Acoustic correlates of stress in Principense Portuguese: a preliminary study

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Abstract

In São Tomé and Príncipe, 98.4% of the population speaks Portuguese. Given that Principense Portuguese (PP) is in contact with a tone language – Lung'Ie, we hypothesize that F0 is an acoustic correlate of stress, unlike Brazilian and European Portuguese. Lung'Ie is a highly endangered Portuguese-lexified creole spoken on Príncipe Island with a tonal H/Ø privative system (Agostinho; Hyman, 2021). This study analyzed the duration and F0 of vowels in 19 Portuguese words and two borrowed words from Lung'Ie, produced by two bilingual speakers of PP and Lung'Ie. Results show that stressed vowels have the highest mean and median duration and greater F0, though the magnitude of difference in F0 between stressed and unstressed vowels is less prominent than that in duration. Thus, we propose that both duration and F0 are acoustic correlates of stress in PP, duration being the principal correlate.

Keywords: suprasegmentals; stress correlates; São Tomé and Príncipe, Lung'Ie, linguistic contact.

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Correlatos acústicos do acento no Português do Príncipe: um estudo preliminar

Resumo

Em São Tomé e Príncipe, 98,4% da população fala português. Lung'Ie, um crioulo com base lexical na língua portuguesa altamente ameaçado, é falado na Ilha do Príncipe e possui um sistema tonal privativo H/Ø (Agostinho; Hyman, 2021). Como o português do Príncipe (PP) está em contato com essa língua tonal, levantamos a hipótese de que a frequência fundamental (F0) seja um dos correlatos acústicos do acento, diferentemente do português brasileiro e europeu. Este estudo analisou a duração e o F0 das vogais em 19 palavras do português e em dois empréstimos do lung'Ie, produzidas por dois falantes bilíngues (PP e lung'Ie). Os resultados mostram que vogais tônicas têm maior duração média e mediana, além de maior proeminência em F0, embora o contraste em F0 seja menos robusto que o da duração. Propomos, assim, que duração e F0 são correlatos acústicos do acento no PP, sendo duração o principal.

Palavras-chave: suprassegmentais; correlatos de acento; São Tomé e Príncipe; lung'Ie, contato linguístico.

Introduction

The phonetic manifestation of stress has been a topic in linguistics for many years (Gordon; Roettger, 2017). Portuguese, as a stress language, has also been the focus of researchers. For Brazilian Portuguese (BP) and European Portuguese (EP), duration and intensity are the principal acoustic correlates, among others, such as fundamental frequency (F0) and vowel quality (Barbosa; Eriksson; Akesson, 2013; Castelo, 2005; Correia *et al*., 2013; Massini-Cagliari, 1992). "This work aims at examining three classes of acoustic correlates of lexical stress in Brazilian Portuguese (BP. However, few works focus on African Portuguese varieties. In Balduino's study, the most recent description of the phonology and phonetic aspects of São Tomé and Príncipe Portuguese (STPP)[3], the author investigates syllable duration in different positions (pretonic, tonic, post-tonic, etc.) and concludes that it is a principal correlate of stress, since "[...] the stressed syllable being the factor that most favors vowel lengthening" (Balduino, 2022, p. 273, our translation). However, the author suggests that separate studies should also be done for the other two acoustic correlates, namely F0 and intensity. This article is based on a pilot experiment for a future project, which aims to provide a more comprehensive description of stress in Principense Portuguese (PP) using a larger corpus.

3 The macro-variety of São Tomé and Príncipe (STPP) can be divided into two micro-varieties, i.e., Santomean Portuguese and Principense Portuguese (Agostinho, 2024; Agostinho; Lamberti; Dos Santos, 2021, p. 51-52).

This study employs statistical analysis based on a small dataset to describe two acoustic correlates of stress in PP—duration and F0—for bilingual speakers of Portuguese and Lung'Ie. The data used is part of the corpus collected by Professor Ana Lívia Agostinho (UFSC) and Professor Amanda Macedo Balduino (Unicamp) in Príncipe in 2016 (Agostinho; Balduino, 2016). Using Praat and a Praat script (Arnhold, 2024), we segmented target words from a carrier phrase and extracted relevant values of duration and F0. These values were then used for statistical analysis, using R (R Core Team, 2023), RStudio (Posit Team, 2024), and the tidyverse package (Wickham *et al*., 2019).

In the next section, we provide some brief linguistic situations in STP. In *Acoustic correlates in other Portuguese varieties*, we review previous works on stress correlates. In *Methodology,* we describe the data, the speakers' profiles, and the data processing procedures. In *Analysis*, we present two analyses. The first two subsections summarize the overall distribution of duration and F0 in Portuguese words, presenting their mean, median, and standard deviation, respectively. The second subsection presents a more detailed analysis of the borrowed words from Lung'Ie, including the duration and F0 values for each token and an illustrative example with a waveform, spectrogram and F0 curves generated in Praat. In *Conclusion*, we summarize the findings and discuss the possibilities for future studies.

Background in STP

The Democratic Republic of São Tomé and Príncipe is a Western African country, situated in the Gulf of Guinea, approximately 225 km off the coast. It covers a territory of 1001 km², consisting of two main islands, São Tomé Island and Príncipe Island, along with 14 islets (INE, 2012). It was colonized by Portugal for nearly 500 years, from the fifteenth century until 1975. According to Bandeira (2017), during the successful settlement (1493) until the beginning of the sugarcane industry, around 1515, there was intensive contact between Portuguese speakers and speakers of different African languages. Such intensive contact created a need for communication between different language groups, leading to the development of a proto-creole known as the Proto-creole of Guinea Gulf, or PGG (Cf. Bandeira, 2017). Later, factors such as geographical isolation, movements of speakers of specific groups, coexistence of people from different African language families, etc., caused this proto-creole branch to develop into four creole languages (Agostinho, 2015; Araujo, 2020; Bandeira, 2017). In the case of Príncipe Island, native speakers of PGG were taken by Portuguese colonists from São Tomé Island to Príncipe. Then, the isolation of Príncipe, the presence of a few Portuguese native speakers, and the need for communication led to the emergence of the creole Lung'Ie (Agostinho, 2015; Bandeira, 2017). According to Hagemeijer (2009), these enslaved people were mainly speakers of Edoid languages, which are tonal.

Lung'Ie is a highly endangered language. In 2012, 1% of the population claimed that they use Lung'Ie in daily life, corresponding to less than two thousand people (INE, 2012, as cited in Balduino, 2018). However, this number is overestimated, as Agostinho (2015) suggests that even if considering various proficiency levels, the number of speakers is less than 200. Meanwhile, the number of native Portuguese speakers has continued to increase. Portuguese has solidified its dominant status in the country through its designation as the official language, urbanization, mass education, and widespread use in the media (Araujo, 2020). As a comparison, in 2012, 98.4% of the population claimed to speak Portuguese (INE, 2012, as cited in Balduino, 2018). Our hypothesis is based on the fact that, even if Lung'Ie is not learned currently as L1 anymore, PP was developed in a time when people were bilingual in Lung'Ie and PP, and the first generations of speakers of Portuguese also spoke Lung'Ie.

Acoustic correlates in other Portuguese varieties

As for BP, duration is considered the most important correlate of stress. According to Massini-Cagliari(1992, p. 38), "the main correlates of stress in Portuguese are (in decreasing order of importance): duration, intensity, and vowel quality." Barbosa, Eriksson, and Akesson (2013) analyze three classes of acoustic correlates, that is, duration, F0 standard deviation, and spectral emphasis values, in three speaking styles produced by 5 males and 5 females. The results show that only duration distinguishes stressed vowels from unstressed vowels, and stressed vowels have a duration more than twice as long as unstressed vowels.

Regarding EP, Delgado-Martins believes that duration and energy are the main phonetic correlates of stress (1986, as cited in Magalhães, 2016), which is widely accepted by other researchers (Castelo, 2005; Correia *et al*., 2013). In the author's view, a systematic association exists between duration and stress in proparoxytones and oxytones, while in paroxytones, as the unmarked pattern in Portuguese, the association is unsystematic. Shih (2024) investigated the acoustic correlates of stress in EP, focusing on five acoustic parameters: F0, F1, F2, intensity, and duration. The results suggested that no single acoustic correlate consistently functioned as a cue for stress in EP. Duration, which was found to be a reliable cue for stress across languages, was limited to certain vowels and speakers.

Regarding STPP, recently, two studies have focused on the prosodic aspect. In addition to Balduino's work (2022), which has been introduced above, another is the study of Braga and Fernandes-Svartman (2019). They focus on the tonal events in Santomean Portuguese and found that " […], such variety exhibits a high tonal density, as tonal accents were found associated with all prosodic words present in the data" (Braga; Fernandes Svartman, 2019, p. 37, our translation), with 97.4% of pre-nuclear contours involving rising tonal accent H (Braga; Fernandes Svartman, 2019, p. 29).

As previously mentioned, the main African substrates of PGG are the languages from the Niger Delta, particularly Edoid languages, where all morphemes are fully specified for tone. Agostinho and Hyman (2021) analyze Lung'Ie, arguing that the language has a restrictive privative H/Ø tone system, with an unusual "weight-to-tone" requirement. According to the authors, the H is culminative but non-obligatory, and the tone-bearing unit is the (vocalic) mora. Nouns can bear one H or be all-Ø, i.e., have no phonological tone. Monosyllables must bear a H, and words with more than one syllable can be all-Ø. Nouns show a weight-to-tone requirement in which long vowels and syllables with codas must have a H. In light-syllable words, the H can be in any syllable, and the tone pattern is synchronically unpredictable. Verbs and ideophones are generally toneless, with very few exceptions. Long vowels are allowed in monosyllabic verbs and the penultimate syllable of a dissyllabic verb.

In line with Shang (2022), various prosodic aspects, such as F0 register, pitch range, and intonation patterns, are essentially more vulnerable to interlinguistic influences, making them more challenging to learn, interpret, and investigate. In the context of São Tomé and Príncipe, initially, Portuguese was learned as an L2. However, due to the mandatory use of Portuguese, which can be traced back to the second colonization phase, this L2 model was transmitted to younger generations and eventually acquired as their L1 (Balduino, 2018; Gonçalves, 2010). In this sense, we hypothesize that Portuguese spoken by Portuguese-Lung'Ie bilingual speakers will exhibit different features from other Portuguese varieties. In addition to duration, F0 will serve as an important acoustic correlate in stress assignment.

Methodology

As there is little available data for PP, we analyzed data from an existing corpus. The data used in this article was collected by Ana Lívia Agostinho and Amanda Macedo Balduino in 2016 in Príncipe Island (Agostinho; Balduino, 2016). . In this article, specifically, we used controlled speech data that employs a carrier phrase "*Eu falo X baixinho*" (in English, 'I say X softly'), where X represents the target words. Each carrier phrase was repeated three times. With the fixed structure of the carrier phrase, the influence of the position of the target word was supposed to be controlled. The data was collected for the purpose of analyzing vowels, so the selection of words and speakers was limited.

Two speakers were selected for this study: one female and one male, both native speakers of Lung'Ie and PP. At the time of recording, the female informant (Speaker 1, hereafter abbreviated as S1) was 54 years old, and the male (Speaker 2, hereafter abbreviated as S2) was 81 years old. Both were born on Principe Island, and their parents were also born in this region.

To cover all possible combinations using a limited dataset, we selected 23 words containing three types of stress (10 paroxytones, 7 proparoxytones, and 6 oxytones) with

seven oral vowels /a, e, ɛ, i, o, ɔ, u/ in the stressed position. As the number of target words is limited, we analyzed all repetitions. Table 1 shows the target words analyzed in this study.

Table 1. Target words analyzed in this study

Category	Word	Stressed vowel	Number of syllables	Stress pattern
Portuguese words	Dolorido	/i/	4	paroxytone
	Modelo	/e/	3	paroxytone
	Roça	/ɔ/	2	paroxytone
	Menino	/i/	3	paroxytone
	Pilha	/i/	2	paroxytone
	Pena	/e/	2	paroxytone
	Tudo	/u/	2	paroxytone
	Boneca	/e/	3	paroxytone
	Fome	/ɔ/	2	paroxytone
	Extra	/e/	2	paroxytone
	Número	/u/	3	proparoxytone
	Sílaba	/i/	3	proparoxytone
	Pérola	/ɛ/	3	proparoxytone
	Pálido	/a/	3	proparoxytone
	Útero	/u/	3	proparoxytone
	Ópera	/ɔ/	3	proparoxytone
	Década	/ɛ/	3	proparoxytone
	Mulher	/e/	2	oxytone
	Final	/a/	2	oxytone
	Doutor	/o/	2	oxytone
	Avô	/o/	2	oxytone
Borrowed words from Lung'le	Micocó[4]	/ɔ/	3	oxytone
	Ossobô[5]	/o/	3	oxytone

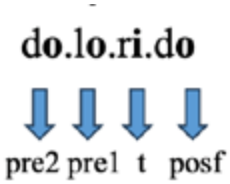
Source: Authors' elaboration

4 A local herb (Cf. Agostinho; Araujo, 2024).

5 A type of bird (Cf. Agostinho; Araujo, 2024).

In Portuguese, stress can fall on one of the three syllables from the right (Barbosa; Eriksson; Akesson, 2013). In the present study, we focus on vowels and categorize them by their positions within the word, using the labels *pre2*, *pre1*, *tonic*, *pos,* and *posf* in box plots to represent, respectively, word-initial pretonic, medial pretonic, tonic, medial post-tonic, and final post-tonic. Figure 1 illustrates this labelling scheme, which reflects the relative distance of each unstressed vowel from the stressed one.

Figure 1. An example of the classification of each vowel position



Source: Authors' elaboration

The segmentation of words and vowels was carried out manually in Praat (Boersma; Weenink, 2025). Duration and center mean F0[6] values for each vowel were extracted using a script (Arnhold, 2024). The R (R Core Team 2023), RStudio (Posit Team 2024), and tidyverse package (Wickham *et al.*, 2019) were used to calculate mean, median, and standard deviation for the two acoustic correlates. The measurements for duration are given in milliseconds (ms) and on a log scale when presenting the figure, while those for F0 are expressed in Hertz and semitones. The conversion from Hertz to semitone follows the method used in the study of Xu (2024). As noted by Traunmüller (1995), the semitone scale offers the most accurate means for comparing males' and females' pitch. Regarding the baseline, we adopt the approach used in studies on tonal languages that takes the speaker's mean F0 as the reference value (Andruski; Costello, 2004; Xu, 2024, p. 202).

Theoretically, the dataset comprised 126 (21 words X 3 repetitions X 2 speakers) words. However, due to the list-reading effect, 30 words were excluded, leaving 96 words and a total of 285 vowels for analysis.[7] Regarding the devoicing of the final unstressed vowel, following Dicanio *et al*. (2020), we still treated these as valid tokens for duration analysis, but as missing values for F0.

6 Center mean F0 refers to the average F0 measured from the central portion of the vowel, specifically the middle 50% of its duration.

7 Words in isolation can show a list-reading prosody, or a final boundary effect, characterized by a rise in F0 on the final vowel. According to Pierrehumbert (1980), boundary tones typically occur at the very end of a phrase or utterance, often marked by H%. In the context of a carrier phrase, as the target words change consistently within the phrase, each target word can be interpreted as forming an independent intonational phrase that brings new information.

Analysis

General statistical description

This subsection will present a statistical description of 285 tokens from 21 words, including 249 tokens from 19 original Portuguese words and 36 tokens from 2 borrowed words from Lung'Ie. Since there are two origins of words that we speculated would behave differently, their analyses were conducted separately.

Table 2 presents the distribution of 249 tokens across vowel types, vowel positions, and speakers in the Portuguese word dataset.

Table 2. Distribution of vowels, vowel position, and speakers in the Portuguese words

Factor	Level	Number (%)
Vowel	/a/	68 (27%)
	/e/	44 (18%)
	/ɛ/	11 (4%)
	/i/	28 (11%)
	/u/	20 (8%)
	/o/	69 (28%)
	/ɔ/	9 (4%)
Vowel position	Word-initial pretonic	6 (2%)
	Medial pretonic	40 (16%)
	Tonic	98 (39%)
	Non-final post-tonic	29 (12%)
	Final post-tonic	76 (31%)
Speaker	Speaker 1	124 (50%)
	Speaker 2	125 (50%)

Source: Authors' elaboration

Analysis of duration

In this subsection, we compare three parameters: mean, median, and standard deviation of duration. Table 3 presents the mean, median, and standard deviation of duration for each vowel position. All durations are expressed in ms.

Table 3. The mean duration and the standard deviation for each vowel position

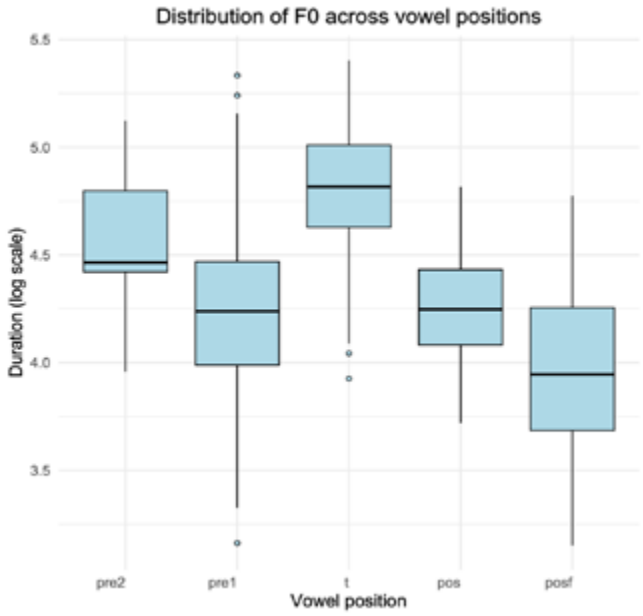
Vowel position	Mean duration (ms)	Standard deviation (SD)	Standard error (SE)
Word-initial pretonic	98	40	16
Medial pretonic	82	44	7
Tonic	**132**	37	4
Non-final post-tonic	79	26	5
Final post-tonic	62	23	3

Source: Authors' elaboration

As shown in Table 3, the stressed vowels have the highest mean duration, 132 ms, more than twice that of the final post-tonic. The mean duration of the word-initial pretonic is relatively high compared to other unstressed vowels, but this is likely due to the small size of only seven data points in this category. The medial pretonic vowels exhibit the greatest variability (SD = 44 ms), compared to 25-38 ms in other positions, although the differences are not large.

Figure 2 illustrates the distribution of duration across vowel positions, including word-initial pretonic, medial pretonic, tonic, non-final post-tonic, and final post-tonic. Duration is on a log scale for visualization.

Figure 2. Distribution of duration (log) across vowel positions in Portuguese words



Source: Authors' elaboration

As shown in Figure 2, stressed vowels have the highest median duration, followed by word-initial pretonic vowels. The difference between medial pretonic vowels and non-final post-tonic vowels is relatively small. Final post-tonic vowels exhibit the shortest median duration.

Table 4 presents the results obtained in Balduino's (2022) study and those obtained in the present study.

Table 4. Mean syllable duration in Balduino's (2022) vs. mean vowel duration in our study

	Balduino's study		**The present study**
Syllable context	Mean syllable duration in Santomean Portuguese (ms)	Mean syllable duration in PP (ms)	Mean vowel duration in PP produced by bilingual speakers (ms)
Tonic	244	179.5	132
Pretonic1	166	132	98
Pretonic2	148	133	82
Pretonic3	174	153	–
Post-tonic	122	99	79
Final post-tonic	130	116	62

Source: Adapted from Balduino (2022, p. 274)

Unlike the present study, which takes vowels as the domain of analysis, Balduino (2022) measured syllable durations. The datasets also differ in size: Balduino's results were obtained from 3,406 tokens of 223 words, whereas the present study includes 249 tokens of 19 words. Although it is difficult to compare them directly, a similar tendency is observed in both studies, where tonic vowels exhibit longer duration. Overall, the duration of PP's vowel produced by Lung'Ie bilingual speakers in the present study is shorter than the PP's syllable duration reported in Balduino (2022), as expected.

Analysis of F0

Regarding F0, we also analyze three parameters: mean, median, and standard deviation. Table 5 presents the mean and standard deviation of F0 in semitones.

Table 5. Mean F0 (st) and the standard deviation, standard error for each vowel position

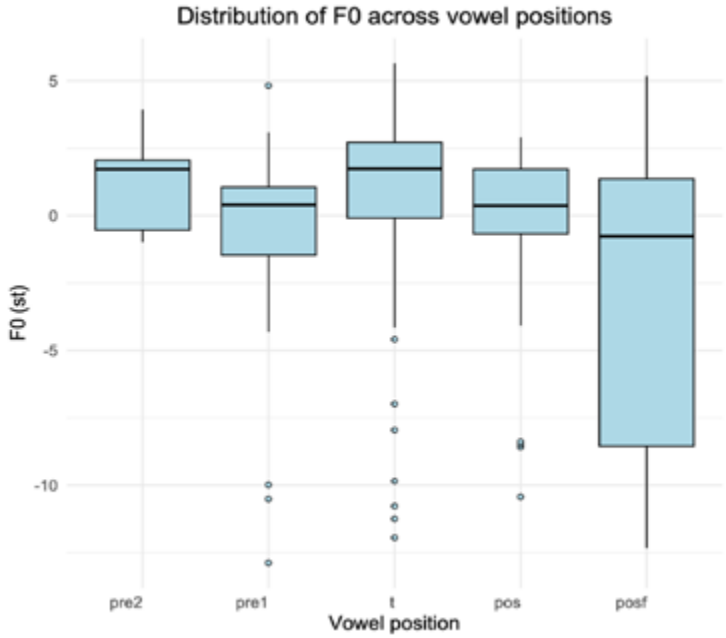
Vowel position	Mean F0 (st)	Standard deviation (SD)	Standard error (SE)
Word-initial pretonic	0.79	1.71	0.70
Medial pretonic	-0.51	1.81	0.29
Tonic	1.00	1.96	0.20
Non-final post-tonic	-1.15	3.42	0.67
Final post-tonic	-1.68	4.14	0.52

Source: Authors' elaboration

As illustrated in Table 5, tonic vowels have the highest mean F0, followed closely by word-initial pretonic vowels. The difference between these two positions is minimal; as mentioned above, the small number of word-initial pretonic tokens (six in total) may inflate this value. Medial pretonic vowels present the third-highest mean F0, followed by non-final post-tonic, while final post-tonic vowels exhibit the lowest F0.

Figure 3 illustrates the distribution of F0 across vowel positions, including word-initial pretonic, medial pretonic, tonic, non-final post-tonic, and final post-tonic. F0 is measured in st.

Figure 3. Distributions of F0 across vowel positions in Portuguese words



Source: Authors' elaboration

As depicted in Figure 3, stressed vowels exhibit the highest median F0, slightly above that of word-initial pretonic vowels. The median line for stressed vowels lies roughly at the center of the box, suggesting that it is a representative value. In contrast, for word-initial pretonic vowels, the median line is positioned near the top of the box, suggesting that most values lie below the median. Final post-tonic vowels have the widest box, which means a larger spread in F0 values.

In conclusion, the tonic vowels exhibit the greatest mean and median duration compared to other vowel positions. Their variability is moderate compared to the other positions. As for F0, tonic vowels likewise show the highest mean and median F0 among other unstressed vowels. Given the small sample size of the present study, it remains uncertain whether these differences are statistically significant. This question will be addressed in our future work with experiments designed specifically to test the hypothesis using a larger dataset.

Case analysis

Regarding the borrowed words from Lung'Ie, the tonic vowels do not consistently show either the longest duration or the highest F0. Table 6 presents the duration values (in ms) and the F0 values (in Hz and in st) for all 36 tokens produced by the two speakers.

Table 6. Comparison of the duration and F0 of borrowed words from Lung'Ie

	S1				S2			
	Vowel	Duration (ms)	F0 (Hz)[8]	F0 (st)	Vowel	Duration (ms)	F0 (Hz)	F0 (st)
Micocó	/i/	75	**157**[9]	4.44	/i/	74	65	-1.41
	/o/	81	75	-8.39	/o/	85	60	-2.94
	/o/	170	106	-2.30	/o/	132	79	1.93
	/i/	50	**142**	2.80	/i/	111	70	-0.04
	/o/	60	137	2.22	/o/	76	57	-3.62
	/o/	69	68	-9.99	/o/	132	71	0.32
	/i/	31	139	2.45	/i/	84	**75**	0.96
	/o/	55	69	-9.60	/o/	**103**	64	-1.81
	/o/	54	142	2.80	/o/	91	73	0.65

8 The values in Hz represent the mean F0 measured over the central 50% of each vowel.

9 Numbers in bold indicate the unexpected cases where the unstressed vowels exhibit either a longer duration or a higher F0.

Ossobô	/o/	117	167	5.55	/o/	108	/	—
	/o/	51	**171**	5.96	/o/	85	62	-2.26
	/o/	134	111	-1.52	/o/	163	81	2.41
	/o/	57	**153**	4.06	/o/	62	74	0.86
	/o/	34	—[10]	—	/o/	66	—	—
	/o/	90	140	2.51	/o/	166	77	1.39
	/o/	58	141	2.52	/o/	**94**	**75**	0.97
	/o/	27	72	-9.01	/o/	94	72	0.27
	/o/	62	68	-9.91	/o/	91	75	0.97

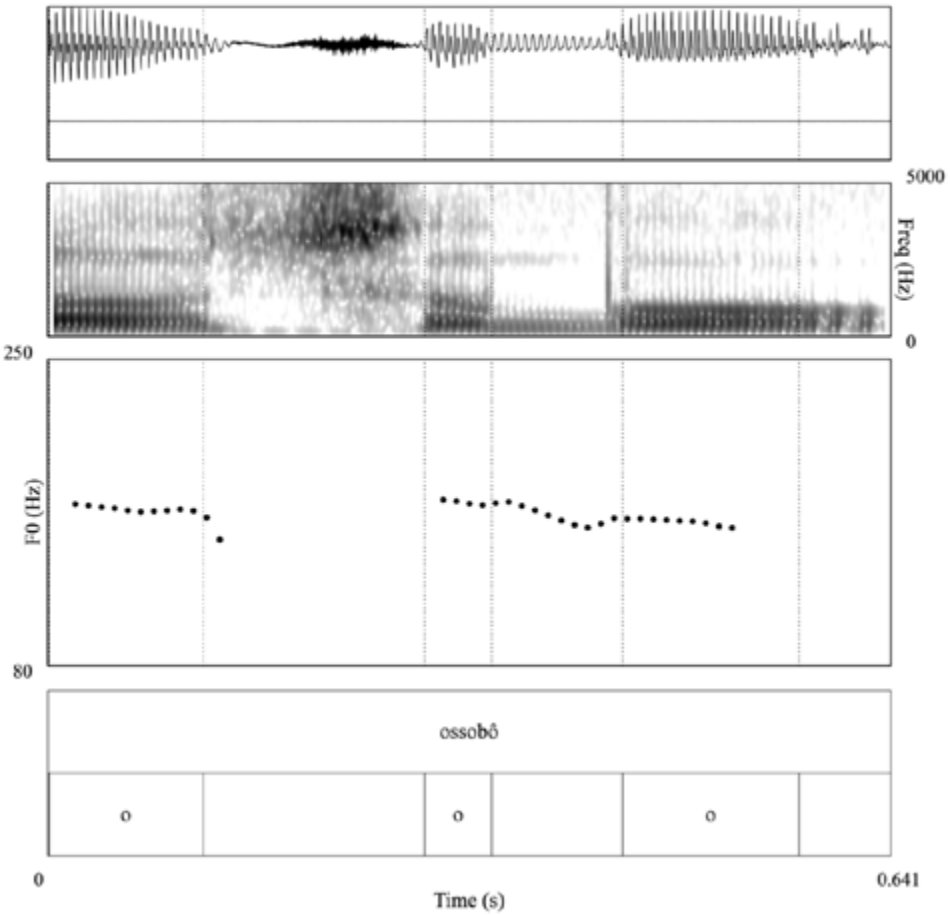
Source: Authors' elaboration

As shown in Table 6, among 36 tokens, there are nine unexpected cases where the unstressed vowels have either a longer duration or a higher F0. They occur not only in the word-initial pretonic but also, in two cases, in medial pretonic vowels. Since most unexpected cases occur in word-initial position, they may reflect a secondary stress or a phrasal accent. However, this hypothesis requires testing with a larger dataset in future work.

Another noted phenomenon is the overall stability of the F0 curve across all vowels (see Figure 4). Unlike the Portuguese words, the highest F0 does not consistently correspond to the expected stressed vowel. As in Lung'Ie, there are words without any H tone (all-Ø), we assume that this is why these borrowed words have such performance.

10 This symbol indicates missing values (i.e., values that could not be detected).

Figure 4. The waveform, spectrogram, pitch curve, and labelled layers of *ossobô* in S1



Source: Authors' elaboration

As observed in Figure 4, the F0 curve is relatively stable, with no evident rising or falling within the vowel. In contrast, the stressed vowel /o/ has a longer duration. As indicated in Table 7, the relative duration of the stressed vowel /o/ corresponds to 44% of the total vowel duration.

Table 7. Duration of each vowel and relative duration in ossobô produced by S1

Vowel	**/o/**	**/o/**	**/o/**
Absolute duration (ms)	117	51	134
Relative duration (%)	39%	17%	44%

Source: Authors' elaboration

In summary, for borrowed words from Lung'Ie, both duration and F0 appear to function as acoustic correlates of stress, although duration is the more consistent one. However, given the limited number of borrowed words analyzed here, it remains to be seen whether they pattern similarly to the Portuguese words or whether the speakers simply produced Lung'Ie words rather than adapting them to Portuguese phonology.

Conclusion

Analyzing a small dataset of 285 vowel tokens, our findings suggest that in PP, duration is a robust acoustic correlate of stress: stressed vowels exhibit longer duration than unstressed vowels. This pattern corroborates previous findings for other Portuguese varieties, such as BP, EP, and São Tomé and Príncipe Portuguese. In addition, PP appears to display a correlation between F0 and stress, with stressed vowels having the highest F0 compared to unstressed vowels. However, the magnitude of the F0 difference across vowel positions is smaller than that for duration, making it uncertain whether F0 is as robust a cue to stress as duration.

The borrowed words from Lung'Ie are characterized by inconsistency in the use of acoustic correlates, although duration appears to be more stable than F0. This pattern may indicate the presence of secondary stress at the word level, a boundary accent in phrasal-initial position, or the possibility that the speakers did not fully differentiate Lung' Ie from Portuguese at the time of recording.

For future research, we will employ a larger corpus with controls for carrier phrases, syllable structure (e.g., V, CV, CVC), number of syllables, vowel quality, and other relevant factors. Such control will also allow for the use of more sophisticated statistical modelling to further assess the robustness of each correlate. Due to time limitations in the present study, we were not able to analyze intensity, another possible acoustic correlate for stress, which will be incorporated into future studies.

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