RESEARCH PAPER

Prosodization of prepositional clitics and prosodic words in Brazilian Portuguese: Investigation of phonetic cues

Lilian Maria da Silva and Luciani Ester Tenani

São Paulo State University, BR

Corresponding author: Lilian Maria da Silva (msilva.lilian@gmail.com)

In this paper, syllable duration (Vowel-to-Vowel unit) and F0 variation are analyzed as cues to distinguish the prosodization of prepositional clitic-host sequence from a syllable within a prosodic word in Brazilian Portuguese (BP). A production task was created to assess 1) whether the syllable production time helps to identify a clitic boundary and a word boundary and 2) whether the F0 configuration aligned to a clitic syllable differs from the F0 configuration aligned to a syllable in a word boundary. The results show that: 1) the syllable duration measurement supports the hypothesis that there is no distinction between prepositional clitics and a syllable which is part of a prosodic word (PW); 2) the pitch range of tonal events associated to the syllable that bears the PW boundary differs from that associated to the syllables that bear a clitic-host sequence boundary. Based on these results we argued that the prepositional clitics are prosodized as a syllable adjoined to its host. This interpretation leads us to suggest that the relevant domain for prepositional clitic prosodization is between PW and PPh (Phonological Phrase) in BP.

Keywords: Prepositional clitic; Prosodic word; Clitic host; Syllable duration; Pitch range; Brazilian Portuguese

1. Introduction

For over three decades, the prosodization of clitics has been investigated in different languages (Bisol 2005; Booij 1996; Guzzo 2015; Halpern 1998; Inkelas 1990; Nespor & Vogel 1986; Peperkamp 1997; Selkirk 1984, 1996; Simioni 2008; Vigário 2003, etc.). Previous studies discuss clitic prosodization within a specific domain in the prosodic hierarchy, called the Clitic Group (e.g., Nespor & Vogel 1986) or Composite Group (e.g., Vogel 2009), or within no specific domain, such as the Prosodic Word (PW) and the Phonological Phrase (PPh) (e.g., Selkirk 1996), as well as within recursive domains (e.g., Inkelas 1990; Kabak & Revithiadou 2009; Peperkamp 1997).

Clitics (henceforth, $[\sigma]_{CL}$) are unstressed, and therefore compared to an unstressed syllable within a word (henceforth, $[\sigma...]_{PW}$). The distinction between $[\sigma]_{CL}$ and $[\sigma...]_{PW}$ is relevant both to formalize the clitics prosodization and to identify the PW domain. For example, in languages such as Dutch (Booij 1996), phonological processes (e.g., prevocalic schwa deletion) provide evidence that $[\sigma]_{CL}$ is part of the PW. This means that $[\sigma]_{CL}$ in Dutch is prosodized in the PW domain. On the other hand, in Brazilian Portuguese (BP), there are different interpretations of that phenomenon: (i) Bisol (2000, 2005) argues that clitics are part of the Clitic Group (Bisol 2000, 2005); (ii) Brisolara (2008) admits recursivity in phonology and suggests that pronominal clitics are part of the recursive

PW; and (iii) Simioni (2008) argues that clitics are prosodized in the PPh. The arguments for each of these approaches are based on phonological processes, such as vowel raising, which supports evidence that $[\sigma]_{CL}$ is different from $[\sigma...]_{PW}$ (which is a syllable of the PW). Thus, the BP literature holds that clitics and their hosts (cl-host) are not prosodized in a single PW domain.

Considering these findings about the clitic prosodization of BP (e.g., Bisol 2000, 2005; Brisolara 2008; Simioni 2008; Toneli 2009), this paper presents an experimental study designed to investigate the phonetic cues of the PW in BP. The results will also be interpreted as part of the answer to the question of whether there is clitic prosodization of BP. We investigate only proclitics and word initial unstressed syllables. Specifically, we consider the unstressed syllable "*de*" within different prosodic boundaries because it can be a prosodic clitic, as in "*de vagar*" ('[of] wandering'), or a part of a PW, as in "*devagar*" ('slowly'). In the first case, there is a PW boundary between the syllable, that is a clitic, and the following word, its host. In the second case, there is no PW boundary, and the syllable is part of the word. Therefore, to begin with, we searched for a duration cue that would distinguish these two syllables, the $[\sigma]_{CL}$, which bears a PW boundary, from the $[\sigma...]_{PW}$, without a PW boundary.

We chose to focus on the syllable "*de*" ('of') only because of the high frequency of this preposition in Portuguese (Biderman 1998; Marcato 2013; Soares et al. 2014), and because it may undergo phonological processes that distinguish it from the $[\sigma...]_{PW}$ "*de*" in BP. In the BP-South variety spoken in Porto Alegre, Bisol (2005) and Simioni (2008) remark that the $[\sigma]_{CL}$ undergoes two processes: the /e/-raising and the /d/-palatalization, as in "[dʒɪ] coração", i.e., "*de coração*" ('with all my heart'). The $[\sigma...]_{PW}$ does not undergo these processes, as in "*[de]coração*", i.e., "*decoração*" ('decoration').

In BP, the /d/-palatalization is a rich and multifaceted phenomenon as highlighted by Cristófaro Silva, Barboza, Guimarães and Nascimento (2012). This phonological phenomenon distinguishes BP varieties; palatalization has implemented a sound change in certain communities and has a low frequency in others. In the Southeastern BP variety spoken in the inner part of the State of São Paulo (henceforth, BP-SP variety), analyzed in this paper, the distinction between the $[\sigma]_{CL}$ "*de*" and $[\sigma...]_{PW}$ "*de*" can also be observed based on the palatalization process, as in the Porto Alegre variety.[1] However, in BP-SP variety, the $[\sigma...]_{PW}$ "*de*" may undergo the same phonological processes as the $[\sigma]_{CL}$ "*de*", such as:

1.   [dʒɪvaˈɡaɪ]

       [devagar]$_{PW}$

       'slowly'

2.   [dʒɪ] [vaˈɡaɪ]

       [de]$_{cl}$ [vagar]$_{PW}$

       '[of] wandering'

In this case, the $[\sigma...]_{PW}$ "*de*" is produced exactly in the same way as the $[\sigma]_{CL}$ "*de*". We are interested in comparing these structures that undergo /e/-raising and /d/-palatalization but differ from each other in prosodic boundaries.

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[1] In some varieties of BP (such as the inner part of Paraná State), the vowel raising process of the mid-vowel /e/ and the palatalization of the stop consonant /d/ do not apply.

Our choice of the preposition "*de*" is also due with the fact that it can be a part of a prepositional phrase PP in different syntactic structures. In BP, as in other languages (e.g., English, according to Burton-Roberts 1991), (PP) can embed complements and adjuncts (about BP, cf. Mioto, Silva & Lopes 2018). Complements are essential elements of syntactic structure, whereas adjuncts are not, because they imply different syntactic mappings of PP, according to the following examples:

3. | A-s | margarida-s | floresce-∅-m | **de novo** | na |
    |-----|-------------|--------------|-------------|-----|
    | The[ART.F]-PL | daisy-PL | bloom-PRS-3PL | again | on[ART.F.SG] |

    fazenda.
    farm[F.SG]
    'The daisies bloom again on the farm.'

4. | A-s | empregad-a-s | morr-ia-m | **de nojo** | de barata-s. |
    |-----|--------------|-----------|-------------|--------------|
    | The[ART.F]-PL | maid-F-PL | die-IPFV-3PL | of disgust | of roach-PL |

    'The maids felt sick about roaches.'

Example (3) presents a PP that corresponds to an adjunct. The subordinating element, i.e., the verbal form (i.e., "*florescem*") and the target PP (i.e., "*de novo*"), are not included in a broader structure (cf. Raposo & Xavier, 2013: 1515). In this case, the adjunct PP can be moved to the final position without impairing the sentence meaning (e.g., "*As margaridas florescem na fazenda de novo*"). Example (4) presents a PP that corresponds to a complement. The subordinating element, i.e., the verbal form (i.e., "*morriam*"), and the target PP (i.e., "*de nojo*") are included in a broader structure whose nucleus is the subordinating term (cf. Raposo & Xavier, 2013: 1511). In this case, the complement PP cannot be moved to the final position because it impairs the sentence meaning (e.g., "**As empregadas morriam de baratas de nojo*"). It is also relevant to observe that "*de*" is part of structures with semantic differences, as in "*de novo*" ('again') and "*de nojo*" ('of disgust' = '[be] sick of'). In general, the "*de novo*" sequence does not have a compositional meaning, but the "*de nojo*" sequence does. Specifically, "*de novo*" constitutes an adverbial phrase whose form is similar to "of course" in English, for example, since both are formed by a preposition + noun combination (about BP: cf. Dias 2001; Ilari, Castilho, Leitão, Kleppa & Basso 2015; Raposo & Xavier 2013). These syntactic-semantic differences of "*de*" are a characteristic which is not found in other prepositional clitics in BP. The unstressed syllable "*de*" is proclitic to its host, as in "*gosto de vagar*", even when this preposition is introduced by the verb that precedes it ("*gosto de*"). As far as we know, such a study about prosodic characteristics of preposition "*de*" in BP remains unpublished.

To sum up, we have chosen to consider the clitic "*de*" specifically because it is a complex preposition, and it can be compared to syllable "*de*" within the PW. In this paper, this comparison allows us to investigate whether the cues of a cl-host sequence boundary differ from the cues of a PW prosodic boundary.

To undergo this comparison, it is necessary to analyze the left edge of the cl-host sequences and of the PW under study. Literature presents evidence of initial strengthening in the prosodic domains (e.g., Cho 2016; Cho & Keating 2001; Fougeron 2001; Fougeron & Keating 1997; Keating 2006; Keating, Cho, Fougeron & Hsu 2004). According to these studies, an articulatory strengthening and a longer duration of segments were observed in the higher prosodic domain boundaries. For example, in English, French, Korean and Taiwanese, Fougeron and Keating (1997) and Keating et al. (2004) investigated linguopalatal contact with the production of the segment /n/ in initial, medial and final positions within the PW, the PPh, the Intonational Phrase (IP) and the Utterance

(U). The authors showed that there is more linguopalatal contact at the initial edge of higher domains than at the initial edge of lower domains and in the medial position of the domains. Similarly, acoustic duration is larger at the initial edge of higher prosodic domains. Although the articulatory movement results are relevant, special attention, in this paper, is paid to duration and F0 cues in BP data. This decision was taken considering the findings about BP mainly, but not restricted to them.

Duration is a relevant cue to distinguish $[\sigma]_{CL}$ from $[\sigma...]_{PW}$ in Persian (cf. Hosseini 2012), which will be reported in detail in the next section. In BP, duration is a robust cue for the identification of the IP boundary when determining preboundary lengthening (Soncin 2018), and no results are reported about duration cues to distinguish the PW boundary from the cl-host prosodic boundary.

The characterization of these two prosodic domain boundaries has been observed from the perspective of F0 cues. Specifically, the intonational characteristics that distinguish PW and cl-host sequences in BP were initially reported by Toneli (2009, 2014) and Toneli, Vigário and Abaurre (2014). These researchers have shown that it is possible to have an initial tonal event (in general, high (H) tone) associated to a PW-pretonic syllable, when there are three or more pretonic syllables (Toneli 2009). This tonal event does not occur associated to functional words adjacent to PW (Toneli, Vigário & Abaurre 2014). The tonal event associated to a syllable at PW-left edge distinguishes the PW domain from the cl-host domain, which constitutes a post-lexical domain between the PW and the PPh. This intonational characterization and its consequences to prosodic hierarchy will be described carefully in the next section, where the research questions and hypotheses are addressed.

Therefore, based on duration acoustic cues, specifically Vowel-to-Vowel unit duration – henceforth, V-to-V unit – (cf. Barbosa 2006, 2007, 2013; Mittmann & Barbosa 2016), and F0 cues, specifically tonal event, and pitch range, we aim to contribute to discussions on the formalization of both the PW domain and the cl-host sequence domain in BP. To the best of our knowledge, this is the first study that investigates phonetic cues considering duration and F0 realizations of unstressed syllables in the PW boundary in comparison to the cl-host sequences in BP.

2. Research questions and hypotheses

In this paper, we investigate the phonetic realization of unstressed syllables (i.e., $[\sigma]_{CL}$ and $[\sigma...]_{PW}$) in PW boundaries. Our main research question is: are there phonetic cues to distinguish the PW from the clitic prosodization sequences? This main question will be assessed as we answer other two research questions, whose results will be interpreted as part of the answer to the clitic prosodization of BP:

Question I: Is there a difference between the duration of $[\sigma]_{CL}$ and $[\sigma...]_{PW}$ that are in the PW boundary?

Question II: Is there a difference between the F0 variation that distinguishes the PW from cl-host sequences?

Regarding the first research question, although the studies of Fougeron and Keating (1997), Cho and Keating (2001), Fougeron (2001), Keating et al. (2004), Keating (2006), and Cho (2016), among others, have not confirmed that duration is a relevant cue to characterize the initial boundaries of lower prosodic domains, such as the PW and the syllable, Hosseini (2012) found out that duration was relevant to distinguish $[\sigma]_{CL}$ from $[\sigma...]_{PW}$ in Persian.

Hosseini (2012) discussed clitic prosodization in Persian from a phonetic approach. According to the author, the voiceless stops in Persian are aspirated, and the degree of aspiration depends on the stop consonant position. Specifically, stop consonants in the word onset position – e.g., /p/ in "*parváz*" ('flight') – and in the stressed syllable onset position – e.g., /p/ in "*sepáh*" ('army') – are more aspirated (cf. Hosseini 2012: 130). Based on this phenomenon, the author asks whether the consonant in proclitic onset position would be as aspirated as those in the word onset position. Therefore, Voice Onset Time (VOT) duration was measured in the stop consonants of proclitics and initial word syllables and, as controlled in this paper, the compared syllables in Persian were segmentally identical – e.g., "*tâ*" ('until') and "*tâbestún*" ('summer') – cf. Hosseini 2012: 130. A paired-sample t-test was applied to assess the significance of averages. The results showed that VOT duration (related to the aspiration level) was significantly shorter in proclitics than in initial word syllables. The author concludes that proclitics in Persian are not prosodized in the PW domain.

In BP, Bisol (2000, 2005), Simioni (2008) and Brisolara (2008) discussed clitic prosodization from a phonological point of view. Here we highlight that, despite theoretical differences among the interpretations on the prosodic integration of cl-host sequences, all of them agree that clitics are different from word unstressed syllables. Thus, based on representations shown in Simioni (2008: 433), adapted from Selkirk (1996), we evaluate the different proposition about proclitic prosodic structure in BP.

(5)　　(a)
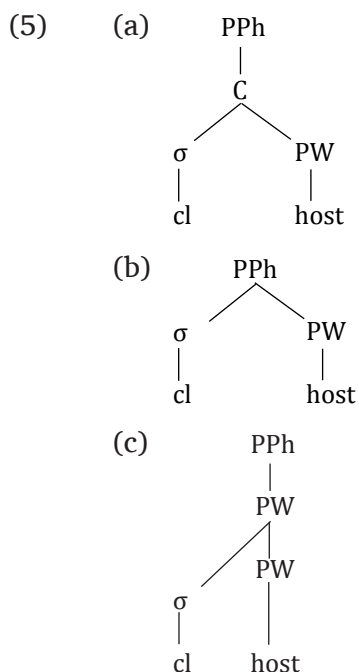
Representation (5a) corresponds to Bisol's (2000, 2005) proposition, according to which proclitics are adjoined to the PW, its host, and they are prosodized in the Clitic Group, an intermediate constituent between the PW and the PPh. According to Bisol (2000, 2005), the existence of the Clitic Group is supported by the elision of the vowel /e/, which would take place exclusively between a clitic and its host.

Representation (5b) presents Simioni's (2008) proposition. This interpretation rejects the Clitic Group and argues that proclitics are attached to the PPh. According to Simioni (2008), the /e/-elision, which was suggested as exclusive to cl-host sequences, can be derived from alignment constraints (cf. Selkirk 1996).

Representation (5c) summarizes Brisolara's (2008) proposition. She argues, like Bisol (2000, 2005), that proclitics are adjoined to the PW-host. Some arguments support this interpretation: (i) proclitics do not integrate a single PW because only post-lexical processes apply to clitics. An example of this is the unstressed word-final vowel neutralization process. In BP, the vowel system is reduced to three vowels in word-final unstressed syllable: /a, i, u/ (cf. Câmara Jr. 1970). Clitics are subject to this process when applied to word-final syllable – e.g., "*m[e] fala ~ m[i] fala* ('tell me') – thus they do not resemble a pretonic syllable incorporated to a single PW; (ii) vowel harmony does not apply to clitic-hosts because the clitic vowel raising occurs regardless of the following vowel height. This process applies specifically to lexical words; (iii) the elision of the vowel /a/ takes place between a clitic and its host – e.g., "*para obstruir > par[o]bstruir*" ('to obstruct') – but it does not happen within the PW – "*baunilha > bunilha**" ('vanilla').

Unlike Bisol's (2000, 2005) approach, Brisolara (2008) refuses the Clitic Group and proposes that proclitics are prosodized in the recursive PW. The recursive structures at the PW level have been proposed in several languages as an alternative to the existence of the Clitic Group (e.g., Inkelas 1990; Kabak & Revithiadou, 2009; Peperkamp 1997; Selkirk 1996; Vigário 2003; Zec 2005; Zec & Inkelas 1991, among others). Regardless of the criticism against this specific domain of clitic prosodization (cf. a detailed systematization of the arguments carried out by Vigário 2010), several studies argue that "prosodic categories [may] display recursion" (van der Hulst 2010: 317) even when Prosodic Phonology early assumptions did not admit recursivity in the prosodic structure (cf. Nespor & Vogel 1986; Selkirk 1984). This means that recursivity is not a consensus in phonology literature.

Regarding recursion at the PW level, Vigário (2010) discussed that the PW recursive proposition may be supported by the distinction between the lexical PW (without clitics) and the post-lexical PW (which can include clitics) in European Portuguese (EP) (cf. Brisolara 2008; Inkelas 1990; Vigário 2003; Zec & Inkelas 1991). Vigário (2003: 203) suggested that, "besides postverbal pronominal clitics, the remaining clitic words are placed in adjacent position to the following prosodic word", in a structure such as [[clitic]σ [host]$_{PW}$]$_{PW}$ (cf. 5c). Afterwards, Vigário (2010) proposed the existence of the Prosodic Word Group (PWG), a domain between the PW and the PPh. The author argued that this term was more appropriate than *phonological cluster* or *composite group* (Kabak & Revithiadou 2006, and Vogel 2009, respectively). Following Nespor and Vogel (1986, 2007) and Vogel (2009), Vigário (2010) stated that recursion is not a fundamental phonological property. She added evidence from different languages in favor of the PWG. This domain addresses two constructions: (i) the prosodization of compound-like constructions, such as "*o hiper-monstruoso*" ('the extra-big one'), that is a derived word with a stressed prefix, naming them "pré-acentual" ('pre-stressed') constructions, and (ii) a complex verbal expression with an internal pronominal clitic, forming a *mesoclitic* construction, as "*dir-se-ia*" ('we would say'). In this proposition, no reference is made to cl-host sequence prosodization, since the evidence for the PWG is mainly based on various types of phenomena applied to compound-like structures.

Adopting another approach, Kabak and Revithiadou's (2009) suggested that recursive PW construction is morphosyntactically motivated, i.e., "differences in morphosyntactic structure are responsible for the differences in which lexical as well as functional elements are prosodified" (Kabak & Revithiadou 2009: 127). Moreover, according to van der Hulst (2010), elements adjoined to a domain create recursive structures and, consequently, there are no reasons why prosodic structures are not recursive.

More recently, Guzzo and Garcia (to be published) proposed different prosodic organizations in BP, based on syntactic and phonology differences of the clitic "*se*". The authors analyzed a BP variety spoken in a specific Southern region of Brazil, known as an

Italian immigration area. In this variety, due to the contact with Veneto immigrants, there is a variation in the application of vowel raising in clitics and in word-final unstressed vowels. Specifically, the authors observed that vowel raising of clitic "*se*" varies according to its syntactic category. In BP, "*se*" can be a pronominal clitic ('himself/herself'), e.g., "*se machuca*" ('she/he hurts herself/himself'), or a non-pronominal clitic ('if'), e.g., "*se chover*" ('if it rains'). Therefore, the clitic "*se*" belongs two syntactic categories and performs two different syntactic-semantic functions in BP. Statistic results showed that vowel raising of the non-pronominal clitic is more frequent than when "se" is the pronominal clitic in this BP variety. According to the authors, the absence of following segmental context which could explain these differences between the pronominal and the non-pronominal clitics indicates that vowel raising is related to prosodic structure. That is to say, the results indicate that differences between the pronominal and the non-pronominal clitic "*se*" cannot be explained by phonotactic factors only. Thus, "differences in phonological behavior between pronominal and non-pronominal clitics are a consequence of their mapping onto distinct prosodic domains" (Guzzo & Garcia, to be published, p. 8). From this conclusion, the authors argued that the clitic that is syntactically freer (which is the non-pronominal clitic in comparison to the pronominal clitic) would be prosodized at a higher prosodic domain above the PW.

Clitic prosodization possibilities were predicted by the typology proposed by Ito and Mester (2019). The authors dealt with enclisis and proclisis phonology as part of the overall process of syntax-prosody mapping, where the beginning and end of a constituent are of special importance. The empirical topic is the impossibility of phrase-final enclisis in English (e.g. *I don't know where Tom's* vs. *Tom's here*). Based on the analysis of the data on enclisis, the authors presented evidence to place Syntax-Prosody Match Theory under General Correspondence Theory. The researchers nested their proposal within classical parallel Optimality Theory and assessed the predictive power of their constraint system by proposing its factorial typology. This approach seems to be a theoretical alternative to formalization of the data on BP and we will come back to this theoretical issue afterwards.

In conclusion, the literature about clitics in BP states that they are not prosodized within a single PW domain. However, it is also relevant to note that, as in many other languages, clitic prosodization in BP remains under discussion, and empirical data of this language can be added to the debate.

Given both the findings of research in Persian (Hosseini 2012), which showed that duration was relevant to distinguish $[\sigma]_{CL}$ from $[\sigma...]_{PW}$, and the results of studies in BP, which argue that cl-host sequences are not prosodized in a single PW domain, our hypothesis is that the duration of $[\sigma]_{CL}$ compared to $[\sigma...]_{PW}$ is significantly different when both syllables are segmentally identical in BP.

The discussion on the second research question (i.e., *is there a difference between F0 variations that distinguishes the PW from cl-host sequences?*) is based on the description of intonational characteristics that distinguish the PW and cl-host sequences in BP as reported by Toneli (2009, 2014) and Toneli, Vigário and Abaurre (2014). It is possible to have an initial tonal event (in general, high (H) tone) associated to the PW-pretonic syllable, when there are three or more pretonic syllables (Tenani 2002; Toneli 2009, among others).

This tonal event is not associated to functional words adjacent to the PW, according to Toneli, Vigário, Abaurre (2014). However, a pitch accent with a semantic contrast function can occur associated to the PW-pretonic syllables (Toneli 2014). Functional words, in turn, are not associated to pitch accent even if they have a primary stress, such as "*para*" ('for') and "*sobre*" ('about'), a fact which is interpreted as an evidence of its unstressed status in Portuguese (for BP, cf. Toneli 2009; for EP, cf. Vigário 1999), as

it has also been reported with regards to English (Selkirk 1996, for example). However, functional words can be stressed and be associated to a pitch accent of IP domain, when there is a corrective focus stress in phrasal context. In this context, it changes the functional words status to a PW domain, according to Toneli (2009). To sum up, a tonal event can be verified in the PW left edge when it has three or more unstressed syllables, but a tonal event cannot be associated to a function word followed by a PW when they form a cl-host sequence.

We considered these intonational characteristics and investigated what it would be like if the PW domain and cl-host sequences had less than three unstressed syllables. This is a context that does not enable a tonal event to be associated to PW-unstressed syllables, which is a feature that distinguishes this domain from a cl-host sequence. We hypothesized that there would be a pitch range effect that distinguishes the PW domain from cl-host sequences when less than three unstressed syllables are considered.

To answer our research questions, a speech production task was developed, as described in the following section.

3. The experiment

3.1. Participants and ethical issues

Nine female native speakers of the BP-SP variety spoken in the Northwest of the State of São Paulo[2] aged between 18 and 28 participated in the task. At the time the experimental task was conducted, all of them were undergraduate students at São Paulo State University (Unesp), in São José do Rio Preto, Brazil. They participated as volunteers in this study. No participant presented articulation difficulties that could impair sentence production.

This experimental study was approved by the Ethics Committee of São Paulo State University (Unesp), Institute of Biosciences, Humanities and Exact Sciences, São José do Rio Preto, Brazil (process number 64739217.7.0000.5466).

3.2. Experimental procedure

The speech production task consisted of reading twenty-six sentences aloud. The experiment was conducted in two stages. Firstly, the reading of sixteen sentences was recorded in a room with a soundproof cabin at the Phonetics Laboratory of the State University of São Paulo (UNESP). Before performing the task, the participants were instructed to read the sentences as naturally as possible. They were monitored by one of the researchers during the task.

After that, the participants were recorded while reading ten additional sentences. The sentence recording procedure of these additional sentences did not take place at the same Phonetics Laboratory due to restrictions resulting from the coronavirus pandemic. Alternatively, the task was conducted remotely, and the ten sentences were recorded through WhatsApp. Therefore, this stage of the task could not be monitored in person by the researchers. In order to ensure better audio quality, each participant received instructions on the remote recording procedure. The participants were instructed to: (i) send an audio test to the researcher; (ii) stay away from windows and in environments with little noise (e.g., rooms) while recording the sentences; (iii) disable the smartphone notifications; (iv) position the smartphone on a non-vibrating surface; (v) keep the same distance from the smartphone while recording all sentences.

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[2] São Paulo State is the area of Brazil with the largest population of this country, comprising 465 cities with almost 46 million inhabitants. The BP-SP variety considered here is spoken by a community located at 438 km from the city of São Paulo (more information: https://cidades.ibge.gov.br/).

On both stages (i.e., in person and remote procedures), the sentences were presented to participants in random order. After the recording, the audios were edited with the help of Sound Forge Pro 11 software.

In total, eight (30,77%) of the twenty-six sentences (100%) were analyzed since they contained the specific contexts under investigation. The other sentences served as distractors in this study.

3.3. Methods

Eight sentences organized into four pairs were produced in order to answer our research questions:

Question I: Is there a difference between the duration of $[\sigma]_{CL}$ and of $[\sigma...]_{PW}$ which are in the PW boundary?

Question II: Is there a difference between the F0 variation that distinguishes the PW from cl-host sequences?

We presented the sentences below. The relevant structures to the analysis are in boldface type.

Pair		Sentences					
1	(1)	A	Rosa	**ama∅**	**de**	**coração**	o
		The[ART.F.SG]	Rose	love[PRS.3SG]	from	heart	the[ART.M.SG]
		namorad-o					
		boyfriend-M.SG.					
		'Rose loves her boyfriend from the deep of her heart'.					

	(2)	A	Rosa	**ama∅**	**decoração**	de	casamento
		The[ART.F.SG]	Rose	love[PRS.3SG]	decor	of	wedding
		'Rose loves the wedding decor'.					

2	(3)	O	Luiz	**precisa∅**	**de pressa**	com	este	documento
		The[ART.M]	Luiz	need[PRS.3SG]	of hurry	with	this	document
		'Luiz needs this document urgently'.						

	(4)	O	Luiz	**precisa∅**	**depressa**	de	outr-o	ajudante
		The[ART.M]	Luiz	need[PRS.3SG]	quicky	of	other-M	helper
		'Luiz needs another helper immediately'.						

3	(5)	As	meninas	**gosta-∅-m**	**de vaga-r**		pela
		The[ART.F]-PL	girl-F-PL	like-PRS-3PL	of wander-INF	around[F.SG]	
		praça					
		square					
		'The girls like to wander around the square'.					

	(6)	A-s	menin-a-s	**volta-∅-m**	**devagar**	para	casa
		The[ART.F]-PL	girl-F-PL	come-PRS-3PL	slowly	to	home
		'The girls come home slowly'.					

4	(7)	O-s	militante-s	**precisa-∅-m**	**de mais**	pessoa-s
		The[ART.M]-PL	militant-PL	need-PRS-3PL	of more	person-PL
		na	passeata			
		in the[ART.F]	march			
		'The militants need more people in the march'.			

(8) O-s   militante-s **precisa-∅-m demais**   da
     The[ART.M]-PL militant-PL need-PRS-3PL too much of[F.SG]
     concordância do   povo
     agreement   from[M.SG] people
     'Militants really need people's agreement'.

Considering Question I, the unstressed syllable "*de*", which is a clitic (i.e., $[\sigma]_{CL}$), was contrasted with the unstressed syllable "*de*", which is part of a PW (i.e., $[\sigma...]_{PW}$). The **Table 1** presents the target syllables and the relevant PW boundaries.

To evaluate the duration of the unstressed syllable "*de*", we measured the V-to-V unit[3] duration in each target item. According to Barbosa (2006: 30), the V-to-V unit is "a vowel and all subsequent asyllabic segments, regardless of the syllabic boundary, up to the onset of the following vowel, which determines the beginning of the following V-to-V unit".[4] V-to-V unit was proposed by Barbosa (2006) based on a speech rhythm dynamic model. This approach was confirmed by experimental results on BP and French rhythm patterns. According to the Speech Rhythm Dynamic Model, speech rhythm is organized in terms of two oscillators: an accentual one and a syllabic one. On the one hand, the accentual oscillator structures phrasal prominences. On the other hand, the syllabic oscillator organizes the speech stream in units which are delimited by the vocalic onset, i.e., in V-to-V units.

Barbosa (2006) clarifies that, although the length of the V-to-V unit does not overlap with the limits of the phonological syllable, the duration of the V-to-V unit has the same order of magnitude as that of the syllable. Thus, the V-to-V unit is a phonetic measure that can be used for syllables. It was therefore chosen as the unit measurement for this study. The choice of the V-to-V unit over the VOT, a unit widely used in international literature (cf. Hosseini 2012), for example, results from the fact that the occlusive consonant of the target syllable is subject to palatalization. Moreover, V-to-V unit duration was relevant for other prosodic phenomena, specifically preboundary lengthening in BP (cf. Soncin 2018).

We consider the V-to-V units related to unstressed syllables in the PW boundary. Thus, the V-to-V unit initiated at the target syllable vowel onset was measured. **Table 2** presents the V-to-V units along with their measurement and comparison.

Table 1: Target syllables and relevant PW boundaries.

Pair	Sentence	Target syllables and relevant PW boundary	
1	(1)/(2)	[[<u>de</u>]$_{cl}$ [coração]$_{PW}$]$_{cl-host}$	[<u>de</u>coração]$_{PW}$
		[[dʒɪ]$_{cl}$ [koɾaˈsɐʊ]$_{PW}$]$_{cl-host}$	[dekoɾaˈsɐʊ]$_{PW}$
		'from heart'	'decor'
2	(3)/(4)	[(<u>de</u>]$_{cl}$ [pressa]$_{PW}$]$_{cl-host}$	[<u>de</u>pressa]$_{PW}$
		[[dʒɪ]$_{cl}$ [ˈpɾɛsɐ]$_{PW}$]$_{cl-host}$	[dʒɪˈpɾɛsɐ]$_{PW}$
		'of hurry'	'quickly'
3	(5)/(6)	[(<u>de</u>]$_{cl}$ [vagar]$_{PW}$]$_{cl-host}$	[<u>de</u>vagar]$_{PW}$
		[[dʒɪ]$_{cl}$ [vaˈgaɹ]$_{PW}$]$_{cl-host}$	[dʒɪ vaˈgaɹ]$_{PW}$
		'of wander'	'slowly'
4	(7)/(8)	[(<u>de</u>]$_{cl}$ [mais)$_{PW}$]$_{cl-host}$	[<u>de</u>mais]$_{PW}$
		[[dʒɪ]$_{cl}$ [ˈmaɪs]$_{PW}$]$_{cl-host}$	[dʒɪˈmaɪs]$_{PW}$
		'of more'	'too much'

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[3] In the literature, another term for the V-to-V unit is *interval* (cf. Fant & Kruckenberg 1989; Farnetani & Kori 1986; McCrary 2004).

[4] The original text is: "uma vogal e todos os segmentos assilábicos que a seguem, independentemente de fronteira silábica, até o *onset* da vogal seguinte, vogal essa que determina o início da próxima unidade VV".

The V-to-V units were measured and tagged manually based on descriptions from an acoustics handbook, which provide criteria for detecting consonants and vowels in the acoustic signal (e.g., Barbosa & Madureira, 2015; Kent & Read 2007). Examples of this procedure are presented in **Figures 1** and **2**, which were created using Praat software (Boersman & Weenink 2016).

Considering Question II, F0 variation was analyzed by identifying tonal events associated to the intonational contour of the compared sentences. We consider that the pitch accent is associated to the stressed syllable of each PW (of each PPh). Specifically, we observed the pitch accents associated to the stressed syllables of the PWs within the following PPhs: (i) PPhs preceding the targets; and (ii) PPhs composed of the targets (i.e., cl-host and PW). Examples of pitch accent identification are presented in **Figures 3** and **4**, which were also plotted with the Praat software (Boersman & Weenink 2016).

The **Table 3** presents the comparison of stressed syllables in each pair.

Table 2: V-to-V units measured and compared.

Pair	Sentence	V-to-V unit measured in target cl-host	V-to-V unit measured in target PW	V-to-V units compared		
1	(1)/(2)	de_coração [[dʒɪ]cl [koɾaˈsɐʊ]PW]cl-host 'from heart'	decoração [dekoɾaˈsɐʊ]PW 'decor'	(e c) [ɪ k]	X	(ec) [ek]
2	(3)/(4)	de_pressa [[dʒɪ]cl [ˈpɾɛsɐ]PW]cl-host 'of hurry'	depressa [dʒɪˈpɾɛsɐ]**PW** 'quickly'	(e pr) [ɪ pr]	X	(epr) [ɪ pr]
3	(5)/(6)	de_vagar [[dʒɪ]cl [vaˈgaɹ]PW]cl-host 'of wander'	devagar [dʒɪvaˈgaɹ]**PW** 'slowly'	(e v) [ɪ v]	X	(ev) [ɪv]
4	(7)/(8)	de_mais [(dʒɪ]cl [ˈmaɪs)PW]cl-host 'of more'	demais [dʒɪˈmaɪs]**PW** 'too much'	(e m) [ɪ m]	X	(em) [ɪm]
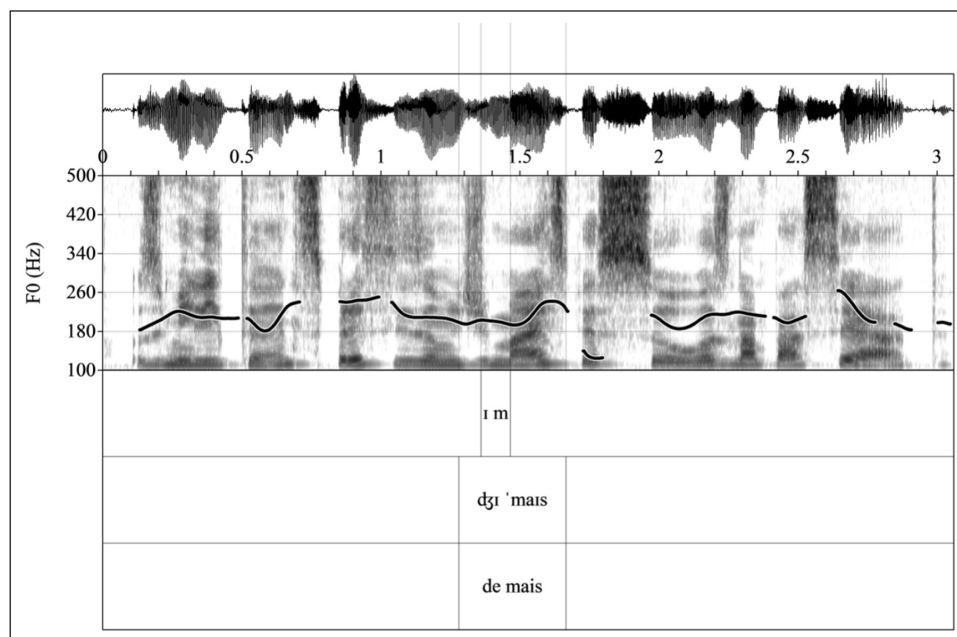
Figure 1: Example of identification of the V-to-V unit [ɪm]. **Target**: [[dʒɪ]cl [ˈmaɪs]PW] ("de mais" ['of more']). **Pair:** 4. **Sentence:** 7.
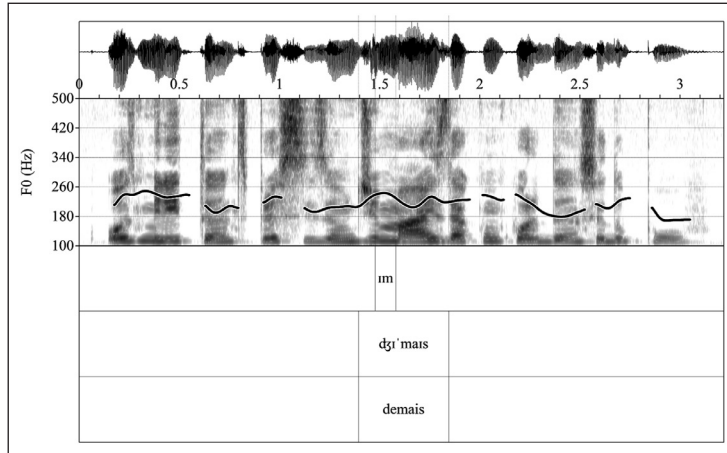
Figure 2: Example of identification of the V-to-V unit [ɪm]. **Target:** [dʒɪˈmaɪs]$_{PW}$ ("demais" [ˈtoo much']). **Pair:** 4. **Sentence:** 8.
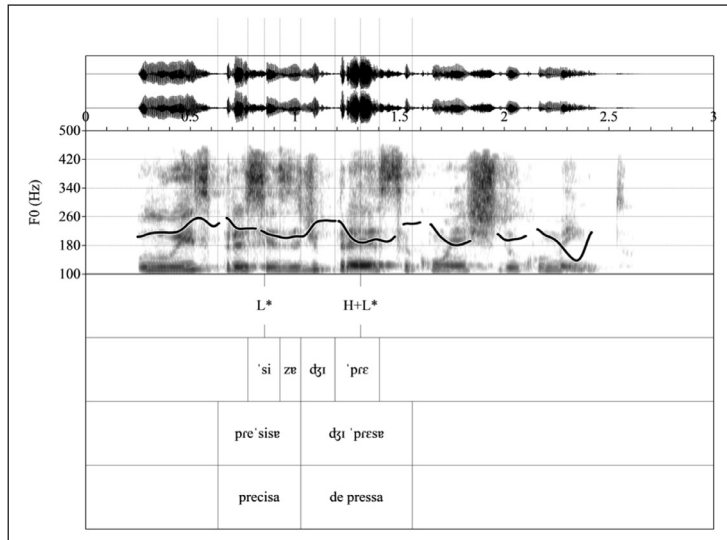
Figure 3: Example of tonal association: L* H+L*. **Targets PPh:** [[pɾeˈsizŒ]$_{PW}$]$_{PPh}$ [[dʒɪ]$_{cl}$ [ˈpɾɛsŒ]$_{PW}$]$_{PPh}$ ("precisa de pressa" [ˈ(he) need of hurry']) **Pair:** 2. **Sentence:** 3.
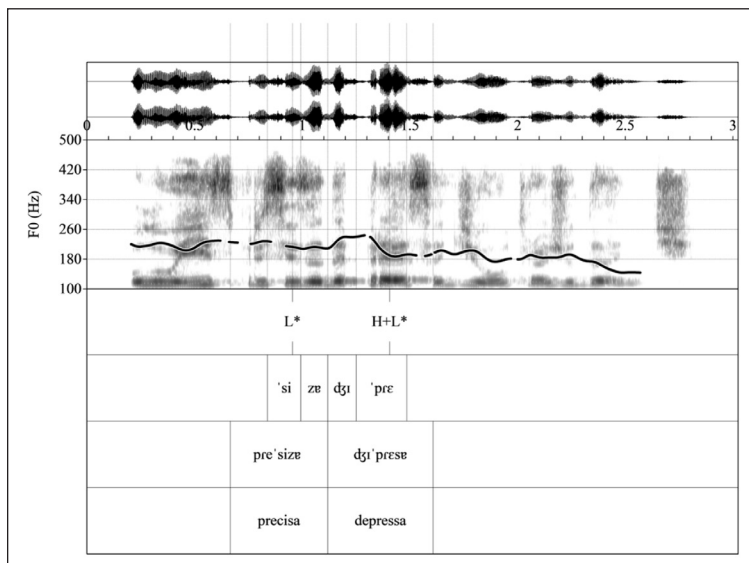
Figure 4: Example of tonal association: L* H+L*. **Targets PPh:** [[pɾeˈsizŒ]$_{PW}$]$_{PPh}$ [[dʒɪˈpɾɛsŒ]$_{PW}$]$_{PPh}$ ("precisa depressa" [ˈ(he) needs quickly']) **Pair:** 2. **Sentence:** 2.

Table 3: Stressed syllables compared.

Pair	Sentence	Stressed syllables cl-host sequences	Stressed syllables PW sequences
1	(1)/(2)	<u>a</u>ma de cora<u>çã</u>o ['ẽ)mɐ dʒɪ kora'sẽʊ] "loves from heart"	<u>a</u>ma decora<u>çã</u>o ['ẽ)mɐ dekora'sẽʊ] "loves decor"
2	(3)/(4)	pre<u>ci</u>sa de <u>pre</u>ssa [pre'sizɐ dʒɪ 'prɛsɐ] "needs to hurry"	pre<u>ci</u>sa de<u>pre</u>ssa [pre'sizɐ dʒɪ'prɛsɐ] "needs quicky"
3	(5)/(6)	<u>gos</u>tam de va<u>gar</u> ['gɔstẽʊ dʒɪ va'gaɹ] "like of wander"	<u>vol</u>tam deva<u>gar</u> ['vɔʊtẽʊ dʒɪva'gaɹ] "come slowly"
4	(7)/(8)	pre<u>ci</u>sam de <u>mais</u> [pre'sizẽʊ dʒɪ 'maɪs] "need of more"	pre<u>ci</u>sam de<u>mais</u> [pre'sizẽʊ dʒɪ'maɪs] "need too much"

3.4. Data analysis

After editing the audio, we used the Praat software to extract both the duration of the sentences and the V-to-V units (in each of the repetitions). The measurements were then normalized in accordance with the ratio between the V-to-V unit duration and the duration of the sentence in which the units were produced.

The duration results were analyzed statistically with the help of Minitab 17 software. The paired-sample t-test was used since the data were interdependent (the controlled variables were always produced by the same informer). To ensure that no differences occurred between the repetitions and between the informers, which could impair the results, a normality test was performed, verifying that the duration between repetitions followed a normal distribution. We used a 5% (α = 0.05) significance level and a 95% confidence level.

4. Results

We analyzed 144 audio subjects (8 sentences × 2 repetitions × 9 subjects). The results are shown following the order of the research questions.

4.1. Question I

The **Table 4** shows the results of the duration comparison between $[\sigma]_{CL}$ and $[\sigma...]_{PW}$ in the four pairs. The V-to-V units duration measurements were compared using a paired-sample t-test. In the comparison between the V-to-V units, the average figure of pair 1 "*de coração*" ('from heart') vs. "*decoração*" ('decor') shows that there were no significant differences between them (p = 0.077). When compared, the average number of the pair presents no difference between "*de pressa*" ('of hurry') vs. "*depressa*" ('quicky'). In the comparison between the V-to-V unit averages concerning the "*de vagar*" ('of wander') vs. "*devagar*" ('slowly') pair, the results showed that there were no significant differences between them (p = 0.154). Similarly, regarding the "*de mais*" ('of more') vs. "*demais*" ('too much') pair, the result of the comparison between the V-to-V unit averages showed that there were no significant differences between them (p = 0.246). Therefore, considering the significance level adopted for this study (α = 0.05), the final result is that the duration is identical for the production of $[\sigma]_{CL}$ and $[\sigma...]_{PW}$ in pair A and pair B.

The answer to the first question is, therefore, that the syllable duration results support the claim that there is no difference between $[\sigma]_{CL}$ and $[\sigma...]_{PW}$. Thus, the hypothesis that

Table 4: Results of the comparison between V-to-V units considering $[\sigma]_{CL}$ and $[\sigma...]_{PW}$.

Pair	Sentences and contexts		V-to-V units Compared	Average	p-value
1	(1)	$[\sigma]_{CL}$	de coração [dʒɪ koɾaˈsɐ̃ʊ] 'from heart'	0.045	
					0.077
	(2)	$[\sigma...]_{PW}$	decoração [dekoɾaˈsɐ̃ʊ] 'decor'	0.040	
2	(3)	$[\sigma]_{CL}$	de pressa [dʒɪ ˈpɾɛsɐ] 'of hurry'	0.071	
					0.676
	(4)	$[\sigma...]_{PW}$	depressa [dʒɪˈpɾɛsɐ] 'quicky'	0.069	
3	(5)	$[\sigma]_{CL}$	de vagar [dʒɪ vaˈgaɾ] 'of wander'	0.0573	
					0.154
	(6)	$[\sigma...]_{PW}$	devagar [dʒɪ vaˈgaɾ] 'slowly'	0.0391	
4	(7)	$[\sigma]_{CL}$	de mais [dʒɪ ˈmaɪs] 'of more'	0.0338	
					0.246
	(8)	$[\sigma...]_{PW}$	demais [dʒɪˈmaɪs] 'too much'	0.0362	

the duration of $[\sigma]_{CL}$ compared to $[\sigma...]_{PW}$ would be significantly different when both syllables were segmentally identical was not confirmed.

In the following section, we present the results for Question 2.

4.2. Question II

The **Table 5** shows the pitch accents associated to each target sequence.

According to Tenani (2002: 33), each PW-stressed syllable which bears a PPh-head has a pitch accent, and a tonal event may occur on PW-unstressed syllables. This optional tonal event depends on the number of unstressed syllables between the stressed syllables of two PW sequences. In the pairs analyzed here, this claim was supported. Firstly, the pitch accents were associated to a stressed syllable of each PW in all sentences. Additionally, a tonal event (H, in general) occurred on the PW2-initial pretonic syllable, as shown in pair 1, for the target PW "*decoração*" ('decor'). In target cl-host, "*de coração*" ('from heart'), a tonal event was not associated to the unstressed syllable "*de*", which is a clitic.

In the pairs with less than three unstressed syllables between the stressed syllables within a two-PW sequence (pairs 2, 3 and 4), a tonal event did not occur associated to the PW2-initial pretonic syllable, neither to the cl-host sequence (PW4). In these sequences, with less than three unstressed syllables between the stressed syllables within the two PWs sequence, we observed a bitonal event (L* + H and H + L*) in the pairs. In addition, a pitch range effect was observed in the bitonal event associated to the PW1-stressed syllable, which lies in the PPh boundary. Therefore, when there was no possibility of a total event to be associated to an PW-initial pretonic syllable (because there were less than three

Table 5: Pitch accent associated to each target PPh and value.

Pair	Sentence	Prosodic Phrasing		Transcription	Value
1	(1)	[[σ̠ σ]₍PW3₎]₍PPh₎	[[σ]₍cl₎ [σ σ σ̠]₍PW4₎]₍PPh₎	[ˈẽmɐ dʒɪ koɾaˈsẽʊ]	
		[[ama]₍PW3₎]₍PPh₎	[[de]₍cl₎ [coração]₍PW4₎]₍PPh₎	'loves from heart'	
		L*+H	H+L*		**11**/18
		L*+H	L*		07/18
	(2)	[[σ̠ σ]₍PW1₎]₍PPh₎	[[σ σ σ σ̠]₍PW2₎]₍PPh₎	[ˈẽmɐ dekoraˈsẽʊ]	
		[[ama]₍PW1₎]₍PPh₎	[[decoração]₍PW2₎]₍PPh₎	'loves decor'	
		L*+H	H L*		**11**/18
		L*+H	L*		07/18
2	(3)	[[σ σ̠ σ]₍PW3₎]₍PPh₎	[[σ]₍cl₎ [σ̠ σ]₍PW4₎]₍PPh₎	[pɾeˈsize dʒɪ ˈpɾɛsɐ]	
		[[precisa]₍PW3₎]₍PPh₎	[[de]]₍cl₎ [pressa]₍PW4₎]₍PPh₎	'needs to hurry'	
		L*	H+ L*		**11**/18
		L*	L*		07/18
	(4)	[[σ σ̠ σ]₍PW1₎]₍PPh₎	[[σ σ̠ σ]₍PW2₎]₍PPh₎	[pɾeˈsize dʒɪˈpɾɛsɐ]	
		[[precisa]₍PW1₎]₍PPh₎	[[depressa]₍PW2₎]₍PPh₎	'needs quicky'	
		L*+H	L*		**14**/18
		L*	H+L*		04/18
3	(5)	[[σ̠ σ]₍PW3₎]₍PPh₎	[[σ]₍cl₎ [σ σ̠]₍PW4₎]₍PPh₎	[ˈg stẽʊ dʒɪ vaˈgaɾ]	
		[[gostam]₍PW3₎]₍PPh₎	[[de]₍cl₎ [vagar]₍PW4₎]₍PPh₎	'like to wander'	
		L*+H	L*		**11**/18
		L*	H+L*		07/18
	(6)	[[σ̠ σ]₍PW1₎]₍PPh₎	[[σ σ σ̠]₍PW2₎]₍PPh₎	[ˈvɔʊtẽʊ dʒɪvaˈgaɾ]	
		[[voltam]₍PW1₎]₍PPh₎	[[devagar]₍PW2₎]₍PPh₎	'come slowly'	
		L*+H	L*		**16**/18
		L*	L*		02/18
4	(7)	[[σ σ̠ σ]₍PW3₎]₍PPh₎	[[σ]₍cl₎ [σ̠ σ]₍PW4₎]₍PPh₎	[pɾeˈsizẽʊ dʒɪ ˈmaɪs]	
		[[precisam]₍PW3₎]₍PPh₎	[[de]₍cl₎ [mais]₍PW4₎]₍PPh₎	'need more'	
		L*	H+ L*		**16**/18
		L*	H+ L*		02/18
	(8)	[[σ σ̠ σ]₍PW1₎]₍PPh₎	[[σ σ̠ σ]₍PW2₎]₍PPh₎	[pɾeˈsizẽʊ dʒɪˈmaɪs]	
		[[precisam]₍PW1₎]₍PPh₎	[[demais]₍PW2₎]₍PPh₎	'need too much'	
		L*	H+L*		**16**/18
		L*	L*		02/18

unstressed syllables between PPh stressed syllables) a pitch range effect was observed on a bitonal event associated to the stressed syllable within the rightmost PPh-head.

We performed an initial examination on the pitch range of the rightmost PW-unstressed syllable within PPh1, as presented in **Table 6**.

In the comparison between PPh1 (before target PW) and PPh3 (before target cl-host), when there was an F0 increase in the unstressed syllable of the rightmost PW, we observed that the pitch range value in PPh1 is wider than the pitch range value in PPh3. Therefore, the pitch range effect was weaker in PPh3 + PPh4 sequences, which confirms the unstressed nature of the clitic.

Table 6: Target syllables, relevant PPh boundary and pitch range value (in semitone).

Pairs	Sentences	Prosodic Phrasing		Values
1	(1)	[a<u>ma</u>]_{PPh3} [ˈ̃ɐ̃mɐ] 'loves'	[(de)_{cl} coração]_{PPh4} [dʒɪ koɾaˈsẽʊ] 'from heart'	0,39st/1,11st
	(2)	[a<u>ma</u>]_{PPh1} [ˈ̃ɐ̃mɐ] 'loves'	[decoração]_{PPh2} [dekoɾaˈsẽʊ] 'decor'	0,17st/5,12st
2	(3)	[preci<u>sa</u>]_{PPh3} [pɾeˈsizɐ] 'needs'	[(de)_{cl} pressa]_{PPh4} [dʒɪ ˈpɾɛsɐ] 'to hurry'	0,07st/5,72st
	(4)	[preci<u>sa</u>]_{PPh1} [pɾeˈsizɐ] 'needs'	[depressa]_{PPh2} [dʒɪˈpɾɛsɐ] 'quicky'	0,41st/11,76st
3	(5)	[gos<u>tam</u>]_{PPh3} [ˈgɔstẽʊ] 'like'	[(de)_{cl} vagar]_{PPh4} [dʒɪ vaˈgaɹ] 'to wander'	0,07st/2,7st
	(6)	[vol<u>tam</u>]_{PPh1} [ˈvɔutẽʊ] 'come'	[devagar]_{PPh2} [dʒɪvaˈgaɹ] 'slowly'	0,46st/5,28st
4	(7)	[preci<u>sam</u>]_{PPh3} [pɾeˈsizẽʊ] 'need'	[(de)_{cl} mais]_{PPh4} [dʒɪ ˈmaɪs] 'of more'	0,13st/1,67st
	(8)	[preci<u>sam</u>]_{PPh1} [pɾeˈsizẽʊ] 'need'	[demais]_{PPh2} [dʒɪˈmaɪs] 'too much'	0,90st/3,22st

The answer to the second question is therefore that the F0 variation is a phonetic cue that distinguishes [σ]_{CL} and [σ…]_{PW}. Thus, these results lead us to formulate the hypothesis that a pitch range effect could be a F0 cue to distinguish PW sequences from cl-host sequences when less than three unstressed syllables between PPh-heads were observed. We highlight that it is necessary to increase the number of informants and perform statistical analysis of the data in order to confirm this hypothesis.

5. Discussion

The production experiment presented sought to find duration and F0 cues that distinguish [σ]_{CL}, which bears a PW boundary (e.g., "*de vagar*" 'of wander'), from [σ…]_{PW}, which does not present any PW boundary (e.g., "*devagar*" 'slowly'). The main question to be answered is: are there phonetic cues to distinguish the PW from the clitic-host sequences prosodization?

The first experimental results support the claim that the syllable duration (V-to-V unit) measure does not distinguish [σ]_{CL} from [σ…]_{PW} in the BP-SP variety. The hypothesis was that the duration of [σ]_{CL}, when compared to that of [σ…]_{PW} would be significantly different when both syllables were segmentally identical. This hypothesis was based on the expectation that the presence of a prosodic boundary between the syllable and its host would increase in the duration of the boundary adjacent syllable when compared to the prosodic word pretonic syllable which does not bear that boundary.

Such results concerning the BP-SP variety differs from those found for Persian (Hosseini 2012). In this language, there is phonetic evidence that supports the claim that there is a duration difference between [σ]_{CL} and [σ…]_{PW}. The segmental duration measure (based

on the VOT unit) increases in the case of a cl-host sequence in comparison with the segmental duration measure. This result supports the interpretation that there is a prosodic boundary between the clitic and its host in Persian. In contrast, the result for the BP-SP variety demonstrates that there is no significant difference in the syllabic duration of the clitic and its host when compared to the duration of the prosodic word pretonic syllable. This result leads us to a first interpretation that the clitic and its host are prosodized within the same domain when no segmental process distinguishes these two sequences.

This interpretation, based on duration measurements, partially follows those from BP-South variety phonologic evidence obtained by Bisol (2005), Brisolara (2008) and Simioni (2008). These studies argue that clitic-host sequences do not belong to the same PW domain in the prosodic hierarchy. They differ from one another in terms of which is the relevant prosodic domain, but the main claim of these studies is that the cl-host sequence is prosodized in a domain above that of the PWs.[5] Our duration results support this main claim and no evidence was found of which is the relevant prosodic domain.

An auditory perception test developed by Silva (2018, 2019) considered two segmental sequences that belong to different prosodic domains: on the one hand, cl-host sequences, such as "*de Creta*" ('from Crete'), i.e., a prepositioned noun phrase, and, on the other hand, PW sequences, such as "*decreta*" ('[he/she] decrees'), i.e., an inflected form of the verb "*decretar*" ('to decree'). A perception test was conducted with native speakers of the BP-SP variety; the recorded speakers spoke the same BP variety. These speakers tended to produce the /e/-raising and the /d/-palatalization when a $[\sigma]_{CL}$ was involved (the sequence was "[dʒɪ] creta") with no accompanying segmental processes when a $[\sigma...]_{PW}$ was involved (the verb form was "[de]creta"). The listeners were able to distinguish these sequences, and they identified the expected sequences. However, these listeners were not able to distinguish the sequences when the segmental processes were applied to $[s]_{CL}$ and to $[s...]_{PW}$, as in the case of "*de pressa*" ('of hurry') vs. "*depressa*" ('quickly'). Based on these results, Silva (2018, 2019) argues that phonological evidence is the key to distinguishing the cl-host sequence from the PW based on the speaker's perception of these two sequences.

This perceptual result and the previous reported duration results lead us to claim that a prepositional clitic is prosodized as a syllable adjoined to its host. This interpretation, based only on prepositional clitic syllable duration, follows the more widely accepted claim that clitics in BP are prosodized in domains above the PW when the application of phonological processes is considered, notably the raising and the elision of the vowel /e/ across the PW boundary (Bisol 2005; Brisolara 2008; Simioni 2008).

Based on phonological processes observed in the BP-South variety, Brisolara (2008) proposes that the recursive PW is the relevant domain for the prosodization of pronominal clitics in pronoun-verb sequences. She argues that there is a symmetry in the prosodization of pronominal clitics, which can occur to the right verbal boundary, e.g., "*ajude-me*" ('help me'), or to its left boundary, e.g., "*me ajude*" ('help me'). In both positions, the pronoun constitutes a recursive PW with its host. Also based on phonological processes observed in the BP-South variety, Bisol (2005) proposes that clitics, in general, are prosodized in the Clitic Group. According to this author, an intermediate constituent between the PW and the PPh like a Clitic Group is the relevant domain for the elision of the vowel /e/, which

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[5] The studies by Bisol (2005) and Simioni (2008) are based on different theoretical frameworks and propose different consequences for the clitic prosodization domain. Bisol (2005) affirms that the clitic and its host are prosodized at the Clitic Group (following Nespor & Vogel 1986, whose model fits into the Nonlinear Phonology theoretical framework), but Simioni (2008) interprets the clitic as being prosodized at the PPh domain (following Selkirk 1996, which is inserted into an Optimality theoretical framework).

is a phonological process that would take place exclusively between a clitic and its host, e.g., "*de + um dia pro outro > dum dia pro outro*" ['overnight'] (cf. Bisol 2005: 175).

Therefore, in the absence of duration evidence, our proposition follows Brisolara (2008) and Bisol's (2005) approaches, whose main claim is that clitics are not incorporated into the host. As argued in these studies, the $[\sigma]_{CL}$ "*de*" is subject only to post-lexical phonological rules. As explained in the Introduction, the $[\sigma]_{CL}$ "*de*" is produced as "[dʒɪ]" in the BP-SP variety. This means that the clitic is subject to the vowel raising and the /d/-palatalization processes, which, according to Bisol (2005), are classified as post-lexical rules in BP. Such as in Brisolara's (2008) study, the vowel raising of the $[\sigma]_{CL}$ "*de*" stems from a neutralization rule applied to vowels in word-final unstressed position. This statement is supported by Marcato (2013), which reported that the BP-SP variety prepositional clitics are not similar to pretonic syllables, with regard to the vowel raising process. In this study, the $[\sigma]_{CL}$ "*de*" was subject to a neutralization rule applied to 94,68% of vowels in word-final unstressed position. Therefore, the phonological process underwent by the $[\sigma]_{CL}$ "*de*" supports Brisolara's (2008) proposition that a cl-host is a recursive PW, which is similar to Vigário's (2003) approach to cl-host prosodization in EP.

Considering the previous discussion, the answer to the question, "*Is there a difference between the duration of $[\sigma]_{CL}$ and $[\sigma...]_{PW}$ that are in the PW boundary?*", is: the syllable duration measurements support the interpretation that the prepositional clitics are prosodized as a syllable adjoined to its host. This result-based interpretation leads us to suggest that the relevant domain for prepositional clitic prosodization is between PW and PPh in BP.

Question II addressed the discussion about whether the pitch range can be a F0 cue for distinguishing the PW from cl-host sequences. We considered structures in which the unstressed functional words within the PW sequences are comparable to the cl-host sequences when they have the same segmental string and the same number of syllables.

In (6.1), there are <u>more</u> than three syllables between the stressed syllables of the two PWs sequences, which configures a context in which (i) pitch accents (T*T) are associated to stressed syllables of each PW (of each of them is a PPh) and (ii) a tonal event (T) may occur on the rightmost PW-initial syllable. In (6.2), this tonal event is not present, because the PW has only two unstressed syllables and the clitic does not bear tonal events. These results corroborate the criterion for distinguishing PWs from cl-host sequences in BP, as stated by Toneli, Vigário and Abaurre (2014).

(6)   (6.1) $[[...\underline{\sigma}\ \sigma\ ]_{PW1}]_{PPh}$ $[[\sigma\ \sigma\ \sigma\ \underline{\sigma}...]_{PW2}]_{PPh}$
                        T*T   **T**   T*T

       (6.2) $[[...\underline{\sigma}\ \sigma]_{PW3}\ ]_{PPh}$ $[[\ [s]_{cl}\ [\sigma\ \sigma\ \underline{\sigma}\ \sigma]_{PW4}]]_{CG}]_{PPh}$
                        T*T   T*T

In (7.1), there are <u>less</u> than three syllables between the stressed syllables of the two PWs sequences, which configures a context in which (i) pitch accents (T*T) are associated to each PW-stressed syllable and (ii) a tonal event associated to the rightmost PW-initial unstressed syllable does not occur. Under these conditions, a pitch range effect is observed on the bitonal event T*T associated to the PW-stressed syllable, which also bears the pitch accent of PPh. We stress the fact that this pitch range effect on T*T is not observed in (7.2) sequences.

(7)   (7.1) $[[...\underline{\sigma}\ \sigma\ ]_{PW1}]_{PPh}$ $[[\sigma\ \underline{\sigma}...]_{PW2}]_{PPh}$
                        T*T   T*T

(7.2) $[[...\underline{\sigma} \, \sigma]_{PW3}]_{PPh}$ $[[[s]_{cl} \, [\underline{\sigma} \, \sigma]_{PW4}]_{CG}]_{PPh}$
        T*T   T*T

Following Ladd (1996), we suggest that this pitch range effect might be a phonetic manifestation of phonological relations between the prosodic constituents considered. According to our interpretation, the higher pitch level on a bitonal event associated to the PW1-stressed syllable may be a phonetic effect which permits to identify the PW sequences in (7.1) just like the tonal event associated to the PW2-initial unstressed syllable in (6.1) does. The comparison between (6.1–6.2) and (7.1–7.2) suggests that F0 variations is a phonetic cue to distinguishing the PW sequences from cl-host sequences prosodization in BP. We predict that the F0 variation will take place on a tonal event associated to the second PW-initial syllable, if this second PW has three or more unstressed syllables and a minimum distance between the PPh-heads (as 6.1). Conversely, a pitch range effect may take place on a tonal event associated to the first PW-stressed syllable, if the second PW has less than three unstressed syllables (as 7.1). The comparison between (6.1–7.1) and (6.2–7.2) suggests that cl-host prosodization occurs in a different domain from that of the PPh.

Considering the discussion above, the answer to the question "*Is there a difference between the F0 variations that distinguishes the PW from cl-host sequences?*" is: the F0 variations support the interpretation that PW sequences are different from cl-host sequences, suggesting that the prepositional clitics are prosodized as a syllable adjoined to its host.

This answer, based on F0 cues, follows the interpretation of cl-host prosodization we proposed previously, which was based on duration measures. The comparison of these results about the interpretation possibilities of cl-host prosodization lead us to suggest that the relevant domain for prepositional clitic prosodization is a domain between the PW and the PPh. This is the interpretation more widely accepted when we consider the studies about the prosodic domains of phonological processes in BP, such as the ones we addressed on section 2.

However, a question remains to be answered: in which domain is the prepositional clitics prosodized? As it can be observed from the formalization in (6.1–6.2) and (7.1–7.2), we suggest that the relevant domain for prepositional clitics prosodization in BP is between the PW and the PPh.

We take into account that the prosodic domain for clitic prosodization lies between the PW and the PPh domains, because we assume that the F0 variation results is a positive evidence to distinguish the PW from cl-host sequences and these clitics would be prosodized in a domain that is different from the PPh.

The possible domains for clitic prosodization are clitic group (Nespor & Vogel 1986, 2007), composite group (Vogel 2009) and prosodic word group (Vigário 2010). The clitic domain adopted by Bisol (2005) for BP has many theorical and analytical problems arising from the strict layer hypothesis as it was initially formalized by Nespor and Vogel (1986). It seems that this type of problem was solved by the CG, proposed by Vogel (2009). This option seems to be relevant to consider since it includes structures with clitics and affixes as well as compound word structures. Although the PWG domain proposed by Vigário (2010) is an appropriate approach for compound words, it is not meant to be the clitic domain for prosodization, but for the recursive PW.

Finally, we would like to bring into consideration the Ito and Mester (2019) approach to clitic prosodization based on the General Correspondence Theory. The constraint system they have proposed can provide a breakthrough in the interpretation of BP cliticization data. We believe that this approach will allow us to take a step further in promoting the

derivation of different facts about clitic prosodization in BP as effects of syntax-prosody mapping. This is a relevant topic for future research.

6. Final Remarks

In this paper, we have shown that the syllable duration measurement (V-to-V unit) supports the claim that there is no distinction between the prepositional clitic syllable and the PW-pretonic syllable in the BP-SP variety. The F0 variation, however, does not support this claim, since the F0 variations distinguish the PW sequences from cl-host sequence prosodization. These two results lead us to suggest that the relevant domain for prepositional clitic prosodization is between PW and PPh in BP-SP. Therefore the clitic prosodization domain differs from that of the PW domain. Our main result is that the F0 variation depends on the number of pretonic syllables of the second PW within a PPh: a tonal event is associated to the PW2-initial unstressed syllable, if this PW2 has three or more unstressed syllables, or a pitch range on tonal event is associated to the first PW-stressed syllable, if the PW2 has less than three unstressed syllables. Inspired by Ladd (1996), we suggest that this pitch range effect might be a phonetic manifestation of phonological relations between the prosodic constituents considered here.

Two issues for future research are: 1) could the duration cue support the claim for the existence of a prosodic boundary between a word and a clitic if another syllable of the clitic-host sequence is considered (for instance, the syllable preceding the clitic)? and (2) could the F0 variation be a more robust acoustic cue to support an intonational configuration associated to the cl-host sequences that differs from the one associated to PW? In addition, we would like to know if there would be a phonetic cue hierarchy for the investigated boundary and, for instance, if a F0 cue might be relevant in the lack of a duration cue. In comparison to Persian, where a duration cue supports the boundary between clitic and its host, we hypothesize that a F0 cue may be relevant for distinguishing the PW boundaries from cl-host boundaries in BP.

Identifying the syllable that belongs to the PW and the syllable that is a phonological clitic in BP lies at the core of the discussion of phonetic cues to identify the PW in BP and, consequently, clitic prosodization in this language, in comparison to others. The issues described here are meant to suggest a research agenda about a variety of Portuguese with the potential to support broader theoretical and methodological discussions of the addressed topics.

We highlight that the production test allowed us to evaluate what the syllable duration measure and F0 cues of the BP-SP variety were under limited conditions. This work has limitations related to the fact that only one segmental context was analyzed, and only a limited amount of data from informants of only one BP spoken variety were considered. The measure of the pitch range effect in the specific context lacks statistical evidence, since we had a limited number of informants. Therefore, this is a preliminary study, and the proposed research questions are its main contribution to future research. Generalizing the results presented here requires the design of different segmental context tests and data collection from informants speaking different varieties of Portuguese.

Therefore, when the results about syllable duration described in this paper are compared to those of a phonological and perceptual nature reported by Silva (2018, 2019), we question which is (or whether there would be) a robust phonetic cue for lower prosodic boundaries in the BP-SP variety, namely, a cue to the prosodic boundary between the clitic and its host when this type of sequence is similar to PW sequences. We sought to answer to this question considering the intonation configuration of the domains within which each of the sequences will be inserted.

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Competing Interests

The authors have no competing interests to declare.

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