

ACOUSTIC DISPERSION SCALES FOR STRESSED FALLING DIPHTHONGS IN TWO PORTUGUESE VARIETIES: PORTUGUESE OF SÃO TOMÉ AND PRÍNCIPE AND BRAZILIAN PORTUGUESE

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- **ABSTRACT:** The aim of this paper is to analyze the oral falling diphthongs in two varieties of Portuguese: São Tomé and Príncipe Portuguese (PSTP) and Brazilian Portuguese (BP). To do so, based on a corpus formed from lexical items elicited through carrier sentences, collected in the field on the islands of São Tomé and Príncipe, West Africa, we extracted the first and second formant (F1 and F2) values of stressed oral vowels using PRAAT. This methodological procedure was carried out in order to establish the acoustic dispersion between the vowel (V) and the glide (G) that form the falling diphthongs in PSTP. Once the acoustic dispersion between the VG was calculated, we established a dispersion scale comprising four points: high dispersion, medium dispersion, low dispersion, and very low dispersion. This scale was then compared to the scale proposed by Eberle (2022) for PB. Finally, a contrast between both scales revealed differences in terms of the acoustic contrast between the V and the G of the oral diphthongs in PSTP and PB. These differences seem to stem primarily from the insertion of [ə] in the stressed oral vowel system of PSTP.
- **KEYWORDS:** Acoustic dispersion; São Tomé and Príncipe Portuguese; Brazilian Portuguese; Stressed diphthongs.

Introduction

This paper aims to contribute to the acoustic description of stressed diphthongs in the Portuguese of São Tomé and Príncipe. Specifically, it focuses on the acoustic dispersion of oral falling diphthongs (VG, where V = vowel and G = glide) in this African variety of Portuguese. An additional objective is to compare the results obtained

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for PSTP with those reported for Brazilian Portuguese (BP), drawing on the findings of Eberle (2022, 2023), whose research focuses on BP.

By comparing two varieties of Portuguese that emerged and are currently used in distinct sociolinguistic contexts, it is possible to assess both structural similarities and differences that characterize Portuguese as a pluricentric language. This comparison allows for the examination of potential linguistic patterns that may unify different varieties. Within this perspective, the phonetic patterns and systemic–formal divergences identified through a comparative study like this one are particularly relevant for the reassessment of linguistic hypotheses and theories. As a result, this research intends to make a substantial contribution to the advancement of knowledge in studies devoted to Portuguese and its diverse varieties, as well as to the fields of Phonetics and Phonology, of which this work forms part.

Finally, although the discussion of linguistic norms and language policies is not among our aims, it is important to emphasize that, by proposing a comparison of Portuguese varieties, this study may nonetheless shed light on an ongoing academic debate: whether Portuguese is a single language with a shared system. The establishment and comparison of acoustic dispersion scales for stressed falling diphthongs in PSTP and BP may represent a modest step toward addressing this question.

This article is organized as follows. Section 2 presents an overview of the Portuguese of São Tomé and Príncipe. Section 3 discusses different proposals for dispersion scales, addressing concepts such as sonority and acoustic dispersion. Section 4 outlines the methodology adopted in the study, and Section 5 presents the results. Final considerations are offered in Section 6.

São Tomé and Príncipe Portuguese

The Portuguese of São Tomé and Príncipe, henceforth referred to as PSTP, is an indigenous variety of Portuguese spoken in São Tomé and Príncipe (STP), an archipelago off the West African coast in the Gulf of Guinea. STP is one of the nine countries where Portuguese is an official language. However, unlike other African countries where Portuguese is spoken as a second language, the archipelago has a high number of native Portuguese speakers, with various national varieties of the language circulating within the country (cf. Baxter, 2002; 2018; Figueiredo, 2008; Balduino, 2022). This includes Santomean Portuguese (PST) and Príncipean Portuguese (PP), two major urban varieties spoken on the islands of São Tomé and Príncipe, respectively. These varieties together constitute what we refer to in this paper as PSTP (cf. Balduino, 2022).

PSTP exists within a multilingual context, where at least four other languages are spoken: Santome/Forro (ISO: 639-3 – CRI), Lung’Ie (ISO: 639-3 - PRE), Angolar (ISO: 639-3 - AOA), and Kabuverdianu (ISO: 639-3 – KEA). The number of speakers of these languages varies significantly. In this regard, the National Institute of Statistics

of STP (INE) published a report in 2012 indicating that Portuguese is spoken by 98.4% of the population. Following Portuguese, Santome (33.6%) is the most widely spoken language in the archipelago. After Portuguese and Santome, Kabuverdianu (8.5%), Angolar (6.6%), and, with the fewest speakers, Lung'Ie (1%) are spoken (cf. INE, 2012).

According to Araujo (2020), before the independence of São Tomé and Príncipe, the indigenous creole languages were acquired at home by children, and Portuguese was learned as a second language only during formal education, which generally lasted four years. Influenced by linguistic ideologies and the social and political prestige associated with Portuguese, individuals who acquired Portuguese, even as a second language, began transmitting it to the next generations (Balduino; Bandeira, 2022). As a result, children began to acquire this variety of Portuguese as their mother tongue, particularly in urban areas. Through this process of linguistic nativization, fueled by factors such as the urbanization of the archipelago, the democratization of education (Araujo, 2020), and the attitudes of speakers (Bouchard, 2019; Balduino, 2022; Balduino & Bandeira, 2022), Portuguese became the most widely used language in the country. Today, Portuguese not only coexists in STP but has also become integrated into the country's linguistic identity, evolving into a part of the local culture in a process of "Santomization" of the language (Bouchard, 2017; 2019; Balduino; Bandeira; Freitas, 2022).

The varieties of Portuguese that emerged in STP therefore display unique characteristics while also sharing linguistic features with cognate varieties of Portuguese, such as BP, European/Portugal Portuguese, and other African varieties, including Angolan, Mozambican, and Guinean Portuguese. From this perspective, this article aims to contribute to the acoustic description of stressed vowels in PSTP, with a particular focus on the acoustic dispersion of oral falling diphthongs in this variety, and to provide a comparison with BP.

The following section discusses the concepts of sonority, dispersion theory, and acoustic dispersion.

Dispersion Scale: Sonority, Dispersion Theory, and Acoustic Dispersion

In this section, we present and evaluate different proposals for contrast scales¹ between vocoids to discuss which vowel sequences are more or less contrastive in terms of acoustic dispersion. The first scale is based on the sonority scale proposed by Parker (2002, 2011), while the second scale is grounded in Flemming's (2004) Dispersion Theory. Finally, the third scale considered in this section is an alternative proposal developed by Eberle (2022), which uses actual formant values in Hz to categorize diphthongs into contrast groups.

¹ We emphasize that contrast is understood here in acoustic terms, as related to the sonority scale, rather than as a binary phonological opposition.

Sonority Scale (Parker, 2002, 2011)

Sonority is a non-binary concept in phonetic and phonological studies, according to which a phonological element can characterize all speech sounds along a continuous, hierarchical scale (Parker, 2011). Numerous studies emphasize the central role played by sonority in phonology, not only in shaping the implementation of various phonological phenomena but also in providing a fundamental explanation for syllable structure across languages (cf. Clements, 1990).

According to Parker's (2002, 2011) sonority scale, which builds on Clements (1990), low vowels exhibit the highest degree of sonority, mid vowels show a lower degree of sonority, and high vowels are the least sonorous. In addition, peripheral vowels display higher sonority than central vowels, and glides are less sonorous than vowels in general, as illustrated in (1).²

(1) Relative Sonority Scale

[a] > [ɛ, ɔ] > [e, o] > [i, u] > [ʋ ə] > [ɪ ʊ] > [j, w]

7 6 5 4 3 2 1

Sonority is understood as the degree of openness of the vocal tract during speech sound production. The greater the degree of openness, the higher the sonority of the segment – and, consequently, the greater its propensity to occupy the syllable nucleus. Thus, the vowel [a] is the most sonorous sound in the system, whereas the glides [j] and [w] are the least sonorous among vocoids. Following the scale proposed by Parker (2011), diphthongs such as [aj] and [aw] exhibit higher sonority because they also display greater sonority contrast, being composed of an open vowel, assigned level 7, and a glide at level 1, as shown in (1). By contrast, diphthongs such as [iw] and [uw] display low sonority and low acoustic contrast: [i], level 4, combined with [w], level 1; and [u], level 4, combined with [j], level 1. From this perspective, diphthong values correspond to the subtraction of sonority levels, yielding a contrast value. Therefore, the higher the resulting value, the greater the diphthongal contrast, as illustrated in (2) (Eberle, 2022, based on Parker, 2011, with the addition of diphthongs formed with [ə], shown in bold).

(2) Sonority Contrast Scale for Diphthongs in BP and PSTP

[aj aw] > [ɛj ɛw əj əw] > [ej ew oj ow] > [iw uj uw] > **[əj əw]**

6 5 4 3 2

With respect to diphthongs, the ordering proposed in the scale in (2) corroborates findings from previous studies by Becker *et al.* (2017, 2018) and Nevins (2012), which

² Originally, Parker's (2011) proposal comprises 17 levels; however, here we present an adapted version that includes only the vocalic sounds considered in this article. The relative proportionality of the levels is nonetheless preserved.

suggest that the plural in [-js], as in *lençol/lençóis* [len'sɔjs] (*sheet*), is preferred by speakers when it is associated with the vowels [a, ε, ɔ]. This preference is attributed to the greater acoustic contrast established between the vocoids in sequences such as [aj] (contrast value 6) and [εj, ɔj] (contrast value 5), a contrast that is not observed in plurals involving the vowels [e, o], which display a lower contrast value (4) and, consequently, lower sonority. Becker *et al.* (2017) interpret these preferences as an effect of the markedness constraint $_N^*$ SHALLOWDIPH, which penalizes the formation of new low-contrast diphthongs, that is, diphthongs not presented in the underlying form. Accordingly, diphthongs such as [εj], [ɔj], and [uj] tend to be avoided in plural formation, whereas the maintenance of the faithful form with [w] is favored.

When analyzing Parker's (2011) proposal with respect to the BP vowels, Eberle (2022) observes that, according to the scale in (2), the diphthongs [ej ew oj ow] should display similar behavior concerning the process of monophthongization. However, this is not what is reported in the literature for BP, since the reduction of [ej] is quite common, whereas that of [ew] is not (Becker *et al.*, 2018) – a result that is also attested by Christofolletti (2013) for Santomean Portuguese data. A similar problem arises when we consider diphthongization data from PSTP, a process that is disfavored for [ow], [uw], [εj], and [aw] in vowel sandhi contexts (Balduino, 2022). These diphthongs display distinct sonority indices – 3, 2, 5, and 6, respectively – indicating that the proposal in (2) fails to account for the data as a coherent sonority-based set. This is essentially because Parker's (2011) proposal does not take segmental frontness into account, a factor that may be relevant for the analysis of sonority contrast (Nevins, 2012).

In addition, the scale in (2) does not differentiate between [i] and [u], classifying both as low-sonority vowels without considering the distinction between front and back vowels. This aspect is relevant for the phonological differentiation of vowels in Portuguese. In light of these issues, it is important to analyze vowel contrast scales while also considering vowel frontness; for this reason, Flemming's (2004) proposal, discussed below, is particularly relevant.

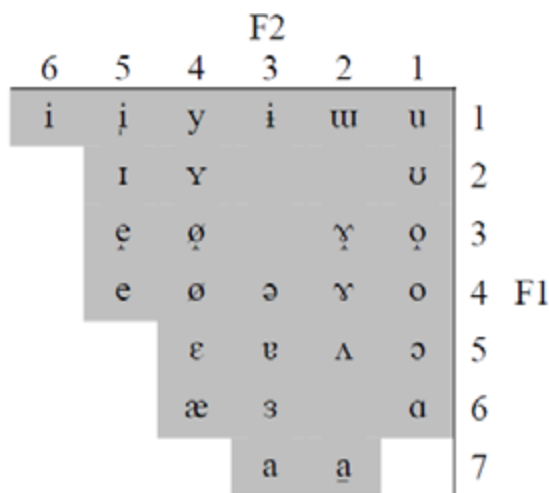
Dispersion Theory (Flemming, 2004)

Adaptive Dispersion Theory posits that the distinctive vowels of a language are arranged to occupy different regions of acoustic space. This arrangement maximizes perceptual contrasts among sounds and avoids confusion in listeners' categorization. From this perspective, Flemming (2004) proposed a Dispersion Theory to account for differences in phonological inventories, based on conflicts between constraints related to the maximization of contrast and those related to the acoustic distance between F1 and F2.

According to Flemming (2004), vowel quality is the most effective way to capture the perceptual dimension of vocoids. Therefore, the most appropriate approach to understanding vowel contrast is to examine the frequencies of the first two formants (F1

and F2). In this framework, the dispersion of vocoids and their perceptual dimension are calculated through the opposition of vowel qualities. Vowel contrast is established and analyzed based on the frequencies of the first two formants (F1 and F2) of opposing segments, since “contrast” presupposes the opposition of at least two distinct segments. For Flemming, these dimensions function like a scale of features; however, integer values are assigned to the features of vowel height ([open 1, 2, 3], corresponding to F1) and place of articulation ([coronal] and [dorsal], corresponding to F2). The scheme proposed by Flemming (2004) is illustrated in Figure 1.

Figure 1 – F1 and F2 Dispersion: Flemming’s (2004) Proposal



Source: Flemming (2004, p. 7)

Based on Figure 1, the distance between a pair of vowels can be calculated from the scalar differences along each dimension. For example, in the diphthong [oj], the distance between [o] and [i] is three levels on the F1 scale, while it is five levels on the F2 scale. By contrast, the diphthong [ɛw] shows a contrast of four points for F1 and three points for F2. It is thus represented as F1:4 & F2:3. The values for the remaining diphthongs are grouped in Chart 1, as presented in Eberle (2022, p. 28), to which we also add the values for diphthongs formed with the nuclear vowel [ə], attested in PSTP.

Chart 1 – Dispersion of Oral Diphthongs in BP and PSTP in Descending Order of Contrast

Diphthong	Dispersion	Diphthong	Dispersion	Diphthong	Dispersion
aj	F1:6 & F2:3	ɔw	F1:4 & F2:0	ej	F1:3 & F2:1
aw	F1:6 & F2:2	oj	F1:3 & F2:5	ow	F1:3 & F2:0

ɔj	F1:4 & F2:5	ew	F1:3 & F2:4	uj	F1:0 & F2:5
ɛw	F1:4 & F2:3	əj	F1:3 & F2:3	iw	F1:0 & F2:5
ɛj	F1:4 & F2:2	əw	F1:3 & F2:2	uw	F1:0 & F2:0

Source: Author's own elaboration based on Eberle (2022)

Considering the falling diphthongs formed by [Vj] and [Vw] for F1, where V represents one of the stressed oral vowels in BP and PSTP, we observe that the hierarchy of segmental contrast remains relatively the same, i.e., [a] > [ɛ, ɔ] > [e, o, ə] > [i, u], with the only change being that [ə] is placed at the same level as the peripheral mid vowels. However, the initial scale proposed by Parker (2011) is modified when considering the contrast established by the diphthongs. Therefore, the contrast scale that was initially: [aj aw]₆ > [ɛj ɛw ɔj əw]₅ > [ej ew oj ow]₄ > [iw uj uw]₃ > [əj əw]₂ is modified to: [aj aw]₆ > [ɛj ɛw ɔj əw]₄ > [ej ew oj ow əj əw]₃ > [iw uj uw]₀.³

Concerning the contrasts of falling diphthongs in the F2 dimension, distinct patterns emerge for [Vj] and [Vw], as shown in Chart 2.

Chart 2 – F2 Dispersion of Falling Diphthongs in BP and PSTP

Vj	u, o, ɔ	a, ə	ɛ	E	Vw	i	e	ɛ	a, ə	u, o, ɔ
Sacale	5 >	3 >	2 >	1	Scale	5 >	4 >	3 >	2 >	0

Source: Adapted from Eberle (2022)

The role of sonority contrast as a potential factor in explaining vowel phenomena in languages is enriched when the distinction between F1 and F2 is taken into account. In PSTP, this differentiation is significant, since specific processes are explained either in terms of the contrast established by F1 or by the distinctiveness of F2. Vowel deletion and devoicing, insofar as they have been reported in studies on the varieties of STP, do not show any relation to F2 (cf. Balduino, 2022, 2025). With respect to [ə], however, in addition to F1, F2 appears to be a relevant factor, since this dimension distinguishes [ə] from [e] and [o] in the acoustic space more clearly than F1. This point will be discussed in greater detail in the analysis of PSTP data.

Flemming's (2004) proposal for establishing acoustic contrast among vocoids is, therefore, insightful; however, as Eberle (2022) shows, it presents certain limitations for the analysis of hiatuses. In this study, we adopt the alternative scale proposed by Eberle (2022), which we present in the following section based on BP data.

³ The subscript number corresponds to the distance value between the vocoids on the scale.

was related to the picture; (ii) say the elicited word in the context phrase “Eu falo X baixinho” (*I say X very low*), where X corresponds to the guessed item; and (iii) repeat the context phrase three consecutive times. After collecting three occurrences of each word, the first repetition was eliminated, and the other two were examined.⁵

The continuation or suspension of the experimental procedures was determined by certifying whether the participant had comprehended (or not) the proposed activity. In this manner, the recording session started with training words, during which we could observe the participants’ speech rate, their ability to guess the target lexical item, and their ability to place it in the context phrase. The training words helped us evaluate the clarity of the instructions for the activities and whether the experiment could be continued.

In chart 3, we present the participants’ profiles, organized by age, sex, bilingualism, formal education, and Island (whether from the urbanized area of São Tomé Island or Príncipe Island).

Chart 3 – Participants - PSTP

Participant	Age	Sex	Bilingual?	Formal Education	Island
1	18	M	No	High	São Tomé
2	19	M	Yes	High	São Tomé
3	23	M	No	High	São Tomé
4	18	M	No	High	Príncipe
5	19	M	No	High	Príncipe
6	20	M	No	High	Príncipe

Source: Authors’ own elaboration

In Chart 3, we observe that this study is a sample of homogeneous urban speech produced by monolingual men from both islands, aged 18-23, with a high degree, and who have never left the country. In contrast to Balduino (2022), who analyzes the recordings of speakers from São Tomé and from Príncipe separately, we did not distinguish the microvarieties of STP because we aim to examine a broader range of the language. That said, we evaluated 888 occurrences of 74 lexical items containing all seven stressed vowels /i, e, ε, a, ɔ, o, u/.

After collecting the data, we used Praat (Boersma; Weenink, 2019) to perform spectral analysis of the tokens, which was essential for proposing an acoustic dispersion scale between PSTP vocoids, based on the methodology implemented by Eberle (2022) for the BP. To calculate the acoustic dispersion of PSTP-stressed vowels, we extracted

⁵ By using context phrases, we ensured that the target structures could be isolated and analyzed in controlled contexts: alternating the nuclei quality and the target syllable stress. Therefore, we controlled the lexical and phrasal prominence, and the seven stressed vowels were analyzed activities.

the first and second formants (F1 and F2) of vowels manually, using medial portions and more stable segments. The values were normalized using the Lobanov method, and we subsequently extracted the mean values by participant and vocoid segment.

These acoustic measures were made to present the stressed vowel system and to calculate the contrast of PSTP diphthongs, following Eberle (2022). The acoustic dispersion of stressed diphthongs, such as [Vj] and [Vw], where [V] represents any vowel, is calculated using the F1 and F2 dimensions and by subtracting the absolute values of the formants. Hence, the dispersion in F1 is calculated by subtracting the F1 of the vowel and of the glides [j/w]: $D_{F1} = |F1_{\text{vowel}} - F1_{\text{glide}}|$, where D_{F1} corresponds to the value of the acoustic dispersion of F1 between the vocoids of the diphthong. The same calculation is made for F2: $D_{F2} = |F2_{\text{vowel}} - F2_{\text{glide}}|$, where D_{F2} corresponds to the value of the acoustic dispersion of F2 between the vocoids of the diphthong.

For example, considering the diphthong [ɛw] in a stressed syllable and in a male speech. The contrast in F1 is calculated by subtracting the F1 value of [ɛ] (502.5 Hz) and [u] (319 Hz), i.e., $D_{F1[\text{ɛw}]} = |502.5 - 319| = |183.5|$ Hz. Hence, the contrast in F1 of [ɛw] is |183,5| Hz. This value will be evaluated inside a scale to identify which diphthongs are more or less contrastive in PSTP.

The last step of the analysis is to compare the acoustic dispersion scale of PSTP-stressed diphthongs with the scale of Eberle (2002) for BP (using the same methodology). As discussed in the last section, Eberle (2022) presents an alternative proposal using absolute formant values in hertz, which was replicated in the present study. Thus, considering the frequency value of vowels attested in Callou *et al.* (2013), we present Eberle’s scales in (3) and (4) again.

(3) F1: [aj] > [aw] > [ɔj] > [ɔw] > [ɛj] > [ɛw] > [oj] > [ej] > [ow] > [ew] > [uj - iw] > [uw]
high medium low minimal

(4) F2: [oj] > [uj - iw] > [ɔj] > [ɛw] > [ɛw] > [aj] > [aw] > [ɛj] > [ej] > [ow] > [ɔw] > [uw]
high medium low minimal

Therefore, following Eberle’s (2022) proposal, we developed a new scale for the F1 and F2 dimensions, based on the absolute values of the vocalic formants of PSTP. Afterwards, we compared the scales of PSTP with the scales of Eberle (2022) presented in (3) and (4), to contrast the two varieties of Portuguese, examining similarities and differences regarding the grouping and division of the acoustic space of vocoids in the F1 and F2 dimensions and, consequently, the acoustic dispersion of oral falling diphthongs.

This paper is framed within the Laboratory Phonology framework (Cohn, Fougeron, & Huffman, 2012); hence, it aims to contribute to the discussion of the relation between the phonetic and phonological components of Portuguese. To achieve this, as discussed in this section, we will use experimental paradigms that control the details of the phonological structures observed, i.e., the oral stressed vowels of PSTP, employing an acoustic examination method that goes beyond the observational techniques of traditional phonological theories (Beckman; Kingston, 2012).

By using the phonetic properties to propose an acoustic dispersion scale for oral falling diphthongs of PSTP, we assume that the knowledge of the sound structure encompasses continuous units and not only subtle ones. Thus, beyond the phonetic description proposed here, we aim to contribute to future studies dedicated to examining the phonological processes of Portuguese concerning the reduction or formation of vocoid sequences, such as monophthongization and diphthongization, respectively (cf. Eberle, 2022). Our hypothesis, following Eberle (2022), is that the acoustic dispersion of diphthongs can be a grammatical trigger for variation through monophthongization and diphthongization - a question to be discussed in more detail in the results section.

In this sense, this paper uses the laboratory methodology to examine the sound structure of human language, which is conceived as complex and non-dual (Pierrehumbert; Beckman; Ladd, 2012). We consider that discrete aspects of phonology, such as vowel and diphthong production, can be incorporated into “uma descrição contínua, a qual resulta de processos cognitivos que estabelecem regiões preferenciais no espaço contínuo e que maximizam a nitidez e a distinção dessas regiões.” [a continuous description, which results from cognitive processes that establish preferential regions within the continuous space and maximize the sharpness and the distinction of these regions] (Pierrehumbert; Beckman; Ladd, 2012, p. 32), and we conjecture that vocoid sequences with greater acoustic dispersion tend to be preserved in the language structure, while diphthongs with lower dispersion are preferably reduced by being less distinct. Aligned with Pierrehumbert, Beckman, and Ladd (2012), instead of treating discrete phonological units as *sui generis*, we understand them within a continuum in which multiple grammatical forces can boost or not their discretization. This study focuses on establishing the acoustic continuum and identifying the preferred vocoid sequences in the acoustic space that maximize the acoustic distinction between PSTP and BP oral falling diphthongs.⁶

That said, the results for PSTP are presented in the following sections.

F1 and F2 dispersion: stressed vowels of PSTP overview

In PSTP, there are seven stressed oral vowels and eight phonetic vowels (Balduino, 2025). The mean normalized values of the phonetic vowel formants of this variety are shown in Chart 4.

⁶ An analysis of phonological processes of Portuguese of acoustic dispersion scale, within the phonology framework, which we propose here is a ramification of this research for the future, yet it will not be discussed in this paper.

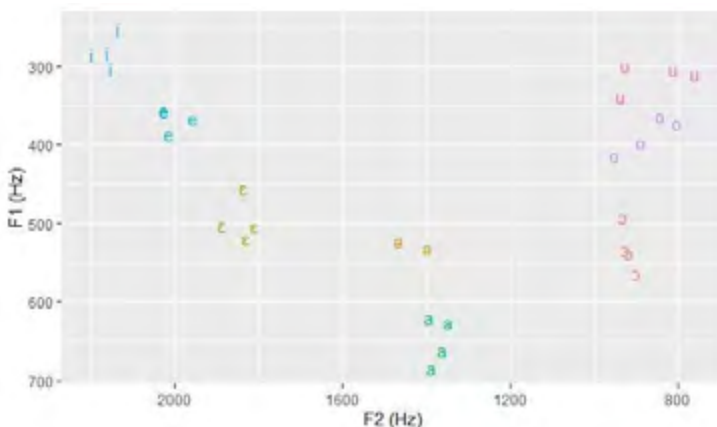
Chart 4 – Mean values of F1 and F2 of PSTP (in Hertz) - Male

	i	e	ɛ	ə	a	ɔ	o	u
F1	278	376	502,5	525,5	622,5	549,5	405	319
F2	2144,5	1987	1898	1427,5	1371,5	910	920,5	932,5

Source: Authors' own elaboration

The distribution of stressed vowels in the acoustic space is shown in Graphic 1. This plot presents the mean values of six male speakers.

Graphic 1 – Plot of stressed vowels of PSTP – male mean values



Source: Authors' own elaboration (RStudio)

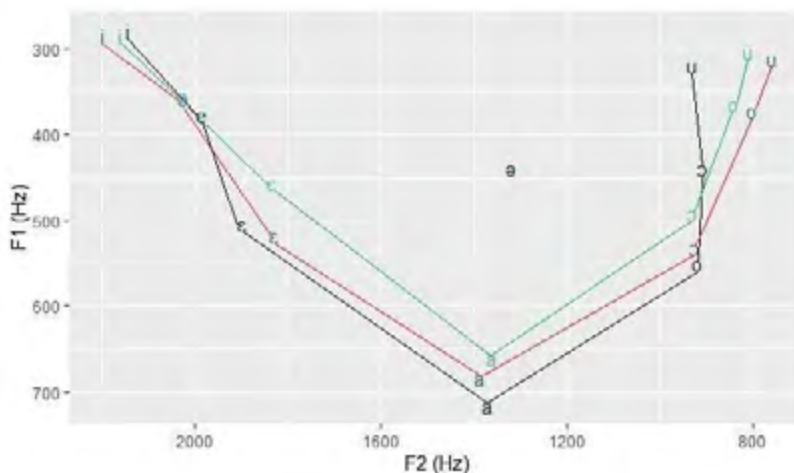
In Graphic 1, we verify the F1 and F2 dispersion in the data analyzed here. In PSTP, unlike BP, there are eight phonetic vowels [i, e, ɛ, a, ə, ɔ, o, u]. The schwa [ə] is an allophone of [a], which was attested in the speech of two participants in different segmental contexts.⁷

Using the BP and EP measures from Escudero *et al.* (2009) for male speakers, we compared the average acoustic space of both varieties of Portuguese with that of PSTP. In Graphic 2, we present the plot for the stressed vowel in the three varieties: PSTP

⁷ The schwa was observed in CV and CVC syllables. C, in the first group of data and in CV syllables, corresponds to the plosives [b, t, d, k, g], fricatives [s, f, ʃ], and liquids [l, r, ʀ]. The only case with a bilabial nasal [m] was the word “mar” (*sea*). Balduino (2018) demonstrates that only coda and following-onset nasal consonants can influence the F1 of the articulated vowel, tauto- or heterosyllabically, which does not correspond to the segmental contexts studied in this paper. On the other hand, in the second group of data, consisting of CVC syllables, the onset consonant could be one of the consonants cited above. In contrast, the coda consonant, invariably, consisted of a lateral or rhotic consonant. Finally, it has to be mentioned that the schwa occurred in monophthongs (e.g., “sal” (*salt*)), in first syllables (e.g., “garfo” (*fork*)), in middle syllables (e.g., “alfaca” (*lettuce*)), and in final syllables (e.g., “sofã” (*sofa*)), but there was no data for onsetless first syllables, e.g., V.CV.CV.

(black), BP (green), and EP (red). In general, despite the methodological differences between our study and Escudero *et al.*'s (2009), which control more the segmental contexts, the varieties are very similar, but PSTP has the smallest acoustic space.

Graphic 2 – Plot for stressed vowel of PSTP (black), BP (green), and EP (red) – male speakers



Source: Authors' own elaboration (RStudio)

Comparing the three varieties, we note that the expansion of the contrasts in stressed syllables does not, at first, expand the acoustic space of PSTP, which actually is smaller, and consequently, has a greater grammatical cost concerning segmental distinction. By producing the vowel [ə], the F1 acoustic space of mid-low vowels is invaded, indicating, therefore, in the Optimality Theory framework (Prince; Smolensky, 1993), a violation of the constraint MinDist (Minimal Distance) in F1 (Flemming, 2004; Kenstowicz; Sandalo, 2016). According to Flemming (2004), the neutralization of mid vowels can restore the minimal distance between vowels in F1; nonetheless, consequently, the number of vowels in the phonetic inventory would be reduced. This is evident in the mid-low vowel raising phenomena in stressed syllables of PSTP (Santiago, 2019; Balduino, 2022; 2025): *cérebro* ['se.ri.bʊ] ~ ['se.ri.bʊ] (*brain*); *abóbora* [a.'bo.bu.rɐ] ~ [a.'bo.bu.rɐ] (*pumpkin*). The loss of contrast between mid-vowels is observed, yet, in raising diphthongs: *diarreia* [di.a.'re.ɾɐ] ~ [di.a.'re.ɾɐ] (*diarrhea*); *ideia* [i.'de.ɾɐ] ~ [i.'de.ɾɐ] (*idea*), and results from the compression of the acoustic space of PSTP due to the maximization of contrasts by producing the [ə], as hypothesized by Flemming (2004).⁸

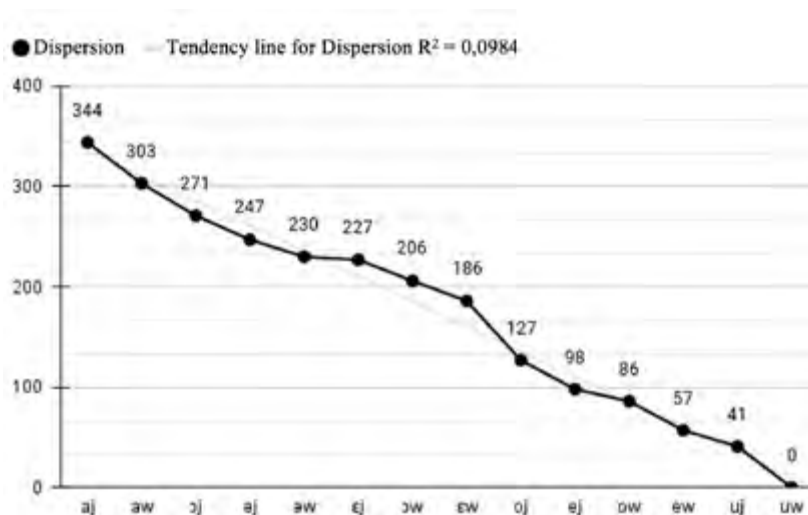
⁸ This topic and other stressed and stressless vowel phenomena are not the focus of this paper, but can be seen in Balduino e Freitas (in press).

The evidence from the F1 and F2 dimensions indicates a distinct acoustic behavior in PSTP compared to BP and EP, necessitating adaptation of the Flemming's (2004) scheme to absolute formant values in Hz for PSTP, as proposed by Eberle (2022) for BP. The difference between the formant values of each stressed vowel was used to calculate the diphthong contrast, as explained in the methodology. To revisit our example presented in the method, the distance between diphthongs' vocoids, [Vj] or [Vw], is measured using the F1 and F2 dimensions by subtracting the absolute values of the formants: $D_{F1} = |F1_{\text{vowel}} - F1_{\text{glide}}|$ and $D_{F2} = |F2_{\text{vowel}} - F2_{\text{glide}}|$. The dispersion between diphthongs will be used to compare which ones are more distant in acoustic space. Afterwards, the results will be contrasted with Eberle's (2022) results for BP.

Acoustic dispersion scales for stressed diphthongs of PSTP

Considering, firstly, the F1 dimension, the contrast in Hz for falling diphthongs is shown in Graphic 3. The *y-axis* corresponds to the values of F1 in Hz, and the *x-axis* to each falling diphthong, in descending order. The values in Hz for each diphthong contrast are also shown. As indicated in Graphic 3, the dispersion in F1 is gradient, with a range between |344| Hz for [aj] and 0 Hz for [uw].

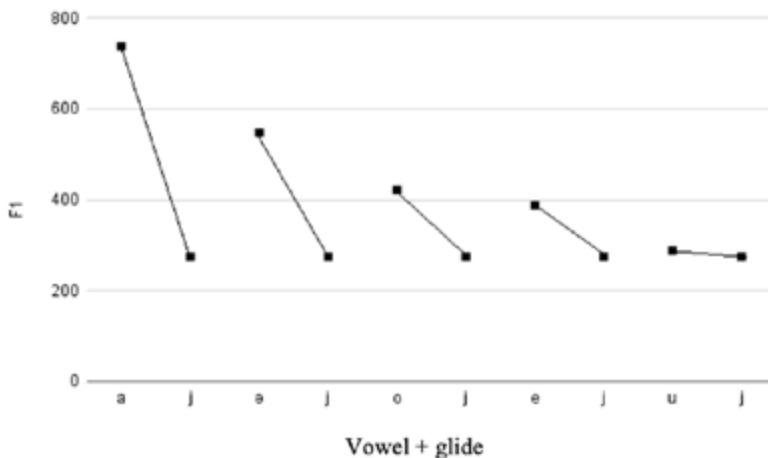
Graphic 3 – Stressed falling diphthongs regarding the F1 dispersion – PSTP



Source: Authors' own elaboration

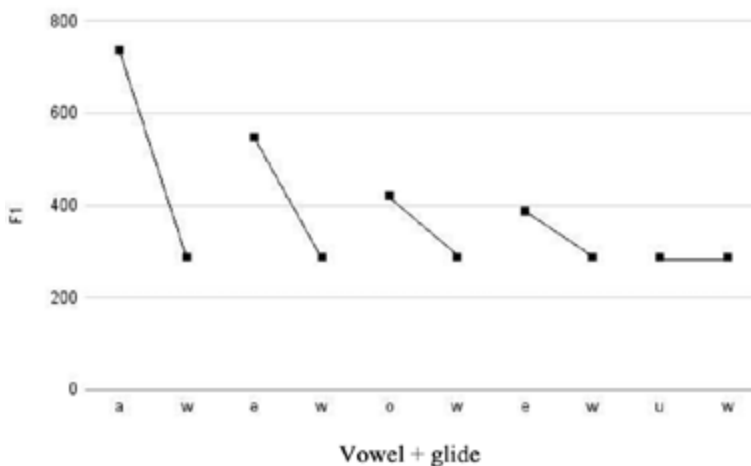
In Graphics 4 and 5, we obtain the dispersions, in descending order, separating the diphthongs into [Vj] e [Vw], in the following order: [aj] > [ɔj] > [əj] > [ɛj] > [oj] > [ej] > [uj], for [Vj], and [aw] > [əw] > [ɔw] > [ɛw] > [ew] > [uw], for [Vw].

Graphic 4 – F1 Dispersion for [Vj] in PSTP



Source: Authors' own elaboration

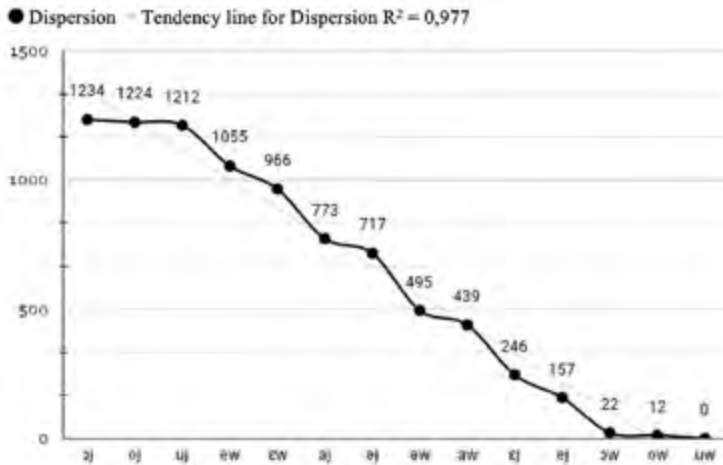
Graphic 5 – F1 Dispersion for [Vw] in PSTP



Source: Authors' own elaboration

Graphic 6 shows the F2 dispersion for [Vj] and [Vw]. The dispersion values of each diphthong have a range of |1234| Hz for the diphthong [ɔj], and 0 Hz for [uw].

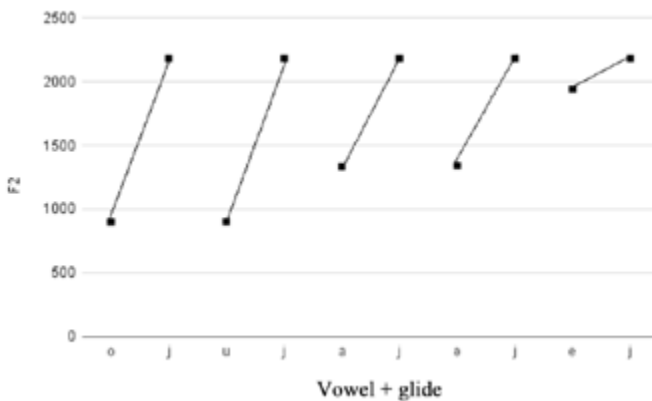
Graphic 6 – Stressed falling diphthongs regarding the F2 dispersion - PSTP



Source: Authors' own elaboration

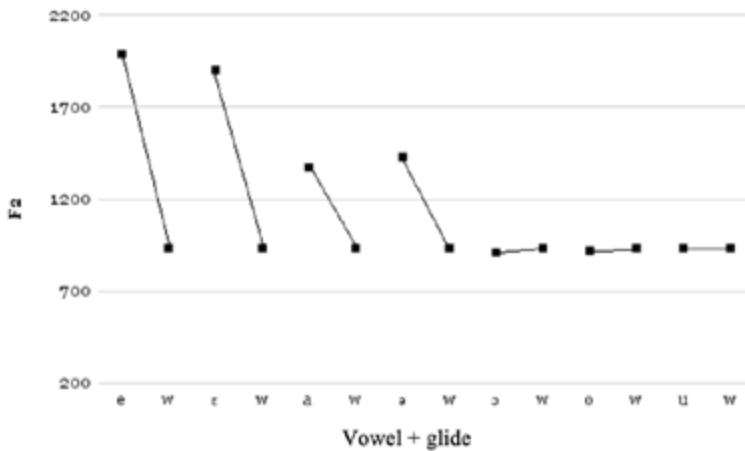
By distinguishing the diphthongs into [Vj] and [Vw], we obtain in descending order the dispersions shown in Graphics 7 and 8 and described here: [ɔj] > [oɔ] > [uj] > [aj] > [ɔj] > [ɛj] > [ej], for [Vj], and [ɛw] > [ɔw] > [aw] > [əw] > [əw] > [ow] > [uw], for [Vw].

Graphic 7 – F2 Dispersion for [Vj] in PSTP



Source: Authors' own elaboration

Graphic 8 – F2 Dispersion for [Vw] in PSTP



Source: Authors' own elaboration

Eberle (2022) analyses the dispersion of BP diphthongs and proposes four levels of contrast, based on the proximity of the values, resulting in diphthongs with high, medium, low, and minimal contrast. Using the dispersions shown in Graphics 3 and 6, we determined a scale for the PSTP diphthongs based on the y-axis values and the four levels of contrast: high, medium, low, and minimal.

Our proposal for PSTP is based on Maddieson (1984) and Flemming (2004), who claim that the acoustic dispersion of vowels must be established from a paired analysis. Similarly to a commutation test, it is necessary to contrast the vowel qualities to determine a minimal sonority distance capable of avoiding confusion during the categorization of distinct vocalic elements. Hence, to ensure there is a phonological contrast, there needs to be a minimal acoustic distinction between vowels after production, for the listener to be able to decode and categorize them. From this thought, and aiming to determine the mean frequency, in Hz, that can mark the relevant acoustic distinction between diphthongs on a scale (as shown in Graphics 3 and 6), we examine the sonority distance between the vowels of PSTP using the mean difference in F1 and F2.

This measurement aims, beyond establishing a minimal acoustic distance, to use the same distance to propose a sonority scale for stressed falling diphthongs. We part from the values of F1 and F2 and contrast a vowel *V* with the immediately preceding *Vp* or following *Vs* vowel in the acoustic space. If we consider our *V* as a value of F1 of the vowel [e], we contrast the value of F1 of the vowel [i] (*Vp*) and [ɛ] (*Vs*), by subtracting [e] - [i] = **DM** (minimal distance to distinguish vowels in the acoustic space). The subtraction values are shown in Chart 5.

Chart 5 – F1 and F2 Minimal dispersion in Hz of stressed vowel in PSTP

	Dispersion in HZ - F1			Dispersion in HZ - F2	
e - i	376 -278	= 98	e - i	2144,5 – 1987	= 157,5
ε - e	502,5 -376	= 126,5	e - ε	1987 – 1898	= 89
o - u	405 -319	= 86	o - u	920,5 – 932,5	= -12
ɔ - o	549,5 – 405	= 144,5	ɔ - o	910 – 920,5	= -10,5
ə - a	525,5 - 622,5	= -97	ə - a	1427,5 -1371,5	= 56
Mean		110,4			65

Source: Authors' own elaboration

For F1, we found a mean difference of 110,4 Hz between vowels. In general, the dispersion between all vowels remained around 100 Hz, except for [ɔ] and [ɔ]; thus, the categorization in four levels for F1 will be made using this value as a reference for the scale regarding falling diphthongs. The same will apply to F2.

F2 dispersions present a significant variability. The greatest distinctivity is |157,5| Hz between [e] and [i]. The most minor difference is between [o] and [ɔ], and [u] and [o], whose F2 distance corresponds to |-10,5| and |-12| Hz, respectively. Considering the variability found in the data, the mean acoustic distance resulting from the subtraction of F2 values of vowels is not an adequate method to determine a dispersion scale. In case if we compared the front and back vowels, we would get a maximization of the acoustic distinctiveness between segments: [i], for example, has a mean difference of |1212| Hz from [u]; [e] - [o], of |1066,5| HZ, and [ε] [ɔ], of |988| Hz, which would not be a good metric as well, because diphthongs do not exhibit that great of a distinction that surpasses 100 Hz in F2.

Based on our initial proposal of using, following Eberle (2022), four levels of dispersion (high - medium - low - minimal) for diphthongs, if we consider the values of the *y-axis* (0 - 1234 Hz) from Graphic 6, and divide them by four, we get a distance of 300 Hz to delineate a dispersion scale for falling diphthongs in stressed position: 0 - 300 Hz (minimal); 301 - 600 Hz (low); 601 - 900 Hz (medium), and over 901 Hz (high). The scale for F1 and F2 is shown in (5) and (6), respectively.

(5) F1: [aj] > [aw] > [ɔj] > [əj] > [əw] > [ej] > [əw] > [ɛw] > [oj] > [ej] > [ow] > [ew] > [uj - iw] > [uw]
high medium low minimal

(6) F2: [ɔj] > [oj] > [uj] > [ew] > [ɛw] > [aj] > [əj] > [əw] > [aw] > [ej] > [ej] > [əw] > [ow] > [uw]
high medium low minimal

Comparing (5) and (6), the dispersion scale changes depending on the dimension analyzed, which highlights the relevance of considering F1 and F2 (and not only F1, as proposed for traditional sonority scales, cf. Goldsmith (1990) and Parker (2011)), as

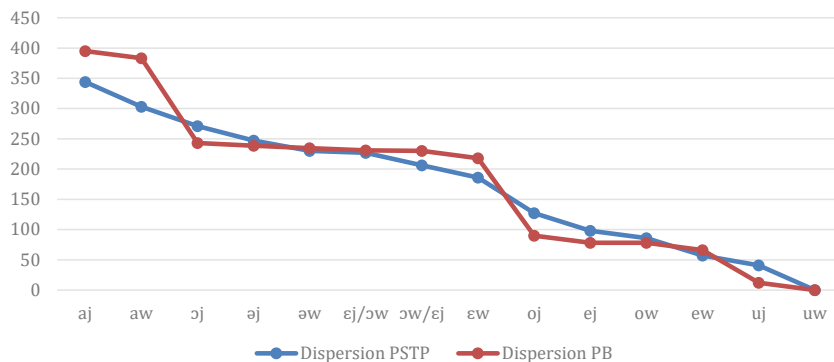
variables to be tested in the monophthongization, vocalization, and diphthongization phenomena.

The acoustic distinction between segments is achieved through speakers’ articulatory effort in a context of segmental prominence (Flemming, 2004). In general, segments tend to be neutralized in contexts of low prominence, e.g., stressless syllables, which requires shorter syllable durations (Flemming, 2004). This correlation between duration and vowel neutralization, especially regarding vowel raising, seems to be a tendency in natural languages, including PSTP, which neutralizes vowels very often in stressless syllables, which are shorter than stressed syllables (cf. Balduino, 2022).⁹

Dispersion of stressed falling diphthongs of PSTP and BP

There are some differences between the PSTP and BP scales, especially regarding the presence of the diphthongs [əj, əw]. The production of a stressed [ə], as an allophone of /a/, is observed in PSTP, but not in BP, which influences the order of diphthongs formed by mid-low vowels on the scales for F1 and F2, becoming different between the varieties. These differences are shown in Graphics 9 and 10, where the BP values come from Eberle (2022):

Graphic 9 – F1 contrast scale - PSTP and PB¹⁰



Source: Author’s own elaboration

Graphic 9 shows that, by comparing the dispersion scales of the diphthongs in F1, the levels of dispersion are more distinguishable in BP than in PSTP, which exhibits

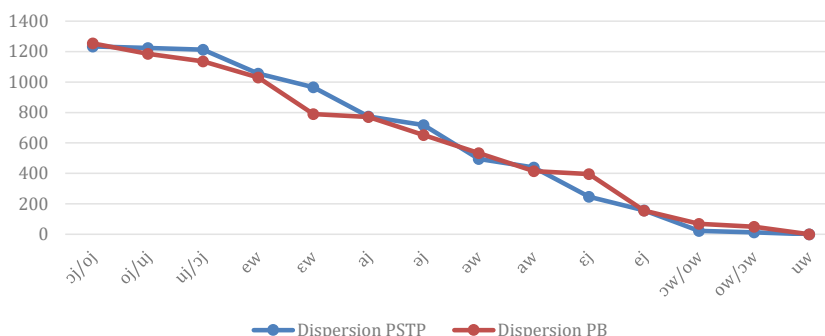
⁹ Neutralization is also attested in PSTP, less often, in stressed syllables, as demonstrated by the presence of [ə] as an allophone of /a/ in stressed position (cf. Balduino, 2022).

¹⁰ In x-axis, the diphthongs that are presented together represent the different order on the PSTP and BP scales, where the first diphthong of the pair refers to PSTP and the second to PB.

a more continuous gradation. We hypothesize that the continuous gradation is due to the presence of the *schwa* in PSTP. Moreover, there is a slight change in the order of some diphthongs, e.g., [ɛj] and [ɔw], which in BP have a similar contrast, and [ɔw] > [ɛj], but in PSTP they are more contrastive, and the order is altered to [ɛj] > [ɔw].

Concerning the F2 scale, there is a greater difference between the order of diphthongs in PSTP and BP, as shown in Graphic 10, where, on the x-axis, the first diphthong in the pair represents PSTP, and the second one, BP. However, the dispersion of the diphthongs remains similar, i.e., there is no drastic change between the scales. Identical to the F1 scale, the F2 scale is more gradual in PSTP than BP, and the levels of contrast are less distinguishable.

Graphic 10 – F2 contrast scale - PSTP and PB



Source: Author's own elaboration

We contrast, in Chart 6, the levels of dispersion of PSTP and BP (Eberle, 2022) and highlight the distinctions.

Chart 6 – Distinctiveness scale of falling diphthongs in PSTP and PB

	(a) PSTP	(b) PB
Dispersion	F1 Scale	F1 Scale
High	[aj] > [aw]	[aj] > [aw]
Medium	[ɔj] > [ɔj] > [ɔw] > [ɛj] > [ɔw]	[ɔj] > [ɔw] > [ɛj] > [ɛw]
Low	[ɛw] > [oj] > [ej] > [ow]	[oj] > [ej] > [ow] > [ew]
Minimal	[ew] > [uj ~ iw] > [uw]	[uj ~ iw] > [uw]

	F2 Scale	F2 SScale
High	[ɔj] > [oj] > [uj ~ iw] > [ew] > [ɛw]	[oj] > [uj ~ iw] > [ɔj] > [ew]
Medium	[aj] > [əj]	[ɛw] > [aj]
Low	[əw] > [aw]	[aw] > [ɛj]
Minimal	[ɛj] > [ej] > [ɔw] > [ow] > [uw]	[ej] > [ow] > [ɔw] > [uw]

Source: Author's own elaboration

Comparing the results for PSTP and BP shown in Chart 6, the significant differences between levels of contrast on the F1 scale are that, at medium and low contrast levels, the order of the diphthongs changes, and, mainly, the diphthong [ew] falls within the minimal dispersion in PSTP. At the same time, it is considered low contrast in BP.

Regarding the levels of dispersion in F2, the diphthong [ɔj] in BP is less contrastive than [uj], [iw], and [oj], and the diphthong [ɛw] is considered a high dispersion in PSTP, while it is medium in BP. Further, the addition of fiphthongs with the vowel [ə] alters the distribution of medium and low levels between the varieties of Portuguese, resulting in classifying [ɛj] as a minimal contrast in PSTP, while low in BP

These differences in the levels of dispersion should reflect in phenomena of the language; therefore, it is expected that the diphthong [ɛj] underwent reduction in PSTP, like the other diphthongs with minimal contrast, which is the case for diphthongs with minimal contrast in BP.

Finally, the results indicate that, when PSTP and BP are compared, phonetic similarities and differences define the Portuguese as a pluricentric language, allowing the identification of some linguistic patterns that unify these varieties. One interesting research question that arises from this study concerns the potential systemic–formal implications that differences in acoustic dispersion may drive in the two varieties. Both PSTP and BP have the possibility of reducing diphthongs (see Christofoletti, 2013; Balduino, 2022; Eberle, 2022), as demonstrated by Eberle (2022), diphthongs with low and minimal contrast in F2 tend to reduce more often (e.g., [pej]xe → [pe]xe -*fish*). Therefore, we can ask whether, in PSTP, this is the same case and whether the contexts that favor reduction are the same in BP and PSTP, given the distinct scales shown in Chart 6. This question, however, will not be answered in this work but will be addressed in a future development of this work.

Conclusion

In this paper, we analyzed the oral falling diphthongs of São Tomé and Príncipe Portuguese and Brazilian Portuguese. To do so, we formulated two acoustic dispersion scales based on the absolute values in Hz of the F1 and F2 formants of each stressed

vowel in contrast with the glides [j] and [w]. Following Eberle (2022), we divided the scales into four levels of contrast: high, medium, low, and minimal dispersion.

Although the two varieties of Portuguese are distinct, the scales of PSTP and BP are similar in general, with a few differences in the order of diphthongs in the scales. We believe that these differences are a reflection of the presence of [ə] in the stressed vocalic system of PSTP, resulting in a more gradient scale of contrast, unlike BP, where the scales are more distinguishable.

Although beyond the scope of this article, our hypothesis, grounded in Eberle (2022) on Brazilian Portuguese monophthongization, is that diphthongs within the same contrast group exhibit similar behavior in phonological processes. This issue, however, remains to be explored in future research.

Acknowledgments

This work was supported by the São Paulo Research Foundation (FAPESP), Brazil, Grant No. 2021/12853-4. Any opinions, hypotheses, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of FAPESP.

EBERLE, Lucas Pereira; BALDUINO, Amanda Macedo. Escalas de dispersão acústica para ditongos decrescentes tônicos em duas variedades da língua portuguesa: português de São Tomé e Príncipe e português brasileiro. *Alfa*, São Paulo, v. 70, 2026.

- *RESUMO: O objetivo deste artigo é analisar os ditongos decrescentes orais em duas variedades da língua portuguesa: o português de São Tomé e Príncipe (PSTP) e o português brasileiro (PB). Para tanto, com base em um corpus formado por itens lexicais elicitados a partir de frase-veículo, coletados in loco nas ilhas de São Tomé e de Príncipe, Costa Oeste Africana, extraímos, com auxílio do PRAAT, os valores do primeiro e do segundo formante (F1 e F2) de vocóides tônicos orais. Esse procedimento metodológico foi feito de modo a estabelecermos a dispersão acústica entre a vogal (V) e o glide (G) que constituem ditongos decrescentes em PSTP. Calculada a dispersão acústica entre VG, estabelecemos, em seguida, uma escala de dispersão compreendendo quatro pontos: alta dispersão; média dispersão; baixa dispersão e baixíssima dispersão. Essa escala foi, por fim, comparada à escala proposta por Eberle (2022) para o PB. Por fim, ao contrapor ambas as escalas, foram observadas algumas diferenças em termos de contraste acústico entre V e G de ditongos orais do PSTP e do PB. Essas diferenças parecem decorrer, sobretudo, da inserção de [ə] no sistema tônico oral de vogais do PSTP.*
- *PALAVRAS-CHAVE: Dispersão Acústica; Português São Tomé e Príncipe; Português Brasileiro; Ditongos tônicos.*

Author Contributions (according to CRediT taxonomy)

Amanda Macedo Balduino: Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Visualization; Writing – original draft.

Lucas Pereira Eberle: Formal analysis; Resources; Visualization; Writing – review & editing.

Data Availability Statement

All datasets supporting the findings of this study is available in a personal file and can be requested from the author(s).

REFERENCES

AGOSTINHO, A. L. **Fonologia e método pedagógico do lung'le**. 2015. Tese (Doutorado em Filologia e Língua Portuguesa) – Faculdade de Filosofia, Letras e Ciências Humanas, Universidade de São Paulo, São Paulo, 2015.

AGOSTINHO, A. L.; MENDES, M. A grafia dos róticos intervocálicos no português da Ilha do Príncipe: fusão fonológica e ensino. **Veredas – Revista de Estudos Linguísticos**, v. 24, n. 3, p. 154-176, 2020.

ARAÚJO, G. Há uma política linguística para o português em São Tomé e Príncipe?. *In*: SOUZA, S.; OLMO, F. (org.). **Línguas em português** – A Lusofonia numa visão Crítica. Porto: Universidade do Porto Press, 2020. p. 173-197.

BALDUINO, A. M. **A nasalidade vocálica no português falado em São Tomé e Príncipe**. 2018. Dissertação (Mestrado em Filologia e Língua Portuguesa) – Faculdade de Filosofia, Letras e Ciências Humanas, Universidade de São Paulo, São Paulo, 2018.

BALDUINO, A. M. **Fonologia do Português de São Tomé e Príncipe**. 2022. Tese (Doutorado em Filologia e Língua Portuguesa) – Faculdade de Filosofia, Letras e Ciências Humanas, Universidade de São Paulo, São Paulo, 2022.

BALDUINO, A. M. **Portuguese Phonology in Context: Comparing São Tomé and Príncipe, Brazilian, and European Varieties**, De Gruyter Mouton, 2025.

BALDUINO, A. M.; BANDEIRA, M. A emergência do português como língua materna em São Tomé e Príncipe. **Roseta**, v. 7, p. 54-75, 2022.

BALDUINO, A. M.; BANDEIRA, M.; FREITAS, S. A santomização da língua portuguesa: língua e identidade nacional em São Tomé e Príncipe. **Cadernos de Estudos Linguísticos**, Campinas, v. 64, e022013, 2022.

- BANDEIRA, M. **Reconstrução fonológica e lexical do protocrioulo do Golfo da Guiné**. 2017. Tese (Doutorado em Filologia e Língua Portuguesa) – Faculdade de Filosofia, Letras e Ciências Humanas, Universidade de São Paulo, São Paulo, 2017.
- BAXTER, A. Semirealization? – The restructured Portuguese of the Tongas of São Tomé, a consequence of L1 acquisition in a special contact situation. **Journal of Portuguese Linguistics**, n. 1, p. 7-39, 2002.
- BAXTER, A. O Português dos Tongas de São Tomé. In: OLIVEIRA, M. S.; ARAUJO, G. A (org.). **O Português na África Atlântica**. São Paulo: Humanitas/Fapesp, 2018. p. 297-324.
- BECKER, M.; NEVINS, A.; SANDALO, F.; RIZZATO, É. The Acquisition Path of [w]-final Plurals in Brazilian Portuguese. **Journal of Portuguese Linguistics**, v. 17, n. 1/4. 2018. DOI: <http://doi.org/10.5334/jpl.189>
- BECKER, M.; CLEMENTS, L. E.; NEVINS, A. Generalization of French and Portuguese plural alternations and initial syllable protection. **Natural Language and Linguistic Theory**, v. 35, p. 299-345, 2017. DOI: <http://doi.org/10.1007/s11049-016-9343-y>
- BECKMAN, J. N. **Positional faithfulness**. University of Massachusetts Amherst, 1998.
- BECKMAN, J. N. **Positional faithfulness: an Optimality Theoretic treatment of phonological asymmetries**. Routledge, 1999.
- BECKMAN, M.; KINGSTON, J. 2. Introduction, Papers in Laboratory Phonology I: Between the Grammar and Physics of Speech (reprint). In: COHN, A.; FOUGERON, C.; HUFFMAN, M. The Oxford Handbook of Laboratory Phonology. New York: Oxford. 2012. p. 10-16.
- BOERSMA, P.; WEENINK, D. **Praat: doing phonetics by computer** [Computer program]. Version 6.0.56, 2019. Disponível em: <http://www.praat.org/>.
- BOUCHARD, M. **Linguistic variation and change in the Portuguese of São Tomé**. 2017. Tese (Doutorado) – Department of Linguistics, New York University, New York. 2017.
- BOUCHARD, M. A distinctive use of R as a marker of Santomean identity. **Journal of Belonging, Identity, Language and Diversity**, v. 2, n. 1, p. 6-24, 2018.
- BOUCHARD, M. The Santomization of Portuguese: A Case Study of Post-Colonial Linguistic Change. **Journal of Ibero-Romance Linguistics**, v. 1, n. 1, p. 1-25, 2019.
- BRAGA, G. **A prosódia do português de São Tomé: a entoação do contorno neutro**. 2018. Dissertação (Mestrado em Filologia e Língua Portuguesa) – Faculdade de Filosofia, Letras e Ciências Humanas, Universidade de São Paulo, São Paulo, 2018.
- CALLOU, D.; MORAES, J. A.; LEITA, Y. As vogais orais: um estudo acústico-variacionista. **Gramática do português culto falado no Brasil**, v. 7, p. 75-93, 2013.

CHRISTOFOLETTI, A. **Ditongos no português de São Tomé e Príncipe**. 2013. Dissertação (Mestrado em Filologia em Língua Portuguesa) – Faculdade de Filosofia, Letras e Ciências Humanas, Universidade de São Paulo, São Paulo, 2013.

CLEMENTS, G. N. The role of the sonority cycle in core syllabification. *In*: KINGSTON, J; BECKMAN, M. E (ed.). **Papers in laboratory phonology I: Between the grammar and physics of speech**. Cambridge: Cambridge University Press, 1990. p. 283-333.

COHN, A.; FOUGERON, C.; HUFFMAN, M. **The Oxford Handbook of Laboratory Phonology**. New York: Oxford. 2012.

CROSSWHITE, K. 2004. Vowel Reduction. *In*: HAYES, B.; KIRCHNER, R.; STERIADE, D. (ed.). **Phonetically based Phonology**. Cambridge: Cambridge University Press, 2004. p. 191-231.

EBERLE, L. **Monotongação, Ditongação e Resolução de Hiatos**. 2022. Dissertação (Mestrado em Linguística) – Instituto de Estudos da Linguagem, Universidade Estadual de Campinas, Campinas, 2022.

EBERLE, L. P. Aumento de proeminência e maximização de contraste via epêntese de glide no português brasileiro. **Letras De Hoje**, v. 58, n. 1, e44765, 2023. DOI: <https://doi.org/10.15448/1984-7726.2023.1.44765>

ESCUADERO, P.; BOERSMA, P.; SCHURT, A. R.; BION, R. A cross-dialect acoustic description of vowels: Brazilian and European Portuguese. **The Journal of the Acoustical Society of America**, v. 126, n. 3, p. 1379-1393, 2009.

FLEMMING, E. Contrast and perceptual distinctiveness. **Phonetically based phonology**, p. 232-276, 2004.

FIGUEIREDO, C. F. G. A concordância variável no sintagma nominal plural do português reestruturado de Almoxarife (São Tomé). **Revista PAPIA**, n. 18, p. 23-43, 2008.

GOLDSMITH, J. A. **Autosegmental and Metrical Phonology**. Oxford: Basil Blackwell, 1990.

GOLDWATER, S.; JOHNSON, M. Learning OT constraint rankings using a maximum entropy model. **Proceedings of the Workshop on Variation within Optimality Theory**, p. 111-120, 2003.

GONÇALVES, R. 2010. **Propriedade de Subcategorização verbal no português de S. Tomé**. 2010. 151 f. Dissertação (Mestrado em Linguística) – Faculdade de Letras, Universidade de Lisboa, Lisboa, 2010.

HAYES, B.; STERIADE, D. The phonetic bases of phonological Markedness. *In*: HAYES, B.; KIRCHNER, R.; STERIADE, D. **Phonetically Based Phonology**. Cambridge: Cambridge University Press, 2004. p. 1-33.

INSTITUTO NACIONAL DE ESTATÍSTICA (INE). 2012. São Tomé e Príncipe em Números. São Tomé: 2001. Disponível em: <https://www.ine.st/index.php>

KENSTOWICZ, M.; SANDALO, F. Pretonic vowel reduction in Brazilian Portuguese: Harmony and dispersion. **Journal of Portuguese linguistics**, v. 15, 2016.

LADEFOGED, P. **Elements of Acoustic Phonetics**. The University of Chicago Press, Ltd., London, 1982.

JOHNSON, W.; BRITAIN, D. L. Vocalization as a natural phenomenon: Explorations in sociophonology. **Language Sciences**, v. 29, p. 294-315, 2007.

KINGSTON, J. The phonetics-phonology interface. *In*: LACY, P. (ed.). **The Cambridge Handbook of Phonology**. Cambridge: Cambridge University Press, 2007. p. 401-434.

MADDIESON, I. **Patterns of Sounds**. Cambridge: Cambridge University Press, 1984.

NEVINS, A. Enfraquecimento e fortalecimento de vogal em português brasileiro. **Letras de Hoje**, v. 47, n. 3, p. 228-233, 2012.

PARKER, S. G. **Quantifying the sonority hierarchy**. University of Massachusetts Amherst, 2002.

PARKER, S. G. Sonority. **The Blackwell companion to phonology**, p. 1-25, 2011. DOI: <https://onlinelibrary.wiley.com/doi/10.1002/9781444335262.wbctp0049>

PIERREHUMBERT, J.; BECKMAN, M.; LADD, R. 3. Conceptual foundations of phonology as a laboratory science (reprint). *In*: COHN, A.; FOUGERON, C.; HUFFMAN, M. **The Oxford Handbook of Laboratory Phonology**. New York: Oxford, 2012. p. 17-39.

PRINCE, A.; SMOLENSKY, P. Optimality theory: Constraint interaction in generative grammar. **Technical Report TR-2**, Rutgers Center for Cognitive Science, Rutgers Univ. R. 1993.

SANTIAGO, H. S. **A tonicidade e o sistema vocálico do português de São Tomé e Príncipe**. 2019. Dissertação (Mestrado em Filologia e Língua Portuguesa) – Faculdade de Filosofia, Letras e Ciências Humanas, Universidade de São Paulo, São Paulo, 2019.

Received on June 10, 2025

Approved on July 6, 2025

Editor responsible: Gisele Cássia de Sousa