NASAL HEADS OR NASAL TAILS? A PAN LUSOPHONE SURVEY OF PRECONSONANTAL MURMUR

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ABSTRACT

This study investigates nasal murmur in preconsonantal environments across Portuguese varieties from Africa, Asia, Europe and South America. We analyzed cross-syllable tokens of the type *nasal vowel* (V_n) + *stop* (C_s) or *fricative* (C_f) to: compare the presence or absence of nasal murmur (N) across pan Lusophone varieties, and examine the acoustic length of N, alone and as a proportion of the total period of nasality expressed in the syllable rhyme. Our findings show significantly fewer instances of N among Brazilian speakers in V_n + C_s contexts. Temporal results, and to a lesser extent the distribution of N in V_n + C_f contexts set apart Brazilian and European varieties from the African and Asian varieties. We conclude by suggesting that dominant variety influence and substratum interference lie behind some of these differences, yielding in an expanded context for the realization of N, and transfer of the nasality locus from V_n to N among indigenizing varieties.

Keywords: preconsonantal murmur, Portuguese nasal vowels, indigenizing language varieties

1. INTRODUCTION

The inventory of Portuguese nasal monothong vowels is as follows: [ĩ, ẽ, ɐ̃, õ, ũ]. Underlyingly, this class of sounds is interpreted by Mateus and d'Andrade [5] as the sequence *oral vowel* + *nasal stop*. Thus, V_n is said to surface "as the nasal feature of the vowel" [5], and the nasal stop is regarded as unexpressed, as in ['mɐ̃.tɐ] "manta" 'blanket' and ['põ.bu] "pombo" 'pigeon'.

With respect to Brazilian Portuguese (BP), Wetzels [15] attributes a phonemic status to the Portuguese nasal vowel, describing it as a bi-moraic sequence of the form /VN/, with /N/ representing a nasal mora. Using MRI technology to study the position of the velum for a single speaker, Rapouso de Medeiros and Demolin [8] show a lowered velum from acoustic onset to offset among V_n tokens, which the authors argue is evidence for the presence of phonological nasal vowels in BP. Interestingly, this finding is contrasted by a study of European Portuguese (EP) nasal vowels in [13], which reports a *raised* velum during the initial portion of the V_n in a range of contexts, both preconsonantal and otherwise.

Studies of nasal vowels in preconsonantal environments have revealed the surfacing of N among speakers of BP and EP varieties, e.g. [2, 4, 6, 7, 10, 11, 13, 14]. In [4], which uses fiberscopic video recordings to study the movement of the velum during nonce word productions containing V_n, N is described as a typically homorganic "acoustic nasal tail", representing the complete lowering of the velum during articulation of the V_n before an obstruent. In this and the aforementioned studies, preconsonantal N is treated as the final phase of the V_n, as opposed to a nasal stop segment with its own inherent acoustic properties, such as may be found in languages with no phonological nasal vowels.

A perception study by Stevens, et al. [12] aimed at native speakers of English, French, and Portuguese shows that EP listeners prefer murmur in V_n + C utterances. In terms of acoustic features, the majority of descriptions of preconsonantal N concern BP varieties. Such studies report: the free variation of [V_n] and [V_nN], with the latter occurring in more than four-fifths of the tokens analyzed [4]; the occurrence of N before both stops and fricatives [4, 6, 7]; and respective mean percentages of the duration of N over the total rhyme between 20 and 65% [7], and 34% [4][i].

With the present study, we sought to further contribute to this picture by: (1) making use of an existing corpus of pan Lusophone speech varieties and performing a cross-Atlantic comparison of the distributional and temporal characteristics of N, and (2) extending this analysis to a sample of indigenizing varieties from Angola, Cape Verde, Timor Leste, Guinea Bissau, Macau, and Mozambique. By 'indigenizing varieties', we mean those which are not fully integrated and receive moderate to high levels of substratum interference.

2. METHODOLOGY

2.1. Informants and corpus

The informants selected for this study were recorded in Lisbon, Portugal, the basic details of which are provided in Table 1. One informant was selected per *topolect*, all of which are native or near-native speakers of Portuguese. The latter learned Portuguese as part of their formative education and all demonstrate a high level of fluency. At the time of recording, informants from Santiago, Cape Verde (SanCV) and Belém, Brazil (BlmBR) had been living in Portugal for a respective total of three and four years. The remaining informants had arrived in Portugal within a period of one month and just over a year.

Table 1: Informant details.

informant ID	age	sex	place of origin
LuaAO	34	m	Luanda, Angola
BelBR	43	f	Belo Horizonte, Brazil
BlmBR	36	m	Belém, Brazil
RioBR	23	f	Rio de Janeiro, Brazil
SpoBR	42	m	São Paulo, Brazil
MacCN	19	f	Macau, China
SanCV	21	m	Santiago, Cape Verde
BisGW	26	f	Bissau, Guinea Bissau
TetMZ	22	f	Tete, Mozambique
AlgPT	27	m	Faro, Portugal
LisPT	27	m	Lisbon, Portugal
TutTL	60[ii]	f	Tutuala, Timor-Leste

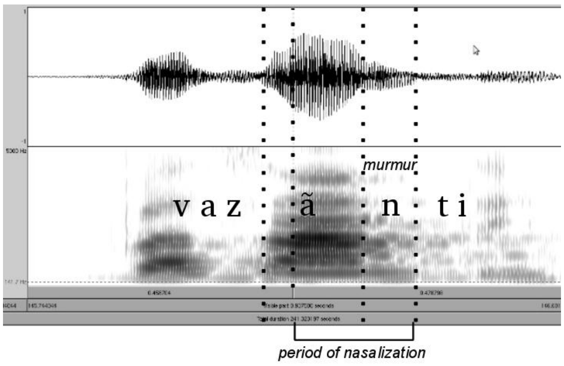
2.2. Recording and analysis procedures

As indicated in section 1, speaker recordings are from an existing corpus, focused on the ongoing collection of read and spontaneous speech data for regional varieties of Portuguese. Materials for the present study belong to the read speech portion of the corpus and largely consist of the same elicitation prompts established in [9]. Audio recordings and stimulus prompts were controlled by an investigator, who remained seated in the same room as the informant. Informants were asked to read the individual words, phrases, and sentences projected in front of them on PowerPoint slides. Recordings were performed using a Marantz digital voice recorder, with a microphone positioned on the table in front of the informant.

From the roughly 90-minute-long digital audio files, 134 target data points were identified and measured by three phoneticians using Praat [1]. In addition to noting the presence or absence of N, duration measures were obtained for: (1) the vowel: (2) the portion of the vowel that was nasalized; (3) N; and (4) the proportion of N over the sum of (2) and (3). This last measure (hereafter referred to as *pN*) was selected as a means of identifying whether, temporally speaking, the locus of nasality occurs within the V_n or N. Cross-coder reliability was aided by double-coding data points.

As illustrated in Figure 1, the detection of N was performed by observing: a sudden drop in overall amplitude following the vowel, and the appearance of abrupt spectral discontinuities and antiresonances [3]. With respect to vowels, the onset of nasalization was signaled through varying combinations of the following cues: a drop in F1 amplitude; an increase in F1 frequency; an increase in F1 bandwidth; an increase in amplitude of the nasal resonances (P0 and P1); the appearance of a nasal resonance at approximately 250 Hz, and additional resonances above this; and formant density in the 0-3,000 Hz range [3].

Figure 1: Waveform and spectrogram image showing measurement boundaries for "vazante" 'ebb' (TetMZ).



The target words identified for this study all contain cross-syllable tokens of the type [V_nC_s] or [V_nC_f], 66 of which derive from stressed syllables, with 68 tokens from unstressed syllables. The types of V_n considered include: [ĩ], n=24; [ẽ], n=49; [ɐ̃]/[ã], n=29; and [õ], n=32. The respective distribution of tokens in initial, medial, and final position is as follows: 41, 68, 25. The right context contains both voiced and voiceless tokens, 100 of which are stops (or, in some cases, affricates, as produced by the BP informants), and the remaining 34 are fricatives. Tokens with V_n + a stop or affricate (hereafter referred to as [C_{sa}]) contain the sounds [p, t, k, b, d, g] and [tʃ, dʒ]; those with [V_nC_f] contain [f, s, ʃ, v, ʒ].

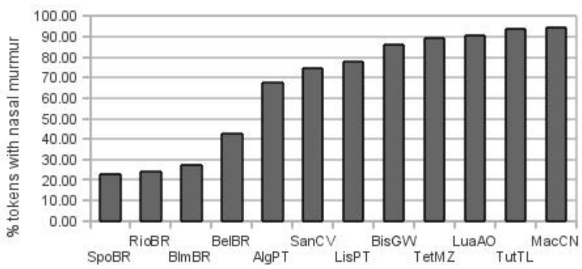
3. RESULTS

3.1. Frequency and distribution of N

In this subsection, we investigate the frequency of N and its distribution in terms of the manner of articulation of the following oral consonant. Due to the elimination of tokens for which the target was missed (often due to a total absence of nasalization or the misplacement of stress), the total number of tokens varies. For BelBR, BlmBR, RioBR, SpoBR, MacCN, SanCV, LisPT, and TutTL, n=134; for TetMZ, n=133; for AlgPT, n=132; and for LuaAO and BisGW, n=131.

Figure 2 presents percentages of tokens containing N across informants, ordered from lowest to highest. Immediately visible in this graph is the difference in the frequency of N distinguishing BP informants from all the rest. A closer look at the BP group revels a disparity with the 85% figure reported in [4] for their single subject from Rio Grande do Sul, Brazil. This could be due to dialectal differences, given that the Rio Grande do Sul varieties are in many ways phonetically distinct from other BP varieties. The difference could also stem from the highly controlled nature of the experiment conducted in [4] and the fact that it concerns nonce words.

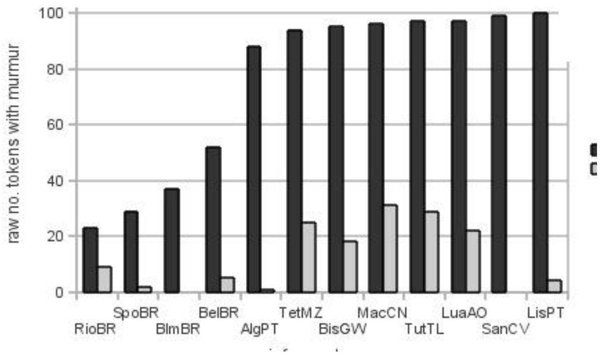
Figure 2: Percentages of tokens with N.



Topolectal varieties with percentages of N exceeding 85% include BisGW, TetMZ, LuaAO, TutTL, and MacCN, i.e. five of the six informants who speak indigenizing varieties of Portuguese. Those varieties depicted in the middle of the graph, with percentages of N between 67% and 78% include AlgPT, SanCV, and LisPT.

In Figure 3, raw numbers of tokens containing N within the context [V_nC_{sa}] or [V_nC_f] are presented. Here, we observe the separate patterning of BP informants for tokens of the type [V_nC_{sa}], while results were more variable for tokens of the type [V_nC_f]. Again, we see a clustering of the same five indigenizing varieties (BisGW, TetMZ, LuaAO, TutTL, and MacCN), showing higher frequencies of N before a fricative. However, the difficulties of identifying N in this context, likely owing to aerodynamic reasons and interactions of nasality with frication in the spectrum, led us to re-concentrate our focus on instances of N occurring before C_{sa}.

Figure 3: Raw number of tokens containing N in [V_nC_{sa}] and [V_nC_f] contexts. The dark bars represent stops; light bars represent fricatives.



Based on the above data, we divided informants into groups, 'BP' (n=536) and 'non-BP' (n=1063), and computed separate aggregate raw scores for tokens with N. A z-score > 4 was computed, yielding the cumulative probability p < .002 in a two-tailed test. Thus, the null hypothesis of equality was rejected, implying significantly different frequencies of N before C_{sa} for the groups 'BP' and 'non-BP'.

3.2. Acoustic durations

The mean and standard deviation of durations of N before C_{sa} are presented in milliseconds in Table 2.

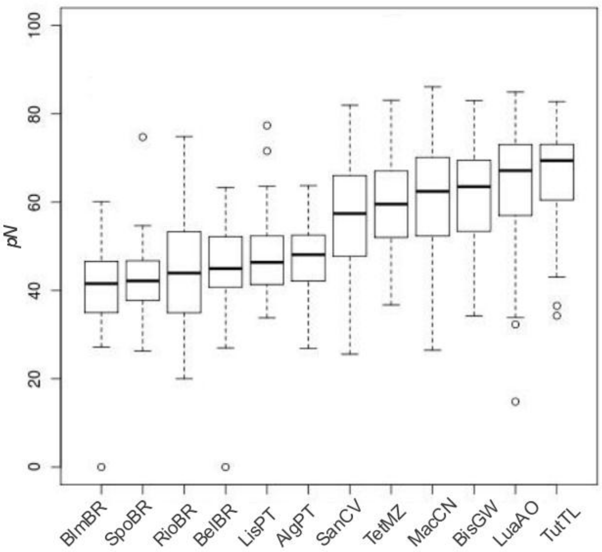
Table 2: Mean and standard deviation of durations of N before C_{sa}, (ms), ordered by mean levels.

Spo BR	**Alg PT**	**Blm BR**	**Bel BR**	**San CV**	**Lis PT**
53 (12) n=25	64 (18) n=88	66 (18) n=27	69 (21) n=45	76 (21) n=98	77 (21) n=100
Rio BR	**Tet MZ**	**Bis GW**	**Mac CN**	**Tut TL**	**Lua AO**
81 (32) n=21	85 (23) n=92	90 (28) n=94	94 (27) n=95	102 (28) n=96	108 (27) n=96

Here, we see a pattern that somewhat mirrors that presented in section 3.1, with the exception of RioBR, whose mean score falls in the middle range, while scores for the remaining BP informants cluster in the lower 53-69 ms range. Given differences in the total number of scores distinguishing BP and non-BP groups, this shift could be the result of a skewed mean for RioBP.

A clearer picture results in the comparison of *pN* before C_{sa} (Figure 4). However, unlike the frequency data, the pattern appears to stem from a difference in fully integrated, indigenized vs. partially integrated, indigen*izing* varieties.

Figure 4: Levels of the *pN* (i.e. the proportion of N over N plus the portion of V that was nasalized).



For this measure, we divided informants into the groups 'indigenized' (n=255) and 'indigenizing' (n=533) topolectal varieties. We applied Levene's test for homogeneity of variance and rejected the null hypothesis of equivalent variances. We then applied a two-sample Wilcoxan rank sum test to analyze the difference between groups. The null hypothesis of this test is that both samples are similar enough to be considered part of the same population. The result was significant, causing us to accept our alternative hypothesis, i.e. that the *pN* is greater for the indigenizing sample (*Mdn*=63.92) than for the indigenized sample (*Mdn*=45.86), W=117413.5, p < .001.

4. CONCLUSION

Two groups, 'BP' and 'non-BP' emerged in our analysis of the frequency of N before C_{sa}, possibly indicating that BP speakers are more constrained in the production of nasal murmur in pre-C_{sa} environments. Alternatively, informants from Africa, Asia and Europe seem to exercise more freedom in this regard, perhaps showing evidence of a gravitational pull by the dominant EP variety.

Analysis of *pN* revealed a grouping of indigenized and indigenizing varieties, also echoing findings by [8] and [13] concerning whether nasality is present during the onset of V_n in BP and EP varieties. Thus, despite that substrate languages for SanCV and BisGW are both Portuguese-based creoles with phonologically behaving nasal vowels, there appears to be a transfer of the nasality locus from V_n to N among speakers of indigenizing varieties. Naturally, caution should be exercised in the interpretation of these findings, given that they are derived from a single speaker per variety. Future work will involve greater speaker numbers and the examination of V_n data using strict criteria for the analysis of phonemic vs. contextual nasalization.

5. REFERENCES

[1] Boersma, P., Weeink, D. 2010. Praat: Doing Phonetics by Computer (computer program, v. 5.1.43). *http://www.praat.org*. Retrieved from 4 August 2010.

[2] Galvão, M.J. 1998. The nasal vowels in Iberian Portuguese. *Proc. 135th Meeting of the ASA* Seattle, 2949-2950.

[3] Harrington, J. 2010. Acoustic phonetics. In Hardcastle, W.J., Laver, J., Gibbon, F.E. (eds.), *The Handbook of Phonetic Sciences*. Oxford: Wiley-Blackwell.

[4] Lovatto, L., Amelot, A., Crevier-Buchman, L., Basset, P., Vaissière, J. 2007. A fiberscopic analysis of nasal vowels in Brazilian Portuguese. *Proc. ICPhS* Saarbrücken, 549-552.

[5] Mateus, M.H., d'Andrade, E. 2000. *The Phonology of Portuguese*. New York: Oxford University Press.

[6] Mendes, G.E.R.M. Jr. 2008. *A Questão das Vogais Nasais no Português Brasileiro*. MA thesis, Universidade Federal do Paraná.

[7] Raposo de Medeiros, B. 2007. Vogais nasais do Português Brasileiro: reflexões preliminares de uma revista. *Revista Letras* 72, Curitiba, 165-188.

[8] Raposo de Medeiros, B., Demolin, D. 2006. Vogais nasais do Português Brasileiro: um estudo de MRI. *Revista da Abralin* 5, 131-142.

[9] Rodrigues, M.C.M. 2003. *Lisboa e Braga: Fonologia e Variação*. Lisbon: Fundação Calouste Gulbenkian.

[10] Seara, I.C. 2000. *Estudo Acústico-perceptual da Nasalidade das Vogais do Português Brasiliero*. Ph.D. thesis, Universidade Federal de Santa Catarina.

[11] Sousa, E. 1994. *Para a Caracterização Fonético-acústica da Nasalidade do Português do Brasil*. MSc thesis, Universidade Estadual de Campinas.

[12] Stevens, K.N., Andrade, A., Viana, M.C. 1987. Perception of vowel nasalization in VC contexts: a cross-language study. *J. Acoust. Soc. Am.* 32, S119.

[13] Teixeira, A. 2000. *Síntese Articulatória das Vogais Nasais do Português Europeu*. Ph.D. thesis, Universidade de Aveiro.

[14] Teixeira, A., Vaz, F. 2001. European Portuguese nasal vowels: an EMMA study. *Proc. Eurospeech* Aalborg, 1483-1486.

[15] Wetzels, W.L. 1997. The lexical representation of nasality in Brazilian Portuguese. *Probus* 9, 203-232.

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[i] Both studies reported fully nasalized vowels.

[ii] Finding a near-native speaker from Timor-Leste required selecting an informant whose primary education was before 1975, during Portuguese control.