Vowel lenition and fortition in Brazilian Portuguese

Enfraquecimento e fortalecimento de vogal em português brasileiro

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Abstract: In this paper I deal with vowel reduction in Brazilian Portuguese and other languages, illustrating the principles (1) that segmental complexity and positional strength are closely aligned in phonological structure, and (2) that syntagmatic distinctness (e.g. between strong and weak positions, and between halves of a diphthong) can induce segmental lenition and fortition. The empirical phenomena covered include asymmetries in pre-tonic vs. post-tonic vowel reduction, differences in the realization of unstressed mid vowels in Northeastern vs. Southeastern Brazilian Portuguese, and preferred diphthongs in the language.

Keywords: Vowel reduction; Diphthong formation; Plural formation; Vowel coalescence; Element Theory

Resumo: Neste artigo, analisamos redução vocálica em português e outras línguas. Ilustramos os princípios de (1) que complexidade segmental e força de posição estão intimamente alinhadas na estrutura fonológica e (2) que a distinção sintagmática (e.g. entre posições fortes e fracas e entre partes de ditongos) pode induzir enfraquecimento e fortalecimento segmental. Os fenômenos empíricos estudados incluem (a) assimetria na redução vocálica em posição tônica vs. pré-tônica, (b) diferenças na realização de vogais médias não-acentuadas em dialetos do nordeste e sudeste do português brasileiro, (c) ditongos preferidos em português.

Palavras-chaves: Redução vocálica; Formação de ditongos; Formação de plurais; Coalescência vocálica; Teoria de Elementos

1 Positional Asymmetries in Vowel Reduction

The aim of this paper is to illustrate the potential for success in applying certain ideas about phonological structure to the pattern of stressed and unstressed vowels in Brazilian Portuguese. The application of the theories under discussion to this language has not been attempted before, and it is therefore my goal to illustrate the potential usefulness of these models to existing puzzles in Brazilian Portuguese phonology, while acknowledging from the outset that it is by no means a complete account, and is intended more to raise new ways of framing certain questions than to provide answers to older (and arguably less explanatorily satisfactory) versions of such questions. The organizing phenomena for the pursuit of these questions is vowel lenition, a term I will use to emphasize its parallelism with consonantal lenition, a domain in which some of these principles are already more familiar.

The first principle whose applicability will be explored is the Government Phonology/Element Theory claim that segmental complexity and positional strength are closely aligned in phonological structure: that segmental lenition happens in weak positions and segmental fortition happens in strong positions, where strong and weak are defined in absolute (e.g. word-initial) and relative (e.g. head of a foot) terms (see Harris 1994 for a general introduction). For consonantal fortition and lenition phenomena (such as the distribution of English *t*-allophones), it is indisputable that the distribution of segmental strength must – and indeed, seems to want to – refer to foot structure. But the potential relevance of feet to vowel lenition – i.e. vowel reduction – has received comparatively less attention, to which we turn.

[1] For comments and suggestions on prior presentations of the ideas in this paper, I thank Elisa Battisti, Philip Backley, Michael Becker, Leda Bisol, Gisela Colischonn, Gean Damulakis, John Harris, Emilio Pagotto, Filomena Sandalo, Luiz Carlos Schwindt, Shanti Ulfsbjornnin, and Leo Wetzels, though none of them should be held responsible for any potential errors.

Let's begin with the well-known facts about Brazilian Portuguese: it has 7 oral vowels and 5 nasal vowels, and in unstressed syllables vowel reduction may occur, although its application is conditioned by a variety of factors, as we shall discuss. The round vowels, when they reduce, go to [u], whereas the palatal vowels, when they reduce, go to [i]. The central low vowel varies in its unstressed realization, which we will represent here as schwa [ə]. The literature that supports the claims in the previous three sentences is so massive I cannot even begin to cite it here without committing dozens of errors of comission, and in light of it, what I have described above cannot be said to constitute anything remotely news-worthy.

On to the first of more nuanced matters: saying "unstressed" is not specific enough: post-tonic reduction is always more obligatory than pre-tonic reduction. Thus, a three-syllable word with penultimate stress will never show reduction in the first syllable while not doing so in the last syllable:

(1) Possible application of reduction to *moleque* 'urchin'
   a. [moleki]
   b. [muleki]
   c. *[muleke]

These facts are by no means unique to Brazilian Portuguese; Karavasilev (2010) documented the same trend in Bulgarian, in which reduction in a nonce word like *opódo* can result in [opódu] or [upódu], but never [upódo]. Why should this be the case? One possible redescription of the facts is to say that vowel reduction is obligatory in post-tonic syllables, but optional in pre-tonic syllables, but this leaves the asymmetry unexplained. What can account for the asymmetry, then? Clearly, linear order alone will not be revealing to derive the left-right difference, whereas appealing to another level of structure may help: the foot. Assuming trochaic feet for penultimate-stressed nouns, words like *moleque* have a foot in which the strong position contains [(le)] and the weak position contains [(ki)]. Vowel reduction thus accentuates the contrast between the strong and weak half of a foot. What about the pre-tonic syllable? In fact, it needn't be footed, and apparently nothing in BP requires exhaustive footing outside of the main stress of a prosodic word. Consider now the following statement:

(2) Vowel reduction is obligatory *everywhere* in BP that is not the strong position of a foot.

The statement in (2), while no doubt too strong in its formulation to cover every aspect of the language, is revealing in understanding (1). Moreover, we can now cover cases in which vowel reduction actually *does not apply at all*, namely 'angry' or 'deliberate' speech, as shown in (3d):

(3) Footing and reduction in *moleque* 'urchin'
   a. $(mo_s)(le_s.ki_w)$: Exhaustive footing; first syllable heads a degenerate foot.
   b. $mu(le_s.ki_w)$: Main trochee footed. First syllable reduces (due to (2)).
   c. *$mu(le_s)(ke_s)$: Main stress in degenerate foot. Impermissible structure.
   d. $(mo_s)(le_s)(ke_s)$: All syllables their own prosodic words; all degenerate feet.

In (3a), footing the first pretonic syllable is possible, while in (3b), leaving it unfooted is also possible. However, as (3c) shows, footing the post-tonic syllable on its own, in the same prosodic word as the main stress, is impermissible. The asymmetry is now stated not in terms of linear order but in terms of foot structure: trochees must be formed, whereas syllables outside the main foot may be optionally assigned structure. When they are footed, they will constitute a head, and hence be protected from reduction. When unfooted, they are subject to reduction like any other weak syllable.

This formulation thus forces us to seek constraints on possible foot structures for trisyllabic words, rather than simply call vowel reduction something that is sometimes optional, sometimes obligatory. On the current view – which is in no doubt need of further refinement – vowel reduction is always obligatory for weak syllables. The idea is that what varies is the foot structure and how it is assigned, and we can now begin to ask what happens with longer words.

Indeed it is also known that asymmetries in reduction possibilities occur for tetrasyllabic words with penultimate stress. Consider the fact that the antepretonic vowel can never reduce to the exclusion of the immediately pretonic vowel.

(4) Possible application of reduction to *mexerica* 'tangerine'
   a. [mixirica]
   b. [mexirica]
   c. *[mixerica]

Again, the asymmetry should be sought not in terms of terms like 'antepretonic ' versus 'immediately pretonic' but in terms of foot structure. Consider the footing of two pretonic syllables: they can be assigned to a trochaic foot, or to no foot at all. Forming a degenerate foot out of only one of them, however, will not be an option:

(5) Possible foot structure in *mexerica* 'tangerine'
a. No footing of pretonic syllables: mi.xi.($ri_{s}.ca_{w}$)
b. Footing: ($me_{s}.xi_{w}$).($ri_{s}.ca_{w}$)
c. Impossible footing: *mi.(xe_{s}).($ri_{s}.ca_{w}$)

If left unfooted, both syllables will reduce. If footed, the strong half will be protected while the weak half will reduce. Constraints on foot structure will prohibit a degenerate pretonic foot that fails to include the preceding syllable in (5c), and hence this pattern of reduction will be impossible. In short, [me.xi.ri.ca] shows an alternating trochaic pattern of strong odd-numbered syllables, and this is why the asymmetry exists in reduction possibilities.

Naturally, I have restricted the discussion to underived words; morphologically complex words such as *policial* 'police officer' with a secondary stress on the initial syllable, may show reduction, but it is derived from *polícia*, which shows pretonic reduction in the base. Such cyclic effects are the bread and butter of both derivational and output-output based approaches designed to account for the retention of segmental alternations from derivational bases that would be otherwise unexpected under a surface syllabification or foot structure, and fall outside the scope of our study of the purely phonological factors influencing vowel reduction.

2 Element Theory and Vowel Realizations

In order for the claim that positional strength and segmental complexity are correlated to go through, we must develop a model of Lusophone vowel systems in which complexity can be clearly 'read off' the structure. Naturally, binary features such as [±round], [±high] cannot be very easily translated into measures of comparative complexity of vowel representations (the valiant efforts of SPE Chapter 9 notwithstanding), in part because vowel systems depend so much on the inventory of contrasts to which each vowel must be compared and contrastively represented. Consider, however, the application of Element Theory (Backley 2011) to Lusophone vowel systems, by comparing Barlavento and Sotavento varieties of Cape Verdean Creole (Macedo 1989):

(6) Vowel Coalescence in Cape Verdean Creole:

Sotavento	Barlavento	
gatu	got	'cat'
branku	bronk	'white'
sidadi	sided	'city'
pai	pe	'father'

The data illustrate a kind of apocope followed by coalescence: the final high vowels of Sotavento (and etymologically found in Portuguese) coalesce into the tonic vowel, and form the combinations |A|+|U| = [o] and |A|+|I| = [e]. In other words, the mid-vowels [e,o] are not 'primitive' but rather derived. This aspect of Element Theory echoes a long grammatical tradition which views the fact that the most common 3-vowel system is [i,u,a] (in terms of typology, Dispersion Theory and Quantal Theory), by elevating these three vowels to the status of atomic primes, the combinations of which can form composite vowels, so that the mid-vowels [e,o] are more complex than the corner vowels in terms of their acoustic signatures and in terms of their formal markedness. (Note that the actual phonetic values of some of these elements and their combinations may vary in sparse vowel spaces, e.g. as [ɪ,ɐ,ɛ]).

As a direct result of building complexity into the number of primes that compose a segment, reduction processes in positions that support less complexity (i.e. unfooted or in the weak half of a binary foot) target these composite structures, and lenition in fact involves the removal of element structure. To take an example from consonant systems, English *t* is represented in Element Theory as a combination of |R,ʔ,H| (representing place, manner, and voicing). In weak, foot-medial position, North American English reduces this set to simply |R|, yielding the process known as flapping, whereas UK English reduces it to |ʔ|, yielding glottalling. The same variation in what is deleted/removed from a segment that finds itself in a prosodically weak position can be found in the contrast between the fate of unstressed [o] in the Slavic languages Bulgarian and Russian, where the former reduces |A,U| to |U| alone, whereas the latter reduces it to |A| alone. (Brazilian Portuguese post-tonic reduction may be essentially characterized as removal of |A| from all vowels, yielding the only remaining possibilities as |I|, |U|, or | |, the latter of which is interpreted as schwa).

Element Theory thus provides a direct way of encoding the observation that paradigmatic and syntagmatic aspects of vowel inventory reduction may be modeled in terms of the combination of primes. Of even greater utility, however, is its notion of *headedness*, which expresses the fact that given a two-element combination, one of the elements exhibits a greater say on the realization of the resulting composite. Distinctions in headedness are empirically necessary for languages (such as, say, English) that distinguish [ɛ] and [æ]: while both are composed of |A,I|, one needs to express their difference formally, and this is accomplished by designating |A| as the head (indicated by underlining) in |A,I| [æ], whereas |I| is the head in |A,I| (where linear order means nothing), which represents [ɛ].

So what of a language with a contrast between tense and lax mid vowels, such as the [e,ɛ] and [o,ɔ] of 7-vowel languages, such as Brazilian Portuguese? I claim that Element Theory underdetermines the answer to this

question, and that this ambiguity is a feature, not a bug, as it enables one to express idiolectal and dialectal variation. In particular, let us assume that a headed combination of two elements is more complex than an unheaded combination:

(7) A headed element-theoretic combination |α,β| is more complex (and thus less easily licensed in a prosodically weak position) than an unheaded version of the combination |α,β|

Returning to the expression of the stressed inventories of 7-vowel systems, we may in principle represent them as either (8a) or (8b) (where stressed [i,u,a] are also headed):

(8a)		(8b)	
|I|	[i]	|I|	[i]
|U|	[u]	|U|	[u]
|I,A|	[e]	|I,A|	[e]
|U,A|	[o]	|U,A|	[o]
|I,A|	[ɛ]	|I,A|	[ɛ]
|U,A|	[ɔ]	|U,A|	[ɔ]
|A|	[a]	|A|	[a]

The only point of variation between (8a) and (8b) is whether the tense-mid series is represented as headed and the lax-mid as unheaded, as in the former, or whether the lax-mid is represented as headed and the tense-mid as unheaded, as in the latter, but I claim that this constitutes precisely the difference between 'Northeastern' (8a) and 'Southeastern' (8b) BP (labels I put in scare quotes to indicate their status as idealizations over large dialectal areas).

In particular, it is often noted that Northeastern speakers reduce the contrast between tense and lax pretonic mid vowels to the lax version of the pair, thereby pronouncing [tɛlɛvisão] 'television' with lax vowels, while Southeastern speakers pronounce this same word as [televisão], with tense pretonic mid vowels. Most accounts of these phenomena have simply recast the facts by saying that lax vowels are the 'default' in the Northeast, while tense vowels are the default in the Southeast. With headedness (and its analytic underdetermination in 7-vowel systems) as a formal aspect of the representation, however, we can encode default status in slightly more nuanced terms, according to (7): in a weak position (e.g. pretonically), the less complex, and thereby non-headed version of the pair will be favored, and this in turn is why [ɛ,ɔ] are preferred in (8a), corresponding to Northeastern dialects, while these same vowels are headed, and hence dispreferred, in Southeastern dialects.

The status of the systems in (8a) vs. (8b) in enacting reduction of specific kinds of headed expressions in fact lead to particular correlational predictions within these dialects. In particular, up until now we have not discussed the representation of nasal vowels, which involve the element |L| in Backley (2011). Nasal [ã], therefore, would be composed of |L,A|.

Recall that Southeastern dialects accomplish neutralization of the [e/ɛ] contrast by removing the headed version, namely |I,A|, and thereby show a dispreference for complex expressions with headed |A|. This makes the prediction that these same dialects will show comparatively more reduction of nasal [ã], producing it instead as a much more centralized [ɐ̃] than their Northeastern brethren (which is reported to be an independently attested observation about the South/North dialectal split), as the |A|-removed version of the vowel would be represented as |L| alone (i.e. a nasal schwa).

By contrast, Northeastern dialects accomplish neutralization of the [e/ɛ] contrast by removing the headed version, namely |I,A|, and thereby show a dispreference for complex expressions with headed |I|. In terms of complex expressions involving nasality and |I|, the nasal diphthong [ẽj] (found in words such as *ontem* 'yesterday') should undergo comparatively more vowel reduction, and indeed it seems to be the case that these dialects reduce nasal mid-vowel diphthongs to [i] (producing forms such as [onti]) more than their Southern kin.

In sum, by encoding the notion of 'default' in a more principled manner as 'the non-headed version of a complex vocalic expression', we can begin to pursue falsifiable correlations as to whether the same dispreferred headed vowels in |I,A| (Northeast [e]) vs. |I,A| (Southeast [ɛ]) correlate with reduction of the headed element in other combinations, such as |L,A| and |L,A,I| respectively.

Moreover, the encoding of headedness as a formal property also makes predictions about the phonetic distribution within the vowel space of these mid vowels: as Kenstowicz (2010) shows for Italian dialects, when [ɛ] is preferred (by hypothesis, system (8a)), "the closed mid vowels are very near to the high vowels, while the open mid vowels are relatively well separated from the single low vowel"; in other words, when [ɛ] is preferred, it is because [e] is more |I|-like – and thus closer to |I| in acoustic space – exactly as represented in (8a).

Further acoustic measurements within Brazilian Portuguese dialects of the [tɛlɛvisão] vs. [televisão] varieties can only sharpen and refine our characterization of the formal and correlational properties of stressed and unstressed vowels in both the oral and nasal subsystems.

3 Preferred Diphthongs and Syntagmatic Fortition

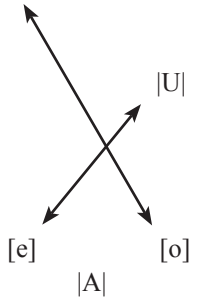
The Element-Theoretic formulation of the primitives |I,U,A|, while extremely effective in characterizing the

reductions in complexity that take place when more complex vowels undergo vowel reduction, nonetheless is in its present form missing out on an important, recurrent crosslinguistic asymmetry: that between |I| and |U|. Donegan 1978 observes that both |I| and |U| characterize extremes in the 'color' (e.g. F2) dimension, as opposed to |A|, which epitomizes an extreme in the sonority dimension, but that nonetheless, |I| exerts more of an upward 'pull' on mid-vowels than |U| does. Indeed, Bisol 1989 notes that variable pretonic reduction in Brazilian Portuguese shows higher rates of application when it is [e] raising to [i] than [o] raising to [u], and characterizes this in terms of the lower F1 (and thereby more extreme articulatory target) of the front vs the back high vowel (see also Fails and Clegg 1992 on BP). In what follows, I wish to pursue the notion that |I| is a more extreme (and hence, more contrastive) target than |U| in its relation to fortition, a process that Donegan 1978 relates to the syntagmatic differentiation between the two halves of a diphthong. If in fact |I| is higher and hence farther from |A| than |U| is, then one might expect the diphthong [aj] to be crosslinguistically preferred to [aw], as the syntagmatic disperson in the former is greater. And in fact, Kubozono (2001) shows that such an asymmetry holds in Japanese, where [aw] is much less prevalent than [aj] (and more susceptible to dialectal monophthongization). The same asymmetry holds in English, in which the Great Vowel Shift bore more exceptions with [aw]-diphthongizaton than [aj]-diphthongization, and even in the synchronic grammar, in which [aw]-diphthongs are severely restricted in terms of which coda consonants they can co-occur with: while rimes with a variety of places such as *ripe, like, bribe, rife, hive, time* exist, words with the same onset and coda but a different diphthongal rime are unattested (and arguably unattestable: **roup, louk, broub, souf, houv, towm* do not have much of a chance; [aw] is only allowed before coronals).

Why should [aj] enjoy this relative freedom compared to [aw], given that both are "low nucleus-high offglide" diphthongs? The answer emerges herein: [aj] involves a greater contrast, a greater distance, between the acoustic targets of each half, as |I| is *even* higher (and hence farther away from) |A| than |U| is. This preference for *syntagmatic dispersion* in a diphthong capitalizes on the fact that the |A|-|I| distance in [aj] is greater than the |A|-|U| distance in [aw], and can in turn shed light on two other facts about diphthongs in Brazilian Portuguese.

It has been amply noted that the diphthong [ew] is dispreferred in many languages; it is non-existent in English, while its 'symmetrical' counterpart [oj] remains. These two diphthongs however are in fact not so symmetrical: the distance from |A,I| to |U| is shorter than that from |A,U| to |I|, as shown in (9):

(9) |I|



The result of umlaut in German [aw] would be expected [ew], but in fact this diphthong (also found in words like *neu*) is pronounced [oj]. The complete change in the pronunciation of this diphthong is the result of shuffling the elements so that the offglide and the non-head component of the nucleus have switched, so that higher/more extreme |I| is placed in the other half, thereby heightening syntagmatic dispersion, as show in (10).

(10)

X	X		X	X
|A|	|U|		|A|	|I|
|I|		→	|U|	

Of the four possible diphthongs [oj], [ow], [ej], [ew], the highest degree of diphthongal disperson occurs with [oj]. It is important to note that even [ej] is not an ideally dispersed diphthong, and for this reason European Portuguese lowers its nucleus, pronouncing it as [ɐj]. Similarly, in East London English, the word *coin* retains its diphthong, while *name* shows lowering of [ej] to [aj]. This 'inexplicable' lowering of the diphthong [ej] is driven by the same syntagmatic dispersion operative throughout other areas of Lusophone grammars, and we turn to a more involved one now.

I contend that plural formation with C-final stems, particularly in those that end in orthographic <l>, involves allomorph selection: the plural has an allomorph which is /-is/ after C-final stems, e.g. [flor-is, rapaz-is] 'flowers, boys'. Now, for [w]-final stems, such as *anel* 'ring', the plural allomorph chosen will be [-is] as well, yielding the intermediate output {a.nɛ.wis}, where the curly brackets denote a representation that is neither underlying nor surface. This representation in fact cannot surface, because of a BP-wide constraint against [w] as a syllable onset, and as a result, something has to delete. The grammar thereby has a choice between [a.nɛws] and [anɛjs]:

(11) Given {a.nɛ.wis} and the ban on [w] as an onset, possible deletion outputs are [a.nɛws] and [a.nɛjs].

Now, my claim for BP is that the choice among these favors [js] over [ws], all else being equal, and in

fact, the majority of /w/-final singulars in BP surface with the ending [js] in the plural, although syllable count is a relevant factor (see Becker, Clemens and Nevins, 2011).

Given the statement that [js] is preferred to [ws], all else being equal, we now must inspect the role of diphthongal dispersion, and in particular, the contribution of the preceding vowel. In fact, Becker, Clemens and Nevins 2011 find in a nonce word study that one of the major determining factors of whether an [w]-final singular (including words with orthographic final <u>, such as *museu* 'museum', *chapéu* 'hat', *degrau* 'step') will choose [js] in the plural depends on the *height* of the vowel: the lax and lower vowels [ɛ,ɔ,a] favor the [-js] plural, whereas the higher vowels favor the [-ws] plural – a fact attested even in 'erroneous plurals' such as *chap*[ɛ]*is*, *degrais* (which never happens to *mus*[e]*u*) – a trend verified in purely auditory presentation of nonce words in which none of orthography, frequency, or diachrony were at issue.

Why, then, do nouns like *mus*[e]*u* reject a plural such as *mus*[e]*is*? Because [e] and [j] are very close in both color and sonority – too close, in fact, and hence /ewis/ → [ews] instead of [ejs]. This issue does not arise for /ɛwis/ → [ɛjs], because [ɛ] and [j] are sufficiently far in sonority to allow for a tolerably dispersed diphthong. The 'erroneous' tendency for [js] plurals instead of [ws] plurals with inputs like {degrawis} is also derived: [aj] shows better dispersion than [aw].

Finally, this discussion raises a testable hypothesis for further research, namely the question of whether the variable and dialectally-specific 'intrusive' [i] before final – s in monomorphemic words such as *rapaz* 'boy', *arroz* 'rice', *gas* 'gas' occurs more with lower vowels than higher vowels (e.g. less in words like *pus* 'pus', *onibus* 'bus', *jesus* 'jesus') – if so, than diphthongal dipersion exerts a force here as well, and illustrates both 'dynamic' and 'static' fortition: the tendency for vowel nuclei to seek the higher sonority elements while offglides seek the higher-colored elements, making [aj] the diphthongal version of Jakobson's (1962) optimal onset-nucleus [pa].

4 Conclusions and Envoi for Further Investigation

This paper has focused on the application of Element Theory representations (Backley 2011) and the models of fortition and lenition developed for consonants and vowels by Harris (1994) and Donegan (1978) to vocalic phenomena in Brazilian Portuguese by way of schematic illustrations of new answers to previously observed asymmetries that had not received these kinds of solutions. The key ideas have been illustrating the relevance of foot structure for understanding asymmetries in vowel reduction, the relevance of ambiguous head status in complex mid vowels for understanding 'default' status, and the relevance of syntagmatic dispersion for understanding plural formation and diphthongal distribution. Like any such initial attempt, it awaits extensive further empirical confirmation, ideally from domains such as productivity experiments like wug-testing, and correlations of diverse and seemingly unrelated phonetic and sociolinguistic measurements that have not been compared in the same studies from within and across dialects of Lusophone varieties.

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Recebido: 28/2/2012
Aprovado: 30/4/2012
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