The contrastive nasality in Portuguese

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1 Introduction

The nasal diphthong, one of the outstanding endings of many lexical items, and the phonological nasal vowel are the subject of this paper. They shall be looked into through Optimality Theory, which is a constraint-based model. As for its contrastive value, data tell us that the nasal vowel, as VN, contrasts with V, the oral vowel (1a), whereas the nasal diphthong contrasts directly with the non-nasal (1b).

(1) a. Nasal vowel
   kaNto - kato ‘corner/to search’
   praNto - prato ‘lament/plate’
   loNbo - lobo ‘back of an animal/wolf’
   seNda - seda ‘path /silkworm’

   b. Nasal diphthong
   maw - maw ‘hand/evil’
   graw - graw ‘seed/grade’
   pøj - boj ‘he/she push/bull’
   kapitãj - capitais ‘captains/capitals’

Portuguese also presents a final vowel with either a glide or a consonant appendix that shall not be mistaken for the true diphthong. Actually, it is the nasality of the final vowel of the word that is manifested with a glide or a homorganic nasal to the vowel, whose phonological value is ensured by VN versus V, faleN/fale ‘you(pl.) speak/you(sg.) speak’, riN/ri ‘kidney/he/she laughs’, in the same way as the non-final vowel, praNtu/pratu ‘weeping/plate’, loNbo/lobo ‘back of an animal/wolf’ (1a).

The nasal vowels occur both in stressed (2a) and unstressed positions (2b, c), but diphthongs are exclusive to the final stressed position (2d), with rare exceptions that may be listed (2e):

(2) a. [vẽntu] ‘wind’
    [lẽnda] ‘legend’
    [kãmpu] ‘field’

b. [vẽndavál] ‘windstorm’
   [lẽndáriw] ‘legendary’
   [pẽdurár] ‘to hang’

c. [ômẽn] ‘man’
   [jr mâw] ‘brother’
   [ʒɔvẽn] ‘young man’
   [se’tĩ] ‘satin’

d. [ɔrfãw] ‘orphan’
   [mãj] ‘mother’
   [ɔrgãw] ‘organ’
   [pøj] ‘he/she puts’

Nasal diphthongs and nasal vowels are inalterable. The variants offered by these contexts are directly related to the nasal (N) which may disappear whenever it is

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found in unstressed final syllables, such as in őmęp-őmi ‘man’, a nasal vowel, őrfāw-őrfu ‘orphan’, a nasal diphthong. In the case of the internal nasal vowel, N takes up different forms upon agreement with the place features of the neighboring segment, such as in séjšu ‘sense’, sênda ‘path’.

According to Mattoso Câmara Jr. (1970), the nasal vowel is the tautosyllabic VN group, i.e., an oral vowel followed by N, which spreads its nasality into the vowel. The phonological contrast is ensured at the underlying level:

(3) kaNto / kato
    praNto / prato
    loNbo / lobo

As for the nasal diphthong, the sequence VCC or VVC with a nasal in the last position is not able to make up a well-formed output, because C2 in the coda is exclusively restricted to /S/. The idea developed in this paper is that the nasal between two vowels, VN-V, licensed only to be a feature, is incorporated into the vowels. The paradigm-nature relation allowed for the data (4) assigns the basis VN to both, the nasal diphthong (1b) and the nasal vowel (1a).

(4) órfão, orfandade, orfanato ‘orphan, orphanhood, orphanage’
    irmão, irmandade, irmanar ‘brother, brotherhood, to match’
    limão, limonada, limoeiro ‘lemon, lemonade, lemon tree’

Besides contrastive phonological nasality, the object of the present study, Portuguese has also allophonic or contextual nasality, which is related to a heterosyllabic nasal consonant to the right and that is not manifested regularly throughout all geographic varieties. In the gaucho (South Brazilian variety), for instance, it occurs in the stressed syllable as in [kā.mä] ‘bed’ and [lā.mä] ‘mud’ and is favored by low vowels, but it is less frequent in unstressed syllables, unlike what happens in the carioca variety (from Rio de Janeiro, in the mid-east) [dā’na.da], ‘damned’ for example, just to mention two varieties of speech.

Based on the facts presented before, we drawn on the assumption that both, the nasal vowel and the nasal diphthong, rely upon VN in their underlying form, with the following difference: VN for the nasal vowel and VN-V for the nasal diphthong.

Leaving aside the allophonic nasal vowel, let us start the analysis, which will be developed in two sections: section 2, the nasal vowel; section 3, the nasal diphthong.

2 The nasal vowel

Portuguese has nasal vowels, along with oral vowels, which are the basic elements of all languages. However, the nasal vowels in Portuguese do not enhance the inventory of phonemes, because the underlying contrast is syntagmatically established between VN versus V, and not paradigmatically between V and Ṽ, as we have seen in (1) and (3).

The seven-vowel system that is fully manifested in the stressed syllable /i, u, e, o, ɔ, e, a/, in Brazilian Portuguese, is reduced to five /i, u, e, o, a/ in the pre-stressed
syllable and in the sub-system of the nasals, and to three in the final stressless position, /i,u,a/ with a variable sub-system in the non-final post-stressed vowel. These neutralizations are not the focus of this study, although their effects can be perceived. Rather, it is in the five-vowel system that nasality brings out its distinctive character in terms of VN.

(5) a. Nasals
   senda 'groove'
   pinto 'chick'
   junta 'joint or council'
   lomba 'steep hill'
   pranto 'weeping'

   b. Orals
   seda 'silk'
   pito 'reprimand'
   juta 'jute'
   loba 'female wolf'
   prato 'plate'

This analysis that deals with contrastive nasal vowels, identified by the tautosyllabic VN and exemplified in (1a), is based on the theory of violable principles that offers a set of constraints to analyze outputs, among which we can mention the two conflicting constraints, the one that requires an input nasal to stand in correspondence with an output nasal, and the one that forbids nasal vowels.

As a VN sequence can occur in any position, final and not final, as in *homen* 'man', *senda* 'path', and stressed and stressless, *campo* 'field', *canteiro* 'flower bed', oral vowels and nasal vowels have an identical distribution. They are unpredictable. This means that in order to permit nasal vowels, Max(N) must be top ranked. It dominates the marked constraint *V(nasal), which becomes inactive over the candidate sets being considered.

Another prerequisite for the suitable mapping says that the vowel in the sequence VN must be nasal. The Mattoso Camara Jr. hypothesis (1970), which is a consensus between Brazilian and Portuguese scholars, attributes the nasality of the vowels to the assimilation from the following tautosyllabic nasal consonant, as we have mentioned in the beginning of this paper. In our analysis, the Branching Nasal constraint does this job.

The conception of the nasal vowel as an underlying VN sequence has been common in the phonology literature since the Prague School, and was emphasized in non-linear phonology (Piggott 1987; Padgett 1994; Wetzels 1997, among others). Nevertheless, the point to be made is the difference between a fully specified nasal and an underspecified nasal, which, in the present analysis, is understood as a nasal without a root.

Following Goldrick (2000), Hemans (2006) among others, we are assuming that the distinction between the fully specified nasal and the underspecified nasal is related to the root node. Whereas the former has a root node, the latter does not have it, as the following representations show:

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1 Personal communication
(6) a. root  

Examples:  

[+nas]  pano, cano, cigano  

b. Underspecified nasal  

root > 0  Examples: pranto, canto, ganso  

Notice that the nasal is a floating coronal. Whereas all specified segments project a root, the underspecified nasal can only project a root and consequently a mora at the expense of offending DEPIO, as we will see in the development of this analysis.  

We are assuming that the nasal vowel is related to the syllabification, since VN, its source, demands a closed syllable. Then the floating input nasal must project a root, and consequently a mora, in the context VN.C.  

In Portuguese, the floating nasal is licensed to be a coda segment by the following consonant or by the precedent vowel, head of the syllable, in which the nasal must be associated, as we see bellow:  

a- If the following consonant is [-cont], as the nasal, both the nasal and the consonant share the place features to form a plenty harmonic group. Ex: kampo, ‘field’, apka ‘rump’, bomba ‘bomb’. It is controlled by IdentC\(_i\)C\(_j\)(place) constraint, in accordance with Pulleyblank (1997).  

b- If the following consonant is [+cont], in which case the continuant feature is not shared, the behavior of the nasal becomes ambiguous: it takes the place features of the following consonant, controlled by IdentCC(place), a general version of IdentC\(_i\)C\(_j\)(place), or it agrees with the Head of the Syllable in which it is inserted. It is controlled by VN(agree).  

c- At word endings, the glide alternates with the nasal segment: [ome]\(_n\) ~ [ome]\(_e\),\(^1\) taking the articulation features of the Head of the Syllable. VN(agree) does its job. Thus the following representations are expected:\(^2\):  

(7) a. Harmonic group :  

\[ \begin{array}{c|c|c} \sigma & / \backslash / / \mu & / \mu / / \mu \\ \hline \sigma & / \backslash / / \mu & / \mu / / \mu \\ \hline \bullet & \bullet & \bullet \\ \hline \bullet & \bullet & \bullet \\ \hline \backslash / / / / \mu & \mu & \mu \\ \hline \end{array} \]  

C Features \(\Rightarrow [\tilde{k}\text{\v{a}m}.\text{pu}]\) ‘field’  

VF \(\Rightarrow [\tilde{a}\text{\thetic}3\text{\v{u}}]\) ‘angel’  

[ome\text{\v{e}p}] ‘man’  

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\(^2\) In some varieties, as in the paulista dialect, the glide inside the word is also an option, mainly if the preceding vowel is a [-post] mid vowel.
Before starting the OT analysis, let us present the arguments that warrant the hypothesis that the nasal vowel is VN, that means, a closed syllable:

(8) Evidence for the VN hypothesis

- The rhotic, which contrasts with the tap between vowels, is realized as a strong vibrant or fricative, but not a tap, after another consonant. *Is[r]ael ~ Is[ʃ]ael. The same occurs after a nasal vowel, indicating the presence of a consonant: õ[r]a ~ õ[ʃ]a, but not õ[r]a ‘honor’.
- The hiatus never occurs between two vowels, if the first is nasal. The nasality is dropped or the nasal is realized as the onset of the following syllable: bom, (good) but boa, ‘good, fem’, um ‘one’ but uma ‘one, fem’.
- An oral vowel emerges when the nasal of the prefix IN is assimilated to the following liquid: [i]mpossível ‘impossible’, [i]nquieto ‘restless’ but [i]legal ‘illegal’ and [i]rregular ‘irregular’.
- The stress on the antepenult, which occurs in a class of words in Portuguese, never occurs when the second syllable is closed by a segment: cátedra ‘cathedra’, but cadéira, *cádeira ‘chair’, pedéstre,*pédestre ‘pedestrian’, as well as in words with a nasal vowel in this position: sonolento,*sónolento ‘sleepy’, corcundo, *córcundo ‘hunchback’.
- Degemination is blocked in connected speech, if the first vowel is nasal: casa amarela > casamarela, ‘yellow house’, but not *lãmarela < lâ amarela ‘yelow wool’.
- An oral vowel emerges, if the final nasal is deleted: homem > home ‘man’, garagem > garage (garage).

All these phenomena suggest the presence of a skeletal element following the vowel which entails that a heavy syllable is formed. This assumption is reinforced by the claim that ‘The nasal vowel is effectively longer than the oral vowel: it is 27% longer than its oral counterpart in stressed syllables and 74% in unstressed syllables’ (Moraes and Wetzels1992). Having in mind these considerations, let us define the constraints:

Max(N): The input (N) must have a correspondent in the output.
(The floating nasal must have some representation in the output.)
MaxIO: Input and output segments must be in correspondence.
(No deletion)
Dep-N: Output segments must have input correspondents.
(No nasal segment epenthesis)
Branching Nasal: The nasal (N) must be branched.
(It branches to the left and the right, to nasalize the left vowel, creating a nasal segment to the right.)
NoLong vowel: Avoid vowels dominated by more than one mora.

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3 See Câmara Jr. argumentation
**IdentCC(place):** A sequence of consonants must be identical in place of articulation.

**Agree (VC):** The nasal segment in coda position agrees in place with the tautosyllabic vowel.

**Final Stress:** If the final syllable is heavy, it must be stressed.

*V(nas):* The nasal vowel is prohibited.

(9) The basic grammar is the following:
Max-N, MaxIO, Branching Nasal >> NoLong Vowel >> DepN >> *V(nasal)

Only the constraints in activity will be called over in the tableaux.\(^4\)

**Tableau 1: prântu but not pratu ‘weeping vs plate’**

<table>
<thead>
<tr>
<th></th>
<th>Max N</th>
<th>Max IO</th>
<th>Branch N</th>
<th>*Long Vowel</th>
<th>Dep N</th>
<th>*V (nas)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. prân.tu</td>
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<td>*</td>
<td>*</td>
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<td>b. prâ.tu</td>
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<td>c. prâ.tu</td>
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<td>d. pran.tu</td>
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<tr>
<td>e. pra.tu</td>
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<tr>
<td>f. pra.tu</td>
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</tbody>
</table>

Candidate (1f) is rejected by the non dominated constraint MaxN, since the floating nasal lacks an output correspondent. It exemplifies the contrast V versus VN, since both words, *pranto* and *prato*, belong to the Portuguese lexicon. Candidate (1e) violates Max(IO) and DepN, since it deletes the input /t/, creating a nasal root. Branching N rejects the candidate (1d) and (1c), because the nasal does not ramify to the left and to the right. The former exhibits a closed syllable without nasal harmony, that means, without satisfying Branching Nasal. It offers an example of the difference between Spanish (with no contrastive nasal vowels) and Portuguese (with nasal vowels). The written word *pranto* is the same for both languages. The latter, (1c), shows a light syllable, which is not expected in accordance with the evidence exposed in (8). The candidate (1b) offends No Long Vowel (Portuguese does not haves long vowel). Then (1a) is the winner.

It is worth noting that the nasality described herein is contrastive. Consequently, the constraint *V(nasal) is not selective.

Finally, the lack of aperture feature correspondence between the output and the input final vowel reflects the effect of the neutralization that reduces the seven-vowel

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\(^4\) A failed candidate as pratun does not figure among the candidates, as well as a failed candidate as prât.tu, since metathesis and prenasalization, which form complex segments as \"b, d, are never observed in the lexicon of Portuguese. In other words, *Linear∗ity and NoPrenasalization are undominated constraints without an interaction with the other constraint of the ranking in discussion. Under these circumstances, the consideration of candidates as prantun and prât.tu wood \"be just a distraction from the real business at hand.\” McCarthy (2002:34)
system to three in stressless final vowels, an expected fact that is not in discussion. If the difference between high and mid final vowels becomes crucial, the *MID constraint will be called upon.\footnote{As for the neutralization, see Câmara Jr. (1970), Bisol & Magalhães (2005) and Lee (2006).}

Let us go back to the central question. Although the VN hypothesis is generally accepted as the input representation, there is little consensus in the literature regarding the output nasal vowel. Most representational approaches attribute the restrictions imposed by the VN hypothesis, expressed in (8), only to the input, showing a simple nasal vowel as output, for instance [ã] or [õ], supposing N deletion. However, it must be noted that a simple nasal vowel, as the candidate (1c), in Tableau1, does not give support for the blockage mentioned in (8), most of them with direct consequences in the output. The output long vowel has been ignored, although the nasal vowel is not rarely represented with two vowels by learners of writing.

In fact, the two well-formed candidates are (1a) and (1b). Both of them, with a heavy syllable, satisfy the Branching Nasal constraint, the claims by Moraes and Wetzels (1992) and the arguments by Câmara Jr. (1970). If a choice must be done, it will be between (a) and (b) in Tableau 1.

Perhaps the best explanation for the preference of a candidate as (1a) over a candidate as (1b) could be done in terms of transparency. The candidate (1a) is more transparent than the candidate (1b), as we can see in the next tableau, in which a constraint proposed by Goldrick (2000), $\mathcal{Rt}$ (Reciprocity), is called over: ‘If a root node projects a mora, then the mora must pronounce the root.’ As Projection demanding Pronounce is not in discussion in this analysis, our version of Reciprocity is: If a root node projects a mora, then the mora must be in correspondence with the root. In other words, if the nasal projects a mora, the mora must be in correspondence with the nasal segment.
Tableau 2: Transparency and ambiguity

<table>
<thead>
<tr>
<th></th>
<th>Max N</th>
<th>Branch N</th>
<th>$\mathcal{R}^\text{RT}$ Recipr</th>
<th>Dep N</th>
<th>$^*V$ (nas)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>σ</td>
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<td>●</td>
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<td></td>
<td>V</td>
<td>N</td>
<td>C</td>
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<td>‘prāntu’</td>
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<tr>
<td>b</td>
<td>σ</td>
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<td>φ!</td>
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<td>μ</td>
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<td></td>
<td>●</td>
<td>●</td>
<td>/\</td>
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<td></td>
<td>V: N</td>
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<td></td>
<td></td>
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<tr>
<td>‘prā:tu’</td>
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</tbody>
</table>

We are in front of an opaque candidate, *prā:tu* and a transparent candidate, *prāntu*, both well formed. The ambiguity between (2a) and (2b) is solved by the reciprocity constraint. In (2b), the nasal mora is transferred to the vowel, creating a long nasal vowel, by violation of Reciprocity, whereas in (2a), the winner candidate, the nasal and the root mora are in direct correspondence, satisfying this constraint. The transparent structure wins.

Many languages reject the NC sequence, where C is a voiceless occlusive. In Mandar, for instance, *maN+tunu* is denasalized and becomes *mattunu*, respecting linearity; in Puyo Pungo Quechua, *maN+pilih* becomes *mamilih*, violating linearity. Others, such as Japanese, do sonorize the consonant, *sin-ta > sida* (Pater 2004). In Portuguese, however, the nasal takes up the place of articulation of the following consonant if it is [-cont], regardless of its voicing, but if it is [+cont] it tends to take up the features from the preceding vowel, as it does in word endings.

(11) kampo ‘field’ gansu ‘goose’
    kantu ‘corner’ ḫu ‘angel’
    kanga ‘yoke’ omeñ ‘man’

The groups *mp*, *nt*, *ŋk* are expected because both the nasal and the following consonant are [-cont]; they must share the articulation features. The NC sequence in which C is a fricative is free to harmonize in place with the preceding vowel, since the nasal and C do not harmonize in continuancy. The latter is a typical example of assimilation in a tautosyllabic VC sequence. It creates a nasal glide that tends to be a consonant within the word and a glide in the end. Nevertheless, there is variation...
between them, which is not in question. The input (N) is licensed to be a coda segment by IdentCC(place) or by VN(agree). The former acts in two versions: the most specific, IC\textsubscript{i}C\textsubscript{i}(place), (Identical Cluster Constraint), which demands that a sequence of identical segments in continuancy must be identical in place of articulation and the most general, ICC(place), which demands that a sequence of consonants must be identical in place of articulation.

Tableau 3: manso versus manto ‘tame vs cloak’

<table>
<thead>
<tr>
<th></th>
<th>IdentC\textsubscript{i}C\textsubscript{i}</th>
<th>Agree(VC)</th>
<th>IdentCC(Place)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. māntu</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. māntu</td>
<td>*!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. mãnsu</td>
<td>*!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. mãnsu</td>
<td>*</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

There is a stringency relation between IC\textsubscript{i}C\textsubscript{i}(place) and ICC(place). If the most specific constraint, the former, is offended, the latter is also offended, but not vice-versa.

In order to discuss the following Tableau, we first need to introduce the constraint called Non-Head Mora as part of the familiar constraints based on the sonority hierarchy. Non-Head Mora poses restrictions based on the sonority of the segments to be licensed in coda, considering its distance from the peak, the Head Mora, the most sonorous segment of the syllable, which in Portuguese is always a vowel. The Non-head Mora, as a familiar constraint, is derived from the sonority scale, whose order is fixed. For our proposal, the point of reference will be (12) that organize the natural classes in terms of sonority classes, going from the best to the worst. It motivates the constraints expressed in (13), which evaluate the phoneme for the suitability as members of the syllable in coda position:

(12) Sonority scale

High vowels (glides) > Liquids > Nasals > Obstruents

(13) Non-Head Mora

*\(\mu\)Obstruent >> *\(\mu\)Nasal >> *\(\mu\)Liquid >> *\(\mu\)High-vowel(glide)

The optimal non-head mora is the most sonorous in accordance with (13), going from the worst to the best.
The question is the distinction between two well-formed candidates, one of which has a moraic coda projected by a nasal, and the other one with a mora projected by a glide. The conflict here is between the minimal sonority (nasal) and the maximal sonority, (high vowels), performed as a glide. The Non-Head Mora will prefer the most sonorous segment. Since the formation of the syllable is not in question, but only the choice of the best candidate, we are simply assuming (13), making reference to Prince and Smolensky (1993), Zec (1995), de Lacy (2004) and Gouskova (2004).

The coda in Brazilian Portuguese is made up by sonorants and by /S/: par, mel, mau, lei, cem, paz, ‘pair, honey, law, hundred, peace’. Complex codas, which occur in few words, are made up by adding /S/ to a well formed rhyme: perspectiva, fausto, ‘perspective, wealthy’.

It is worth noting, however, that in complex final codas with nasality, the agreement in coronality with /S/ is a possibility, since both glide and /S/ are [+cont]. In this case, IdentCᵢCᵢ(Place) constraint is satisfied. Nevertheless, VN (Agree) can also be satisfied, since tōws ~tōjs ‘tunes’, for example, are variants that identify dialects. They are related by a floating dominance.

In Tableau 4, the pair, *μ Nasal >> *μ High V, is taken separately from (13) in order to account for the choice of the best candidate. The former demands the most sonorous coda, whereas the two latter demand harmonization with the tautosyllabic vowel or with the following segment if the continuancy is shared by both.

From Agree(VN) >> IdentCiCi (place), the candidate with faithfulness to the input wins; from IdentCiCi (place) >> Agree(VN), the winner is the coda in harmony with the vowel. Nevertheless, Non-Head Mora opens the door for the two latter constraints on floating dominance.

Tableau 4: tōws or tōjs ‘tunes’

<table>
<thead>
<tr>
<th></th>
<th>*μ Nasal</th>
<th>*μ Heigh V</th>
<th>AgreeVN</th>
<th>IdCᵢCᵢ (place)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td>tōws</td>
<td>*</td>
<td>!</td>
<td></td>
</tr>
<tr>
<td>c.</td>
<td>tōjs</td>
<td>!</td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>d.</td>
<td>tōns</td>
<td>!</td>
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</tbody>
</table>

Candidates (4d) and (4c) are neglected by Non Nasal Mora, which selects (4a) e (4b). The solution then depends on the interrelation of the two last constraints. When VN-Agree dominates IdentCC (place), as it is the case of the (southern) gaucho variety here represented, tōws is of general use. The inverse ranking: IdentCᵢCᵢ (Place) >> Agree(VN), preferred by the (Mid East - Rio de Janeiro) carioca variety, among others, primes on tōjs. It satisfies IdCᵢCᵢ(place), since both glide and /S/ are [+cont]. There is no need for further comments.

Summary
For a language as Portuguese, in which an oral vowel is nasalized by a tautosyllabic N with a contrastive value, Optimality Theory makes it available for a faithfulness constraint, Max N, to call for an input and output correspondence, in such a way that the nasal is present in both. Branching Nasal which demands bifurcation of the nasal gives account for the nasal vowel. Both of them, on top of the hierarchy, dominate *V (nasal), whose prohibition of the nasal vowel plays no active role. Conditions related to the emergence of N as a glide or a consonant, and its place agreement with the preceding or the following segment, complement the analysis in further detail.

3 The nasal diphthong

Portuguese has two types of diphthongs: the true diphthong corresponding to two input vowels, one of which becomes a glide by syllabification, and the false diphthong, with only one vowel in the input, made up by the assimilation of features of the neighboring segment. The variable diphthong arises in the nasal vowel system but also in the oral vowel system: omêj~omi ‘man’ garazêj~garaži ‘garage’; bežu~ bezu ‘kiss’, zanejru~ zaneru ‘January’.

(14) a. True Diphthongs

<table>
<thead>
<tr>
<th>Oral</th>
<th>Nasal</th>
</tr>
</thead>
<tbody>
<tr>
<td>perau</td>
<td>[peráu] ‘deep hole’</td>
</tr>
<tr>
<td>cauteloso</td>
<td>[kawtelózu] ‘careful’</td>
</tr>
<tr>
<td>leitura</td>
<td>[lejtúra] ‘reading’</td>
</tr>
<tr>
<td>portão</td>
<td>[portãw] ‘gate’</td>
</tr>
<tr>
<td>põe</td>
<td>[põj] ‘he/she puts’</td>
</tr>
<tr>
<td>capitães</td>
<td>[kapitãj] ‘captains’</td>
</tr>
</tbody>
</table>

b. False Diphthongs

<table>
<thead>
<tr>
<th>Oral</th>
<th>Nasal</th>
</tr>
</thead>
<tbody>
<tr>
<td>peixe</td>
<td>[péjji]~ péjji ‘fish’</td>
</tr>
<tr>
<td>viagem</td>
<td>[viázêj ~ viázê~ viázi] ‘trip’</td>
</tr>
<tr>
<td>feira</td>
<td>[féjra~ féra] ‘market’</td>
</tr>
<tr>
<td>homem</td>
<td>[ómêj~ ómê~ ómi] ‘man’</td>
</tr>
<tr>
<td>caixa</td>
<td>[kájfa~ kájfa] ‘box’</td>
</tr>
<tr>
<td>som</td>
<td>[sõw~sõn] ‘sound’</td>
</tr>
</tbody>
</table>

Although our intention here is not to discuss this point, it has been called upon to clarify the difference between the variable diphthong in word endings as in homem [´omêj] ‘man’ and viagem [vi´azêj]`trip’, tons [tõwos] ‘tones’, which is described in the same way as a nasal vowel, as we have seen in the preceding section, and the true diphthong that is described hereunder.

Another point to be noted is that the sequence V(nasal)V does not originate a hiatus. Diachronically and synchronically, the nasal is lost or performed as the onset of the following syllable: luna > lúa > lua ‘moon’; bom (-fem), boa (+fem),’good’, um (-fem) uma(+fem) ‘a/an’.

Furthermore, the problem raised by two vowels with a nasal segment (N) in between is controlled by DEP N, which prohibits the nasal without a root to be a segment. Whereas the floating nasal projects a root at the expense of DEP N, when the question is a simple nasal vowel, as we have seen in the preceding section, a floating nasal between two vowels can only be a feature.
The difference lies in the fact that the input nasal vowel is VN, whereas the input nasal diphthong is VN-V. This is our proposal. The empirical evidence to postulate two different underlying forms to the nasal vowel and the oral vowel is in the contrast exemplified in (1), (3) and (5). The empirical evidence to distinguish the underlying nasal vowel from the underlying nasal diphthong is in the contrast exemplified below:

(15) Nasal vowel versus nasal diphthong

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>p  a  n  o</td>
<td>[´pa.nu]</td>
<td>p  a  n  o</td>
<td>pão</td>
<td>[´pãw]</td>
<td></td>
</tr>
<tr>
<td>c  i  g  a  n  o</td>
<td>[´si.ga.nu]</td>
<td>m  a  n  o</td>
<td>mão</td>
<td>[´mãw]</td>
<td></td>
</tr>
</tbody>
</table>

Having considered the underlying difference between nasal vowels and nasal diphthongs, let us go back to some key points, before starting the analysis: i) regarding the difference between the nasal vowel and the nasal diphthong, the nasal vowel as VN contrasts with the single-standing vowel, V, _seda/seda_ ‘path/silk’, _pranto/prato_ ‘weeping/plate’, whereas the nasal diphthong contrasts directly with the oral diphthong _pãw/pau_ ‘bread/stick, _grãw/graw_ ‘seed/grade’. This shows that N, as a feature, covers the two vowels of nasality. Then the constraint Branching Nasal will be active; ii) the nasal vowel may occur in any position of the word, initial, intermediary and final: _insensu, korenti, omen_ , ‘incense, current, man’, with stress or without stress: _kânto/kantóra_ ‘song/song stress’, whereas the diphthong is always stressed and limited to the final position of the word: _ir´mãw, ´põj_ ‘brother, he/she puts’. Then _Final Stress_ is a condition for the diphthong; and finally iii) the nasal, the trigger, may be manifested as an adjacent segment to the nasalized vowel: _prãntu, kâpga_ ‘weeping, yoke’, whereas in the diphthongs it is only a feature: _irmãw, limôjs, kapitãjs_ ‘brother, lemons, captains’, as previously mentioned.

Before defining the constraints, we must return to the underlying nasal representation. Having in mind the distinction concerning to the nasal root, notice that the nasal without a root, between the vowel root and the theme vowel, is a feature:

(17)a. The nasal with a root

```
   • • • •
   |   |   |   |
   p  a  n  o | [´pa.nu] |
   c  i  g  a  n  o | [´si.ga.nu] |
```

b. The nasal without a root

```
   • • •
   |   |   |
   p  a  n  o | pão | [´pãw] |
   m  a  n  o | mão | [´mãw] |
```
To maintain this distinction in contexts surrounded by vowels, the introduction of a root nasal must be intercepted by DEP and, obviously, the nasal feature emerges. This means that Dep (Nasal) and Max (Nasal) constraints must be highly ranked. Due to the high ranking of Max and DEP, the nasal feature must be linked to a root node which already exists. Since it is floating, something must be said about the exact position where it will emerge. Obviously, there are two surrounding root nodes. Consequently, the Branching Nasal does this job.

Since the insertion of a root nasal is prohibited by DEP, and the sequence of two vowels is condemned by ONSET, a diphthong is the solution. Then the theme vowel will be syllabified in the same syllable as the preceding vowel, producing a syllable with two moras. Branching Nasal covers the two vowels with nasality and the nasal diphthong emerges:

(17) The underlying structure of the nasal diphthong

\[
\begin{align*}
\sigma & \hspace{1cm} / \hspace{1cm} \backslash \\
\mu & \hspace{1cm} \mu \\
| & \hspace{1cm} | \\
\bullet & \hspace{1cm} \bullet \\
| & \text{\_\_\_\_} \\
\text{a n o} & = \text{\_\_\_\_} \text{\_\_\_\_} \\
\end{align*}
\]

Another point, which has already been observed, is that the nasal diphthong that emerges from this grammar is a true diphthong, that means, a diphthong with two underlying vowels. The glide is not derived by assimilation. This means that Max V has also an important role since the theme vowel cannot be deleted. Finally, concerning to stress, trochee prevails in Portuguese, but if the final syllable is heavy, it attracts the stress, with rare exceptions. So Final Stress has a role in this ranking, since the nasal diphthong, which occurs only in word endings, is a heavy syllable. The constraints, some of them already defined, are the following:

**Max(N):** The input nasal (N) must have a correspondent in the output.
(The nasal cannot be deleted).

**MaxV:** The theme vowel must have a correspondent in the output.
(The theme vowel cannot be deleted.)

**Dep-N:** The nasal output segment must be in correspondence with a nasal input segment.
(No epenthesis)

**Branching Nasal:** The nasal (N) must be branched.
(It branches to the left and to the right).

**MaxIO:** Input segments cannot be deleted.

**Final Stress:** If the final syllable is heavy, it must be stressed.

**V(nas):** The nasal vowel is prohibited.

**Onset:** Syllables must have an onset.
Considering that DEPN is highly ranked for the reason already discussed, the ranking of Onset must be enlightened. In the nasal environment, where hiatus is prohibited, the satisfaction of Onset constraint is relevant only if the higher constraints are relevant, i.e., Onset is dominated by the nasal constraints. Consequently there is some difference in relation to the nasal vowel ranking, that means, there are two contextual grammars. The nasal diphthong ranking is:

(19) MaxN, MaxV, DepN, Branching N >>Onset, Final Stress >> *V(nas)

<table>
<thead>
<tr>
<th>Tableau 5: pagão [pa´gāw] but not pagano ‘pagan’</th>
</tr>
</thead>
<tbody>
<tr>
<td>/p a g a n o/</td>
</tr>
<tr>
<td>a. pa´gōw#</td>
</tr>
<tr>
<td>b. pa´gaw#</td>
</tr>
<tr>
<td>c. pa´gāw</td>
</tr>
<tr>
<td>d. pa´gā.n̄o</td>
</tr>
<tr>
<td>e. pa´gāŋ</td>
</tr>
<tr>
<td>f. pa´gaw</td>
</tr>
<tr>
<td>g. pa´gā.ō</td>
</tr>
</tbody>
</table>

The problem to solve is the possibility of a hiatus, since the inputs have two vowels in sequence. Diphthongization is the expected solution, since N, which must be preserved, (MaxN), is forbidden to emerge as a segment by DepN, which is highly ranked. Onset condemns (5g). MaxN rejects (5 f), since the floating nasal lacks an output correspondent. Candidate (5e) deletes the theme vowel and creates a root, that is, a nasal segment, violating Max V and DepN. Candidate (5d) with a nasal segment is rejected by DepN. Candidate (5c) offends Branching N, since the N must branch to the left and to the right. Being the diphthong a heavy syllable in final position, it must be stressed, as the stress system of Portuguese demands. Then candidate (5b) is rejected. The winner is candidate (5a), the most harmonic. Notice that it responds positively to the arguments presented in (8).

The glides in the candidates presented in the tableau above, as well as in the following one, are the result of syllabification: the last mid vowel is reduced to a high vowel in the VV sequence and syllabified as a glide.

3.1 The marked diphthong

Three Latin nominal structures are the source of Portuguese diphthongs: anu, one, ane: manu, manus > mão, mãos, leone, leones > leões, pane, panes, pães. The final nasal vowel was formed by the elimination of the intervocalic nasal, leaving the nasal feature into the vowels, orphanu > órfão; if the vowels are identical they are reduced to one, lana > lã > lã (Câmara Jr. 1975: 65).
The point is the avoidance of a combination of two rounded nasal vowels. As we already know, the basic assumption is that the nasal diphthong is made by the combination of root vowel plus theme vowel, also called terminal vowel. The root nominal vowels are, as in its origin, aN and oN, and the theme vowels are three: /a,e,o/. The following combinations would be expected, but the last one is blocked:

(20) aN +o > ão [ãw], example [pãw] /paN/ ‘bread’
aN +e > ãe [ãy], example [pãjs] /paN / (plural)
oN +e > õe [õy], example [limõjs] /limoN/ ‘lemon’
oN +o > õu [õw], example * [limõws] /limoN/ (plural)

In terms of Lexical Phonology, the root vowel ã is preserved at the word level and in all the paradigm. The root vowel Œ is preserved in derivation and inflection but not at the word level. This distribution is shown in (22).

(21)a. irmaN > irmandade, irmanar, irmãos, irmão [irmãw] ‘brother’
pagaN > paganismo, pagãos, pagão [pagãw] ‘pagan’
sidadaN > sidadania, sidadãos, sidadão (cidadão) [sidadãw] ‘citizen’

b. limoN> limonada, limões, but limão [limãw] ‘lemon’
leoN > leonino, leões, but leão [leãw] ‘lion’
patroN, patronato, patrões, but patrão [patrãw] ‘boss’

Portuguese shows two solutions to avoid the nasal marked diphthong in the grammar:

(22)a. Deletion of the nasal
coN + operar > cooperar ~coperar ‘cooperate’
coN + opositor >co-opositor ‘with the opposer’

b. Delabialization with lowering of the head vowel
limoN-o > limãw≠, *limõw ‘lemon’
leoN-o > leãw≠, *leõw ‘lion’

The prefix com /koN/ next to /o/, a word initial vowel, loses its nasality, resulting in an oral vowel (22a). The nasality is preserved at the expense of the delabialization and lowering of the vowel (22b). Notice that two labial nasal segments inside the word are licensed, for example: [ˈtõmbu], [ˈpõmbu]’fall, pigeon’ as well as the variable diphthong õw ~õ, in monosyllabic words, as we have seen in section 2. What is not allowed is the invariant output nasal true diphthong, two nasal rounded vowels in correspondence with an input with two vowels, discussed in this section: /leoN-o/ > [leãw≠], but not *[leõw≠]’lion’.
The avoidance of ōw seems to be a case of dissimilation in the context of two marked segments. Besides the fact that the nasal vowel is marked because there is not a system formed only by nasal vowels, the rounded vowel is also marked because there is not a system formed only by round vowels. Then *ōw, which combines nasality and roundness, is the marked diphthong.

The data show that we are dealing with dissimilation, with synchronic and diachronic evidence. To account for this kind of problem, Alderete (2004), resorts to Local Conjunction (23), based on OCP to explain dissimilation.

(23) Dissimilation as Local Conjunction (Alderete 2004:395)

OCP effects are derived by markedness constraints, doubled in a local context

It is founded in the following assumptions (Alderete, 2004:395):

(24) 'A. The inventory derived by constraint interaction:
Inventory patterns are characterized through the interaction of faithfulness and markedness constraints.
B. Markedness through constraint satisfaction:
If property P is marked in structural inventories, then there is a constraint in universal grammar that marks forms bearing P.
C. Local Conjunction:
Multiple constraint violations in a local context are categorically worse than the same violations in a non-local context.'

These assumptions combine to explain why marked elements are active in dissimilation: two marked segments in a local context attract dissimilation, whereas a marked segment alone is preserved, when the relative markedness of the segment is not in competition. In other words, the existence of two marked segments in a domain implies the presence of the marked segments in the grammar.

On the basis of these assumptions, Alderete (2004) proposes a constraint ranking in which faithfulness and markedness constraints interact to explain why marked elements are active in dissimilation. A double marked local constraint, represented by [ ], dominates Faithfulness, which dominates a non-doubled Local Constraint. If the Local Constraint is dominant, the double marked elements do not belong to the system.

Many cases are cited, as, for example, Lymans Law in Japanese: More than one voiced obstruent is not allowed: ori-game is well-formed as well as kami-kaze but not *kami-gaze, with two voiced obstruents. Labial Dissimilation occurs in derived stems in Tashlihiyt Berber, a language that does not permit a stem containing two segments with labial specifications: m-kaddab is converted to n-kaddab. Among the cases cited by the author, the round nasal diphthong dissimilation in Portuguese could be included: leõj̃s and limõj̃s are well-formed, but not *leõw, neither *limõw,
which are converted to leãw and limãw. The feature responsible for the roundness of the head vowel is lost, at the expense of lowering, resulting in the diphthong ãw.

This analysis is presented in Tableau 6. Supposing that the candidates now in observation satisfy the basic constraints of the nasal grammar, already discussed, the problem to solve is the avoidance of the marked diphthong.

Central for DLC is that dissimilation is driven by markedeness, consequently No Double Nasal Rounded Vowels constraint, *[[nasal, round]] (25), a markedeness constraint, dominates IdentIO[high] (27), a faithfulness constraint, which dominates the non-double nasal round vowel, [V round, nasal] (26). In (25)-(27), we define the new constraints on the line of Alderete (2004).

(25) *V [nasal, round]]
   Avoid two tautossyllabic nasal round vowels

(26) *[V nasal, round]
   Avoid nasal round vowel

(27) Ident IO [ high]
   If an input segment is [α high], then its output correspondent is [α high] (Kager1999).

The double markedness constraint, performing a local self-conjunction, *[[nasal, round]] (25), bans a diphthong with two nasal round vowels. It dominates IdentIO [high], which demands the preservation of the input height features. The non-double nasal round vowel, in its relation to the highest constraint, allows the candidate that does not offend the double marked constraint to be the winner.

Tableau 6: Dissimilation as Local Constraint

<table>
<thead>
<tr>
<th></th>
<th>*V[nasal,round]</th>
<th>IdentIO[High]</th>
<th>*V[nasal,round]</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. pa.trãw</td>
<td>**</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>pa.trõw</td>
<td>*!</td>
<td>*</td>
<td>**</td>
</tr>
<tr>
<td>b. li.mãw</td>
<td>**</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>li.mõw</td>
<td>*!</td>
<td>*</td>
<td>**</td>
</tr>
</tbody>
</table>

The candidates satisfy the constraints related to nasality, already discussed, reason why they don’t figure in this tableau. The prohibit diphthong is in discussion. The two tautossyllabic nasal labial vowels that the candidates patrõw and limõw exhibit are rejected by the Local Double Constraint. This constraint bans the marked diphthong
regardless of its paradigm, in which the presence of the /o/ vowel prevails: 
*patronato*, *patrõfs*, *limonada*, *limõfs*. It does not reject only one nasal round vowel as in *patrõfs* and *limõfs*. Both candidates (6a), and (6b) *patrãw e limãw*, which show 
dissimilation, are selected regardless of the offended non-double correspondent constraint.

In fact, the nasal diphthongs have two input roots: the root AN and the root ON, 
the former prevailing in combination with the terminal vowel /o/, (singular and 
plural names) and the later with the terminal vowel /e/ (plural names), but ON next to 
/o/ (singular names) becomes [ɾ] by dissimilation, resulting ãõ, [ɾw̃].

As we see, dissimilation is active in Portuguese in the formation of the true nasal 
diphthong. It is motivated by a Local Constraint which bans two marked tautosyllabic 
vowels.

In conclusion, dissimilation is an effect of the interrelation of markedness and 
faithfulness constraints, in which the Local Conjunction has a central role in this 
grammar. It offers an explanation for the prohibition of two nasal round vowels in 
the diphthong system of Portuguese.

### 3.2 The nasal diphthongs and the plural

As for the thematic vowels, /a, o, e/, whose only property is to be shared by all 
members of a given class, we must notice that the simplest structure of a word in 
Portuguese is formed by a root and a theme vowel. In general, the same vowel 
prevails in the singular and in plural forms, but sometimes this theme vowel 
emerges only in the plural, *flor, flores, ‘flower, flowers’*. In some other cases, a word 
belongs to a class in the singular and to another one in the plural. For example, the 
singular nominal *patrão* belongs to the class of thematic vowel -o, already 
analyzed, but the plural nominal *patrões* belongs to the vowel class -e.

<table>
<thead>
<tr>
<th>Thematic vowel (a)</th>
<th>Thematic vowel (o)</th>
</tr>
</thead>
<tbody>
<tr>
<td>irmã, irmãs/irmaN-a/ ‘sister’</td>
<td>irmão, irmãos /irmaN-o/ ‘brother’</td>
</tr>
<tr>
<td>lã, lãs /laN-a/ ‘wool’</td>
<td>cristão, cristãos /kristaN-o/ ‘christian’</td>
</tr>
<tr>
<td>maçã, maças /masaN-a/ ‘apple’</td>
<td>benção, bênçãos /bensaN-o/ ‘blessing’</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Thematic vowel /e/ (plural)</th>
<th>Exceptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>limões /limoN-e-S/ ‘lemon’</td>
<td>pães, /paN-e-S/ ‘breads’</td>
</tr>
<tr>
<td>feijões /feĩzõN-e-S/ ‘bean’</td>
<td>alemães, /alemaN-e-S/ ‘germans’</td>
</tr>
<tr>
<td>patrões /patroN-e-S/ ‘boss’</td>
<td>cães, /kane-S/ ‘dogs’</td>
</tr>
</tbody>
</table>

What is called “exception” in (28d) reveals in fact a tendency to maintain /e/ as 
the theme vowel in plural nasal diphthongs. These examples are already consensual,

---

6Although the low nasal vowel has been transcribed in this paper by ā, it is in fact lightly more 
posterior and less low, phonetically [8].

7 For theme vowels, see Câmara Jr. (1979) and Alcântara (2003).
but many others show variation, including alternation of the root vowel as, for example, *anciãos, ancães, ancões, ‘old men’ and *anãos, anões, ‘dwarf/s’.

Leaving aside these cases and (28a, b), whose plural is made by adding /S/ to the singular forms, let us see, in Tableau 7, the plural of the words discussed in Tableau 6, i.e. words with an /oN/ root which take the theme vowel /e/, showing the difference from its singular counterpart. Here the Local Constraint does not have a role, since the theme vowel is not /ol/. Thus Tableau 7 recapitulates Tableau 5.

Tableau 7: patrões but not *patrones ‘bosses’

<table>
<thead>
<tr>
<th>Max N/V</th>
<th>Dep N</th>
<th>Branch N</th>
<th>Onset</th>
<th>Final Stress</th>
<th>*V (nas)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. pa. trôjs.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>**</td>
</tr>
<tr>
<td>b. pa.ˈtrôjs.</td>
<td></td>
<td></td>
<td></td>
<td>*!</td>
<td>**</td>
</tr>
<tr>
<td>c. pa.ˈtrôjs.</td>
<td></td>
<td>*!</td>
<td></td>
<td></td>
<td>#</td>
</tr>
<tr>
<td>d. pa.ˈtrô.nes</td>
<td></td>
<td></td>
<td></td>
<td>*!</td>
<td></td>
</tr>
<tr>
<td>e. pa.ˈtrôns</td>
<td></td>
<td>*!</td>
<td></td>
<td>*!</td>
<td></td>
</tr>
<tr>
<td>g. pa.ˈgã.ô</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>*</td>
</tr>
</tbody>
</table>

Candidate (7a) is the winner. Candidate (7b) offends Final Stress. Candidates (7c) is condemned by Branching Nasal, the nasal does not go to the right and to the left. The insertion of the nasal root is prohibited by DepN (7d). Candidates (7e) offends Max V and DepN. It deletes the theme vowel and creates a root nasal. And (7f) is rejected by Onset.  

3.3 The sequence of two identical vowels

The last question to be addressed is the final nasal related to two identical input vowels, where diphthongization is not a solution. At first sight, it could be taken as a case of dissimilation driven by markedness, discussed in (3.1). But is not the case of a prohibition on two long vowels, a double markedness constraint, since the Portuguese system does not have long vowels.

What is under discussion is the combination of two identical vowels, from which a long vowel or a two-moraic vowel can emerge. This is the case, among others, of the feminine words as irmã, irmãN+a, ‘sister’, versus masculine words as irmão, irmãoN+o, ‘brother’. From the degemination of two vowels, the result is a long vowel, although the complete fusion, a non long vowel, is also a possibility.

Although fusion does not involve deletion, the Linearity is in question. Pater (2004) explain by Linearity constraint, defined below, the blockage of fusion in identical IO segments. Linearity is in conflict with No long Vowel.

(29) Linearity

\[ S_1 \text{ reflects the precedence structure of } S_2 \text{ and vice-versa} \]

---

8 The /S/ plural is invisible to stress rules.
(30) NoLong vowel
Avoid vowels dominated by more than one mora

Following this and having in mind that N does not have root, and that it can only be realized as a feature in the sequence VN-V, where V is a theme vowel, the two identical vowels in sequence favor fusion. The subscripting is used to indicate the crucial correspondence relationship:

(31) Root \( \bullet \bullet \bullet \bullet N \bullet \) (Input) \( \bullet \bullet \bullet \bullet \) (Output)
    \( i \ r \ m \ a_1 \ a_2 \) \( i \ r \ m \ \tilde{a}_{1,2} \)

Tableau 8: \( irm\tilde{a} \) but not \( irm\tilde{a}n \) neither \( irm\tilde{a}y \) ‘sister’

<p>| | | | | | | | | | | | | |</p>
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</thead>
<tbody>
<tr>
<td>i r m a_{1,2}</td>
<td>N/V</td>
<td>Dep</td>
<td>N</td>
<td>Onset</td>
<td>Final</td>
<td>Stress</td>
<td>Long</td>
<td>V</td>
<td>LIN</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. ir. m\tilde{a}_{1,2}</td>
<td></td>
<td></td>
<td></td>
<td>⏯</td>
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<td></td>
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<td>*</td>
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<td></td>
</tr>
<tr>
<td>b. ir. m\tilde{a}_{1,2}</td>
<td>N/V</td>
<td>Dep</td>
<td>N</td>
<td>Onset</td>
<td>Final</td>
<td>Stress</td>
<td>Long</td>
<td>V</td>
<td>LIN</td>
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<tr>
<td>c. ir m\tilde{a}_{1,2}</td>
<td></td>
<td></td>
<td></td>
<td>⏯</td>
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<td></td>
<td></td>
<td>*</td>
<td>!</td>
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<tr>
<td>d. ir. m\tilde{a}_{1}</td>
<td>N/V</td>
<td>Dep</td>
<td>N</td>
<td>Onset</td>
<td>Final</td>
<td>Stress</td>
<td>Long</td>
<td>V</td>
<td>LIN</td>
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<tr>
<td>e. i. m\tilde{a}_{1}</td>
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<td>⏯</td>
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<td>*</td>
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</tr>
<tr>
<td>f. i r m\tilde{a}_{1,2}</td>
<td>N/V</td>
<td>Dep</td>
<td>N</td>
<td>Onset</td>
<td>Final</td>
<td>Stress</td>
<td>Long</td>
<td>V</td>
<td>LIN</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>g. ir. m\tilde{a}_{1,2}</td>
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<td>⏯</td>
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<td></td>
<td></td>
<td>*</td>
<td>!</td>
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</tbody>
</table>

At the expense of Linearity, the winner is (8a). However, with the reverse ranking, in which LIN dominates No Long the candidate (8b) would be optimal.
The explanation concerning long vowel has been given in the preceding section.

Summary

The analysis of the nasal diphthong is simple and transparent. The question to be solved is the hiatus. Diphthongization is the solution, since N, between two vowels, can only be realized as feature. Some problems arise, demanding dissimilation or fusion. Dissimilation is the option to avoid the marked diphthong \( [\tilde{o\tilde{w}}] \). Fusion of identical vowels is the option to avoid hiatus, when the diphthong can not emerge.

4 Derivatives of root with a final N
Before reaching the conclusion, we will briefly touch on the floating nasal in derivative words. The preceding section showed that the floating nasal between the root and the theme vowel is a feature, suggesting that the N between two vowels is only a feature. Nevertheless, examples in (32) show N as an onset, when V2 is the initial vowel of an affix. Then a contextual difference, which is conducted by the input, is noticeable: N surfaces as a feature between two vowels only if V2 is a terminal vowel, i.e., a theme vowel.

(32) Examples
limoN + ada > limonada. Prosodic word: [li´mãw]
pagaN +ismo > paganismo Prosodic word: [pa´gãw]
leoN + ino > leonine Prosodic word:[ le´ãw] ~ [ljãw]
kartoN+ isto: kartonista Prosodic word: [kar´tãw]
valeNtoN + a > valentona (inflection by derivation). Prosodic word: [valen´tãw]

Some derivative words lose the floating nasal, feijão > feijoada, limão> limoeiro, but most of them preserve it, as in (32), calling our attention to an interesting point: When a nasal vowel is involved, the base for the derivatives is the root and not the prosodic word. In other words, the affix is attached to a floating nasal, which, in derivatives emerges as segment in onset position. The first point to be noted is the faithfulness of the derivative to the input, indicating that Max N and Branching N are highly ranked. And due to the fact that the nasal emerges as a segment, DepN is lower. As for Onset, it is dominated by the higher constraints, since the satisfaction of Onset constraint is relevant only if the higher constraints are obeyed. The ranking is:

(33) MaxN, Branching N >> Onset >> Dep N >> *V(nasal).

Tableau 9: limonada ‘limonade’

<table>
<thead>
<tr>
<th></th>
<th>MaxN</th>
<th>BranchN</th>
<th>Onset</th>
<th>Dep N</th>
<th>*V (nas)</th>
</tr>
</thead>
<tbody>
<tr>
<td>/l i m o n - a d a/</td>
<td></td>
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<td></td>
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<tr>
<td>a. limonada</td>
<td>*</td>
<td></td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>b. limonada</td>
<td></td>
<td>*!</td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>c. limoada</td>
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<td></td>
<td>*</td>
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</table>

The winner is (9a), in which the floating nasal creates a root to be an onset, violating DepN, but satisfying the high constraints. This is a case of the Emergence of the Unmarked: the obedience to the high faithfulness constraints gives chance to Onset to be satisfied at the expense of DepN. The default nasal segment emerges as an onset.
To conclude, the paper proposed a precise account of the contrastive nasalization in Portuguese, under the framework of Optimality Theory. Although the trigger of the phenomena, a nasal without a root, is the same for both, nasal vowel and nasal diphthong, as well as the basic constraints, there are some constraints that become active in one but not in the other ranking.

The interaction with other constraints of the system, which motivates discussions about different points of the grammar, gives support for the nasal constraint ranking which concerns on contrastive nasality.

Clearly, this proposal must have similar results in other languages, however, with some consequences due to the particular properties of each language.

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