Nasal coda and vowel nasality in Brazilian Portuguese

Although it seems trivial to admit nasal vowels in BP, a phonological account, better known as biphonemic, claims that there are only nasalized vowels in BP, as they are followed by a nasal consonant. From other views, nasal consonant loss could be pointed out as responsible for full nasalization in romance languages [1] and emergence of this lost consonant would be advocate [2]. In this work our claim is that nasal vowel gesture in BP must be understood as two gestures not aligned in time. In other words, the nasal gesture starts well after the vocalic gesture and goes beyond the closure gesture, in words like *campa*, allowing for the rise of a nasal appendix (NAP) [3] and for nasal quality relatively late in the vowel. Taken as a nasal coda, the NAP is not a full consonant that follows the rhyme but a gradual nasal gesture that yields nasal quality to the vowel. Comparing nasal to nasalized vowels showed to be a relevant issue in other to a deeper understanding of both the role played by NAP and the light contrast, at least auditory, between the former and the latter.

The main study, accompanied by an auxiliary one, aimed at comparing nasal and nasalized vowels in terms of nasal air flow and duration. BP has five nasal vowels /ɜ̃, ẽ, ĩ, õ, ũ/ that occur in syllables as (1) $V_nC_oV_o$, (2) CV_n C_oV_o and (3) CV_n, where C can be either an oral or a nasal consonant. Nasalized vowels can occur in syllables such as (1) and (2) with a nasal consonant instead of a C_o. Five Brazilian speakers, two female and three male, produced disyllabic words and non words (Tables 1 and 2) in the carrier sentence "Eu digo ____claramente". Each sentence was repeated four times and recorded in an EVA2 station [4]. The low /ɜ̃/ and high /ĩ/ nasal vowel and their nasalized counterparts were selected as representative of their group for this experiment.

Aerodynamic measures were made in order to get a maximum value of nasal airflow (MAX NAF), in 50 ms windows for both nasal vowel (NV, excluding NAP) and nasalized vowel (nV). The first window was aligned with the vowel first pulse. NV duration, including as well as excluding its nasal coda, was compared to nV duration (*pampa* x *pama*). Qualitatively – as expected (see Figure 1) – both NV and nV showed ascending mean values of MAX NAF. A Mann-Whitney u-test showed significant difference between NV and nV, both low and high. Low NV showed a greater MAX NAF than the low nV MAX NAF ($0.031dm^3/s > 0.18dm^3/s$, p-value = .001). The same happened to high vowels ($0.063\ dm^3/s > 0.035\ dm^3/s$, p-value = 0). Aerodynamic results showed that both nasal and nasalized vowels possess growing NAF, but the former has a higher NAF, which is attributed to the NAP process. Durational results showed that NV are longer than nV (Mann-Whitney u-test, p-value = 0) for both low vowel (188 ms > 147 ms) and high vowel (164 ms >121 ms), if NAP is not excluded. Since our reasoning is that there is an overlapping between NAP (44 ms) and the initial portion of /p/, a subtraction of NAP length approximates NV and vN durations. Low and high NV (NAP excluded) have 144 ms and 120 ms, respectively.

In the auxiliary study (Table 3), a GLMM indicated no difference between the length of sequences constituted by nasal vowel + /p/ and oral vowel + /p/ ($p>0.10$), for low vowels (265 ms = 249 ms). An analogous result was obtained for high vowels. However, a vowel + oral coda + /p/ sequence as the one in *caspa*, is longer than the nasal vowel + /p/ sequence (> 348 ms). These results are in line with the idea that the nasal coda lies in the temporal domain of /p/, and point out to a peculiar interplay between the nasal gesture and the oral gesture that follows. Such interplay is due to a fine gestural orchestration that preserves vowel quality so that nasalization is installed and gradually attains a NAF peak (NAP) that plays an important role in vowel nasality.

Table 1: Low (left) and high (right) nasal vowels

pampa	pimpa
campa	quimpa
ampa	impa

Table 2: Low (left) and high (right) nasalized v.

pama	pima
cama	quima
ama	ima

Table 3:Three groups of different sequences: Group 1, with low and high nasal vowels; Group 2, with low and high oral vowels, Group 3 with low and high oral vowels followed by /s/. Measured sequences are underlined.

Group 1		Group 2		Group 3	
p<u>amp</u>a	p<u>imp</u>a	p<u>ap</u>a	p<u>ip</u>a	p<u>asp</u>a	p<u>isp</u>a
c<u>amp</u>a	qu<u>imp</u>a	c<u>ap</u>a	qu<u>ip</u>a	c<u>asp</u>a	qu<u>isp</u>a
a<u>mp</u>a	<u>imp</u>a	<u>ap</u>a	<u>ip</u>a	<u>asp</u>a	<u>isp</u>a

References

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