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Study of the variable (NI) in Manaus-Brazil: data treatment with r

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Abstract: The variable (nj) is present in paroxytone words ending in –nia and – nio in Brazilian Portuguese. Some variants for this variable were registered by Cruz (2004) in her research in the countryside of Amazonas. Rodrigues (2014) started research on this variable among the speakers in the capital city, Manaus, looking for some evidence of a strong palatalization process, as a pre- analysis carried out in 2014 indicated. The aim of this paper is to present a second data analysis carried out as part of a Sandwich Phd Program, which should result in the quantitative analysis of this linguistic variation. The methods used in this paper involved acoustic analysis with formant measurements and spectrographic cues and quantitative data treatment with R Software.

Key-words: Variable (nj). Acoustic analysis. Quantitative analysis. R Software.

1 INTRODUCTION

Rodrigues (2014) started her research thesis based on Linguistic Atlas of the Amazon- ALAM, which included an investigation of nine representative micro-regions of the Amazonas state, created by Cruz (2004). Even though Manaus, the capital of Amazonas, was not part of Cruz's research, living in that city it is possible to recognize some variation in words like *Antônio*, which is a paroxytone that ends in *nio*.

In order to register this variation, Rodrigues (2014) started a research on the palatalization of /nj/ in Manaus, assuming that the palatal variants [nʲ] and [ɲ] were to be found in higher number in comparison to the other ones registered in ALAM, based on her hearing impressions.

One data collection was carried out in 2014, in Manaus, in order to verify and formally register the existence of variation, having it as a start point for the whole research process.

A list of twenty Brazilian Portuguese words was created in order to have ten paroxytones ending in –nia and ten ending in -nio, bringing up the environment vowel+nj+a and vowel+ni+o. Data collection was carried out through the audio recording of a guided test , that is a guided interview that elicited the words from the created list. Some words that seemed to be unfamiliar to the speakers were shown to them on the computer and the spekers would read them.

Eighteen Manauara speakers were recorded. Nine men and nine women, being three

couples from the age group of 18 to 25 years old, three couples from the age group of 35 to 50 years old and three couples from the age group of 65 year old and older.

In a preliminary analysis (Figure 02), holistically studying the variable in the spectrogram in Praat, and trying to identify the variants through hearing, four variants were identified:

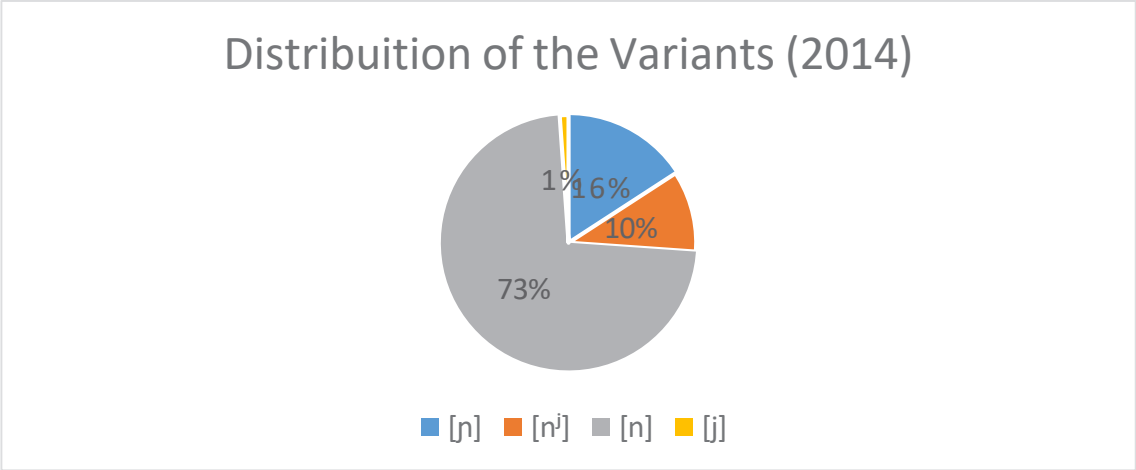


Figure 01: Distribution of nasal variants in the pre-analysis of Rodrigues (2014).

Based on this pre-analysis, the hypothesis that the palatal variants would stand out seemed to be concrete.

This paper aims to present a second data analysis carried out as part of a Sandwich Phd Program, which should result in the quantitative analysis of this linguistic variation

2 METHODS

The first step in order to get accurate data for the quantitative analysis that is expected to be reached in the end of this research was to precisely identify all the variants through acoustic cues in the spectrogram in Praat.

Ladefoged (2001), when describing the three English nasal consonant sounds m, n and ŋ, pointed out that there is a sharp discontinuity just before the nasals, caused by the moment of the articulatory occlusion, either when the lips come together or when the tip

of the tongue reaches the alveolus.

The pattern described by Ladefoged (2001) to identify nasal consonants is as follow:

> All three nasals have a first formant which has distinctly less energy (is fainter) than in the preceding vowel, and which has a very low frequency, around 200Hz. For each of them there is also another formant visible in the neighborhood of 2,500Hz, but there is comparatively little energy in the region normally occupied by the second formant. (Ladefoged, 2001:54)

The author also stated that the main difference between the three nasals are not in the wholly nasal portions, but in the onsets to these portions. And one pattern that differentiates the nasal alveolar n from the nasal velar ŋ is that for the first one the second formant lower in frequency just before the tip closure, however the third formant is slightly higher, and for the second one, the second and third formants come together.

Thomas (2011) affirms that consonant variation in its place of articulation can be checked when one examines the transition from the vowel to the consonant. He suggests the following steps to quantify this kind of variation:

> To quantify variation, you need to measure formant values at two places: a. The onset of the vowel(for a CV transition) or offset (for VC). b. somewhere farther into the vowel, either (a) a set distance from the onset or offset or (b) a fraction of the duration through the vowel or (c) at the point where the vowel reaches its maximum F1 value, maximum or minimum F2 value, or a steady state. (Thomas, 2011:101)

Taking into consideration the acoustic cues proposed by Ladefoged and Thomas, the acoustic analysis of Manaus data started with the recognition of each nasal variant through the combination of hearing impression and the location of the second and third formants at the transition VC at two places: the offset of the vowel and, approximately, 1 to 1,5 seconds after the vowel offset, as suggested by Thomas (2011).

Formant measurements were also taken at two more places, the offset of the nasal and, approximately, 1 to 1,5 seconds after the nasal offset. This measurement was done in order to verify if there is any correlation between the second and third formant distance and the place of articulation of the nasal at those last places. Figures 03, 04 and 05 illustrate how the measurements were held for the identification of the three nasal variants [nj], [n̪j] and [ɲ].

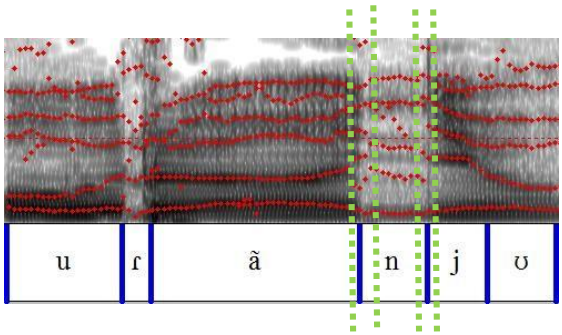


Figure 02: Word *urânio* produced by the speaker g1f01 from Manaus data. The green lines represent the four places of formant measurements. The nasal variant [nj] was identified here.

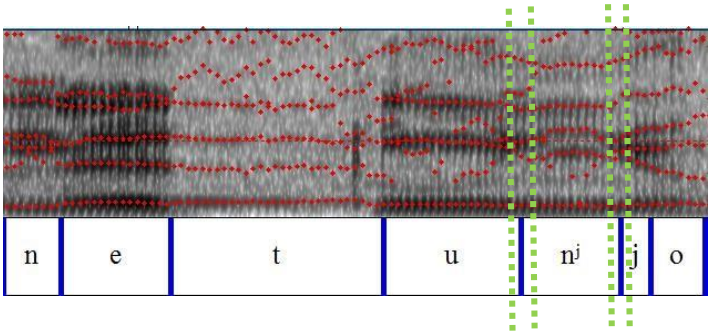


Figure 03: Word *netúnio* produced by the speaker g1m03 from Manaus data. The green lines represent the four places of formant measurements. The nasal variant [nʲj] was identified here.

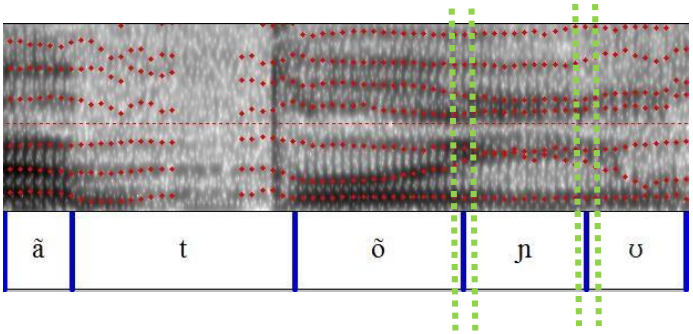


Figure 04: Word *Antônio* produced by the speaker g3m01 from Manaus data. The green lines represent the four places of formant measurements. The nasal variant [ɲ] was identified here.

The pattern found for the identification of the nasal variants [nj], [nʲj] and [ɲ] in Manaus data was:

- Second and third formants at the offset of the vowel may appear very distant from

each other for the majority of the cases when the next sound is an alveolar nasal, with a distance of 750Hz to 1200Hz. However, these two formants may appear very close to one another in this same context, with a distance between 500Hz and 700Hz. The identification of the alveolar nasal is made when the second place of measurement indicates a distance above 400Hz.

- When the second and third formants come together at the first two places of measurement, with a very low distance between 100Hz and 400Hz, the next sound is a palatal nasal.
- The palatalized alveolar nasal is identified when the average of formants distance is between 500Hz and 650Hz at both first places of measurements.
- The third place of formant measurement used in this research seems to follow the pattern identified for the first two places of measurements. When the average distance between the formants at the offset of the vowel, the onset of the nasal and the offset of the nasal is below 500Hz, it indicates a palatal nasal. When it is between 500Hz and 650Hz, it indicates palatalized nasal. Formant distance above 650Hz indicates an alveolar nasal.

Two non-nasal variants were identified in this methodological step. One of them is [j], which represents the iotization on the variable (nj) and the variant [ø] that means that the variable (nj) is deleted. Formants measurements were only made at the offset of the vowel in the cases of iotization and deletion of the variable. These non-nasal variants were identified by the sound and by the lack of the sharp discontinuity described by Ladefoged. Figures 06 and 07 illustrates the identification of the two non-nasal variants [j] and [ø] in Manaus data.

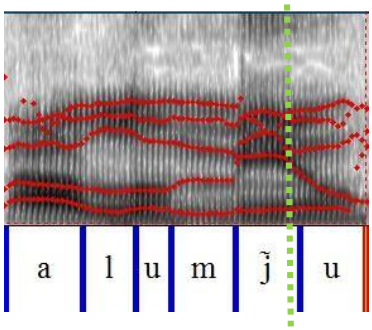


Figure 05: Word *alumínio* produced by the speaker g1m01 from Manaus data. The green line represents the place of formants measurement. The non-nasal variant [ø] was identified here. A case of deletion of the variable (nj)

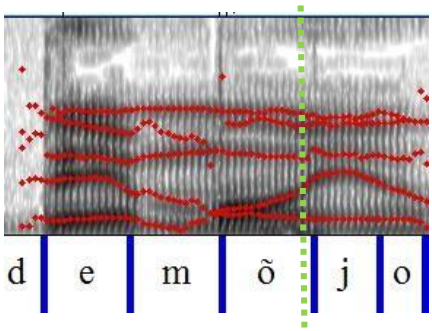


Figure 06: Word *demônio* produced by the speaker g1m01 from Manaus data. The green line represents the place of formants measurement. The non-nasal variant [j] was identified here. A case of iotization of the variable (nj), where it becomes a semivowel/glide.

The other measurement made using Manaus data was of the amplitude of the preceding vowel and the nasal segment in order to identify any other acoustic cues that could help with the identification of the nasal variants.

For the amplitude measurement the both segments, vowel and nasal, were individually extracted and then opened in Praat Objects. The mean amplitude was taken by using the function Query > Sound Info. See the following figures sequence.

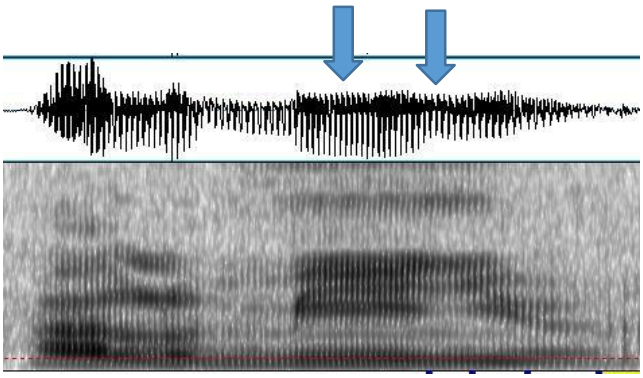


Figure 07: The blue arrows point to the amplitude of the vowel and the amplitude of the nasal segment, from left to right.

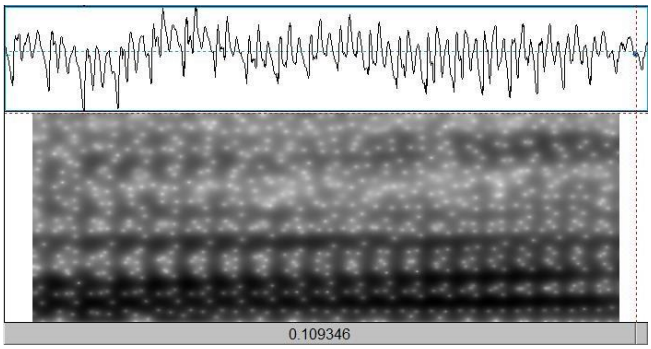


Figure 08: The segment of the vowel /õ/ from the word *demônio*.

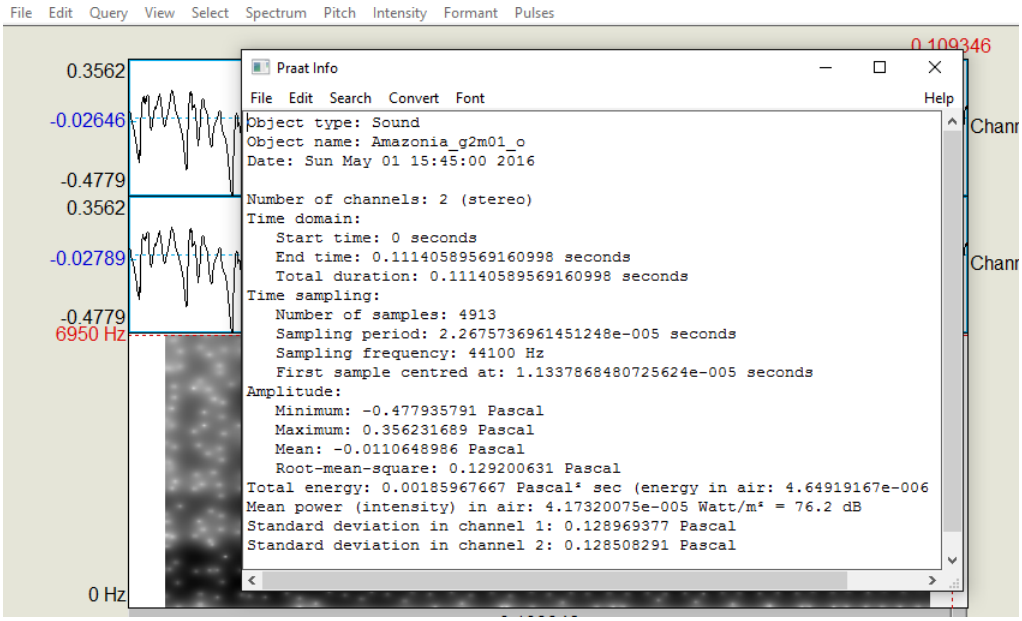


Figure 09: The Sound Info window with Amplitude measurements.

After making all the formants measurements and identifying the variants, all data was annotated in an Excel document. The social factors taken into consideration were: gender and age (birth year). The linguistic factors were: noun category (proper or common), preceding vowel (i, e, a, o, u) and word ending (nia, nio). The acoustic features were: formants measurements at four distinct places (for the nasal variants), the average formant distance at the three first places of formants measurements (for the nasals variants), amplitude measurement (of the vowel and the consonant) and the amplitude proportion of the nasal amplitude in relation to the vowel amplitude.

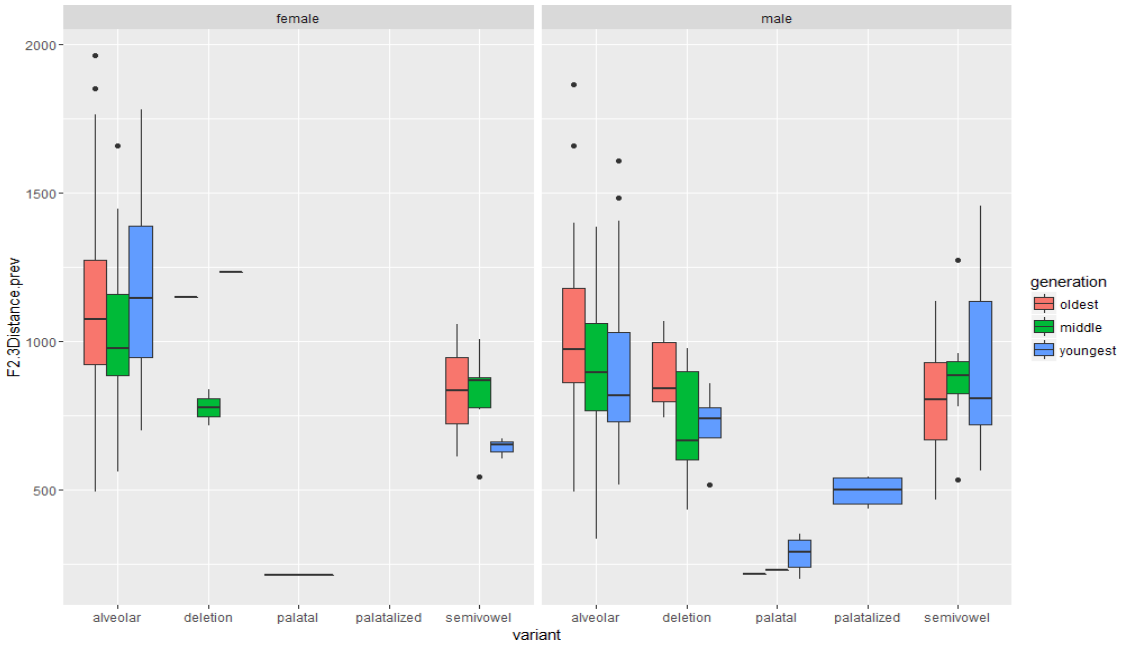
The Excel document was then manipulated in the Statistical Software R.

3 RESULTS

The results will be presented by category: social and linguistic factors, and acoustic features.

3.1 Social Factors: sex and generation

The following boxplot shows the distribution of the five variants over the social features sex and generation. The oldest generation holds speakers born before 1946. The middle, speakers born between 1965 and 1986. And the youngest, speakers born after 1987. Note that the y-axis is formed with the distance values between the second and third formants measured at the offset of the preceding vowel. This is the only measurement that covers all variants.



Boxplot 01: Gender x Generation X Variants.

Even though this data is not big enough for an accurate regression analysis, it gives us some social aspects of the variation. In boxplot 01 we recognize that the palatal [ɲ] and palatalized [nʲj] variants are used only by male speakers. Male speakers are also the ones who use more the other two non-nasal variants, the iotization with the glide [j] and the deletion [ø].

Taking into consideration that these palatal variants and these non-nasal variants were produced in 95% of the data from the Phonetic Letter 94 of ALAM, carried out in the countryside of Amazonas, little towns hidden in the Amazon forest, far from the capital city Manaus, Boxplot 01 than shows that female speakers in Manaus avoid these stigmatized forms. Therefore, they are the ones to produce more the alveolar variant.

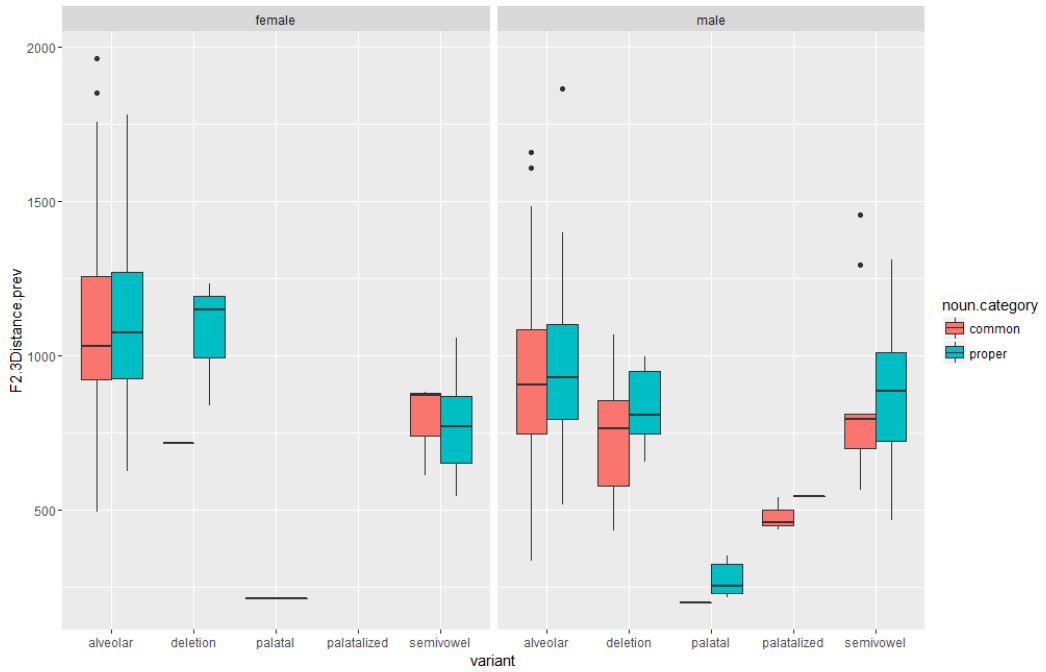
Young males seem to be the ones leading the use of the stigmatized forms. In the other hand, young females lead the use of the alveolar variant. Due to the awareness sense of the usage of the stigmatized variants that the female speakers seem to make use of, trying to sound city-like, I believe that this linguistic variable represents change from above. The variants used in Manaus are imported from the countryside of the state.

3.2 Linguistic Factors: noun category, preceding vowel and word ending

In the word list created for this research there are seven proper names: *Virgínia*, *Efigênia*, *Betânia*, *Goiânia*, *Amazônia*, *Antônio* and *Junior*. Thirteen common names were also used: *alpínia*, *gênia*, *insônia*, *calúnia*, *petunia*, *condomínio*, *alumínio*, *oxigênio*, *milênio*, *crânio*, *urânio*, *demônio* and *netúnio*.

Five vowels were preceding the word ending –nia and –nio. The nasalized vowels /ẽ/, /õ/ and /ã/, in the words from the list these vowels appear with a nasal accentuation (^) and the oral vowels /i/ and /u/.

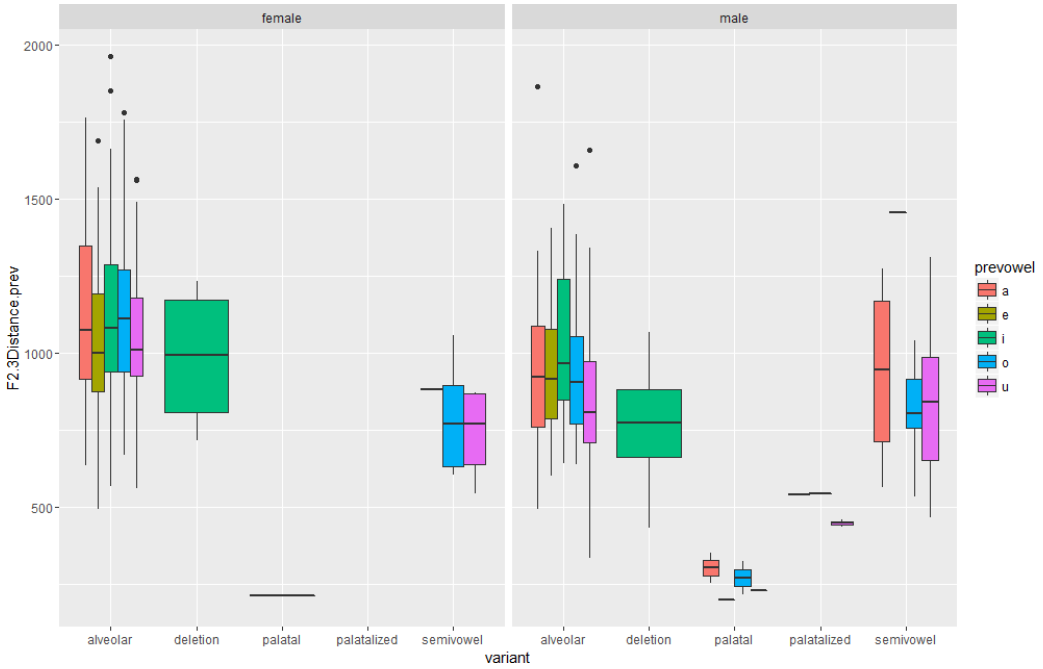
The next boxplot shows the correlation between the noun category and the variants.



Boxplot 02: Noun category X Variants.

In boxplot 02 it is possible to see that proper nouns seem to be more likely to go under the non-standard variants, that is the palatal and the non-nasal variants.

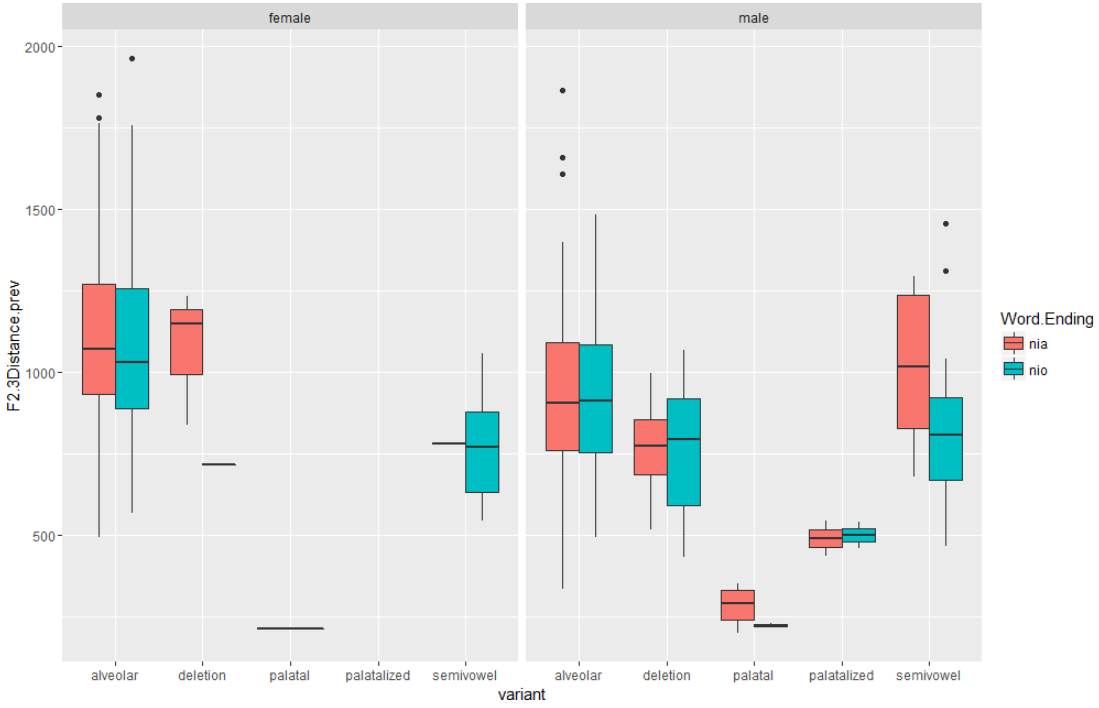
Boxplot 03 shows the correlation between the preceding vowel and the variants.



Boxplot 03: Preceding vowel x Variants.

In boxplot 03 it is possible to identify that the variant deletion of (nj) only happens when the preceding vowel is /i/. The deletion of /n/ here can be explained with the fact that it is between two similar high vowels. The high vowel
/u/ seems to facilitate the iotization process as well, as in an attempt to put two high vowels together. Round vowels /a/ and /o/ also seem to facilitate the iotization process and they are also the only ones to be preceding the palatal variants.

The following boxplot shows the correlation between the word ending and the variants.



Boxplot 04: Word Ending x Variants.

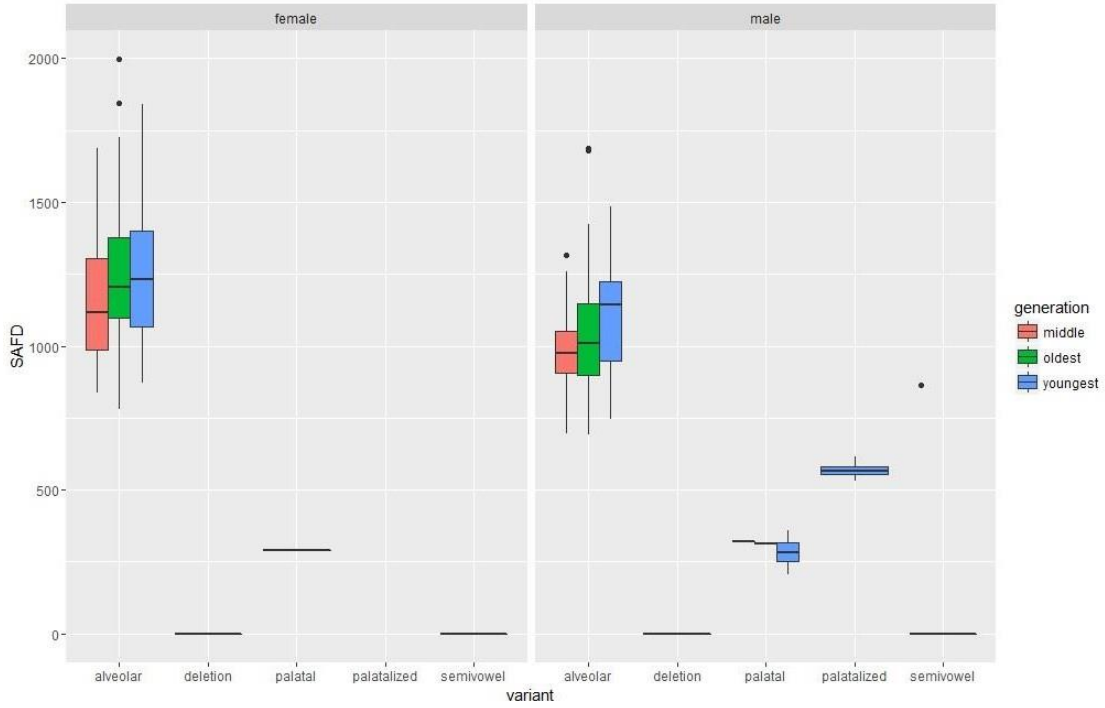
In general, boxplot 04 shows that there seems to be no relevant correlation between the word ending and the variants in Manaus data, for the number of occurrences seem to be balanced. The only data that stands out in this boxplot is that the palatal nasal variant happens only with the ending –nia. However, the number of occurrences of this variant is very low in comparison to the other ones.

3.3 Acoustic Features: Formants measurements and amplitude

As described in the methodological session, measurements of the second and third formants at the offset of the vowel and some point after it are a good cue for variant recognition, when investigating consonant variation in point of articulation.

For reasons already mentioned also in the methodological session of this paper, the following boxplot shows the correlation between the average distance

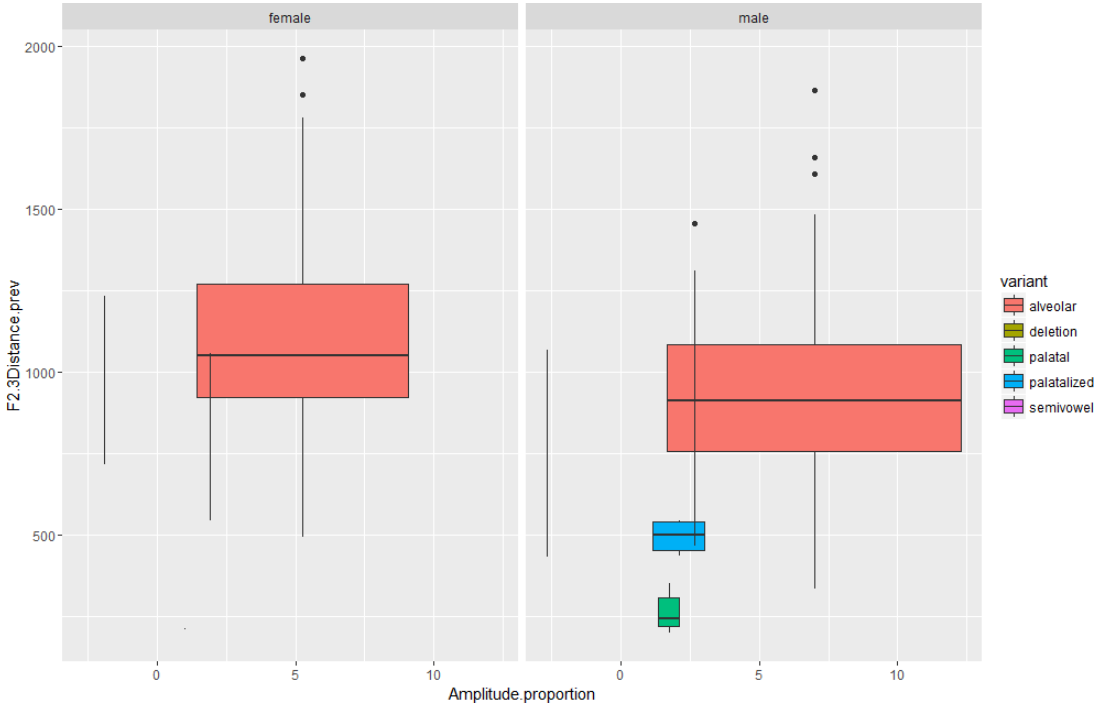
of formants at three different points (the offset the vowel, a point after it in the onset of the nasal and at the offset of the nasal) and the nasal variants: the alveolar, the palatalized and the palatal.



Boxplot 05: Simplified Avarage of the Formant Distance at three points x Variants X Social factors.

Boxplot 05 shows that the higher the distance between the second and the third formant though the whole nasal segment, more alveolar-like the nasal consonant will be.

The next boxplot correlates the amplitude proportion with the variants. Ladefoged (2001) describes that nasals are making by blocking the sound from coming out of the mouth, instead, the sound comes out through the nose, and it affects the amplitude (loudness). In general, nasal consonants are expected to present lower amplitude than oral vowel for instance. The amplitude of the preceding vowel and the nasal segment was measured in Pascal. The amplitude proportion was calculated by dividing the preceding vowel amplitude by the nasal segment amplitude.



Boxplot 06: Amplitude Proportion x Variants.

In boxplot 06 it is possible to see that the amplitude proportion of the alveolar nasals present a longer range than the amplitude proportion of the palatal variants in relation to their preceding vowels. The smaller values for the palatal variants, though, show that the maximum proportion is near to 1:3, that is the amplitude of the palatal variants reach a maximum of 3 times shorter amplitude in relation to the preceding vowel. Whereas the alveolar variant may reach up to 12 times shorter.

To conclude this session of results it is pertinent to present a new graphic with a new variants distribution after this new analysis.

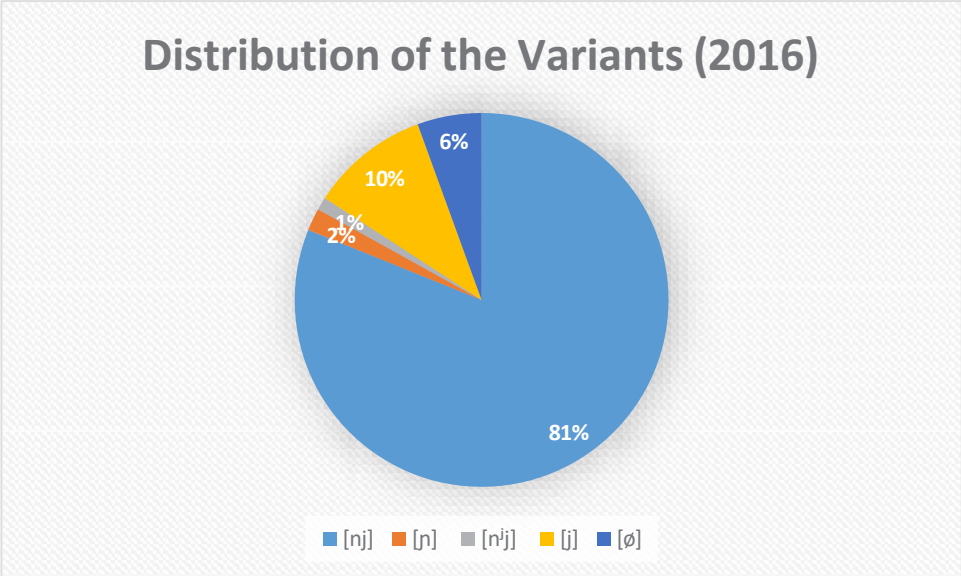


Figure 11: New distribution of nasal variants in the analysis of Manaus data in 2016.

As a result of this new analysis, it is possible to state that the majority of variants of the variable (nj) in Manaus data are nor palatal-related, but non-nasal related, that is the variants of iotization (the variable becoming a semivowel/glide) and the deletion (the variable is not pronounced).

4 CONSIDERATIONS

When the graphics of distribution of variants from Manaus data generated at two distinct of time, two years apart from one another, are compared, it is clear the role of an accurate acoustic analysis, which is not done taking into consideration only hearing or visual impressions, but mainly acoustic features such as formants measurement.

The research on the variable (nj) in Manaus data still has more aspects to be added. Some other acoustic features may be studied in the future, such as the preceding vowel duration and the nasal consonant duration. As well as word frequency can be added as a linguistic factor.

For now, it seems to be a good start to be able to identify the five variants of the variable (nj) and their correlation with the social and linguistic factors and acoustic features discussed in this paper.

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