Prominence Augmentation via Nasalization in Brazilian Portuguese[1*]
Andrew Nevins and Paula Pinheiro Costa
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Abstract: This article aims to demonstrate that dialectal and idiolectal variants of Brazilian Portuguese that exhibit rhotic metathesis (e.g. *vidro > vrido* 'glass'), spontaneous nasalization of high vowels (as in diachronic *hibernum > inverno* 'winter' and non-standard *ingreja* 'church'), and pretonic vowel lowering of mid-vowels are all instantiations of the same process: prominence-boosting in stressed, secondary-stressed, or word-initial positions.
Keywords: spontaneous nasalization, Brazilian Portuguese, rhotic metathesis, prominence augmentation, initial syllables

1. Overview

Nasality on vowels is a well-known feature of Portuguese, a diachronic development from nasal coda consonants that the existence of forms such as Spanish *lana,* Italian *lana*, Catalan *llana*, Romanian *lână* 'wool' alongside Portuguese *lã* [lẽ] clearly demonstrate that the latter language lost the coda consonant altogether, in favor of nasalization of the preceding vowel. There are, however, what are called 'non-etymological' cases of nasalization found in Portuguese (alongside the well-known case of *muito* [mũj̃.tʊ] 'many', phonemically nasal in all varieties, via a sporadic diacronic progressive nasalization and simply not orthographically indicated; Lipski 1973), and these are the non-standard (and sometimes less prestigious) pronunciations such as *idioma* [ˌĩ.d͡ʒi.ˈõ.mɐ] 'language'*, igreja* [ĩ.ˈgɾe.ʒɐ] 'church'*, idiota* [ĩ.d͡ʒiˈɔ.tɐ] 'idiot'*,* and *identidade* [ĩ.ˌdẽ.t͡ʃiˈda.d͡ʒɪ] 'identity' with a nasal initial vowel. All of these preceding forms – some of the most representative and well-known cases – have in common the fact that they involve a high front vowel in the initial syllable, and through a quantitative analysis of over two hundred examples presented within this paper, we conclude that there is a pattern informing why spontaneous nasalization arises in examples such as these, as opposed to being randomly articulatorily distributed throughout the language. In short, we claim that spontaneous nasalization is a strategy to perceptually enhance prominence, and tends towards particular vowels in particular syllabic positions, arising indeed potentially 'spontaneously', as opposed to being a case of variable dialectal lexicalization.

Thus, during a visit to a virtually unknown fishing village in Brazil named *Picinguaba* [pi.sĩ.ˈgwa.bɐ], a highly literate Portuguese speaker called it [pĩ.si.ˈgwa.bɐ], apparently transposing the nasal vowel to the first syllable. This 'real-time error' was not the result of dialectal divergence (as the toponym is so low frequency that one cannot claim there are two lexicalized variants), but rather, we contend, revealing of a latent and recurring tendency that occurs in the language: to make stressed syllables even more prominent than they otherwise would be. Specifically, the foot structure of this four-syllable word is composed of two trochees, whereby the initial syllable has secondary stress (see Collischonn 1994). The strong syllable within the first foot should ideally have more prominence than the weaker syllable in this foot. Transposing the nasality from the prosodically weaker syllable onto the stronger one accomplishes just that, in a manner similar to what Smith (2005) called Prominence Augmentation.

The intuition is that certain prominent positions, in particular, stressed and/or initial syllables, demand the presence of prominence-increasing material (a clearly violable tendency, but one present, the force of which when exerted can be observed). Highlighting this particular case with a version of Zoll's (1998) COINCIDE constraints, which demand marked segments such as nasal vowels in initial syllables, would look as follows:[2]

(1) Tableau for Nasal Metathesis towards Initial Syllable

/ pi.sĩ.ˈgwa.bɐ/	COINCIDE(σ_1,NasalV)	DEP [+nasal]	LINEARITY
☞ [pĩ.si.ˈgwa.bɐ]			*
[pi.sĩ.ˈgwa.bɐ]	*!		
[pĩ.sĩ.ˈgwa.bɐ]		*!	

With this small 'error' in encoding and reproducing the town's toponym, we have an entire phonological tendency writ small: what properties of this particular word are responsible? This requires spelling out the following three questions for Brazilian Portuguese: (A) when does a syllable require prominence (i.e. a theory of secondary stress and prominent positions), as in the case of the initial syllable of this four-syllable paroxytone word? (B) what kinds of syllables are needier than others (e.g. those with higher vowels, or those with one or fewer consonants in the onset)? (C) What kinds of processes (and segments) can be employed to enact prominence-boosting, and how can these be formally represented?

The Stress-to-Weight Principle (SWP; e.g. Prince 1990) is employed to explain cases in which a stressed syllable (whether lexically or predictably stressed) undergoes additional phonological processes to gain weight, such as addition of a coda consonant (in Italian *raddoppiamento sintattico;* Borrelli 2002) or post-tonic syncope in Tonkawa (Gouskova 2007), and this principle affords insight into a wide range of strategies. Indeed, glide insertion before [s] in final-stressed syllables in the Carioca dialect (Rio de Janeiro) of Brazilian Portuguese (BP) (e.g. rapa[j]s 'guy') has been analyzed in Nevins (2015) as an instance of the SWP, under the assumption that coda [s] is non-moraic and hence such stressed syllables require additional weight. Nonetheless, there are certain processes affecting primary (and secondary) stressed syllables that cannot be easily modeled in terms of weight-addition via moraic structure *per se*, but nonetheless do involve a broader notion of prominence (see e.g. Ryan 2014 for application of this notion for weight-to-stress cases), as shown in (2a)-(2d):

(2)   *Prominence Scales employed in Augmentation*
       a. diphthongs > simplex nuclei
       b. complex onsets > onsetful > onsetless
       c. nasal vowels > oral vowels
       d. low vowels > mid vowels > high vowels

The scales in (2) can be derived from a combination of increased duration for all of these, as is clearly true for cases of more segmental material (2a-b), and has been phonetically demonstrated for (2c) by Morães & Wetzels (2003) and for the vowel scale in (2d) by Crosswhite (1999). We contend that the phonologized effects of weight are stated in terms of

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[2] We include secondary stress as the input to the tableau for expositional purposes, remaining agnostic as to whether this is the result of underlying assignment, the presence of a constraint not shown in this tableau, or the output of an earlier stratum of phonological computation (as secondary-stress has a post-lexical character in BP; Collischonn 1994).

weight-sensitive comparisons in phonological terms, although they phonetically derive from increased duration.

2. Prominence-Demanding Positions in Brazilian Portuguese

As is generally known throughout the Romance languages, main stress on all lexical items besides verbs (which are outside the scope of this study) falls within a three-syllable window from the right edge, enabling minimal triplets (e.g. *sábia* 'sage', *sabía* 'knew-imperf.', *sabiá* 'thrush'), with penultimate stress being the default. Final stress occurs predictably when the final syllable is heavy, ending in a glide or rhotic (e.g. *ane[w]* 'ring', *abajur* 'lampshade', *hero*[j] 'hero'). This quantity-sensitivity, discussed by Bisol (1992) and Wetzels (2007), does not always hold for final sibilants, which is what compels glide epenthesis.

      The productivity of these principles, as discussed by Hermans & Wetzels (2012) can be found in new coinages such as acronyms and pharmaceuticals, which follow these principles blindly. None of these bear orthographic accents; the accents shown below indicate where stress is assigned phonologically:

      (3)   *Novel formations showing adherence to Main-Stress Assignment*
              a. <u>Final WSP</u>: Detran, Procon, Funai, Susau, Benes, Proer, Varsul, Anpol, Efexor, Dorless, Beserol
              b. <u>Default penult otherwise</u>: Óvni, Bradésco, Texáco, Úfba, Clopsína
              c. <u>Final epenthesis leads to penult</u>: Fapéspi, Telprági, Valméti, Nisulídi

More spectacular cases come from blend first-names, which are a goldmine for study given the onomastic creativity of anthroponyms in Brazil: *Gustavo+Maria = Gusmar*, and the famous case of the six soccer players from the 1970 World Cup *Tostão+Pele+Rivelino+Carlos Alberto+Gérson+Jairzinho* yielding the first name *Tospericargerja* (born that year), whose unusual name bears no need for an orthographic accent because, as inventive as his parents were, his name still has default penultimate stress.

      Given the Weight-to-Stress-Principle holding over final syllables, followed by penultimate stress as a default, exceptional lexically-marked stress is therefore any case of antepenultimate stress or any case of a final-stressed light syllable. Indeed, antepenultimate stress is not only unproductive, but has a tendency to be levelled out to penultimate stress, as found in colloquial pronunciations such as (4), in which the medial vowel is deleted (see França 2009, among others):

      (4)   *Examples of antepenultimate stressed words undergoing syncope to become default penutimate-stressed:*
          a. árvore [ˈah.vo.ɾɪ] > arvre [ˈah.vɾɪ]   'tree'
          b. abóbora [a.ˈbɔ.bo.ɾɐ] > abobra [a.ˈbɔ.bɾɐ]   'pumpkin'
          c. xícara [ˈʃi.ka. ɾɐ] > xicra [ˈʃi.kɾɐ]   'teacup'
          d. córrego [ˈkɔ.he.gʊ] > corgo [ˈkɔh.gʊ]   'creek'
          e. estômago [is.ˈtõ.ma.gʊ] > estomgo [is.ˈtõ.gʊ]   'stomach'
          f. ônibus [ˈõ.nɪ.bʊs] > onbus [ˈõj̃.bʊs]   'bus'
          g. cônjuge [ˈkõ.ʒu.ʒɪ] > conge [ˈkõ.ʒɪ]   'spouse'

As Herman & Wetzels (2012) point out, there are two sets of regular antepenultimate stress: those that involve a high vowel in a hiatus context causing throwback in (5), and those (Leo Wetzels, pers. comm, and Asaf Bachrach, pers. comm) with prestressing suffixes (or possibly pseudo-suffixes synchronically) in (6):

(5)   *Antepenultimate stress with high vowel + vowel sequences:*[3]
        a. Antônio [ɐ̃.ˈtõ.njo]   'proper name'
        b. pátria [ˈpa.tɾjɐ]   'homeland'
        c. tábua [ˈta.bwɐ]   'board'
        d. Tânia [ˈtɐ̃.njɐ]   (proper name)

(6)   *Antepenultimate stress with prestressing sufixes -ico, -ido, -ula:*[4]
        a. elétrico [e.ˈlɛ.tɾɪ.kʊ]   'electric'
        b. plástico [ˈplas.tɪ.kʊ]   'plastic'
        c. tímido [ˈtʃi.mɪ.dʊ]   'timid'
        d. rápido [ˈha.pɪ.dʊ]   'rapid'
        e. flâmula [ˈflɐ̃.mʊ.lɐ]   'banner'
        f. edícula [e.ˈdi.kʊ.lɐ]   'cottage'

Cases like (5) thus form an 'island of reliability' among the exceptions (although even the last two forms undergo sporadic glide metathesis, forming *ta*[w]*ba* and *Ta*[j]*na* as an application of the SWP). The cases in (6) form a set of recurrent exceptions where high vowels repel stress recurrently with these formatives and may require only listing the (pseudo-suffixes) in question *(-imo, ido, -ico, -ula,…)*. Thus, while antepenultimate stress is lexical and exceptional, cases like (5-6) do seem to reduce the overall unpredictability given smaller pattern-governed cases within the exceptionality.

Now, what about secondary stress in BP? In general, secondary stress seems to be assigned separately (and perhaps *after*) the marking of primary stress. Thus, while there is variation among speakers in terms of whether a given lexical item has penultimate or non-penultimate stress for a handful of forms (e.g. *rúbrica* [ˈhu.bɾɪ.kɐ] vs. *rubrica* [hu.ˈbɾi.kɐ] 'rubric'; *projétil* [pɾɔ.ˈʒɛ.t͡ʃiw] vs. *projetil* [pɾɔ.ʒɛ.ˈt͡ʃiw] 'projectile'), and for segmental properties (e.g. *assovio* [a.so.ˈvi.ʊ] and *assobio* [a.so.ˈbi.ʊ] 'whistle' are in free variation), there is no free variation between antepenultimate and final stress known for any form (say *ássovio* and *assovió*). Given the lack of much interspeaker variation in main stress, it is notable that there is indeed persistent variation in *secondary* stress, as pioneeringly discussed by Collischonn (1994); see also Buckley (2016) and Hualde & Nadeu (2011) for related phenomena in Spanish. In English and Dutch, secondary stress can also be diagnosed by a syllable that is not a schwa (e.g. not a reduced vowel). Thus, English differentiates *rái.der* with [ə] vs *rá.dàr*, both with the same main stress but different secondary stress. In BP, secondary stress is diagnosable by relative prominence, though the acoustic correlates are complex (see Moraes 2003).

Importantly, as shown by Collischonn (1994), there are two strategies for assigning secondary stress, neither of which is apparently weight-sensitive. There is an initial dactyl strategy, found in words with an odd number of syllables before the main stress, and a rhythmic strategy.

(7)   *Variable Secondary Stress with Odd-Number of Pretonic Syllables:*
        a. marácujá [ma.ɾa.ku.ˈʒa] ~ màracujá [ˌma.ɾa.ku.ˈʒa]   'passionfruit'
        b. abàcaxí [a.ˌba.ka.ˈʃi] ~ àbacaxí [ˌa.ba.ka.ˈʃi]   'pineapple'

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[3] In Portuguese orthography, antepenultimate stress is marked by an acute accent generally, but by a circumflex accent when a nasal vowel (i.e. before a nasal consonant).

[4] Pseudo-suffixes of this sort may also be at play with anthroponyms such as Jéfferson, Éverton, with antepenultimate stress.

c. Aràcajú [a.ˌɾa.ka.ˈʒu] ~ Àracajú [ˌa.ra.ka.ˈʒu]   (toponym)

According to Collischonn, these are optional, automatic, and post lexical, and even affected by late fast speech rules such as glide formation. Thus tetrasyllabic *in.vi.á.vel* [ˌĩ.vi.ˈa.vɛw] 'unviable' has initial secondary stress, whereas trisyllabic *in.vjá.vel* [ĩ.ˈvja.vɛw] does not, and pentasyllabic *ro.(dò.vi)(á.rja)* [hoˌdo.vi.ˈa.ɾjɐ] 'bus station' has secondary stress on *do*, whereas tetrasyllabic *(rò.do)(vjá.rja)* [ˌho.do.ˈvja.ɾjɐ] has it on *ro*.

Parallel work on Spanish, e.g. by Buckley (2016), has suggested that an initial dactyl is a possible footing strategy to achieve initial prominence, but in fact, considering even longer words opens the possibility that a ternary dactyl is simply a permitted foot-type in the inventory of secondary-stress feet. Thus the heptasyllabic city (originally multimorphemic in its Tupi-Guaraní source, but not analyzed as such in BP) in São Paulo is *(Ì.ta).(qùa.que.ce).(tú.ba),* with secondary stress on the first and third syllables, and main stress on the sixth. Interestingly, with even-numbered pretonic syllables, there is no room for such variation, and thus the derived demonym is an *Ì.ta.qùa.que.cè.tu.bén.se*, with secondary stress on the first, third, and fifth syllables, and main stress on the seventh. Derived demonyms themselves, however, can exhibit medial dactyls, as in *Aràcaju.én.se*, in which the second syllable alone has secondary stress, and the main stress falls on the fifth syllable.[5]

A final factor to consider in secondary stress is its apparent reassignment in cases of stress clash. Like English *thirtéén* vs *thírteen mén* or *Tennesséé* vs *Ténnessee Wílliams*, BP disallows stress clash caused by adjacent words (or compounding-suffixes): *café* 'coffee' *càfezínho* 'coffee-dim.' (and not *cafézínho*); see Sandalo & Truckenbrodt (2002) for phrasal examples. But is this retraction, or simply erasure of the stress altogether, and reassignment based on Initial Dactyls? There is evidence that it is erasure + reassignment:[6]

(8)   *Variable secondary stress following stress-clash reassignment:*
        a. picolé [pi.ko.ˈlɛ]   'popsicle'
        b. picòlezínho [piˌkɔ.lɛ.ˈzĩ.ɲʊ]   'popsicle-dim.', rhythmic trochee pattern
        c. pìcolezínho [ˌpi.kɔ.lɛ.ˈzĩ.ɲʊ]   'popsicle-dim.', initial dactyl pattern

With this overview of secondary stress assignment, we can now delimit the set of prominence-demanding positions in BP as those with main stress, those with secondary stress, where secondary stress is assigned by either rhythmic counting leftward from the main stress (always found in cases of an even-number of pretonic syllables), or in case of an odd-number of pretonic syllables, variation between the rhythmic pattern and use of dactyls (either medial or initial). There is, however, one additional position we must add to the inventory of prominence-demanding syllables, going above and beyond those resulting from foot structure, and that is the word-initial syllable itself.

The word-initial syllable, we contend, is a crucial site for prominence boosting, even if not directly footed as a locus of secondary stress. Many articulatory studies have found prominence boosting of segments at the edges of initial domains, as distinct from that of stressed syllables; see Fougeron (2001) and Cho & Keating (2009). We appeal to the findings of Smith (2005) that the initial position is one that requires prominence-boosting for the psycholinguistic purposes of lexical access and word-recognition, in addition to potentially for reasons of speech planning by the speaker. For phonologically-based studies of the importance of the initial syllable, see Beckman (1998) and Becker et al (2018), among many others.

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[5] Medial dactyls can also be observed as the result of phrasal footing, e.g. *Peço vocês encarecidamente* [(ˈpe.so.vo)(ˈses.en.ca)(ˈre.ci.da)(ˈmen.te)] 'Ask.1sg. you.pl warmly'.
[6] We thank Leo Wetzels for suggesting this generalization.

Summarizing this section overall, we expect prominence-boosting processes to affect (and not affect) the following syllables:

(9a) Syllables potentially demanding prominence-boosting:
i. Main stress[7]
ii. Secondary Stress
iii. Initial Syllable

(9b) Syllables never demanding prominence-boosting:
i. Non-initial syllables with no secondary stress

Thus, consider the frequently described phenomenon of pretonic mid-vowel lowering in Northeastern dialects of Brazilian Portuguese (as described in oversimplified terms in Nevins (2012), for example). As the careful study of Santana (2019:204) shows, this mid-vowel lowering does not in fact affect all syllables, but only secondary-stressed or initial ones. Thus, for a word like *televisão* 'television' with two pretonic mid-vowels, we expect the following possibilities, given the variability in secondary-stress and footing outlined above:

(10) *Possible and Impossible Patterns of Prominence Boosting in NE BP:*
a. Prominence-Boosting on head of initial dactyl and initial syllable: (tɛ̀.le.vi)são
b. Prominence-Boosting on head of R>L trochee and initial syllable: tɛ(lɛ̀.vi)são
c. Impossible pattern: (9a) with lowering of second, non-head: (tɛ̀.lɛ.vi)são, or (àpɛ).(lí.do) 'nickname'

This concludes the overall outline of the patterns to be described in this paper: we have (a) a set of prominence-boosting positions, (b) a set of prominence-needy syllable types, and (c) a set of processes that seek to boost syllables that fall in both (a) and (b). Thus, in (9), the prominence-boosting positions are those of initial position and/or secondary stress, the prominence-needy syllables are those with lower sonority (e.g. closed mid-vowels), and the process to achieve prominence-boosting is mid-vowel lowering, a process specific to Northeastern BP and outranked by constraints on faithfulness in other dialects of Portuguese.

A similar pattern to (9) can be found in rhotic metathesis in the Romance languages; thus, there is alternation between *crocodillo* and *cocodrillo* 'crocodile' showing variation between stressed syllable and initial syllable, whereby medial unstressed syllable is never touched (see Damulakis 2005: 66). This kind of rhotic metathesis is found in non-standard forms in BP (and for coda cases such as 11d, seems to hold independently of whether the rhotic realization is retroflex, velar fricative, or glottal fricative):

(11) *Rhotic metathesis to the primary/secondary stressed-syllable*
a. [ˈvi.dɾʊ] > [ˈvɾi.dʊ]   'glass'
b. [is.ˈtu.pɾʊ] > [is.ˈtɾu.pʊ]   'rape'
c. [fits.ˈpɛ.tɾɪ.kɪ] > [fits.ˈpɾɛ.tɪ.kɪ]   ('Fitzpatrick' proper name)

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[7] Interestingly, Brazilian Portuguese final syllables headed by underlying /i/ or /u/ typically attract stress, e.g. *bambú* 'bamboo', *sushi* 'sushi'. This typologically surprising attraction of stress to low-sonority nuclei may be related to differentiating them from the underlying /e,o/ that post-tonically reduce to [ɪ,ʊ] and are never stressed. In fact, words with final /i/ without final stress, e.g. *táxi* 'taxi' may even be analyzed by speakers as with an underlying /e/, as found in the possible vocative form [tak.se]. Whatever the analysis of stress-attracting final /i,u/ may be, it is noteworthy that no examples of spontaneous nasalization in our corpus are found with such vowels. Presumably, in final open syllables, they have enough prominence on their own, without nasalization (though notably, in Carioca dialects they may develop schwa-offglides, e.g. [bẽˈbuᵊ, suˈʃiᵊ] 'bamboo, sushi').

d. [ˌla.gahˈʧi.ʃɐ] > [ˌlah.gaˈʧi.ʃɐ]   'lizard'

There is ample documentation of the diachronic phenomenon of rhotacism in Portuguese (e.g. *branco* 'white', compare Spanish *blanco* and French *blanc*) which is often colloquially extended to newer words (e.g. *Leblon > Lebron* 'toponym'). The reason for such substitution, often not explicitly commented upon, is arguably to improve the sonority profile of the onset, as /r/ is more sonorous than /l/ (and indeed, this feeds into the restriction that [tl, dl] are banned as word-initial onsets while [tr, dr] are allowed; see Moreton 2002 for pertinent discussion from English, and Pons-Moll 2008 for the proposal that taps are more sonorous than laterals in Romance). Rhotacism is so common it often overshadows the arguably distinct, stress-related phenomenon of rhotic metathesis: the migration of the /r/ from a complex onset in an unstressed syllable into that of a stressed syllable. The cases reviewed herein are entirely non-standard and have not been treated in diachronic literature on Portuguese, as they are sporadically found, and unattested in standard variants. Consider moreover the oft-noted example *problema > pobrema* 'problem'. While this may have the appearance of 'rhotacism', this would not explain the disappearance of the /r/ in the first syllable. Similarly, wholesale liquid metathesis (of the kind found in *miraklo > milagro* 'miracle') is not at stake as the form is not *plobrema*. Instead, what is happening is that the unstressed syllable is robbed of its rhotic, as an unstressed syllable is not allowed more prominence than a stressed one. Thus, we treat *problema > poˈbrema* as a case of metathesis to the stressed syllable.

Similarly, Lipski (1992a) who collects examples from Spanish such as *fábrica > frábica* 'factory' and *dentro > drento* 'inside', as well as initial-syllable transpositions like *petróleo > pretóleo* 'petroleum', mentions (p.100) "This apparent leftward skewing of consonant clusters may have to do with relative prominence, articulatory energy, or the position of the stress peak within the word." Clàudia Pons-Moll (pers. comm) cites examples from Majorcan Catalan such as *padrí > pradí*, which depart from the stressed syllable, but crucially move to the initial syllable. While examples of leftward metathesis by only one syllable are found (as metathesis is often sporadic), we contend that, parallel to (10), rhotic metathesis can be to a primary/secondarily stressed syllable, *or to the initial syllable*, but is less likely to migrate to a non-initial, unstressed syllable. Rhotic metathesis is widely discussed for the Iberian languages, but here we limit our attention to BP, where it manifests itself as a prominence-augmentation phenomenon.

In a tellingly parallel fashion, Blevins & Garrett (1998) cite the example of Bagnères-de-Luchon, for which "Posttonic r has moved one syllable to the left, into the historically stressed syllable (which is often also the initial syllable)." The analysis they posit is exactly within the spirit adopted here: "In addition, long-distance movement processes evidently move segments or features into syllables which are in some sense more prominent: stressed syllables, as in Colville; or initial syllables, as with Bagneres-de-Luchon French and Ancient Greek. We cannot fully explain these patterns, but they are consistent with the view that the segments and features in Table 1 occupy long durational windows which allow for their reinterpretation in nonhistorical positions. This perceptual reinterpretation involves segments and features which are drawn to positions of prosodic prominence." (p. 527).

Rhotic metathesis is thus already discussed in the literature as a case of prominence-augmentation, and we contend that the nasal vowel metathesis found in (1) above is exactly parallel to such cases. In what follows, we turn to spontaneous nasalization – the introduction of nasal vowels in non-etymological positions, with the same motivation, but in cases for which no existing nasal vowel can be said to have been transposed. Such cases, to our knowledge, are not found with rhotics (e.g. spontaneous insertion of rhotics as the second member of an onset cluster).

3. Spontaneous Nasalization as Prominence-Augmentation

We repeat below the prominence scales from (2):
(2)   a. diphthongs > simplex nuclei
         b. complex onsets > onsetful > onsetless
         c. nasal vowels > oral vowels
         d. low vowels > lower-mid vowels > upper-mid-vowels > high vowels

      Many authors (especially Smith 2005) have proposed that certain phonological processes can be understood in terms of prominence augmentation, especially when initial or secondarily-stressed syllables do not have sufficiently prominent segmental material (including onsets, shown to contribute to syllable weight in Topintzi (2010) Many phenomena, both within standard and non-standard varieties of BP, can be understood within this logic. For example, Wetzels' (1997) neutralization of mid-vowels to the lower, [-ATR] version in proparoxytones (dactylic lowering) and in penultimate-stressed words that violate the Final-WSP (spondaic lowering) is once such case, motivating the distribution of this vowel in m[ɔ]vel 'furniture', ab[ɔ]bora 'pumpkin', d[ɔ]lar 'dollar', [ɔ]rfã 'orphan', f[ɛ]lix 'proper name', Pers[ɛ]fone 'proper name' and so forth. Once we view vowel height as a kind of sonority that increases the prominence of a syllable, these marked foot-types receive greater sonority in the head position, again using the logic of COINCIDE as defined in Zoll (1998), as shown in the tableau in (13) for dactylic lowering.

(12)   *Definition of* COINCIDE *family of constraints*
         COINCIDE (strong position, prominent property)
         (i) $\forall x$ (x is a strong position $\exists y$ (y=prominent property $\wedge$ *Coincide* (x,y)) • *Coincide*
         (x,y) will be true if $y=x$, y dominates x, or x dominates y
         (ii) Assess one mark for each value of x for which (i) is false.

We can now apply this to the position Head-Dactyl, as a prominence-augmenting position. In terms of why the head of a dactyl should be a prominent position, consider the representations in Martínez-Paricio & Kager (2015) and in Hermans & Wetzels (2012), according to which the head of a dactyl, in a recursive binary representation, is the head of a head of a foot, and hence doubly strong.

(13) *Tableau for Dactylic Lowering[8]:*

/ per(ˈse.fo.nɪ) /	COINCIDE(Head-Dactyl, [-ATR])	DEP [+low]	DEP [-ATR]
☞ [per(ˈsɛ.fo.nɪ)]			*
[per(ˈse.fo.nɪ)]	*!		
[per(ˈsa.fo.nɪ)]		*!	

      The collection of spontaneous nasalization data in BP we analyze here is based on Costa (2019), and composed of 219 examples in which nasalization occurs in positions that deviate

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[8] As mentioned earlier, we include secondary stress (and footing) as the input to the tableau for expositional purposes, remaining agnostic as to whether this is the result of a constraint not shown in this tableau, or the output of an earlier stratum of phonological computation (as secondary-stress has a post-lexical character in BP; Collischonn 1994). See also footnote 12 for suggestive evidence that spontaneous nasalization is a process with a late character, following the determination of rhotic allophony.

from the etymological and/or standard forms of such words in BP. The data are based on written forms collected from social media and blogs. While one might protest that written forms are not revealing, the fact is that one does not always have a recording device handy while spontaneous nasalization is uttered. Nonetheless, the existence of non-etymological nasalization in BP forms such as *indioma* 'language', *ingreja* 'church', *indiota* 'idiot', *indentidade* 'identity', *ingnorante* 'ignorant' are widely known to all speakers of the language, even if dismissed as mere errors. Souza e Melo (2015) collected written data from ninth-year students in the city of Recife, and reports that she "has observed as a teacher that this kind of nasalization is very widespread among students" (p. 79, translation ours); see also passing mentions in Marroquim (2008; p.47).[9] Alves (2004), working on the *quilombo* Portuguese of Gurutubana, Minas Gerais, notes the recurrence of "spurious nasalization" in word-initial position and with the vowel /i/ (p.21).

Cases of nasal epenthesis with initial onsetless [i] in fact have some diachronically enshrined cases, the most famous being Latin *hibernum*, which became *inverno* in Spanish and Portuguese.[10] While most of the well-known examples cited above start with a word-initial onsetless high front vowel, this is by far not the only set of such cases (and indeed, it is difficult to claim that these all have negative connotations from a pseudo-prefix *in-* as this would be unlikely for the cases of 'church' and 'identity'). All written sources were taken from ones with more than 50 non-repeated hits, and the top hits were verified as ones with a clear author who was a speaker of Portuguese. In addition, to make sure that these patterns were not purely due to orthotactic trends (e.g. word-initial <in> sequences), Costa (2019) collected audio samples in individual recordings, in which specific words were targeted by means of elicitation and interviews, largely with interviewees without university-level education, which we contend inhibits this kind of spontaneous nasalization, an otherwise natural and understandable trend given the phonology of the language, but one that is stigmatized when a 'known' form exists – unlike the very case with which we began this article. The following is a sample of spontaneous nasalization as found in Costa (2019)[11]: the full set occurs in the appendix.

(14)   *Examples of Spontaneous Nasalization via Epenthesis:*
    a. idiota [ĩ.d͡ʒiˈɔ.tɐ]   'idiot'
    b. igreja [ĩˈgɾe.ʒɐ]   'church'
    c. ironia [ˌĩ.ɾo.ˈni.ɐ][12]   'irony'

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[9] Such forms are also frequently commented upon in blogs, e.g. http://mixdereferencias.blogspot.com/2016/12/palavras-erradas-que-parecem-certas.html (accessed 1 June, 2019). At the moment, we have only conducted a thorough study of this phenomenon in Brazilian varieties of Portuguese. According to Ezra Champal Nhampoca (pers. comm), Mozambican varieties with extensive contact with Bantu languages such as Changana may exhibit non-etymological nasality, e.g. *enconomia* 'economy'. European Portuguese is likely to maintain a different system of nasalization, as apocope can generate the existence of emerging minimal pairs such as *com* [kõ] 'with' vs *kone* [kõn] '(sushi) cone', potentially yielding a system like contemporary French.

[10] Interestingly, *hibernar* was re-borrowed from Latin with the meaning 'to hibernate', and this item has re-undergone spontaneous nasalization in our sample: [ˌĩ.beɦ.ˈnah].

[11] The oft-commented form *morta(n)dela* [ˌmoh.tã.ˈdɛ.lɐ] 'mortadela' has an etymologically nasal source, as it appears as a variant in Italian itself (see https://www.ildolomiti.it/societa/2018/la-storia-della-mortandela-orgoglio-della-val-di-non, accessed 1 June 2019).

[12] Mattoso Câmara Jr. (1970) assumes that nasal vowels pattern like closed syllables with a coda consonant, thereby explaining why the distribution of rhotics in BP – in particular, the 'strong', or fricative rhotic (as opposed to the tap) occurs after a closed syllable, as in *Israel* 'Israel', *enredo* 'storyline', *Henrique* 'proper name', *honra* 'honor', *genro* 'son-in-law'. However, our collection of spontaneous nasalization includes

    d. usufruir [ũ.ˌzu.fɾu.ˈih]   'to make use of'
    e. ebulição [ĩ.ˌbu.li.ˈsãw̃]   'boiling'
    f. ocorrer [ˌõ.ko.ˈheh]   'occur'
    g. abacaxi [ã.ˌba.ka.ˈʃɪ]   'pineapple'
    h. afligir [ˌa.flĩ.ˈʒih]   'to ail'
    i. aipim [ˌa.ĩ.ˈpɪ̃j̃]   'yucca'
    j. pichação [pĩ.ʃaˈsãw̃]   'grafitti'
    k. pudim [pũˈdɪ̃j̃]   'pudding'
    l. cobaia [kõ.ˈbaj.jɐ]   'guinea pig (i.e., test case)'

 Ideally, these data points can all be evaluated in a perceptual study – in a same/different or ABX task, or one in which participants rate the degree of deviation amongst two pronunciations – to see how acceptable and/or perceptually salient these are (and potentially with pseudo-words as well).

    Of 219 total examples of spontaneous nasalization, 182 of them (83%) occurred in the initial syllable. A breakdown by vowel quality is found below:[13]

(14) *Spontaneous Nasalization targets, by individual vowel*

Vowel	Occurrences	%
i	175	80%
u	18	8%
e	10	5%
o	11	5%
a	5	2%
Total	**219**	

    As can be verified, there is an extremely high rate of occurrence for [i], followed by [u], though nearly ten times less. While one might generalize specifically to [i] as opposed to high vowels specifically, it is important to recall that in BP, the overall distribution of [i] is much higher than that of [u], and even more pronounced in initial position (where words like *umbigo* 'navel' are often non-standardly pronounced as *imbigo*). Summing up [i] and [u] with the caveat that [u] is rarer to begin with, high vowels make up 88% of the total targets of spontaneous nasalization. (See Cedergren & Sankoff 1975 for a similar rate of vowel nasalization of high vowels vs non-high vowels in Panamanian Spanish). In fact, Hajek & Maeda (2000) report that "at low levels of velic opening, nasalization is likely to be perceptually more salient in high vowels". They reanalyse the oft-cited diachronic height hierarchy of nasalization, bringing many counterexamples to the fore, and concluding that the oft-noted effect of low vowels is often brought about by increased duration, and that when duration is controlled, studies such as House & Stevens 1956 find that "synthetic low vowels require almost three times as much velic opening as high vowels before they are identified as nasal by American listeners".

[ĩ.ˈɾa.dʊ] 'irate' and [ˌũ.ɾu.ˈgwaj] 'Uruguay', in which nasalized vowels precede the tap. These could be taken to suggest either that Mattoso Camara's generalization that nasalized vowels are equivalent to closed syllables is not absolute (perhaps as already challenged by the existence of the proper name of a soccer place *Dãr.ley*), or that the spontaneous nasalization under scrutiny in this paper is a 'late' process, imposed after the determination of rhotic allophony. In addition, as suggested by Leo Wetzels (pers. comm), while the fricative rhotic is largely not found after diphthongs, the process of l-vocalization can create such sequences for words such as *melro* 'blackbird', *guelra* 'gill', or *bilro* 'bobbin', which yield a diphthong before the fricative rhotic.

[13] Onsetless initial /e/ (or at least, etymological/orthographic <e>) is very frequently reduced to [i], particularly when nasalized or preceding sibilants.

As for the front-back asymmetry found in BP, this is in fact consistent with an assertion made by Ohala (1975), who suggests that given two vowels with similar F1 values, those with higher F2 values are more easy to nasalize.[14]

The epenthesis of nasalization on an initial, onsetless high vowel is shown below, using an adaptation of COINCIDE specific to this position[15]:

(15) *Tableau for Epenthetic Nasality in Initial, Secondary-Stressed Position*

/i.di.ɔ.ta/	COINCIDE (σ̀,NasalV)	DEP [+nasal]	*Nasal V
☞ [ˌĩ.d͡ʒi.ˈɔ.tɐ]		*	*
[ˌi.d͡ʒi.ˈɔ.tɐ]	*!		

The same process of prominence-boosting occurs below, in which spontaneous nasalization is found in the initial syllable – even if not secondarily-stressed:

(16) *Tableau for Epenthetic Nasality in Initial Position*

/i.ˈgɾe.ʒɐ/	COINCIDE (σ1,NasalV)	DEP [+nasal]	*Nasal V
☞ [ĩ.ˈgɾe.ʒɐ]		*	*
[i.ˈgɾe.ʒɐ]	*!		

As for the high vowel effects, these could be captured by a family of COINCIDE constraints specific to each vowel height, with DEP(Nasal) interleaved in terms of tolerance, as shown for example in (17):

(17)   *Height-Specific Rankings for Prominence-Boosting Nasalization:*
COINCIDE (σ1,NasalV$_{high}$) >> DEP [+nasal] >> COINCIDE (σ1,NasalV$_{mid}$) >> COINCIDE(σ1,NasalV$_{low}$)

As can be observed in the examples in (14), the majority of these examples involve prominence-boosting on an initial syllable, a secondary-stressed syllable, or a stressed-syllable (and moreover, usually a high vowel, and in fact an onsetless high vowel). Lipski (1992b) contains a number of parallel examples from Afro-Hispanic *bozal* Spanish, as listed below, which he contends represents "the addition of a [+nasal] autosegment to the beginning of certain words" (p.264).

(19)   *Spontaneous Nasalization in Bozal Spanish:*
a. suplica > sumprica   'begs'
b. ripito > rimpito   'rhythm'
c. despachar > dimpachá   'to send'

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[14] In terms of the following consonant, 41% of the 219 BP cases of spontaneous nasalization occurred before fricatives. As discussed by Ohala & Busà (1995), the airflow required by fricatives causes articulatory opening and subsequent ambiguous perceptual effects that can either lead to nasal deletion before fricatives (e.g. *gans > goose* in English) or nasal insertion (e.g. *bonaça > bonanza* in Spanish).

[15] In this paper, we adopt the position that nasal vowels involve addition of the feature [+nasal], though this is compatible, under minor adjustments, with this being the result of addition of a coda nasal that triggers regressive nasalization.

d. repica > rimpicá   'to chime'
e. iglesia > ingresia   'church'
f. ofrece > unfrece   'offer'

Lipski (1992b:285) concludes that these "apparent word-internal nasal consonants, added syllable-finally, in reality represented vowel nasalization, possibly combined with low-level epenthesis of an occlusive nasal element before the following consonant".

Let's now consider the breakdown by stress in BP:

(20) *Spontaneous nasalization within sample, breakdown by stress*

Stress level	Occurrences	%
Primary stress	24	11%
Secondary stress	83	38%
No stress	112	51%
Total	**219**	

As can be seen, primary stressed cases are the least type-frequent (although certain token-frequent cases, such as *mendi(n)go* [mĩˈd͡ʒĩ.gʊ] 'mendicant' exist.[16] Some of these may be chalked up to a tendency for harmony, such as *ni(n)cho* 'niche', which is so commonly used in this form that it may be changing in the language, and related phonologically-triggered instances may be due to aggressive reduplication (in the sense of Zuraw 2002 for non-etymological cases of insertion such as *she<u>r</u>bert*.) with an existing syllable with nasality already present. In order to model the fact that speakers resist spontaneous nasalization on a primary stressed syllable, IDENT(±nasal)-σ́ would outrank all of the relevant COINCIDE constraints.

Secondary-stressed ones make up a significant percentage, cases such as *ve.i(n)cuˈlar* [ve.ˌĩ.kuˈlah] 'to convey'. However, for some of these, given the remarks above that secondary stress is variable, we cannot be fully certain that the version with spontaneous nasalization indeed was rendered with secondary-stress on the nasalized syllable.

Finally, let us consider the completely non-accented ones. Of these, how many are in the initial syllable? 88%, as can be seen below, greatly confirming the tendency already reported and modelled by COINCIDE (σ_1,NasalV).

(21) *Spontaneous nasalization in the 112 unstressed syllables, breakdown by syllable position*

Position	Occurrences	%
σ_1	98	88%
σ_2	13	12%
σ_3	1	1%
Total	**112**	

As this table shows, the overwhelming majority of cases of spontaneous nasalization in the initial syllable occur when it is unstressed. Of the items with spontaneous nasalization immediately preceding the stressed syllable (and thus not secondarily stressed), one such case is *aim.pim* 'yucca', most likely a case of aggressive reduplication in Zuraw's sense (e.g.

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[16] A potential etymology offered for the word *gringo* 'foreigner' for Spanish involves an epenthetic nasal in the word *griego* 'Greek', accompanied by reduction of the diphthong. See Sayers (2009) for extended discussion.

sporadic occurrences of *sancrosanct* in English, or *Ur.ber* for 'uber' in BP)[17], and the other is *mortandela* 'mortadela'; see footnote 11 for discussion of this case.

Summing up, therefore, constraints such as COINCIDE (σ_1,NasalV) are intended to guarantee that spontaneous nasalization will be attracted to the initial syllable, and its height-specific family of subconstraints to those with high vowels. The guiding intuition is that nasalization increases prominence, and that the initial syllable, and specifically when it is a shorter-duration high vowel, needs this increased prominence. For durational data on pretonic high vowels vs non-high vowels, see Faveri (1991) and Morães (1999), both of whom found pretonic high vowels to be up to 40% shorter than the non-high vowels. Indeed, as mentioned in footnote 7, variants of the Carioca dialect of BP specifically enhance stressed high vowels (e.g. aˈm[iᵊ]go 'friend', açaˈ[iᵊ] 'açai', Banˈg[uᵊ] 'toponym'). However, why should nasal epenthesis (or metathesis) occur more with *onsetless* initial syllables? We turn to this last issue in the final section.

4. Nasality as a Contributor of Weight

Before proceeding, we wish to include here some novel data from a study of Brazilian Portuguese loanwords as adapted into Maxakalí, an indigenous Macro-Jê language spoken in Minas Gerais, Brazil, as reported in Silva et al (2019).

(22)   *Spontaneous Nasalization in Initial Onsetless High Vowels in Maxakalí Loanwords*
        a. açúcar   [aˈsukəh] > [ãˈtɕouɻ]   'sugar'
        b. espelho   [isˈpeʎʊ] > [ĩ̃ˈpæj]   'mirror'
        c. espora   [isˈpɔɾə] > [ĩ̃ˈpʊɡ̊]   'spur'
        d. Oliveira   [oliˈveɾə] > [ũnĩˈbɛɡ̊]   (proper name)

While the authors treat this phenomenon as the result of a constraint specific to the native language, *#ORALV, the question immediately arises as to why Maxakalí, too, disprefers onsetless oral initial syllables (particularly as the examples above are not found in Pinheiro's corpus of BP forms with spontaneous nasalization).

It is already known that pretonic high vowels are shorter than pretonic non-high vowels (see above; Faveri 1991 and Morães 1999). It is also known that nasal vowels are longer than their non-nasalized counterparts (Morães & Wetzels 1992). Finally, onsetful syllables are naturally longer than onsetless syllables, by virtue of having more segmental material.

Thus, following the work of Topintzi (2010) and Ryan (2014), let us consider onsets as contributing to syllable weight; thus Cristófaro Silva et al (2017) show that child BP, deletion of the tap and compensatory lengthening in *prato* [ˈpaːtʊ] 'plate' leads to a length distinction with *pato* [ˈpa.tʊ] 'duck'. Following the work of Morães & Wetzels (2003), let us consider nasal vowels as bearing an additional unit of weight as compared to their oral counterparts. Now, it would be straightforward to have a version of the SWP as follows for a word such as *i(n)çar* 'to hoist' which undergoes spontaneous nasalization. Coincide would require two moras, which could be satisfied either by [+nasal] epenthesis or by onset epenthesis, with the later considered more costly.

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[17] A related case in an initial syllable is sobrancelha 'eyebrow', which has both the variants s<u>o</u>mbracelha, with metathesis (perhaps affected by the existing lexeme *sombra* 'shadow'), and so<u>m</u>brancelha, with epenthesis; the latter case perhaps may be analyzable as aggressive reduplication.

(23) *Initial Tableau for Nasal Epenthesis as Weight Satisfaction*

/i.ˈsah/	COINCIDE(σ_1,2μ)	DEP (Cons)	DEP(+nasal)
☞ [ĩ.ˈsah]			*
[i.ˈsah]	*!		
[ti.ˈsah]		*!	

The problem with this style of analysis is that it would mean syllables with an onset consonant and a nasal vowel would have *three* moras. At this point, we arrive at a theory with potentially more weight distinctions than are required for stress assignment and quantity-sensitivity per se. This immediately brings us to the gradient model of Brazilian Portuguese stress in Garcia (2017), similar to the gradient model of weight presented in Ryan (2014). In such a model, specific gradient values are assigned to onsetful vs onsetless syllables and to those with coda consonants / nasalization. In the absence of specific numerical values at present, we can abstractly formalize a scale as in (24), leading to the revised tableau in (25):

(24) *Gradient values of weight contribution*
  a. Onsets contribute an amount Wo of syllable weight; Nasalization contributes an
    amount W_N of syllable weight, where potentially $W_N \neq W_O$
  b. Vowels bear an inherent amount of weight W_v, a function of their height
  c. The total weight of a syllable is thus $W_{v} + W_N + W_O$
  c. Let $W_{v} + W_N = W_T$, a threshold for sufficient prominence for initial syllables

(25) *Revised Tableau for Nasal Epenthesis as Weight Satisfaction*

/i.ˈsah/	COINCIDE(σ_1,W_T)	DEP (Cons)	DEP(+nasal)
☞ [ĩ.ˈsah]			*
[i.ˈsah]	*!		
[ti.ˈsah]		*!	

More refined models of gradient stress, such as those in Garcia (2017), who adopts a logistic regression, though without specific constraint formulations, would be needed to confirm these with specific durational values, ideally in a manner akin to that developed in Ryan (2014) for gradient onset weight.
   In closing, we note that although onsets themselves are never inserted wholesale, rhotic metathesis does occur (recall (11)), by hypothesis, to increase the prominence according to the second member of a branching onset. DEP(Cons), therefore, might be more ideally formulated in terms of insertion of a prosodic onset node, and when one already is present, the metathesis of a rhotic to its second position is less intrusive. In a sense, these results support the split margin hypothesis of Baertsch & Davis (2003) that the second position of an onset and the coda have something in common – in BP, both can be mustered to increase syllable weight. Let us consider an amendment of (24) with the split margin hypothesis:[18]

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[18] In the present formulation, we attempt to follow the spirit of Gordon (2004:288), who cautions: "We do not find languages with very complex and asymmetrical criteria, even if such criteria might be plausible on purely phonetic grounds. Possible examples would be languages in which long-voweled syllables and those containing low vowels are heavy, or languages in which low vowels followed by a sonorant coda are heavy. An intuitive explanation for the absence of such hypothetical phenomena is that they are phonologically too complex. A major part of the theory of weight proposed here is a limitation on the structural complexity of the available distinctions".

(26) *Gradient values of weight contribution with the Split margin hypothesis*
      a. Initial Onsets contribute an amount Wo of syllable weight
      b. A coda consonant (and nasalization) contributes the same amount
           of syllable weight as the second member of an onset, both being
           margins contributing an amount W_M of syllable weight,
           where potentially $W_M > W_O$
      b. Vowels bear an inherent amount of weight W_v, a function of their height
      c. The total weight of a syllable is thus $W_{v} + W_M + W_O$
      c. Let $W_{v} + W_M = W_T$, a threshold for sufficient prominence for initial syllables

With the addition of (26b), we may consider one last interesting datum, observed by the authors, by a child acquiring BP who substituted nasalization for a complex onset. The word in question, *dri'blar*, with a complex onset, was simplified (with rhotacism or rhotic metathesis to the stressed syllable). Removal of the rhotic placed the coronal stop and the high front vowel in contact, feeding affrication (see Cristófaro Silva et al 2017 for phenomena of this sort in child BP) to [ʤi]. Most interesting, however, is the epenthetic nasalization that occurs [ʤĩ ˈbɾafi], by hypothesis as compensation for the loss of the second member of the onset, in order to preserve W_T (the constraints compelling rhotic metathesis are not included in this tableau):

(27)   *Tableau for nasalization as compensatory weight addition in onset simplification*

/ dɾi ˈblafi/	COINCIDE(σ_1,W_T)	*COMPLEXONS	DEP(+nasal)
☞ [ʤĩ ˈbɾafi]		*	*
[ʤi ˈbɾafi]	*!	*	
[dɾi ˈbɾafi]		**!	

While compensatory lengthening (i.e. rime augmentation) under loss of margin /r/ has been explored for Samothraki Greek by Topintzi (2010) and by Cristófaro Silva et al (2017) for child BP, the case in (27) would be the first to our knowledge of the inverse, namely addition of margin coda (indicated via [+nasal]) to compensate for loss of onset weight. It also raises the question of other sources of coda epenthesis in BP for the sake of achieving COINCIDE(σ_1,W_T), and it may be that cases such as *uɾ.ber* 'Uber' occur instead of epenthetic nasalization specifically because nasal [ũ] is extremely marked in BP, as mentioned above. Thus, summarizing with broad brushes the patterns of prominence augmentation, for the mid-vowels, spondaic lowering to [-ATR] (as in (13)) is available; for /i/, nasalization is preferred (as lowering any further would require more feature changes), and for /u/, where it occurs, rhotic epenthesis may be a strategy.

5. Conclusions and Future Directions
We have suggested that primary- and secondary- stressed syllables (and initial syllables) are like magnets, in drawing more segmental material toward them in order to enrich the asymmetry between them and unstressed syllables. The need for this additional segmental material arises most sharply with the durationally shortest syllables: high vowels, in onsetless syllables. Repair strategies include epenthesis or metathesis of nasality, mid-vowel lowering, and rhotic metathesis, all of which increase syllable prominence (duration, most acutely). Strategies such as glide insertion or raddoppiamento sintattico in Italian may also be seen as prominence-enhancement (and indeed, raise the question of whether non-etymological gemination in Italian forms such as *repubblica* occur quantitatively more often when the

stressed nucleus that benefits durationally is a high vowel). Of course, there are cases of spontaneous nasalization outside of high vowels in onsetless initial syllables, but the quantitative predominance of the pattern we have identified is what we aim to capture through the analysis presented above.

A full theory of gradient weight must take into account not only the relative contribution – both phonologically and phonetically – of nasalization versus branching onsets (which we have argued may be in a compensatory relation), but also that of vowel height itself, and crucially how these factors all interact. Thus, future studies may benefit from greater exploration of the relatedness of spontaneous nasalization of word-initial vowels with the phenomenon of vowel lowering of word-initial onsetless vowels discussed in Jiménez & Lloret (2013), according to whom Valencian Catalan lowers unstressed but word-initial *espina, escala, entendre* to *aspina* 'thorn', *ascala* 'stairs', *antendre* 'to understand', respectively. From this perspective, spontaneous nasalization in BP forms part of a much larger pattern of positional markedness within Iberian languages.

One of many final questions with which we wish to end is the relationship between vowel lowering (of the mid-vowels, as discussed above for Northeastern dialects) and nasalization. To our knowledge, these processes do not apply jointly. One might contend that either adding nasalization or enacting vowel lowering is enough, and that too many deviations from faithfulness are incurred by epenthesizing both marked features. On the other hand, this particular combination, namely [-ATR] mid vowels that are [+nasal], is generally ruled out in the phonology of Brazilian Portuguese.[19] Nonetheless, a complete theory of gradient weight may be able to derive why nasalization or vowel lowering provide just the right amount of additional weight for prominence-boosting, without the need for applying both.

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[19] In dialects found within the states of São Paulo and Paraná, however (Maximiliano Guimarães, pers.comm; Filomena Sandalo, pers. comm) there is however an 'island of reliability' in exceptionally allowing nasal [-ATR] mid vowels only with the back vowel [ɔ̃] in stressed syllables and only before [m] in words such as *fome, nome* [fɔ̃mɪ, nɔ̃mɪ] 'hunger', 'name', and even forming a minimal pair among verbs *some* [sõmɪ] 'sum up 3.sg' vs *some* [sɔ̃mɪ] 'disappear (imper.)!', not distinguished in standard BP dialects. Spontaneous nasalization is not expected here, as these are allophonically nasal in any event; it is only their [-ATR] character that is unexpected.

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Appendix: List of Non-Standard forms with Spontaneous Nasalization

Num	Standard Form	Nasalized form (written)	Phonetic Transcription	
1	acolchoado	aconchoado	[a.ˌkõ.ʃu.ˈa.dʊ]	padded
2	afligir	aflingir	[ˌa.flĩ.ˈʒih]	to ail
3	aipim	aimpim	[ˌa.ĩ.ˈpĩ]	yucca
4	abacaxi	ambacaxi	[ã.ˌba.ka.ˈʃɪ]	pineapple
5	abundância	ambundância	[ˌã.bũ.ˈdã.sjɐ]	abundance
6	aviamento	avinhamento	[a.ˌvi.ɲa.ˈmẽ.tʊ]	goodwill
7	bandido	bandindo	[bã.ˈd͡ʒĩ.dʊ]	bandit
8	bagunça	bangunça	[bã.ˈgũ.sɐ]	mess
9	banqueta	banquenta	[bã.ˈkẽ.tɐ]	footstool
10	banquete	banquente	[bã.ˈkẽ.t͡ʃɪ]	banquet
11	biblioteca	binblioteca	[bĩ.ˌbli.o.ˈtɛ.kɐ]	library
12	cidadão	cindadão	[ˌsĩ.da.ˈdã w̃]	citizen
13	ciúme	cinhume	[sĩ.ˈɲu.mɪ]	jealousy
14	cobaia	combaia	[kõ.ˈbaj.jɐ]	guinea pig
15	comigo	comingo	[ku.ˈmĩ.gʊ]	with-me
16	colônia	conlônia	[kõ.ˈlõ.njɐ]	colony
17	corromper	conrromper	[ˌkõ.ɦõ.ˈpeh]	to corrupt
18	conselho	consenlho	[kõ.ˈsẽ.ʎʊ]	advice
19	convencido	convencindo	[ˌkõ.vẽ.ˈsi.dʊ]	convinced
20	cozinha	conzinha	[kõ.ˈzĩ.ɲa]	kitchen
21	detrimento	dentrimento	[ˌdẽ.tri.ˈmẽ.tʊ]	detrimento
22	desviar	desvinhar	[ˌdiʃ.vĩ.ˈɲah]	to divert
23	distinguir	dinstinguir	[ˌdĩʃ.t͡ʃĩ.ˈgwih]	to distinguish
24	dinstintivo	dinstintivo	[ˌdĩʃ.t͡ʃĩ.ˈt͡ʃi.vʊ]	distinctive
25	empoderado	emponderado	[ˌĩ.põ.de.ˈra.dɐ]	empowered
26	empoderamento	emponderamento	[ˌĩ.põ.ˌde.ra.ˈmẽ.tʊ]	empowerment
27	eclipse	enclipse	[ĩ/ẽ.ˈkli.pɪ.sɪ]	eclipse
28	educação	enducação	[ĩ.ˌdu.ka.ˈsã w̃]	education
29	educador	enducador	[ĩ.ˌdu.ka.ˈdo.ra]	educator
30	engajado	enganjado	[ˌĩ.gã.ˈʒa.dʊ]	engaged
31	eleger	enleger	[ˌĩ.le.ˈʒeh]	to elect
32	elucidar	enlucidar	[ĩ.ˌlu.si.ˈdah]	to elucidate
33	essencial	enssencial	[ẽ/ ĩ.ˌsẽ.si.ˈaw]	essential
34	etiqueta	entiqueta	[ˌĩ.t͡ʃi.ˈke.tɐ]	label
35	entupido	entunpido	[ˌĩ.tũ.ˈpi.dʊ]	stuffed up
36	feiura	feinhura	[fẽj.ˈɲu.ɾɐ]	ugliness

37	fruta	frunta	[ˈfɾũ.tɐ]	fruit
38	governo	governo	[gõ.ˈveɦ.nʊ]	government
39	hesitei	hensitei	[ˌĩ.zi.ˈtej]	hesitated-1sg
40	hesitou	hensitou	[ˌĩ.zi.ˈtow]	hesitated-3sg
41	hibernar	himbernar	[ˌĩ.beɦ.ˈnah]	to hibernate
42	hidratado	hindratado	[ˌĩ.dɾa.ˈta.dʊ]	hydrated
43	hidratar	hindratar	[ˌĩ.dɾa.ˈtah]	to hydrate
44	higiênico	hingienico	[ˌĩ.ʒi.ˈẽ.ni.kʊ]	hygienic
45	hiato	hinhato	[ĩ.ˈɲa.tʊ]	hiatus
46	hipnotizado	hinpnotizando	[ˌĩ.pi.ˌno.t͡ʃi.ˈzã.dʊ]	hypnotized
47	hipnotizar	hinpnotizar	[ˌĩ.pi.ˌno.t͡ʃi.ˈzah]	to hypnotize
48	hipócrita	hinpócrita	[ĩ.ˈpɔ.kɾɪ.tɐ]	hypocrite
49	hipoteca	hinpoteca	[ˌĩ.po.ˈtɛ.kɐ]	mortgage
50	história	hinstória	[ĩʃ.ˈto.ɾjɐ]	history
51	histórico	hinstórico	[ĩʃ.ˈto.ɾɪ.kʊ]	record
52	horrível	honrrível	[õ/ũ.ˈhi.vew]	horrible
53	humilhação	huminlhação	[u.ˌmĩ.ʎa.ˈsãw̃]	humiliation
54	ideal	indeal	[ˌĩ.de.ˈaw]	ideal
55	ibérico	imbérico	[ĩ.ˈbɛ.ɾi.kʊ]	Iberian
56	impressão	imprensão	[ˌĩ.pɾẽ.ˈsãw̃]	impression
57	impressionado	imprenssionado	[ĩ.ˌpɾẽ.sjo.ˈna.dʊ(ɐ)]	impressed
58	impressionar	imprenssionar	[ĩ.ˌpɾẽ.sjo.ˈnah]	to impress
59	ibope	inbope	[ĩ.ˈbɔ.pɪ]	Brazilian Institute of Public Opinion and Statistics
60	ebulição	inbulição	[[ĩ/ẽ.ˌbu.li.ˈsãw̃]	boiling
61	içamento	inçamento	[ˌĩ.sa.ˈmẽ.tʊ]	hoisting
62	içar	inçar	[ĩ.ˈsah]	to hoist
63	ícone	íncone	[ˈĩ.kõ.nɪ]	icon
64	iconografia	inconografia	[ˌĩ.ko.ˌno.gɾa.ˈfi.ɐ]	iconography
65	economia	inconomia	[ĩ.ˌko.no.ˈmi.ɐ]	economy
66	econômico	inconomico	[ˌĩ.ko.ˈno.mɪ.kʊ]	economic
67	icterícia	incterícia	[ˌĩ.ki.te.ˈɾi.sjɐ]	jaundice
68	idade	indade	[ĩ.ˈda.d͡ʒɪ]	age
69	idealismo	indealismo	[ĩ.ˌde.a.ˈliʃ.mʊ]	idealism
70	ideia	indeia	[ĩ.ˈdɛ.jɐ]	idea
71	idêntico	indêntico	[ĩ.ˈdẽ.t͡ʃɪ.kʊ]	identical
72	identidade	indentidade	[ĩ.ˌdẽ.t͡ʃi.ˈda.d͡ʒɪ]	identity
73	indigente	indingente	[ˌĩ.d͡ʒĩ.ˈʒẽ.t͡ʃɪ]	indigente
74	indignação	indinguinação	[ˌĩ.d͡ʒĩ.ˌgi.na.ˈsãw̃]	indignation
75	indignado	indinguinado	[ĩ.ˌd͡ʒĩ.gi.ˈna.dʊ]	indignant

76	idioma	indioma	[ˌĩ.d͡ʒi.ˈð.mɐ]	language
77	idiossincrasia	indiossincrasia	[ˌĩ.djo.ˌsĩ.kɾa.ˈzi.ɐ]	idiosyncrasy
78	idiota	indiota	[ˌĩ.d͡ʒi.ˈɔ.tɐ]	idiot
79	idiotismo	indiotismo	[ĩ.ˌd͡ʒi.o.ˈt͡ʃiʃ.mʊ]	idiocy
80	editar	inditar	[ˌĩ.d͡ʒi.ˈtah]	to edit
81	idolatra	indolatra	[ĩ.do ˈla.tɾɐ]	idolize-3sg
82	idólatra	indólatra	[ĩ.ˈdɔ.lɐ.tɾɐ]	idolatrous
83	idolatrar	indolatrar	[ĩ.ˌdo.la.ˈtɾah]	to idolize
84	idolatria	indolatria	[ĩ.ˌdo.la.ˈtɾi.ɐ]	idolatry
85	idôneo	indoneo	[ĩ.ˈdõ.njʊ]	legitimate
86	idoso	indoso	[ĩ.ˈdo.zʊ]	elderly
87	efetuar	infetuar	[ĩ.ˌfe.tu.ˈah]	to conduct
88	ignição	ingnição	[ĩ.ˌgi.ni.ˈsãw̃]	ignition
89	ignóbil	ingnobil	[ˌĩ.gi.ˈnɔ.bɪw]	ignoble
90	ignorado	ingnorado	[ĩ.ˌgi.no.ˈɾa.dʊ]	ignored
91	ignorância	ingnorancia	[ĩ.ˌgi.no.ˈɾã.sjɐ]	ignorance
92	ignorante	ingnorante	[ĩ.ˌgi.no.ˈɾã.t͡ʃɪ]	ignorant
93	ignorar	ingnorar	[ĩ.ˌgi.no.ˈɾah]	to ignore
94	egoísta	ingoísta	[ˌĩ.go.ˈiʃ.tɐ]	selfish
95	igreja	ingreja	[ĩ.ˈgɾe.ʒɐ]	church
96	igual	ingual	[ĩ.ˈgwaw]	equal
97	igualar	ingualar	[ˌĩ.gwa.ˈlah]	to equalize
98	igualdade	ingualdade	[ˌĩ.gwaw.ˈda.d͡ʒɪ]	equality
99	iguaria	inguaria	[ˌĩ.gwa.ˈɾi.ɐ]	delicacy
100	iate	inhate	[ĩ.ˈɲa.t͡ʃɪ]	yacht
101	ilegal	inlegal	[ˌĩ.le.ˈgaw]	illegal
102	ilegítimo	inlegítimo	[ˌĩ.le.ˈʒi.t͡ʃɪ.mʊ]	illegitimate
103	ilegível	inlegivel	[ˌĩ.le.ˈʒi.vew]	illegibile
104	ileso	inleso	[ĩ.ˈle.zʊ]	unscathed
105	ilícito	inlicito	[ĩ.ˈli.si.tʊ]	illicit
106	ilimitado	inlimitado	[ĩ.ˌli.mi.ˈta.dʊ]	unlimited
107	ilógico	inlógico	[ĩ.ˈlo.gɪ.kʊ]	illogical
108	iludir	inludir	[ˌĩ.lu.ˈdih]	to delude
109	Iluminismo	inluminismo	[ĩ.ˌlu.mi.ˈniʃ.mʊ]	Enlightenment
110	ilusão	inlusão	[ˌĩ.lu.ˈzãw̃]	illusion
111	ilustrar	inlustrar	[ˌĩ.luʃ.ˈtɾah]	to illustrate
112	ilustre	inlustre	[ĩ.ˈluʃ.tɾɪ]	illustrious
113	equivalente	inquivalente	[ĩ.ˌki.va.ˈlẽ.t͡ʃɪ]	equivalent
114	equívoco	inquivoco	[ĩ.ˈki.vo.ku]	misconception
115	irracional	inracional	[ĩ.ˌha.sjo.ˈnaw]	irrational

116	irradiação	inradiação	[ĩ.ˌha.d͡ʒja.ˈsãw̃]	radiation
117	irado	inrado	[ĩ.ˈɾa.dʊ]	irate
118	irrealizável	inrealizável	[ˌĩ.he.ˌa.li.ˈza.vew]	unattainable
119	irreconciliável	inreconciliável	[ĩ.ˌhe.kõ.ˌsi.li.ˈa.vew]	unreconcilable
120	irreconhecível	inreconhecível	[ˌĩ.he.ˌkõ.ɲe.ˈsi.vew]	unrecognizable
121	irrecuperável	inrecuperável	[ˌĩ.he.ˌku.pe.ˈɾa.vew]	unrecoverable
122	irrecusável	inrecusável	[ĩ.ˌhe.ku.ˈza.vew]	undeniable
123	ironia	inronia	[ˌĩ.ɾo.ˈni.ɐ]	irony
124	ironizar	inronizar	[ĩ.ˈɾo.ni.ˈzah]	to mock
125	irreal	inrreal	[ˌĩ.he.ˈaw]	unreal
126	irredutível	inrredutível	[ĩ.ˌhe.du.ˈt͡ʃi.vew]	relentless
127	irrefletido	inrrefletido	[ĩ.ˌhe.fle.ˈt͡ʃi.vew]	thoughtless
128	irrefutável	inrrefutável	[ĩ.ˌhe.fu.ˈta.vew]	irrefutable
129	irregularidade	inrregularidade	[ĩ.ˌhe.gu.ˌla.ɾi.ˈda.d͡ʒɪ]	irregularity
130	irrelevante	inrrelevante	[ĩ.ˌhe.le.ˈvã.t͡ʃɪ]	irrelevant
131	irreligioso	inrreligioso	[ˌĩ.he.ˌli.ʒi.ˈo.zʊ]	unreligious
132	irremediável	inrremediável	[ˌĩ.he.ˌme.d͡ʒi.ˈa.vew]	irretrievable
133	irremovível	inrremovível	[ĩ.ˌhe.mo.ˈvi.vew]	unremovable
134	irreparável	inrreparável	[ĩ.ˌhe.pa.ˈɾa.vew]	unrepairable
135	irresponsável	inrreponsável	[ĩ.ˌhejʃ.põ.ˈsa.vew]	irresponsible
136	irrepreensível	inrrepreensível	[ˌĩ.he.ˌpɾe.ẽ.ˈsi.vew]	irreproachable
137	irresistível	inrresistível	[ĩ.ˌhe.ziʃ.ˈt͡ʃi.vew]	irresistible
138	irrestrito	inrrestrito	[ˌĩ.hejʃ.ˈtɾi.tʊ]	unrestricted
139	irreverente	inrreverente	[ĩ.ˌhe.ve.ˈɾẽ.t͡ʃɪ]	irreverent
140	irrigar	inrrigar	[ˌĩ.hi.ˈgah]	to irrigate
141	irritação	inrritação	[ĩ.ˌhi.ta.ˈsãw̃]	irritation
142	irritar	inrritar	[ˌĩ.ɦi.ˈtɐh]	to irritate
143	isenção	insenção	[ˌĩ.zẽ.ˈsãw̃]	exemption
144	isento	insento	[ĩ.ˈzẽ.tʊ]	exempt
145	esgrima	insgrima	[ĩʃ.ˈgɾi.mɐ]	fencing
146	isolado	insolado	[ˌĩ.zo.ˈla.dʊ]	isolated
147	isolar	insolar	[ˌĩ.zo.ˈlah]	to isolate
148	isopor	insopor	[ˌĩ.zo.ˈpoh]	styrofoam
149	específico	inspecífico	[ˌĩʃ.pe.ˈsi.fɪ.kʊ]	specific
150	expectativa	inspectativa	[ˌĩʃ.pe.ˌki.ta.ˈti.vɐ]	expectation
151	especulou	inspeculou	[ĩʃ.ˌpe.ku.ˈlow]	speculated-3sg
152	esplêndido	insplendido	[ĩʃ.ˈplẽ.d͡ʒɪ.dʊ]	splendid
153	esplendor	insplendor	[ˌĩʃ.plẽ.ˈdoh]	splendor
154	espontâneo	inspontâneo	[ˌĩʃ.põ.ˈtã.nɪw]	spontaneous
155	isqueiro	insqueiro	[ĩʃ.ˈke.ɾʊ]	lighter

156	esquema	insquema	[ĩʃ.ˈke.mɐ]	scheme
157	estagnado	instagnado	[ĩʃ.ˌta.gi.ˈna.dʊ]	stagnant
158	histérica	instérica	[ĩʃ.ˈtɛ.ɾɪ.kɐ]	hysterical
159	estima	instima	[ĩʃ.ˈt͡ʃi.mɐ]	esteem
160	estimulo	instimulo	[ˌĩʃ.t͡ʃi.ˈmu.lʊ]	stimulate-1sg
161	estímulo	instímulo	[ĩʃ.ˈt͡ʃi.mʊ.lʊ]	stimulus
162	extraordinário	instraordinário	[ˌĩʃ.tra.ˌoh.d͡ʒ i.ˈna.ɾɪw]	extraordinary
163	estúpido	instúpido	[ĩʃ.ˈtu.pi.dʊ]	stupid
164	ítem	intem	[ˈĩ.tẽj]	item
165	interromper	intenrromper	[ĩ.ˌtẽ.hõ.ˈpeh]	to interrupt
166	itinerante	intinerante	[ĩ.ˌt͡ʃi.ne.ˈɾã.t͡ʃɪ]	itinerant
167	itinerário	intinerário	[ĩ.ˌt͡ʃi.ne.ˈra.ɾɪw]	itinerary
168	exame	inzame	[ĩ.ˈza.mɪ]	exam
169	eximir	inzimir	[ˌĩ.zi.ˈmih]	to shirk
170	irregularidade	inrregular	[ĩ.ˌhe.gu.ˈlah]	irregularity
171	jejum	jenjum	[ʒẽ.ˈʒu]	fasting
172	joelho	jonhelho	[ju.ˈɲe.ʎu]	knee
173	liberdade	linberdade	[ˌlĩ.beɦ.ˈda.d͡ʒɪ]	liberty
174	livro	linvro	[ˈlĩ.vɾʊ]	book
175	mandioca	mandinhoca	[ˌmã.d͡ʒĩ.ˈɲɔ.kɐ]	manioc
176	maracujá	maracunjá	[ma.ˌɾa.kũ.ˈʒa]	passionfruit
177	mendigo	mendingo	[mĩ.ˈd͡ʒĩ.gʊ]	mendicant
178	melancolia	menlancolia	[mẽ.ˌlã.ko.ˈli.ɐ]	melancholy
179	misturar	minsturar	[mĩʃ.ˈtu.ɾah]	to mix
180	mortadela	mortandela	[ˌmoh.tã.ˈdɛ.lɐ]	mortadela
181	necessidade	nencessidade	[nẽ.ˌse.si.ˈda.d͡ʒɪ]	necessity
182	nicho	nincho	[ˈnĩ.ʃʊ]	niche
183	nítido	níntido	[ˈnĩ.t͡ʃi.dʊ]	clear
184	obrigado	obringado	[ˌo.bɾĩ.ˈga.dʊ]	thank you
185	ocorreu	oncorreu	[ˌõ.ko.ˈhew]	occurred-3sg
186	pentecostal	pentencostal	[pẽ.ˌtẽ.koʃ.ˈtaw]	pentecostal
187	pentecostes	pentencostes	[ˌpẽ.tẽ.ˈkoʃ.t͡ʃɪʃ]	Pentecost
188	picadeiro	pincadeiro	[ˌpĩ.ka.ˈde.ɾʊ]	arena
189	pichação	pinchação	[ˌpĩ.ʃa.ˈsãw]	grafitti
190	picolé	pincolé	[ˌpĩ.ko.ˈlɛ]	popsicle
191	piolho	pinholho	[pi.ˈɲo.ʎʊ]	louse
192	possibilidade	possinbilidade	[ˌpo.sĩ.ˌbi.li.ˈda.d͡ʒɪ]	possibility
193	pudim	pundim	[pũˈd͡ʒĩ]	pudding
194	reiterar	reinterar	[he.ˌĩ.te.ˈɾah]	to reiterate

195	reivindicar	reinvindicar	[hẽɾ̃.ˈvĩ.d͡ʒi.ˈkah]	to claim
196	restrição	restrinção (ões)	[ˌhejʃ.tɾĩ.ˈsãw̃]	restriction
197	sanduíche	sanduinche	[ˌsã.du.ˈĩ.ʃɪ]	sandwich
198	seguro	segunro	[si.ˈgũ.ɾʊ]	secure
199	sibilante	simbilante	[ˌsĩ.bi.ˈlã.t͡ʃɪ]	sibilante
200	sigilo	singilo	[sĩ.ˈʒi.lʊ]	confidentiality
201	sigiloso	singiloso	[ˌsĩ.ʒi.ˈlo.zʊ]	confidential
202	sobrancelha	sombracelha	[ˌsõ.bɾa.ˈse.ʎɐ]	eyebrow
203	sobrancelha	sombrancelha	[ˌsõ.bɾã.ˈse.ʎɐ]	eyebrow
204	sujeito	sunjeito	[sũ.ˈʒej.tʊ]	subject
205	tranquilo	tranquinlo	[tɾã.ˈqwĩ.lʊ]	tranquil
206	trufado	trunfado	[tɾũ.ˈfa.dʊ]	truffled
207	uruguai	unruguai	[ˌũ.ɾu.ˈgwaj]	Uruguay
208	usufruir	unsufruir	[ũ.ˌzu.fɾu.ˈih]	to make use of
209	útero	untero	[ˈũ.te.ɾʊ]	uterus
210	utilizado	untilizado(a)	[ũ.ˌt͡ʃi.li.ˈza.dʊ]	used
211	utilizar	untilizar	[ũ.ˌt͡ʃi.li.ˈzah]	to use
212	utopia	untopia	[ˌũ.to.ˈpi.ɐ]	utopia
213	veicular	veincular	[ve.ˌĩ.ku.ˈlah]	to convey
214	ventilador	ventinlador	[vẽ.ˌt͡ʃĩ.la.ˈdo]	fan
215	Vicente	vincente	[vĩ.ˈsẽ.t͡ʃɪ]	proper name
216	vídeo	vindeo	[ˈvĩ.d͡ʒʊ]	video
217	vigência	vingência	[vĩ.ˈʒẽ.sjɐ]	validity
218	viado	vinhado	[vĩ.ˈɲa.dʊ]	deer
219	viagem	vinhagem	[vĩ.ˈɲa.ʒẽj̃]	voyage