 1995 assertion that there exists no such feature. (Walsh argues instead for the feature [liquid].) The resolution of this discussion is not strictly relevant to our analysis here.

14 Here we will make the noncrucial assumption that the stressed vowel is the head of the PrWd.

15 It has been noticed that nasalization correlates strongly with stress. Consider, as an example, the alternation in verbal forms adduced by Vandresen (1975:87):

	[‘ɐ̃]mo	‘I love’
	[‘ɐ̃]mas	‘you love’
but	[a’mɐ̃]mos	‘we love’

We are aware that many other factors (which will not be discussed here) may affect nasalization. There are examples where nasalization correlates with stress but only if both phenomena are cyclic. Perini (1971) (cited by Leite 1974:73) notes the contrast between *c*[a]*mính+a* ‘he walks’ and *c*[ɐ̃]*m+ính+a* ‘small bed’. Nonetheless, Leite also notes that many dialects do not have this kind of contrast. The correlation between stress and nasalization also fails in cases were we find nasal vowels in atonic position (e.g. [bɐ̃ ‘nɐ̃nɐ̃]). Finally, a difference should be made between optional and non-optional nasalization or even between different degrees of nasalization (see Ladefoged 1967).

16 The traditional interpretation is that the nasal deletes in intervocalic position when the first vowel carries the primary stress of the word; then the final /o/ becomes a glide. Obviously, this kind of analysis would clash with monotonicity and parallelism, two basic assumptions of OT.

17 One might wonder why *[kãw̃po] does not satisfy assimilation. If one assumes the articulator group hypothesis in which [continuant] is located under PA (Padgett 1992, 1994, and others), then the assimilated nasal will be [-cont], but the two segments of [w̃p] disagree for this feature. Another reason could be that [labial] is a vocalic PA for [w] while assimilation is computed with respect to the consonantal PA.

18 This generalization is blurred by a phonetic neutralization that renders the initial vowel of a nasal diphthong as the centralized low vowel [ɐ̯)]. For this restriction in diachronic development, see Mattos e Silva 1991:76.

19 We still have not treated the data in (8d), *leoa ~ leoas*. This feminine singular/plural pair is interesting only in that it shows loss of nasalization (from /leon + a/). Since there are no [õã] sequences or dipthongs in the language (see the appendix), the nasal is completely effaced.

20 Azevedo (p. 89) cites words with obstruent-final syllables, even [-continuant] ones, but these are always broken up by epenthesis in Brazilian Portuguese (BP), and are frequently elided in Continental Portuguese (Mâttoso Câmara 1953:79, 1972:48-9). In the case of epenthesis in BP, an otherwise unattested stress pattern obtains, with the ante-antepenultimate syllable receiving stress in some cases: /ritmiko/ [rí ti mi ku]. The epenthetic vowel apparently is transparent here; we leave this for further research. See Alderete 1995 for a typology of 'degree of participation' that epenthetic segments may show in other prosodic patterns.

21 The case of Lt. COMPUTARE > *comptar* > Sp., Port. *contar*, suggests that this situation is resolved by eliminating the obstruent, thus maintaining the nasal consonant, which is more closely related to the nuclear vowel. Compare Spanish and Portuguese, however, in their treatment of /-ns/. /transportar/ is often [tras.por.tar] in Spanish, but is [trã(n)s.por.tar] in Portuguese, since the nasal may incorporate into the nucleus in Portuguese, but not Spanish; that is, there can be (phonetically audible) nasal vowels in the one language, but not the other.

22 Girelli (p. 64). He extends this to the case of /r, s/ in BP using an X'-notation of syllable structure.

23 Except */ɔw/, which is unexplained.

References

Agard, Frederick B. 1984. *A Course in Romance Linguistics, Volume 1: A Synchronic View*. Washington, D.C.: Georgetown University Press.

Alcover, Antoni and Fransesc Moll. 1968. *Diccionari Català-Valencià-Balear* 1. Spain: Palma de Mallorca.

Alderete, John. 1995. Faithfulness to prosodic heads. Paper presented at The Derivational Residue in Phonology. Tilburg University. October 5-7, 1995. Rutgers Optimality Archive.

Andrade Pardal, Ernesto d'. 1977. *Aspects de la Phonologie (générative) du Portugais*. Lisboa: O Centro de Linguistica da Universidade de Lisboa.

Azevedo, Milton M. 1981. *A Contrastive Phonology of Portuguese and English*. Washington, D.C.: Georgetown University Press.

Back, Eurico and G. Mattos. 1971-1972. *Gramática Construtural de Língua Portuguesa*. Two vols. São Paolo: FTD.

Back, Eurico. 1973. São fonemas as vogais nasais do português? *Construtura* 4.297-317.

Barbosa, Osmar. 1967. *Dicionário de Flexão das Palavras*. Rio de Janeiro: Biblioteca Línguas Vivas.

Brakel, C. A. 1979. A gramática gerativa e a pluralização em português. *Boletim de Filologia* 25.55-96.

Brandão de Carvalho, Joaquim. 1988. Nasalité et structure syllabique en portugais et en galicien: approche non linéare et panchronique d'un problème phonologique. *Verba* 15.237-263.

Brasington, R. W. P. 1971. Noun pluralization in Brazilian Portuguese. *Journal of Linguistics* 7.151-177.

Cagliari, Luiz Carlos. 1981. *Elementos de fonética do português brasileiro*. MA thesis, Universidade Estadual de Campinas.

Carlton, Terence R. 1991. *Introduction to the Phonological History of the Slavic Languages*. Columbus, Ohio: Slavica Publishers.

Cintra, Geraldo. 1962. Ensaios sôbre a estrutura do português de Brasil. *Estudos* 1.17-31.

Colman, Fran. 1983. 'Vocalisation' as nucleation. *Studia Linguistica* 37.30-48.

de Chene, Brent E. and Stephen R. Anderson. 1979. Compensatory lengthening. *Language* 55.505-535.

Girelli, Carl Anthony. 1988. *Brazilian Portuguese Syllable Structure*. Doctoral Dissertation, University of Connecticut.

Goldsmith, John. 1976. *Autosegmental Phonology*. Doctoral Dissertation, Massachusetts Institute of Technology. (Distributed by the Indiana University Linguistics Club: Bloomington).

Guitart, Jorge M. 1989. Concatenation-stratum phonology (nee lexical phonology) and a Dominican dialect of Spanish. *American Spanish Pronunciation: Theoretical and Applied Perspectives,* ed. Peter C. Bjarkman and Robert M. Hammond, 187-195. Washington, D.C.: Georgetown University Press.

Hall, Robert A. 1943a. The unit phonemes of Brazilian Portuguese. *Studies in Linguistics* 1.1-6.

Hall, Robert A. 1943b. Occurrence and orthographic representation of phonemes in Brazilian Portuguese. *Studies in Linguistics* 2.6-13.

Hammarström, Göran. 1954. Review of Holger Sten 1944. Les particularités de la langue portugaise. *Revista do Laboratório de Fonética Experimenta* 2.158-162. Coimbra: Universidade de Coimbra.

Hammarström, Göran. 1962a. Review of José Gonçalo Herculano de Carvalho 1958. *Fonologia mirandesa*. *Romance Philology* 15.350-356.

Hammarström, Göran. 1962b. Discussion of Morais Barbosa 1962. *Proceedings of the Fourth International Congress of Phonetic Sciences*. Helsinki, 1961. 709. The Hague: Mouton.

Harris, James W. 1980. Noncatenative morphology and Spanish plurals. *Journal of Linguistic Research* 1.15-33.

Head, Brian F. 1965. *A Comparison of the Segmental Phonology of Lisbon and Rio de Janeiro*. Doctoral Dissertation, University of Texas, Austin.

Hensey, Fritz. 1968. Questões de fonologia gerativa: as regras de pluralização. *Estudos Linguísticos* 3.1-10.

Holt, D. Eric. In preparation. Constraint Interaction in the Development of Syllable Structure from Latin to Spanish and Portuguese. Doctoral Dissertation, Georgetown University.

Inkelas, Sharon. 1995. The consequences of Optimization for underspecification. *Proceedings of the 24th North East Linguistics Society*. Amherst, Massachussetts: Graduate Linguistics Student Association.

Inkelas, Sharon, Cemil Orhan Orgun and Cheryl Zoll. 1996. Exceptions and static phonological patterns: cophonologies versus presepecification. Rutgers Optimality Archive, ms.

Itô, Junko, Yoshihisa Kitagawa and Armin Mester. 1995. Prosodic faithfulness and Correspondence: Evidence from a Japanese argot. To appear in *Journal of East Asian Linguistics*.

Johnstone, T. M. 1975. The Modern Southern Arabian Languages. *Afroasiatic Linguistics* 1.93-121.

Kenstowicz, Michael. 1995. Base-identity and uniform exponence: Alternatives to cyclicity. Massachusetts Institute of Technology, ms. Rutgers Optimality Archive.

Lacerda, Armando de and Brian F. Head. 1962. Análise de sons nasais e sons nasalizados do Português. *Revista do Laboratório de Fonética Experimental*, 6.5-70. Coimbra: Universidade de Coimbra.

Lacerda, Armando de and Göran Hammarström. 1952. Transcrição fonética de português normal. *Revista do Laboratório de Fonética Experimental* 1.119-135. Coimbra: Universidade de Coimbra.

Lacerda, Armando de and P. Strevens. 1956. Some phonetic observations using a speech-strecher. *Revista do Laboratório de Fonética Experimental* 3.5-16. Coimbra: Universidade de Coimbra.

Ladefoged, Peter. 1967. Linguistic Phonetics. *UCLA Working Papers*.

Lamontagne, Greg and Keren Rice. 1995. A Correspondence account of coalescence. *Papers in Optimality Theory*, ed. Jill N. Beckman, Laura Walsh Dickey and Suzanne Urbanczyk, 211-223. University of Massachusetts Occasional Papers in Linguistics 18. Amherst, Massachussetts: Graduate Linguistics Student Association.

Leite, Yvonne de Freitas. 1974. *Portuguese Stress and Related Rules*. Doctoral Dissertation, University of Texas, Austin.

Lipski, John M. 1973. The surface structure of Portuguese: plurals and other things. *Linguistics: An International Review* 111.67-82.
Lloyd, Paul M. 1994. Contribution to the study of the syllable structure of Old Spanish. Paper presented at the Modern Language Association meeting. San Diego, California. December 28, 1994.
López, Barbara Stradt. 1979. *The Sound Pattern of Brazilian Portuguese (Carioca Dialect)*. Doctoral Dissertation, University of California, Los Angeles..
Louro, José Inês. 1954-55. Estudo e clasificação das vogais. *Boletim de Filologia* 15.215-248.
Malmberg, Bertil. 1971. La structure phonétique de quelques langues romanes. *Phonétique générale et romane*. 301-342. The Hague & Paris: Mouton.
Mascherpe, Mario. 1970. *Análise comparativa dos sistemas fonológicos do inglês e do português*. São Paolo: Cadeira de Linguia e Literatura Inglesa. Faculdade de Filosofia, Ciencias e Letras de Assis. Distribuidores: Livraria Francesa.
Mattos e Silva, Rosa Virgínia. 1991. *O purtuguês arcáico: fonologia*. São Paolo: Contexto.
Mattoso Câmara, Joaquim. 1953. *Para o estudo da fonêmica portugesa*. Rio de Janeiro: Simões.
Mattoso Câmara, Joaquim. 1970. *Estrutura da língua portuguesa*. Petrópolis, RJ: Voces.
Mattoso Câmara, Joaquim. 1972. *The Portuguese Language*. Trans. by Anthony J. Naro. Chicago: University of Chicago Press.
McCarthy, John J. 1995. Extensions of faithfulness: Rotuman revisited. University of Massachussetts, Amherst, ms. Rutgers Optimality Archive.
McCarthy, John J. and Alan Prince. 1995. Faithfulness and reduplicative identity. *Papers in Optimality Theory*, ed. Jill N. Beckman, Laura Walsh Dickey and Suzanne Urbanczyk, 249-384. University of Massachusetts Occasional Papers in Linguistics 18. Amherst, Massachussetts: Graduate Linguistics Student Association.
McCawley, James D. 1968. *The Phonological Component of a Grammar of Japanese*. The Hague: Mouton.
Mester, R. Armin. 1994. The quantitative trochee in Latin. *Natural Language and Linguistic Theory* 12.1-61.
Mira Mateus, Maria Helena. 1975. *Aspectos da Fonologia Portuguesa*. Lisboa: O Centro de Estudos Filológicos.
Morais Barbosa, Jorge. 1962. Les voyelles nasales portugaises: interprétation phonologique. *Proceedings of the Fourth International Congress of Phonetic Sciences*. Helsinki, 1961. 691-708. The Hague: Mouton.
Morais Barbosa, Jorge. 1965. *Etudes de phonologie portugaise*. Lisboa: Junta de Invetigações do Ultramar.
Morais Barbosa, Jorge. 1983. *Etudes de phonologie portugaise*. 2nd ed. Evora: Universidade de Evora, Divisão de Línguas e Literatura.
Morales-Front, Alfonso. 1994. *A Constraint-based Approach to Spanish Phonology*. Doctoral Dissertation, University of Illinois, Urbana-Champaign.
Padgett, Jaye. 1992. Stricture and Nasal Place Assimilation. Linguistic Research Center report LRC-92-08. University of California, Santa Cruz. In revised form in *NLLT* (1994).

Parkinson, Stephen. 1983. Portuguese nasal vowels as phonological diphthongs. *Lingua* 61.157-177.
Perini, M. 1971. The process of nasalization: Evidence from Portuguese. University of Texas, Austin, ms.
Pontes, Eunice. 1965. *Estrutura de Verbo no Português Coloquial*. Petrópolis: Vozes.
Porzio Gernia, María Luisa. 1976. Tendenze strutturali della sillaba latina in età arcaica e classica. *Scritti in onore de G. Bonfante*, 757-779. Brescia: Paideira Editrice.
Prince, Alan and Paul Smolensky. 1993. Optimality Theory: Contraint Interaction in Generative Grammar. Rutgers University and University of Colorado, Boulder, ms.
Reed, David W. and Yolanda Leite. 1947. The segmental phonemes of Brazilian Portuguese. *Phonemics: A Technique for Reducing Languages to Writing*, ed. Kenneth L. Pike, 194-202. Ann Arbor: University of Michigan Publications.
Reighard, J. and A. de Almeida. 1983. /R/ en début et en fin syllabiques dans les dialects portugaises. *Revue de l'Association Québécoise de Linguistique* 3.177-186.
Repetti, Lori. 1989. The Bimoraic Norm of Tonic Syllables in Italo-Romance. Doctoral Dissertation, University of California, Los Angeles.
Rogers, Francis M. 1954. Review of Mattoso Câmara 1953. *Language* 30.503-509.
Rosenthall, Sam. 1994. Vowel/Glide Alteration in a Theory of Constraint Interaction. Doctoral Dissertation, University of Massachusetts, Amherst.
Russell, Kevin. 1995. Morphemes and candidates in Optimality Theory. University of Manitoba, ms. Rutgers Optimality Archive.
Saciuk, Bohdan. 1970. Some basic rules of Portuguese phonology.. *Studies Presented to Robert B. Lees by his Students*, ed. Jerrold M. Sadock and Anthony Vadek, 197-222. Papers in Linguistics Monograph Series 1. Edmonton and Champaign: Linguistic Research, Inc.
Sletsjöe, Leif. 1971. La vocalisation du *l* et les formes *as* et *des* en ancien français. *Sprache und Geschichte: Festschrift für Harri Meier zum 65 Geburtstag*, ed. Eugenio Coseriu and Wolf-Dieter Stempel, 449-458. Munich: Fink.
Sproat, Richard and Osamu Fujimura. 1993. Allophonic variation in English /l/ and its implications for phonetic implementation. *Journal of Phonetics* 21.291-311.
St. Clair, Robert N. 1971. The Portuguese plural formation. *Linguistics: An International Review* 68. 90-102.
Sten, Holger. 1944. Les particularités de la langue portugaise. *Travaux du Cercle de Linguistique de Copenhague 2*. Copenhagen: Munskgaard.
Steriade, Donca. 1995. Underspecification and markedness. *The Handbook of Phonological Theory*, ed. John Goldsmith. 114-174. Oxford: Basil Blackwell.
Stevens, K.N., Andrade, A. and M.C. Viana. 1988. Perception of vowel nasalization in VC contexts: A cross-language study. Paper presented at the Annual Meeting of the Acoutical Society of America.
Sütterlin, Ludwig. 1916. Lautbildung.
Tláskal, Jaromir. 1980. Remarques sur les voyelles nasales en portugais. Zeitschrift für Phonetik, *Sprachwissenschaft und Kommunikationsforsching* 33.562-570.
Trager, George L. 1943a. Note on Hall 1943a. *Studies in Linguistics* 1.6.
Trager, George L. 1943b. Note on Hall 1943b. *Studies in Linguistics* 2.12-13.
Tranel, Bernard. 1996. French liaison and elision revisited: a unified account within Optimality Theory. *Aspects of Romance linguistics: Selected Papers From the*

Linguistic Symposium on Romance Languages XXIV, ed. Claudia Parodi, Carlos Quicoli, Mario Saltarelli and María Luísa Zubizarreta. Washington, D.C.: Georgetown University Press.

Trigo, R. Lorenza. 1988. On the Phonological Derivation and Behavior of Nasal Glides. Doctoral Dissertation, Massachusetts Institute of Technology.

Trigo, R. Lorenza. 1993. The inherent structure of nasal segments. *Phonetics and Phonology 5: Nasals, Nasalization and the Velum,* ed. Marie K. Huffman and Rena A. Krakow, 369-400. New York: Academic Press.

Vandresen, Paolino. 1975. O vocalismo português: implicações teóricas. *Revista Brasileira de Linguística* 2.80-103.

von Essen, Otto. 1964. An acoustic explanation of the sound shift [ɬ] > [u] and [l] > [i]. *In Honour of Daniel Jones: Papers Contributed on the Occasion of His Eightieth Birthday 12 September 1961*, ed. David Abercrombie, et al, 53-58. London: Longmans.

Walsh Dickey, Laura. 1995. The Phonology of Liquids. Doctoral Dissertation, University of Massachusetts, Amherst. Defense Draft, November 8, 1995.

Wetzels, W. Leo. 1991. Contrastive and allophonic properties of Brazilian Portuguese vowels. *New Analyses in Romance Linguistics (LSRL 18, 1988)*, ed. Dieter Wanner and Douglas Kibbee, 77-99. Philadelphia: Benjamins.

Williams, Edwin B. 1962. *From Latin to Portuguese: Historical Phonology and Morphology of the Portuguese Language*. Philadelphia: University of Pennsylvania Press. First edition 1938.

Yip, Moira. 1995. Identity avoidance in phonology and morphology. University of California, Irvine, ms. Rutgers Optimality Archive.