Master's thesis in General Linguistics

Phonological Aspects of Arara (Carib, Brazil)

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Abstract

The Cariban language family originally had about 40-50 members, of which 20 or more languages are still spoken today. Among these languages, many still lack thorough studies. The number of speakers of the different Cariban languages varies from 12,000 to three individuals. Arara is among the languages that have a reasonable number of speakers, but it is poorly described. This paper attempts to complement the existing studies by presenting an analysis of the phonological system of the language.

This study examines the vowel and consonant inventories, and their allophonic variation. The main process observed is assimilation. Stress, syllable structure, consonant clusters and vowel sequences are also investigated. The phonetic investigation focuses on both the articulatory and acoustic phonetics. Duration and vowel quality are the main cues analyzed. Aspects of an acoustic analysis of consonants are explored to a lesser degree. The analysis offered here consists of an initial exploration of the language. It should be stressed that in-depth investigation of the phonology of Arara remains is still to be done.

Acknowledgments

I want to express my gratitude to some people who helped to carry out this study, as well to people who helped in many ways.

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Contents

1. Introduction

Arara is a Cariban language spoken in northern Brazil by about 300 individuals. The language is also known as *Arara do Pará* in order to differentiate the group from other Arara groups located in the country, such as Arara Shawãdawa (*Arara do Acre*), a Panoan language, and Arara Karo (*Arara de Rondônia*), a Tupian language. In this study, I will use the word 'Arara', literally 'macaw' in Portuguese, to refer only to the Cariban Arara language. In the following, an analysis of the sound system of Arara is offered. Native speakers generally recognize dialectal variation; however, phonologically, the two existing dialects are very similar. This study is based mainly on the variety spoken in the village of *Cachoeira Seca*, although I will also mention features of the dialect spoken in the *Laranjal* village. The only other Arara village, *Volta Grande do Xingu*, has no remaining speakers. I start with a brief description of the sociolinguistic situation in the villages as well as the place of the language in the Cariban family. In the second section, I present and discuss the consonant inventory. In the third section, I describe the vowel inventory. This is followed by a description of the stress pattern and its phonetic correlates. In section five, I present the syllable structure along with the consonant clusters and vowel sequences attested in the corpus.

1.1 The Arara language and the Cariban linguistic family

Map 1. 💡: Arara geographic localization. Adapted from UNESCO Interactive Atlas of the World's Languages in Danger. Available at: http://www.unesco.org/culture/ich/index.php?pg=00206.

The Cariban linguistic family consists of approximately 25 living languages that can be found in a large area of the Amazon region, including Venezuela, Colombia, Guyana, French Guiana, Suriname and Brazil[1]. In Brazil, most of the Cariban languages are distributed in two major branches: a northern branch, found in the northernmost region of the country, north of the Amazon river, and a southern branch, primarily located in the Xingu indigenous area[2]. The Arara people live in isolation from other Cariban peoples, being located between the two major concentrations of Cariban groups (see map 1). They are surrounded by Tupian groups, such as Assurini, Araweté, Juruna, among others.

The exact position of Arara within the Cariban family and its relation to other languages is still not very clear, especially since the available material has not been sufficient to provide a solid basis for comparison. Rodrigues (1986), based mainly on the similarity of some lexical items, proposed Arara as the most closely related language to Ikpeng. Pachêco (2001) also presented some shared lexical items, but in addition compared some morphosyntactic features, thereby reinforcing the genetic relationship. Furthermore, Meira and Franchetto (2005) have suggested that Arara is also closely related to Bakairi and less closely related to Kuikuro[3]. In their view, the three languages- Arara, Ikpeng and Baikari- form a subgroup within the southern branch, which they called the 'Pekodian[4]' subgroup. However, further comparison of the morphology and syntax in these languages is still necessary in order to assert the exact degree of affinity that Arara holds in relation to Ikpeng and Baikari. A classification of Arara within the southern Cariban languages would contribute to the complete description of the linguistic family and, more broadly, it would provide support to various proposals regarding the migration of the Cariban groups, as observed by Meira and Franchetto (2005).

[1] The count of languages presented here follows Meira (2006). For an overview of extant classifications of the Cariban family, see Gildea (1992, 1998).
[2] *Parque Indígena do Xingu*.
[3] However, this work adopted the classification presented in Rodrigues (1986) and Pachêco (2001), and was not evaluated independently with Arara data.
[4] The name comes from the words for 'woman' in Bakairi, 'pekodo', and Ikpeng 'petkom' (Meira and Franchetto, 2005).

1.2 The Arara people and the sociolinguistic situation

Map 2. Arara indigenous areas. Adapted from UNESCO's Interactive Atlas of the World's Languages in Danger.

The Arara people, as the group is called in Portuguese, refer to themselves as [ugrɔ̃ɲˈmɔ] which means 'the people, we'. Currently, they live in three villages: *Arara* (*Laranjal*), *Cachoeira Seca do Iriri* and *Arara da Volta Grande do Xingu.* The first two villages are located on the banks of the Iriri river, a tributary to the Xingu River, and the other village is located more to the north, on the right banks of the lower Xingu River (see map 2). In the *Laranjal* village, there are 236 native speakers. A smaller number of Arara speakers is found in the *Cachoeira Seca* village, where there are 98 individuals, all native speakers. The group from the third village, *Arara da Volta Grande do Xingu,* have only recently identified themselves as Arara descendants. Since 2008, the Brazilian authorities have recognized their claim. This community has 98 inhabitants, none of whom speaks Arara; however, there is interest in learning the language[5].

The Arara communities are essentially young and comprised of mostly children and teenagers, along with some adults and a few elderly people. In *Cachoeira Seca* and *Laranjal*, only the older

[5] *Fundação Nacional da Saúde* (FUNASA), census 2009.

members of the communities can be considered monolinguals. The majority of the population has some proficiency in the national language, Portuguese, which is acquired mainly through school and television.

According to the UNESCO classification presented in the Interactive Atlas of the World's Languages in Danger (2009), the Arara language at the present is considered 'vulnerable', which is defined as a language community where most children speak the language, but it may be restricted to certain domains (e.g., the home). 'Vulnerable' is the lowest degree of endangerment considered by the UNESCO classification. As such, notwithstanding the small number of Arara speakers, this classification apparently suggests that the situation is not quite alarming. Relative to many Brazilian native languages that are severely endangered (with languages from many different families having only a handful of speakers, such as Ayuru [Tupí] and Oro Win [Chapacura]), this may be the case. However, the current classification of Arara does not mean that the language deserves less attention or is somehow safe. The endangerment status of the language implies a shift in the transmission and use of the native language, even while some transmission is still taking place. Therefore, this status shows that urgent initiatives should be carried out in favor of the documentation and maintenance of this language.

The Arara economy is built around what the people collect or hunt in the forest. The river is also an important source of subsistence, as well as the fruits and root crops cultivated on small farms. In addition, some families raise chickens and ducks. These sources of livelihood form a natural cycle based on the dry and rainy seasons, as described in detail in Teixeira-Pinto (1997). Nowadays, a few people earn a salary in the villages being employed as nursing assistants. Another way to earn money is by selling handicrafts in the nearest city, Altamira (PA, Brazil). Sometimes, people move to this city temporarily in order to work and bring goods back to the village, including sugar, coffee, salt, batteries and clothes, among other things.

1.3 Previous studies

The Arara people became well-known in the 1970's during the construction of the Trans-Amazonian Highway, which passed right through the area where some of their groups were living at the time. Previously, the Arara people were considered to be extinct. The advent of highway construction in the area brought national attention to this indigenous group that many believed had already disappeared. The 'Brazilian expansion' into the forest fueled an antagonistic relationship between the Arara people and the non-indigenous people. After many years of solid resistance involving the loss of many lives, the last group accepted permanent contact with the Brazilian Bureau of Indigenous Affairs (FUNAI)[6] in the late years of the 1980's. Since then, a number of studies on the Arara people and their language have been carried out, mainly from an anthropological perspective.

Teixeira-Pinto (1997) presents the most extensive work: an ethnographic description that has as its central theme the analysis of the '*Ieipari'* ritual, a celebration involving trophies formed from the skulls of enemies. Among other anthropological works, Coelho (2003) examines the lyrics of some traditional songs, and Estival (1991) describes instrumental music performances that are part of a ritual in the dry season.

There are two preliminary linguistic studies: Isaac Souza (1988) and Shirley Souza (1993). The former is a survey based only on the variety spoken in the *Laranjal* village. It presents a detailed phonetic transcription of the language. This transcription includes: complex segments such as a pre-fricative lateral, initially devoiced glides [ʬw, ʭj], and partially voiced nasals [mm̥, n̪n̪̥]; a voiced dental implosive [ɗ̪]; and, among other peculiarities, lowered and raised articulation (represented by the symbols '˯', '˰') and retracted and advanced articulation ('˒', '˓') of the vowels. Souza's phonemic analysis results in 11 consonant segments /p, t, k, tʃ, m, n, ŋ, l, r, w, j/ and 6 vowels /a, e, i, ɨ, o, u/. The elaborate phonetic inventory he presents is not followed by an

[6] The Brazilian federal institute that is responsible for the indigenous peoples of Brazil.

instrumental phonetic analysis of any kind. The second study (Souza 1993) focuses on an analysis of some Arara morphological features. In this description, the voiced plosives are given phonemic status, which is different from the earlier analysis presented in Souza (1988). None of these works discusses aspects of the dialect spoken in *Cachoeira Seca*.

1.4 The data

The data analyzed in this study were recorded in the field by the linguist Vilacy Galucio and the author during a visit of two weeks to the villages of *Laranjal* and *Cachoeira Seca* in July 2009. The main collaborators were nine native speakers of Arara. Four of them are from *Cachoeira Seca*: Tybribi [tɨbᵊriˈbi], Iau [jaw], Tjoktjogulo [tʃɔkˇtʃɔguˈlɔ] (known as Arapuka) and Kuit [kuitˇ], three men and one woman, respectively. The other five are from *Laranjal*: Lalau [laˈlɑw], Toliktu [tɔlikˇtu], Motibi [mɔtʃiˈbi], Moko [mɔˈkɔ] and Akui [akuˈi], two women and three men, respectively. The age of the main consultants ranges from 20 (Akui) to 35 (Motibi) years old.

The corpus consists of approximately 600 lexical items recorded with a Marantz recording device and head worn microphone. The elicitation sessions were based on a 400 word list, which was adapted from the Swadesh list for use in the Amazon region by the linguists of *Museu Paraense Emílio Goeldi*, a Brazilian federal research institute. The list is organized by semantic fields; there are references to cultural objects, fauna and flora commonly found in the area, kinship terms, body parts, elements of nature, and basic grammatical items. In addition, the corpus contains words from the Carib comparative list made by Spike Gildea, some verbal and nominal paradigms as well as some brief sentences.

1.5 Presentation

The International Phonetic Alphabet (IPA) comprises a set of symbols and diacritics that have been consistently used to describe languages of all around the world. In this report, I generally use IPA symbols and their usual phonetic values for an approximate specification of the articulations of Arara sounds. The present analysis follows the presentational model of the *Illustrations of the IPA* found in The *Journal of the International Phonetic Association (JIPA).* This journal is

"especially concerned with the theory behind the International Phonetic Alphabet and discussions of the use of symbols for illustrating the phonetic structures of a wide variety of languages" (http://journals.cambridge.org/action/displayJournal?jid=IPA). I follow traditional phonemic theory and incorporate some aspects of theories that have their basis in the distinctive features analysis, such as that outlined in the seminal work Sound Pattern of English (SPE) (Chomsky and Halle, 1968).

2. The Arara consonant inventory

In table one, I present the consonant inventory of Arara. Allophonic variation and distribution of each phoneme will be discussed organized around natural classes of segments. Phonologically significant contrasts will be illustrated through the (near) minimal pairs presented in the following subsections.

	Bilabial	Alveolar	Palatal	Velar
Plosives	p b	t d		k g
Affricate			t͡ʃ	
Nasal	m	n		ŋ
Flap		ɾ		
Lateral		l		
Approximant	w		j	

Table 1. Phonemic consonants[7]

2.1 Plosives

Arara plosives /p, t, k, b, d, g/ are produced as unaspirated consonants. In the coda position, the phonemes /p, t, k/ are pronounced mostly as non-released consonants, as in words like [piˈɾɔkˀ] 'black fly', [iˈbɨtˀ] 'female', [pikˀˈtu] 'drink', [tagwɛtˀˈkẽm] 'sugar, sweet'.

Voiceless plosives occur in syllabic onset or coda, as in [tɔp.ˈkakˀ] 'bow', [ɛk.ˈtãn] '(tree) branch'. Voiced plosives can also occur in syllabic onset or coda positions, but do not occur in the peripheries of the word. In internal coda position, these phonemes only occur when followed by the approximants /l, r, w/, as in [ɛ.dabᵊ.ˈrũn] 'door', [igᵊ.ˈɾu] 'tapioca, *beiju';* [kut.kug.ˈwi] 'hawk sp.'; [ɔd.ˈwatˀ] 'hammoc'; [wag.ˈwak] '*jacupemba*', [ugᵊ.lũŋ.ˈmo] 'our tongue'. Within a single

[7] A voiceless glottal fricative consonant [h] was attested in the words [kuhku] 'owl sp.' and [kahkitˀ] 'female name', however further studies need to be carried out in order to understand the distribution of this segment.

morpheme (non-derived word) the sequence [C.j] (C=plosive) has not been observed (but see allophones of /t/).

The voiced plosives occupy an interesting position in the Arara system: they have apparently become fully independent phonemes through recent developments[8]. It is common for Cariban languages to have only a series of voiceless plosives in their consonant inventories, sometimes with voiced allophones (Meira, 2005). In Arara, some (near-) minimal pairs demonstrate the contrast between the voiced and voiceless series of these sounds in an intervocalic position (see examples in (1)).

(1)

/p/-/b/	/t/-/d/	/k/-/g/
[ɨˈpɨ] ‘root sp (*cará*)’	[mɨˈta] ‘monkey sp.’	[waˈkatˀ] ‘alligator’
[ɨˈbɨ] ‘stone’	[mɨˈda] ‘wait’	[waˈga] ‘white vulture[9]’
[waˈpi] ‘*taboca* arrow’		[waˈgɔ] ‘sloth sp.’
[waˈbi] ‘fish sp. (*peixe-cachorro*)’		

Free variation in intervocalic position has been attested in certain words, as in [ibonaˈɾi] ~ [iponaˈɾi] ‘young leaf of *tucum*’, [jɔˈgɔ] ~ [jɔˈkɔ] ‘bee sp.’, [itɔɾɔˈɛ] ~ [idɔɾɔˈɛ] ‘owl sp’. This variation was observed in the data provided by one speaker in particular and would appear to be less frequent in the speech of other speakers. In this sense, further elicitation with more speakers would be worth in order to establish the exact synchronic stage of plosives contrast in the language and if there is change in progress. Free variation has been attested in other positions as well. However, in careful speech, only the voiceless variety occurs in the peripheral positions of words. As for variation in the word-final position, the non-released plosives can be perceptually ambiguous when perceived out of context. This is due to the voice lag of the previous vowel that is sufficiently long to give the impression of a voiced consonant. The waveform exemplifies the final plosive of the word /toˈlutˀ/ [tɔˈluḏˀ] ‘ripe, soft’.

[8] Recent studies- I. de Souza (1988) and S. de Souza (1993)- disagree on the phonemic status of these plosives.
[9] Elicited only in *Laranjal* village. The collaborator from *Cachoeira* village did not recognize this word.

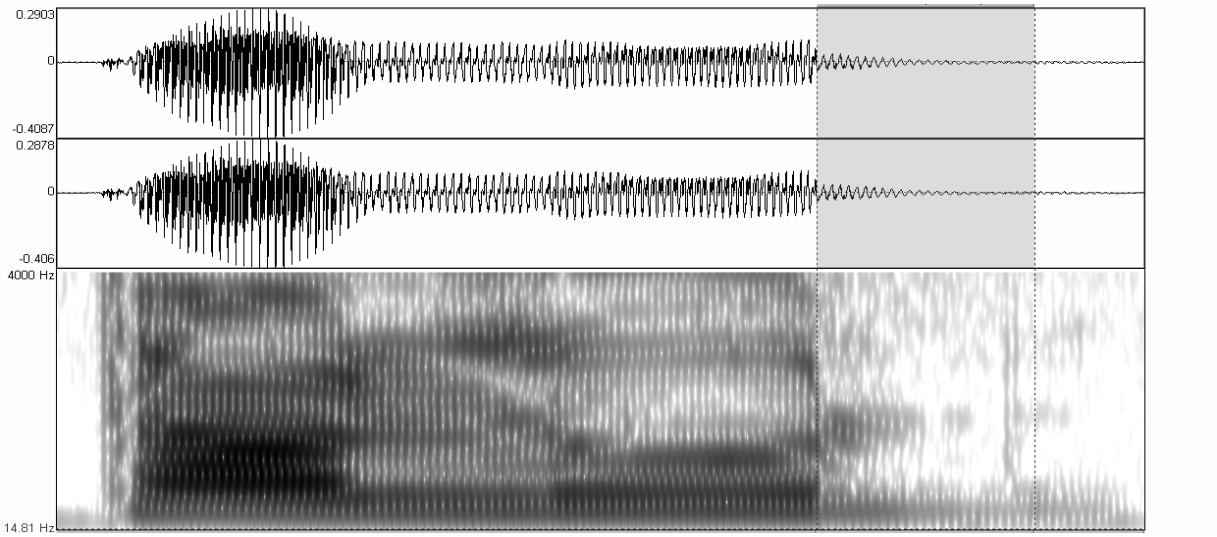


Figure 1. Waveform and spectrogram of the word /toˈlutˀ/ [tɔˈluḍˀ] ‘ripe, soft’. Voice lag is highlighted.

A possible explanation of the variation outlined above can be found in the hypothesized historical development of the voicing contrast in Bakairi, one of the languages that are genetically more closely related to Arara. Meira (2005) argues that diachronically voiceless plosives became voiced between vowels, except when they occurred in consonant clusters. In this case, one of the plosives became a glottal stop which was deleted afterwards (Proto-Carib *VCCV > *VʔCV > Bakairi VC $_{[-VOICE]}$V (Meira, 2005), C=/p, t, k/), and a new series of intervocalic voiceless plosives arose, which contrasted with the voiced plosives. In Arara, such a diachronic process could account for the fact that only voiceless plosives occur in careful speech at the peripheries of words. In intervocalic position, as stops become voiced, variation arises; the older voiceless variants alternate with the new voiced ones. This suggests that voiceless consonants are prone to vary with their voiced counterparts, but not the other way around. When CC clusters are reduce to simple voiceless plosives, some voiceless stops vary freely with their voiced counterparts (i.e. those that had been simple voiceless plosives in intervocalic position), while others do not (i.e. those that were part of CC clusters, or occurred at the peripheries of worlds). This would lead to phonogenesis, in which ‘non-varying’ plosives would contrast with ‘varying’ plosives – the former would be the new voiceless plosive phonemes /p, t, k/ and the latter the new voiced plosive phonemes /b, d, ɡ/. Later on, the voiced plosive phonemes stabilize, being always voiced [b, d, ɡ],

while the voiceless plosive phonemes /p, t, k/ begin again to become voiced, in intervocalic position, creating variation ([p]~[b], [t]~[d], [k]~[ɡ]) for at least some words. As a result, present-day /k/ may be stable in some cases, as in the word [wɔkɔˈri] and vary in others, [jɔˈkɔ]~[jɔˈgɔ], but /ɡ/ is always stable, as in the word [ɔgɨˈpu]. This is illustrated in the examples below.

(2) /k/ [k]~[ɡ] [jɔˈkɔ] ~ [jɔˈgɔ] ‘bee sp.’
/k/ [k]~[ɡ]* [wɔkɔˈɾi] [wɔgɔˈɾi]* ‘dog’
/ɡ/ [ɡ]~[k]* [ɔgɨˈpu] [ɔkɨˈpu]* ‘snake sp. *(jararaca)*’

The synchronically observed cases of clusters with a voiced plosive (/b, d, ɡ/) always involve another voiced consonant, usually an approximant (/l, r, w/, which never had a voiceless counterpart). These cases are also probably the result of the loss of vowels. Although one may not exclude the possibility that a cluster with one of these voiced approximants might also be one of the environments (like the intervocalic environment) in which voiceless stops could likely become voiced.

2.1.1 Some phonetic aspects of plosives

Voice onset time (VOT) corresponds to the interval between the plosive release and the voicing onset of the next vowel. It differentiates voiced and voiceless categories of plosives in many languages, such as English, Dutch, Tamil, Korean, among others (Lisker and Abramson, 1964). This is also true for Arara. The main difference between voiced and voiceless plosive is the presence of VOT in this last category. Since /b, d, ɡ/ may be fully or partially voiced, vocal fold vibration may not alone be indicative of the voicing status of the plosive sounds.

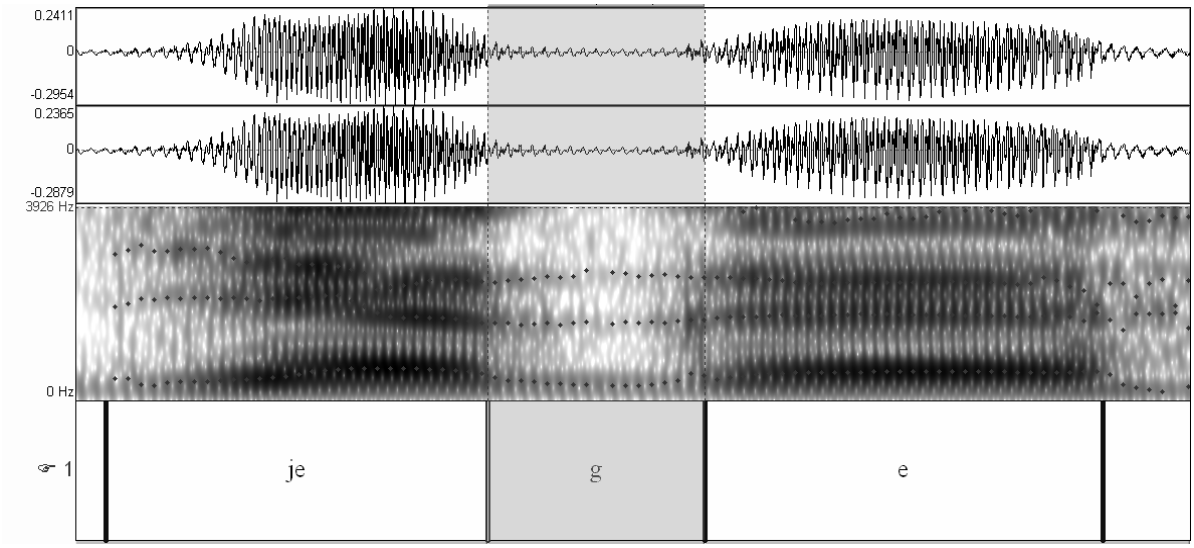


Figure 2. Waveform and spectrogram of a fully voiced plosive from the word /jege/ ‘woodpecker’.

As the figure 2 illustrates, fully voiced plosives present small harmonic amplitudes during the closure of the articulators, while partially voiced plosives tend not to present low-frequency harmonics before the plosive release (cf. Figures 2 and 3).

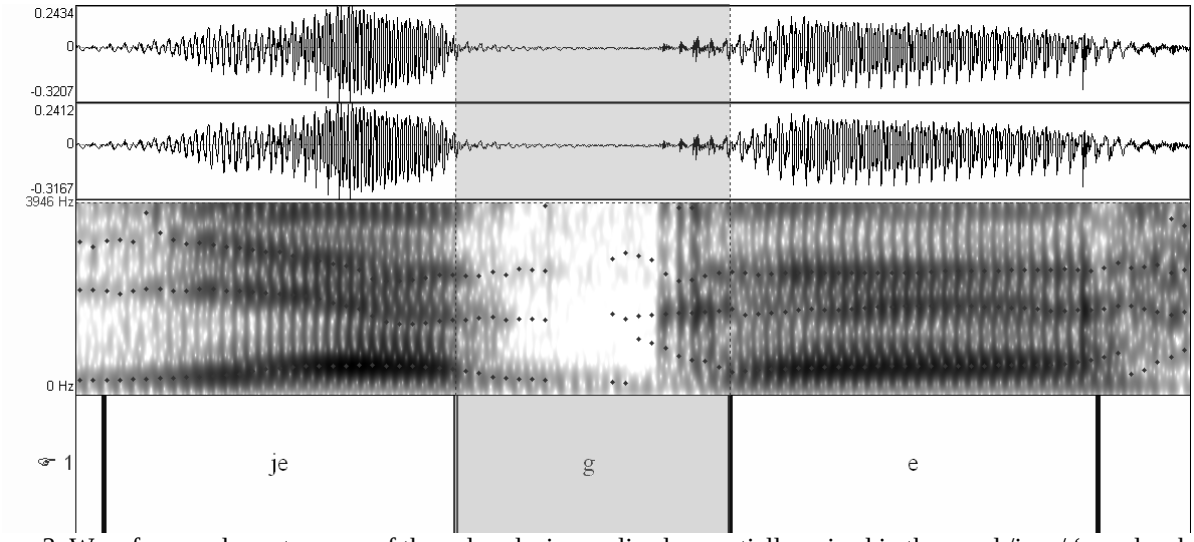


Figure 3. Waveform and spectrogram of the velar plosive realized as partially voiced in the word /jege/ ‘woodpecker’.

In many languages, VOT of voiceless plosives is sensitive to place of articulation. Usually, /p/ presents the lowest VOT values, while /k/ shows the highest values: p < t < k. In addition, aspirated plosives present higher VOT than their non-aspirated counterpart: p^h > p, t^h > t, k^h > k. Table 2 illustrates Arara VOT mean values of voiceless plosives. The measurements come from segments in the onset position of final and non-final syllables of words pronounced in isolation. The results demonstrate that plosives present short VOT, that is, there is no aspiration. Bilabials

and alveolar plosives present comparable VOTs and the greatest VOT is characteristic of the velar plosive, around 37 ms (see detailed description of analyzed words in section 4).

	Non-final		Final
p	Mean	15	19
	s. d.	5	7
t	Mean	18	17
	s. d.	5	8
k	Mean	37	36
	s. d.	9	9

Table 2. Mean values and standard deviation of plosives VOT in ms.

2.1.2 *Voicing assimilation*

Voicing assimilation in certain intervocalic position is a general phenomenon in both villages. Plosives occurring at word boundaries followed and preceded by vowels or the labiovelar glide take over the voicing of these environments[10] (see examples in (2)).

(2) /p/ /kurɐp ɔmrɔ/ 'you are beautiful' → [kurɛb#ɔmrɔ]

/t/ /oriŋko tarik/ 'big pan'→ [ɔɾĩŋkɔ#daɾikˀ]

/wampiat wanpɐ/ '*bacaba* juice is bitter' → [wãmpiad#wãn+pɛ]

/k/ /wawri kurɐp/ 'tasty *bacaba* juice'→ [wawɾi#guɾɛpˀ]

/tuduk wɨna/ 'give it to me (imp.)' → [tudug#wɯna]

Voicing assimilation also occurs in word initial position when a vocalic morpheme is attached to the root. Some examples are in (3):

(3) /paraˈta/ 'plate' → [ɨ+baraˈtãn] 'my plate'

/tukˈto/ 'field' → [ɨ+dukˈtɔ̃n] 'my field'

/papa/ 'father' → [ɨ+baˈpãn] 'my father'

Another context where voicing assimilation occurs is in postnasal positions. A nasal causes a following voiceless obstruent to be voiced, including the affricate. However, contrary to the

[10] I use '+' to indicate morpheme boundaries and '#' for word boundaries.

previous voicing assimilation process, voicing assimilation in nasal context does not apply to both dialects. It would appear that only in the *Laranjal* dialect is voicing assimilated, while in the *Cachoeira Seca* dialect the obstruents remain voiceless in this position. The assimilation process occurs both within the morpheme and across morpheme boundaries. Table 3 gives examples for each dialect.

	Word – gloss	*Laranjal*	*Cachoeira Seca*
Single morpheme	/impɔ/ '*pequi* fruit'	[ĩᵐᵇbɔ]	[ĩᵐᵇpɔ]
	/kumanta/ 'bean'	[kumãⁿda]	[kumãⁿta]
	/imumtʃi/ 'head'	[ĩmũᵐᵇdʒi]	[ĩmũᵐᵇtʃi]
Morpheme boundary	/igwãm kɔ/ 'sit (imp.)'	[igwãm+ᵑgɔ]	[igwãm+ᵏkɔ]
	/tɔgwamte uro/ 'I am sat'	[tɔgwãm+dɛ#uⁿrɔ]	[tɔgwãm+tɛ#uⁿrɔ]
Word boundary	/ɨmren pɨt͡ʃin/ 'my son's leg' /ugon kurep/ 'handsome man'	[ɨmrɛ̃n#bɨᵈt͡ʃĩn]	[ugõn#kuⁿrɛpˀ]

Table 3. Obstruents' sonorization according to each village

Note that, as seen in section 2.1, the unique environment where voicing assimilation does not occur is within non-derived words, except in the cases where the variations take place.

2.1.3 Allophones of /d/

In the *Cachoeira Seca* dialect, the voiced alveolar plosive /d/ in intervocalic position, or between a vowel and the labiovelar glide /w/, can be pronounced by curving the tongue tip up and back into the mouth, resulting in a retroflex articulation [ɖ]. Sometimes, it can even be pronounced as a retroflex flap [ɽ]. In the Figure 4, we can observe both possible realizations, which would appear to be free variants of each other.

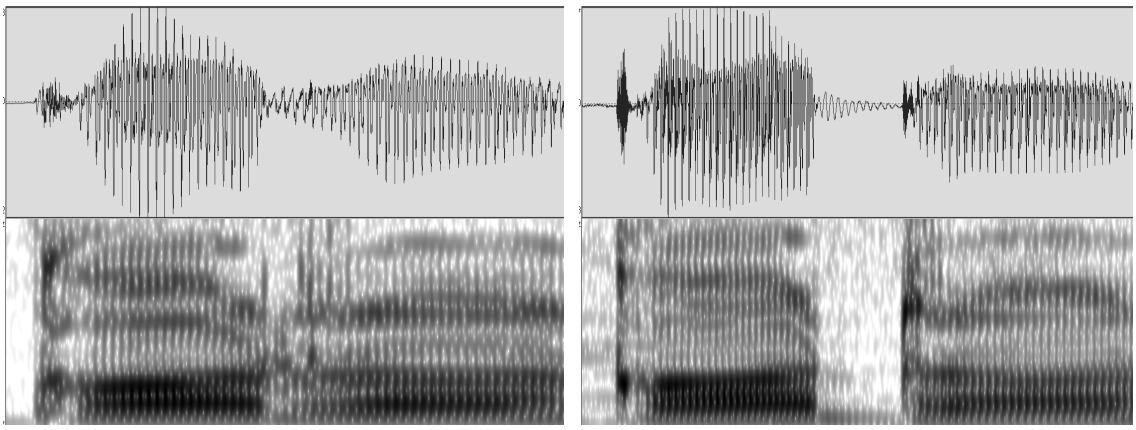


Figure 4: Waveforms and spectrograms of the retroflex consonants in intervocalic position, [kɔɽɔ] (left) and [kɔɖɔ] (right). Allophones of /d/ in the word /orekodo/ ‘mouse sp’.

On the right, the retroflex is articulated as a plosive. We can observe a small amplitude of the fundamental frequency in the waveform during the closure period, followed by a burst at the release moment. On the left, when it was pronounced as a flap, there is no evidence of articulatory closure or release. Some other examples:

(4) /odwat/ ‘hammock’ → [ɔɖˈwatˀ] ~ [ɔɽˈwatˀ],
/jedwet/ ‘my hammock’ → [jɛɖˈwɛtˀ] ~ [jɛɽˈwɛtˀ]
/tudo/ ‘owl sp.’ → [tuˈɖɔ] ~ [tuˈɽɔ]

Besides, palatalization as a secondary articulation was attested. During the alveolar articulation /d/, the front of the tongue may rise toward an i-like position before the high back vowel. Palatalization occurs in words like /aˈdu/ ‘fire, firewood’ → [aˈɖʲu]; /jɛdu/ ‘beetle sp.’ → [jɛˈɖʲ u]; /ɨdukton/ ‘my field’ → [ɨdʲukˈtɔ̃n].

In *Laranjal*, no retroflex articulation has been observed, however the alveolar plosive /d/ can be articulated as a flap [ɾ], as in /idara/ ‘fly’ → [iɾaˈɾa] or /jɛdɛm/ ‘my husband’ → [jɛˈɾɛ̃m] .

2.1.4 Allophones of /t/

The voiceless alveolar plosive /t/ can be realized as the alveolar flap [ɾ] when it occurs in a word boundary position in intervocalic environments.

(5) /pɔnɛ tarikˀ/ → [pɔnɛ ɾarikˀ] (or [pɔnɛ darikˀ], as seen in 2.1.2)
‘big catfish’

/paru tɨt urɔ/ → [paɾu ɾɨɾ uɾɔ] (or [paɾu dɨd uɾɔ])

'I want water'

Neutralization of the alveolar /t/ and the affricate /tʃ/ occurs before the palatal glide /j/ or the high front vowel /i/ (see affricate in section 2.2). Some examples are:

(6) /onat jodo/ → [ɔnatʃɔɖɔ] /kampɔt jatkɨru/ → [kãmpɔtʃatkɯɾu]
maize owner fire ash
'maize's owner' 'fire's ash'

/ kut-ip-ta / → [kutʃipta] /ɨ-bɨt idwɛtˀ/ → [ɨbɨtʃidwɛtˀ]
3PL-take a bath-FUT 1S-wife hammock
'we are going to take a bath' 'my wife's hammock'

The corpus also presents a few examples where, instead of being neutralized with the affricate, the alveolar plosive /t/ is voiced in the environment mentioned above.

(7) / wɔt itˈpɨn / → [wɔditˈpɨ̈n] /wɔt jɛpi/ → [wɔdjɛpi]
'fishbone' 'fish scale'

Plosives phones are summarized in Table 4:

/p/ →	[p] / V_V, #_, _# [b] / V_#V , V#_V [b] / N_, V_V	/t/ →	[t] / V_V, #_, _# [tʃ] / _#j, V_+i, V_# i [ɾ] / V_#V , V#_V [d] / V_#V, V#_V, V_#j [d] / N_, V_V	/k/ →	[k] / V_V, #_, _# [g] / V_#V, V#_V [g] / N_, V_V
/b/ →	[b] / V_V [b] / _l [b] / _r [b] / _w	/d/ →	[ɖ] / V_V [ɽ] / V_V, V_w [ɾ] / V_V, V_w [d] / V_V [dʲ] / _u	/g/ →	[g] / V_V [g] / _l [g] / _r [g] / _w

Table 4. Plosives phones.

The above allophonic variations are optional. The phoneme /t/ has four phones: [d], [ɾ], [tʃ] and [t]. The allophones [t], [d], [ɾ], [tʃ] may occur in the same environment, between vowels, but [tʃ] only

occur before /i/, /j/. Voiced plosive allophones preceded by a nasal only occur in the *Laranjal* dialect. The phoneme /d/ can be realized as: [ɖ], [ɽ], [ɾ], [d] and [dʲ]. The allophones [d], [ɖ], [ɽ] and [ɾ] may occur in intervocalic positions; [ɽ] and [ɾ] also occur before the labiovelar glide /w/; [dʲ] occurs before the high back vowel /u/. The retroflex allophones only occur in the *Cachoeira Seca* dialect, and in free variation with their non-retroflex counterpart [ɖ] ~ [d], [ɾ] ~ [ɽ]. Thus, in the *Laranjal* dialect, only [d] and [ɾ] are allophones of /d/. In both dialects, voiced plosives allophones occur in intervocalic positions or before the approximants /l, w, ɾ, j/.

2.2 The affricate

Arara has a voiceless affricate phoneme /t͡ʃ/. Its occurrence is restricted to syllabic onset positions. This consonant is more frequent before /a/ and /i/ as in [t͡ʃaˈmitˀ] ‘monkey sp.’ and [ɪ̃ᵐpɨaˈt͡ʃi] ‘arm’.

There are few examples in the corpus of this consonant before /u/: [wɔˈt͡ʃũm] ‘fish sp (*Piaba)*’ and before /o/: [rõŋˈt͡ʃõm] ‘bird sp’. It has not been observed occurring before the other vowels /e/ and /ɨ/. Notice that the simple alveolar /t/ also occurs in analogous environment where the affricate /t͡ʃ/ occurs. Some examples are:

(8)

/t͡ʃ/		/t/	
[mɨˈt͡ʃãŋ]	‘caterpillar’	[tagãntaˈga]	‘butterfly’
[t͡ʃagaktʃaˈga]	‘banana sp.’	[tiɛgɾɔˈdɔ]	‘wood pecker sp.’
[t͡ʃiˈɾ̃ɪ̃ŋ]	‘star’	[ituˈtũn]	‘vagina’
[t͡ʃɔkt͡ʃɔguˈlɔ]	‘male name, bird sp.’	[tɔˈkɛp]	‘put’

2.3 Nasals

The nasal consonants /m, n, ŋ/ of Arara can occur in the onset or coda position of a syllable. In contrast to the other nasals, the velar nasal never occurs word-initially. Nasal consonants do not assimilate the place of articulation of adjacent segments. The alveolar nasal can be palatalized as [ɲ] before the high front and high back vowels as in the following examples:

(9) /ɔnŋɔn+um[11]/ → [ɔnŋɔ̃ɲum] (domesticated) ‘cacao fruit’

/ɛnibɛŋ/ → [ɛɲiˈbɛ̃ŋ] ‘carry’

There is an isolated example of the bilabial nasal /m/ being realized as the bilabial plosive [b]: [ɨmnu] ~ [ɨbnu] ‘my meat, body’. This may be a result of diachronic processes where *punu, the proto-word for ‘flesh’, is nasalized after an elision, leading to the synchronic form /imnu/: *punu[12] → v-bunu → v-bnu → v-mnu. (Near) minimal pairs are presented below to illustrate the phonemic status of each nasal consonant.

(10)

/n/-/t/		/m/-/b/	
[ipũn] ‘foot’	[iputˇ] ‘body hair, skin’	[imɨ̃n] ‘belly’	[ibɨ̃n]‘brother’
/n/-/d/		/m/-/p/	
[idũn]‘jealousy’	[inũn] ‘pig’s smell’	[imũn] ‘son’	[ipũn] ‘foot’
/ŋ/-/k/		/n/-/l/	
[kɔ̃ŋˈpɔ] ‘rain’	[kɔkˈpɔ] ‘wild fruit’	[ɔnat] ‘mice’	[ɔlat] ‘can’
/n/-/ŋ/		/m/-/n/	
[anɔ̃n]‘ink, painting’	[aŋɔ̃n] ‘rest’	[imũn] ‘son’	[inũn] ‘pig’s smell’
/ŋ/-/g/			
[ɨ̃ŋᵘɾu] ‘your eye’	[igᵘɾu] ‘*tapioca, beiju*’		

2.4 Liquids

The liquids are the lateral approximant /l/ and the flap /ɾ/. The lateral /l/ occurs only in onset position. In the *Cachoeira Seca* dialect, its pronunciation can be slight retroflex. The flap /ɾ/ also occurs only in onset position, but with a slight difference between dialects. Only in the *Cachoeira Seca* dialect are there occurrences of this phoneme in word-initial position. In corresponding words in the *Laranjal* dialect, there is an initial vowel before the flap, as illustrated in (11).

(11)

Cachoeira Seca	*Laranjal*	Gloss
[ɾutˇpu]	[uɾutˇpu]	‘termite’

[11] The augmentative suffix ‘-um’ is also used to denote the domesticated status of a plant or animal.
[12] Meira (2010) personal communication.

[ɾɛˈɾɛ]	[ɛɾɛˈɾɛ]	‘bat’
[ˈɾɔ̃ŋ]	[ɔˈɾɔ̃ŋ]	‘earth’
[ɾatˀkatˀ]	[aɾatˀkatˀ]	‘kingfisher’

Some minimal pairs of both phonemes are:

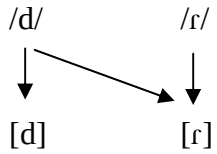
(12) /ɾ/-/l/ /r/-/d/

[iˈɾu] ‘older brother’ [iˈlu] ‘tongue’ [aˈɾɔ] ‘lung’ [aˈḍɔ] ‘fish sp (*mandi*)’

[ibɔˈɾɨ] ‘mouth, lip’ [ibɔˈlɨ] ‘navel’

As observed in overviews of the language family, with few exceptions (Bakairi, Ikpeng), Cariban languages do not use to have a phonemic distinction between [l] and [r] (see Derbyshire (1999) and Meira (2006)). In Arara, the flap [ɾ] represents an interesting case of neutralization, since it occurs as an allophone of two different phonemes /r/ and /d/. This is exemplified in the fact that [aˈdɔ] can vary with [aˈɾɔ] for /adɔ/ ‘fish sp (*mandi*)’, but [a’ɾɔ] cannot vary with [aˈdɔ] for /aˈɾɔ/ ‘lung’:

/adɔ/ 'fish sp.' ~ [aɾɔ]
/aɾɔ/ 'lung' *[adɔ]



2.5 Glides

The glides are the palatal /j/ and the labiovelar /w/. Both of them are produced without friction. The labiovelar /w/ is articulated with slight lip rounding. These consonants frequently occur in the onset position of a syllable. In the corpus analyzed, there are only a few examples of these glides in the word-final position, generally in proper names. These are [i.aw] and [waj], both male names. Also, the word [ka.re.ˈi] ‘non-indigenous person’ is sometimes pronounced as [ka. ˈrej][13]. Within a single word morpheme, the corpus does not present any occurrences of glides in an

[13] This last term is known as a “South-Americanism” and is found in many indigenous languages of Amazonia, but whose origin is unclear. The fact that the more archaic word for non-indigenous is [udɔtˀ] suggests that [karej] is probably a loan word in the language.

adjacent position to their closest vowels /i/ and /u/. However, these glides segments are probably best analyzed as phonemes in their own right, rather than allophones of /i, u/ in the onset position of a syllable. The assigned phonemic status avoids sequences of four vowels in the same word, as in [wa.ˈjɔ] ‘gourd (*cuia*)’ (which could be [u.a.i.o]). Other examples, including a minimal pair, are presented in (13):

(13)	[iˈwɛtˈ]	‘his excrement’	[ɔˈjɔtˈ]	‘tree sp. (*cumaru*)’
	[iˈbɛtˈ]	‘his leg’	[wajuˈgɔ]	‘*irara*’
	[ɛˈwɛ]	‘palm tree sp. (*murumuru*)’	[iwaˈjɔ̃n]	‘ his/her plate ’
	[waˈjũm]	‘bee sp’		

In our sample, there is one unique example from the *Cachoeira Seca* dialect where the palatal approximant [j] appears to have a voiced affricate [dʒ] as an optional variant. This is in the word /jɛlɨ/→[dʒɛˈlɨ] ‘my vagina’. Variation has not been observed in other words.

Further analysis of Arara personal prefixation might clarify whether the glides belong to the consonant class of phonemes, despite their vocalic quality. Gimson (2001) explains that phonetic criteria and phonological analysis may assign different categories to the same unit, for instance, the consonantal function of the English glides /j, w/ are provided by the article behavior when combined with these segments. Thus, *the* is pronounced /ðɪ/ or /ðiː/ before a vowel as in *the ear* /ðɪ iər/, and /ðə/ before a consonant as in *the cat* /ðə k^{h}æt/, *the year* /ðə jɪər/, *the watch* /ðə wɒtʃ/. This evidence demonstrates that /j, w/ belong to the consonantal category, though they are phonetically described as being vowel-like.

3. The Arara vowel inventory

As is typical for Cariban languages, Arara presents six contrastive oral vowels /a, e, i, ɨ, o, u/. Length and nasalization are not distinctive features. However, oral vowels can be nasalized to some degree. It is common to perceive a phonetic glottal stop or a glottal fricative after a word or an utterance that ends with a vowel. The glottal stop, thus, may assume a demarcative function by

signing morphological boundaries. The phonemic contrast between each vowel is demonstrated with the following (near) minimal pairs:

/ɛ/ : /i/ : /a/	/ɔ/ : /ɨ/	/ɛ/ : /ɨ/
[kuˈbɛ] ‘arrow’	[kɔˈtʃi] ‘fish sp.’	[iˈbɛtˀ] ‘his leg’
[kuˈbi] ‘poisonous liana’	[kɨˈtʃi] ‘dust, dirt’	[iˈbɨtˀ] ‘his wife’
[kuˈba] ’tatu’		

/a/ : /ɔ/	/ɛ/ : /u/	/ɔ/ : /e/
[iˈbakˀ] ‘far’	[mɔˈbɛ] ‘*cajá* fruit’	[iˈwɔt] ‘his fish’
[iˈbɔkˀ] ‘above, on’	[mɔˈbu] ‘canoe’	[iˈwɛt] ‘his excrement’

/ɔ/ : /u/	/i/ : /ɨ/	/u/ : /ɨ/
[tʃiˈgɔ] ’flea’	[iˈputˀ] ‘his skin, body hair’	[joˈɾu] ‘land tortoise’
[tʃiˈgu] ‘urine’	[ɨˈputˀ]‘my skin, body hair’	[juˈɾɨ] ‘pig mud’

3.1 Acoustic analysis

The acoustic analysis presented below illustrates formant frequencies of Arara vowels. The analyzed vowels come from words pronounced in isolation by speakers of the *Cachoeira Seca* dialect. F1 and F2[14] were examined at five points along each Arara vowel. However, in some tokens, fewer points were considered in order to avoid transition effects. The starting point of each waveform was measured from the initial zero-crossing of the first complete wave cycle. The end point was measured from the final zero-crossing of the last cycle. The starting and ending points were considered in relation with the formant frequencies, as illustrates figure 3. No quality change was observed along the analyzed vowels.

[14] The lowest formant frequencies– F1 and F2– are the acoustic cues mostly used to characterize/identify vocalic sounds (Ladefoged, 2001a; 2001b).

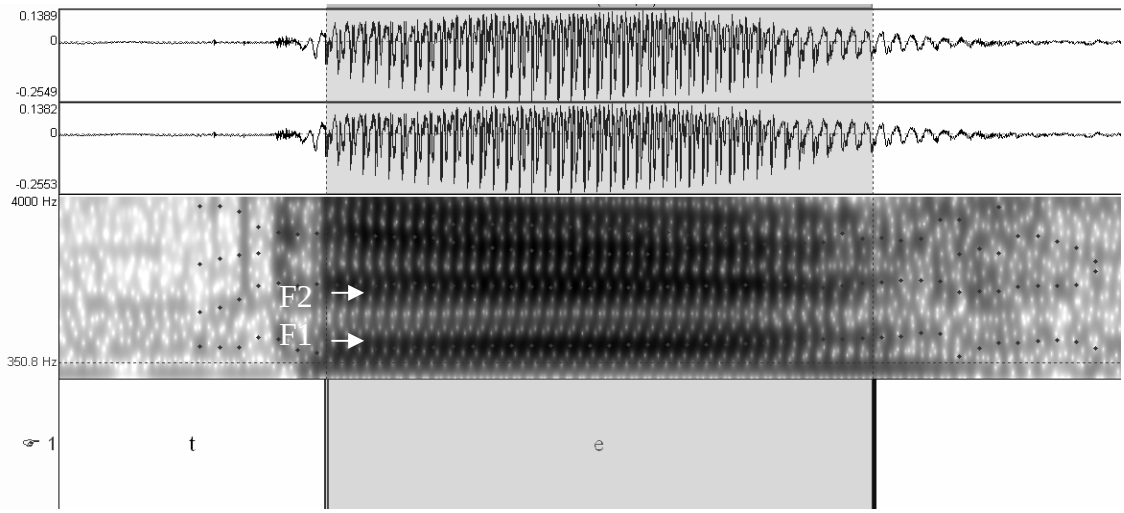


Figure 5. Spectrogram and waveform of the last vowel in the word /pɨlepˈtɛ/ ‘knife’.

All vowels were in open syllables in final and non-final word positions. Nasalized vowels, sequences of vowels, as well as sequences of glides and vowels were avoided. The words that the analyzed vowels were selected from are in Tables 5 and 6. Table 5 illustrates the words recorded with one female speaker[15] and Table 6 illustrates words recorded with three male speakers. Analyzed vowels are underlined.

amimˈru	his/her belly	imaŋaˈrɨ	her breast, his/her chest	ɔlaˈtʃi	your mouth
aˈgan	mat	impɨatʃi	arm	ɔmaŋaˈrɨ	your breast or chest
ɨbaˈnan	my ear	ibɔˈrɨ	lip	ɔˈpun	your foot
ɨˈbɨ	stone	iˈpun	foot	ɔbanãn	your ear
ɨˈpɨ	root	igˈru	tapioca, *beiju*	ɔmpɨatʃi	your arm
ɨˈbɛ	my lower leg	jamimˈru	my belly	pɨlɛpˈtɛ	knife
ɨˈpun	my foot	kwaˈrɨ	straw	paraˈta	plate
ɨdɔpˈtʃi	my bow	kuruaˈtʃi	vulture sp.	pɨtʃiˈga	knife
ɨlaˈtʃi	my mouth	karaˈtɔ	gourd	pɔrɛŋˈkɔ	armadillo
ɨmpɨaˈtʃi	my arm	kɔdɛgˈwat	cotton	pɔriˈdɔ	basket
ɨmaŋaˈrɨ	my breast or chest	kuˈbi	poison vive *(timbó)*	tɔrɔˈtʃi	bird sp. *(sabiá)*
ɛŋpiˈputˀ	eyebrow	kuˈbɛ	arrow	tauˈpa	banana sp. *(nanica)*
ɛˈpi	bark, leather, skin	kuˈrɛp	good, beautiful	takɨˈi	manioc flour
ɛdaˈlup	fast	kumanˈta	bean	tukˀtuˈku	turtledove
ɛdɛgumˈri	knee	maraˈpa	boat oar	waˈpi	arrow
imˈpɔ	*pequi* fruit	manˈtɔ	*tucum*	warɛˈkɔ	deer sp.
idɛgumˈri	your knee	munˈpɔ	mouse sp.	wɔŋɔbɔˈtʃi	vulture sp.
idɔpˈtʃi	his/her bow	ɔtpiˈdɔ	armadillo sp.	wamimˈru	your belly
ilaˈtʃi	his/her mouth	ɔtˈpɛ	warm		
iˈlu	his/hertongue	ɔdɔpˈtʃi	your bow		

Table 5. Words used in the acoustic analysis for the female charts.

[15] The size and shape of speaker’s vocal tracts bias formant frequencies, mainly between male and female speakers, and between adults and children. (Liberman and Blumstein,1988; Ladefoged, 2001a).

adɔ	fish sp.	kaˈra	parrot sp.	rutˈpu	terminate
awaˈbɛ	bee sp.	kɔt͡ʃaduˈlɨ	I got burned	t͡ʃiˈbri	spider
ɨbɛt	my upper leg	kɔˈt͡ʃi	fish sp. *(piau)*	t͡ʃiruˈka	wild dog
ɨbɨt	my wife	kutʃaˈmit	monkey sp.	tʃarɔktʃarɔ	parrot sp.
ɨbɛt	my upper leg	lɨkunˈtɛn	scorpion	tʃitʃi	sun
ɨpɨ	root	mɨˈta	monkey sp.	tagantaˈga	butterfly
imˈpɔ	*pequi* fruit	mɔˈdɔ	earthworm	tagaˈt͡ʃi	hummingbird
idaˈra	fly	ɔˈbɛt	your your upper leg	taˈgi	grasshopper
ilu	his/her tongue	ɔˈdɨ	what?	taˈrɔ	*ariramba*
ɛlɨ	vagina	ɔgɨˈpu	snake sp.	timɛuˈrɛ	*paca*
jaguˈri	agouti	ɔgrɔ	jaguar	tɔpaja	fish sp.
jɛˈdu	beetle sp	ɔmɛˈrɔ	crab	tuˈdɔ	owl sp.
jɛˈgɛ	wood pecker	ɔrɛkɔˈdɔ	armadillo sp.	tuduˈgɨ	moth
jɛkɨˈtɛt	otter sp.	paˈru	water	tuˈpɔ	gourd
jɔˈkɔ	bee sp.	pɛˈlitˀ	toad sp. *(gia)*	wanuɛˈlɨ	honey bee
joˈru	tortoise	pɨt͡ʃiˈmi	mucuine	warɛˈkɔ	deer sp.
kabɔgˈwa	bee sp.	piˈrɔkˀ	blackfly	wɔkɔˈri	dog
kajaˈtu	parrot sp.	pɔratamku	arthropod sp. *(paquinha)*		
karaˈja	parrot sp.	pɔtpɛˈri	tick		

Table 6. Words used in the acoustic analysis for the male charts.

A total of 418 tokens of vowels were analyzed. Table 7 presents mean values and standard deviations of formant frequencies in final (7a) and non-final (7b) positions for the female speaker.

(a)

		F1	F2
a	Mean	808	1488
	s. d.	37	114
e	Mean	699	1982
	s. d.	14	73
i	Mean	400	2508
	s. d.	40	79
ɨ	Mean	655	1126
	s. d.	58	101
o	Mean	437	1606
	s. d.	26	163
u	Mean	409	1059
	s. d.	32	65

(b)

		F1	F2
a	Mean	811	1594
	s. d.	34	90
e	Mean	609	2055
	s. d.	33	108
i	Mean	387	2456
	s. d.	28	97
ɨ	Mean	446	1422
	s. d.	62	110
o	Mean	659	1183
	s. d.	33	119
u	Mean	477	988
	s. d.	23	134

Table 7. F1 and F2 mean formant frequencies and standard deviation for the female speaker.

Table 8, below, presents mean values and standard deviations of formant frequencies in final (8a) and non-final positions (8b) for the male speakers.

(a)

		F1	F2
a	Mean	724	1413
	s. d.	25	105
e	Mean	527	1798
	s. d.	23	100
i	Mean	329	2250
	s. d.	33	113
ɨ	Mean	372	1485
	s. d.	34	193
o	Mean	591	1147
	s. d.	24	72
u	Mean	399	1017
	s. d.	36	143

(b)

		F1	F2
a	Mean	705	1465
	s. d.	41	95
e	Mean	495	1790
	s. d.	26	53
i	Mean	342	2099
	s. d.	23	79
ɨ	Mean	377	1353
	s. d.	37	91
o	Mean	616	1093
	s. d.	27	55
u	Mean	461	1161
	s. d.	49	128

Table 8. F1 and F2 mean formant frequencies and standard deviation for the male speakers.

The Figures below represent formant frequencies of Arara vowels in the acoustic space. Figures 6 and 7 illustrate the frequency values of the female speaker, and Figures 8 and 9 illustrate formant frequencies of the male speakers. Number of tokens of each vowel are: Fig. 4- /a/: 13, /e/: 10, /i/: 15 /ɨ/: 18, /o/: 24, /u/: 11; Fig. 5- /a/: 26, /e/: 11, /i/: 12, /ɨ/: 28, /o/: 27, /u/: 9; Fig. 6- /a/: 14, /e/: 11, /i/: 15, /ɨ/: 18, /o/: 18, /u/: 17; Fig. 7- /a/: 21, /e/: 12, /i/: 24, /ɨ/: 16, /o/: 14, /u/: 12.

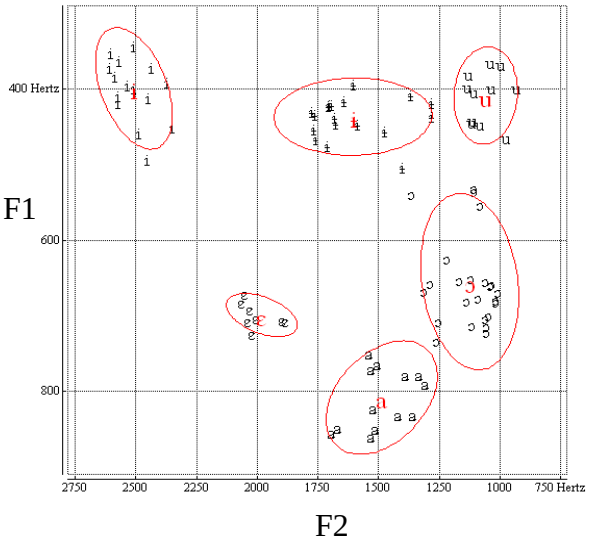


Figure 6. Average values in final position for a female speaker (91 tokens of vowels)

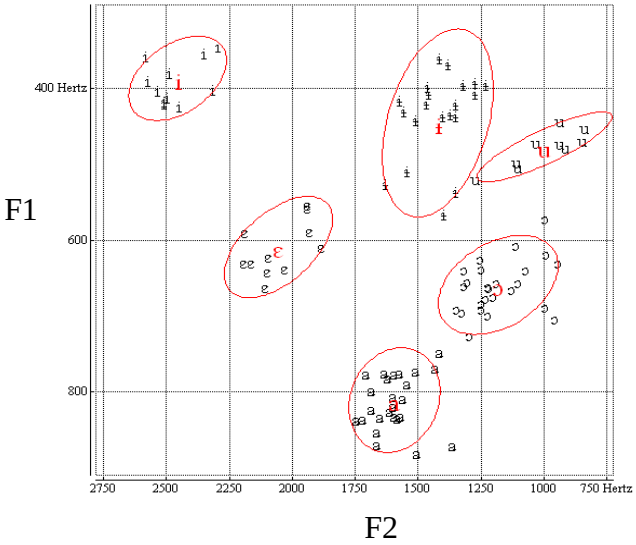


Figure 7. Average values in non-final position for a female speakers (113 tokens of vowels)

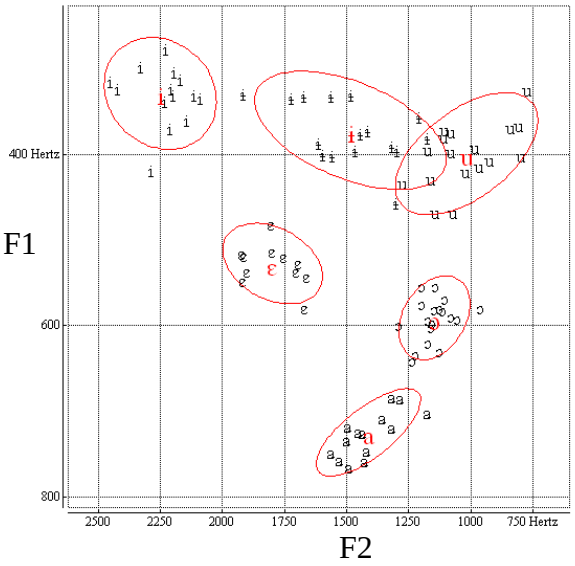


Figure 8. Vowel dispersion in final position for male speakers (91 tokens)

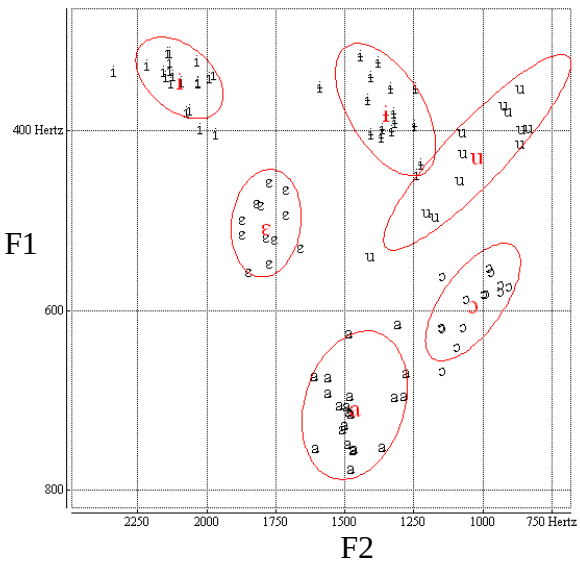


Figure 9. Vowel dispersion in non-final position for male speakers (100 tokens of vowels)

Figures 6 through 9 illustrate the relationship between traditional articulatory description and formant frequencies of Arara. By comparing the values of final and non-final positions there is no significant variation between the two positions observed. The range of values indicates vowel quality variations, which are described as follows:

- /a/ can be pronounced as a low central vowel [a] or with a slight rising at the back of tongue, producing a back unrounded vowel [ɑ]
- /i/ is articulated as a typical high front vowel [i]
- /ɨ/ presents a very large area of dispersion, with various realizations between the high central vowel [ɨ] and the high back unrounded vowel [ɯ]
- /e / is articulated as a mid-low front vowel [ɛ]
- /o/ is articulated as a mid-low back vowel [ɔ]
- /u/ presents a range of values, which may vary from a high back vowel [u] to mid-high back vowel [o].

As seen in the vowel dispersion space, the most unstable vowel in Arara is [ɨ]. Interestingly, its allophonic variation decreases the distinction between the two back vowels of the language,

something not in accordance to the principle of maximal dispersion (Liljencrants and Lindblom, 1972).

4. Stress

It is debatable whether all languages have stress. In many languages, cognate words can form minimal pairs in which the stress is the only difference. Some examples are from Spanish ‘hablo’ [ˈablo] ‘I speak’/ ‘hablo’ [aˈblo] ‘s/he spoke’, and from English ‘permit’ [ˈpərmit] (noun)/ ‘permit’ [pərˈmit] (verb) and ‘import’ [ˈɪmpɔːt] (noun)/ ‘import’ [ɪmˈpɔːt] (verb). On the other hand, in French for example, this contrast is not observed; rather the prominence is determined in the phrase (Gussenhoven, 2004). In Arara, it appears that syllabic prominence is perceived in the last syllable of words, independent of the structure of the syllable, as in words like [pɔtˈpa] ‘fish sp. *(piaba cascuda)*’, [tɔpˈkak] ‘bow’, [pikˈtu] ‘drink’. Affixes are stress-neutral to this pattern, and the final prominence is observed in un-derived as well as in derived words. Some examples of words derived by prefixation and suffixation are presented in (14):

(14)	webɨˈnɨ	jageˈda	korigu'nɨ
	/w+eb+ɨˈnɨ/	/j+age+ˈda/	/k+origu+ˈnɨ/
	1SG+come+PAST	1SG+cut+FUT	1SG+dance+PAST

The question to be addressed in this section is whether the last syllable in Arara words can be considered to have stress. Phonetically, a number of correlates may indicate the difference between stressed and unstressed syllables, while some languages do not present observable phonetic stress at all. Some characteristics of stress commonly found in world’s languages are energy distribution across the frequency spectrum, duration, and accuracy with which articulatory targets are articulated (Gussenhoven, 2004).

In order to observe whether Arara presents stress, I analyze the following phonetic correlates: vowel quality, VOT, pitch (F0) and duration. Among these phonetic cues, vowel quality does not constitute a correlate of stress in Arara. Whereas the quality of vowels in unstressed syllables is

likely to be more shwa-like than that of stressed syllables, in Arara vowels do not tend to centralize in the phonetic space. As observed in Section 3.1, the quality of vowels in non-final word position does not present significant changes in relation to vowel quality found in word-final position (see Tables 6 and 7, and Figures 6 through 9, in section 3.1 above). VOT measurements of final and non-final syllables may demonstrate whether stressed syllables are treated with greater articulatory care. Table 9 presents the words from which VOT was analyzed. The speakers (one woman and three men from *Cachoeira Seca*) pronounced the words in isolation.

akoˈtu	piece	mariteˈum	wild cockroach	tuˈrɔk	horsefly
eŋpiˈput	eyebrow	mɨˈta	monkey sp.	tamtabˈrem	spider
ɨˈpɨ	root	ɔgɨˈpu	snake sp.	taˈwe	monkey sp.
iˈpun	his/her foot	paraˈta	plate	tibɔgeˈdem	armadillo sp.
ibaˈpan	father	piˈrɔm	arrow	tuktuˈku	turtledove
idukˈton	his/her field	pɔriˈdɔ	basket	tiaˈkɨt	centipede
iduktonˈkom	their field	pakeˈni	duck	tigrigriˈnem	black
iˈput	body hair	pomɔriˈum	beetle sp.	timeuˈre	*paca*
iwakaˈtʃi	buttocks	pɔratamˈku	arthropod sp. *(paquinha)*	tɔpˈkak	bow
jeˈge	woodpecker	paˈtɨt	mouse sp. *(quandu)*	tɔrɔˈrɔŋ	water snail
kamˈtʃik	monkey sp.	pɨreˈwa	tree sp. *(camarupa)*	tʃiruˈka	*quati*
karaˈja	parrot	pilepˈte	knife	tuˈduk	give it!
karaˈtɔ	gourd	piˈrɔk	blackfly	tiegrɔˈdɔ	woodpecker sp.
kuˈbe	arrow	pɔˈne	catfish	taˈbet	It is dry
kajaˈtu	parrot sp.	pɔriˈa	tree sp. *(pati)*	tarikˈpe	big
kɔkˈtɔn	cicada	pumiʼe	woman	tɨrintɨʼrin	tinamou sp.
kamˈpɔt	fire	raʼpe	tree sp. *(pau d'arco)*	trigrigiʼnem	black
kampurupɨˈem	bean	tagantaʼga	butterfly	tukˈtɔ	field
karɔkpieˈum	electric eel	tagaˈtʃi	hummingbird	tumˈnet	dry
karamˈpi	duck	taˈrɔ	otter	kareˈi	non-indigenous
koŋtʃiˈpe	cold	tɨbetʃiˈum	lizard	kɔŋˈpɔ	rain
kuˈbi	poison vine	toŋtʃiˈri	lizard sp.	kuˈjak	monkey sp
kaˈbɔ	heaven	mariteˈum	wild cockroach	wareˈkɔ	deer sp.
maraˈpa	par	tuduˈgɨ	moth		

Table 9: words from where VOT where analyzed. Total of tokens is 301, distributed in final position: /p/: 47, /t/: 46, /k/: 7; non-final position: /p/: 43, /t/: 90, /k/: 70.

VOT measurements are illustrated in Table 10. It would appear that the values of /p, t, k/ VOT in final position are comparable to the values found in non-final position. Therefore, articulatory accuracy as measured by VOT is also not correlated to stress in the language.

VOT	position	p	t	k
Mean	Non-final	14	18	36
s.d.	syllable	5	5	9
Mean	Final	19	16	36
s.d.	syllable	7	4	9

Table 10. Mean VOT and standard deviations of plosives in final and non-final positions.

Next two potential cues to be checked were pitch (F0) and duration. Both phonetic cues were obtained from 150 tokens of words. These words contain only open syllables and were spoken in isolation (see Table 11). The speakers are fluent in the *Cachoeira Seca* dialect.

wa'pi	arrow	tʃi'go	flea	tebɨ'nɨ	s/he came
ku'be	arrow	tu'do	owl sp.	jage'da	I will cut
ku'bi	poison vine *(timbó)*	tʃi'tʃi	sun	jage'nɨ	I cut
ka'na	sugarcane	pa'ru	water, river	jagu'ri	agouti
mo'bu	canoe	mo'do	earthworm	tʃari'na	chicken
ta'gi	grasshopper	po'ne	catfish	pɨtʃi'mi	insect sp. *(mucuim)*
pa'ma	fruit sp.	pori'do	basket	pake'ni	duck
jo'ru	tortoise	ko'tʃi	fish sp.	tʃiru'ka	wide
ra'pe	tree sp. *(pau d'arco)*	kara'to	gourd	ware'ko	deer sp.
mɨ'ta	monkey sp.	pɨtʃi'ga	knife	tudu'gɨ	moth
ta'mɨ	tobacco	tome'la	fruit sp. *(muruci)*	toromo	nut
je'du	beetle sp.	para'ta	plate	warami	*inajá* fruit
jo'ko	bee sp.	mara'pa	oar	woŋobo'tʃi	Vulture
ka'ra	parrot sp.	toro'tʃi	bird sp.	pɨgoru'ma	parrot sp.
ka'bo	heaven	taga'tʃi	hummingbird	kareka're	natural medicine
mo'be	fruit sp. *(cajá)*	waro'da	bee sp	koriguɨ	I danced
ta'ro	otter	woto'mo	tapir	moriguɨ	you danced
we'ro	margay	woko'ri	dog		
je'ge	woodpecker	potʃi'ma	mosquito		
wa'bi	fish sp	webɨ'nɨ	I came		

Table 11. Words whose syllables were measured.

Figure 10 illustrates mean maximum pitch values of each syllable of Arara disyllables, trisyllables and polysyllables (including phonological words and utterances).

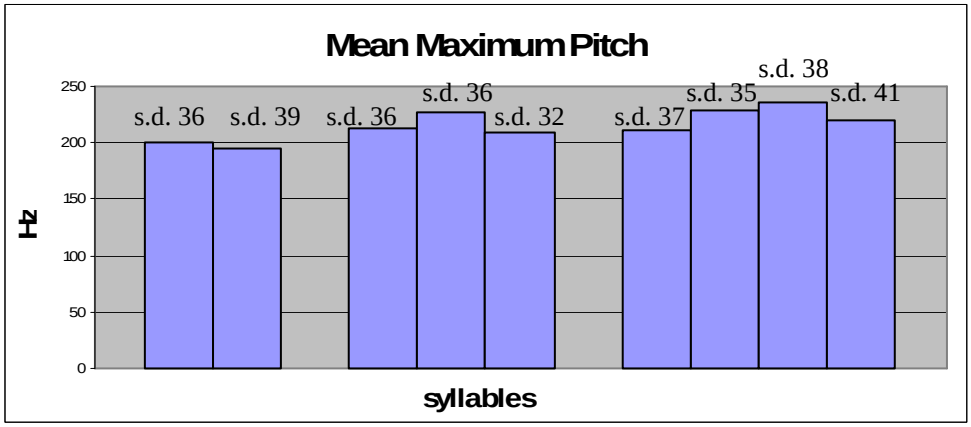


Figure 10. Mean maximum pitch (F0) for each syllable in disyllables, trisyllables and quadrisyllables.

The highest maximum pitch was found in the penultimate syllable of words, while last syllables present lower maximum pitch frequencies. The investigation of the correlation of pitch with stress includes knowing whether stressed syllables attract tones, and, if they do, what tones can appear on the stressed syllable. If L 'low' as well as H 'high' tones can occur, there will be no constant pitch feature correlating with the stressed syllable. However, in Arara a general rising falling pattern over words has been observed (see ultimate and antepenultimate syllables in Figure 10). Therefore, it is reasonable to check in future studies if the peak of that rise-fall is consistently aligned with any one syllable. If this is the case, that syllable is a possible candidate for stress. Nevertheless, such conclusion must rely on the investigation of complete prosodic structure of the utterance and its intonation.

Mean duration measurements of disyllabic, trisyllabic and quadrisyllabic words are presented in Figure 11.

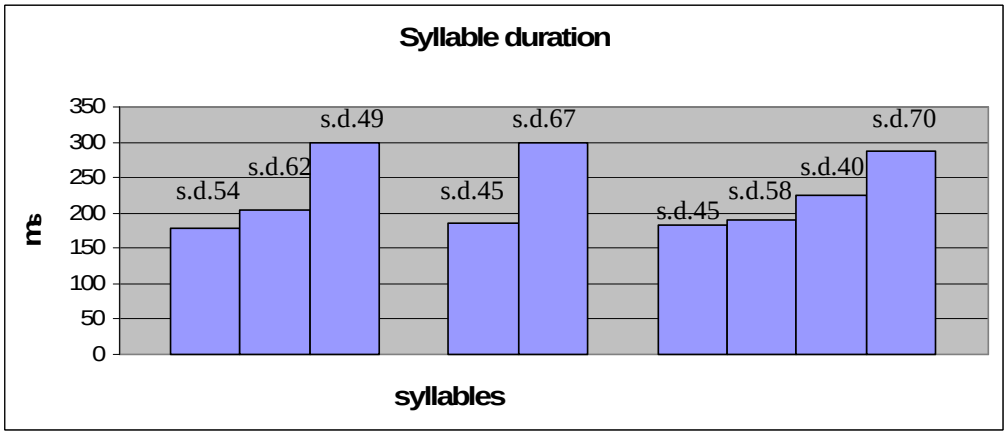


Figure 11. Mean syllable duration. Disyllables (78 tokens, standard deviation (s.d) 45, 67 ms), trisyllables (61 tokens, s.d. 54, 62, 49 ms), polysyllables (11 tokens, s.d. 45, 58, 40, 70 ms).

It would appear that syllables get longer as they get closer to the end of the word. In this case, due dataset restrictions it is not possible to assert whether the lengthening is prominence-related or effect of phrase-final lengthening phenomenon, which can be extended over a multisyllabic domain (Continuous domain hypothesis) (Turk and Dimitrova, 2007).

The observed phonetic cues do not reveal any foot structure in the language. The expected behavior of iambs and trochees is the alternation of stressed and unstressed syllables. According to

Hayes (1995) metrical notation, (. *)(. *) corresponds the iambic pattern, where an asterisk represents the rhythmically strong syllable, the non-head is represented by a dot; and the mirror image (* .)(* .) corresponds the trochaic rhythm. Therefore, the normal picture would be a convergent pattern of one or more cues, which would lead to the stress difference between the syllables of both feet of words of the type (CVCV)(CVCV). However, measurements of formant frequencies, VOT, pitch (F0) and duration suggest the absence of phonetic stress in Arara.

5. Syllable structure

The syllable is a phonologically motivated unit since it is commonly related to phonotactic constraints or processes that refer to the syllabic domain or its edges (Ewen and van der Hulst, 2001). The template (C)V(C) represents the syllable structures of Arara. That is, the onset maximally contains one consonant and coda is not obligatory. All syllables can occur in any position of a word, as illustrates table 12.

	Initial	Medial	Final
V	/a.e/ ‘bee sp.’	/ti. a. kɨt/ ‘centipede’	/o.go.i/ ‘snake sp.’
VC	/ap.te.nu/ ‘cloud’	/ti.ap.ko/ ‘toucan sp.’	/mi.ta.um/ ‘*bacuri* fruit’
CV	/re.re/ ‘bat’	/u.mi.ŋo/ ‘cassava’	/to.ro.mo/ ‘brazil nut’
CVC	/tuk.to/ ‘field’	/e.ben.ku.tʃi/ ‘*quatipuru*’	/ku.rep/ ‘well, beautiful, good taste, right’

Table 12. Syllabic pattern.

The vowels /a, e, ɨ, o, u/ may occupy all V positions. All consonants can be in the coda position of the syllable types VC, CVC, except /b, d, g, l, r/ do not occur in word-final position. The onset of the syllable types CV, CVC may be occupied by all consonants, but /ŋ, b, d, g/ not occur in word-initial position, and only in the *Laranjal* dialect does /r/ not occur in initial position of the word.

5.1 Vowel sequence

No diphthongs are attested in Arara. On the other hand, there are many heterosyllabic vowel sequences: [aɛ, au, ɛu, ɛi, ia, iɛ, iu, ɔu, ɔɛ, ɔi, ui, ua, uɔ, uɛ, ɨɛ, ɨi, ɨa, ɨaɛ, iɛu, iaɛ].

Examples are presented in (15). No sequence of vowels of the same quality was found within the word.

(15)		
	a.	**aɛ, au** /a.e/ ‘bee sp.’; /mi.ta.um/ ‘*bacuri* fruit’
	b.	**ɛu, ɛi** /pe.um/ ‘land tortoise’; /je.i/ ‘tree, wood’
	c.	**ia, iɛ, iu** /e.mi.a.rɨ/ ‘hand’; /pu.mi.e/ ‘woman’; /tig.ri.u.de/ ‘smooth’
	d.	**ɔu, ɔɛ, ɔi** /po.u/ ‘peccary’; /po.e.pe/ left’; /o.go.i/ ‘snake’
	e.	**ui, ua, uɛ, uɔ** /ku.i/ ‘parrot sp.’; /i.du.a/ ‘forest’; /o.du.et/ ‘hammoc’; /ku.o/ ‘frog’
	f.	**ɨi, ɨɛ, ɨa, ɨau** /ta.kɨ.i/ ‘manioc flour’; /tɨ.e.ri/ ‘ant sp.’; /im.pɨ.a.tʃi/ ‘arm’; /tɨ.a.u.go/ ‘ant sp.’
	g.	**iɛu** /ka.rok.pi.e.um/ ‘eel’
	h.	**iaɛ** /o.mi.a.e.gu/ ‘fish sp. *(traíra)*’

5.2 Consonant clusters

Medial clusters are heterosyllabic. Since no word starts with adjacent consonants, the medial clusters must be split into two parts, see examples in (16). Heterosyllabic clusters avoid the violation of the maximal onset aloud in the language.

(16)		
	a.	**br** /web.ruk/ ‘frog sp.’, /ib.rin.da/ ‘next (object, people)’
	b.	**wr** /maw.re/ ‘blue tinamou’, /waw. ri/ ‘*bacaba* fruit, juice’
	c.	**gr** /pag.ri.wa/ ‘capybara’
	d.	**tp, tk** /pot.pe.ri/ ‘tick’, /rat.kat/ ‘bird sp. *(ariramba)*’
	e.	**pt, pk, ptʃ** /og.rop.tɨk/ ‘monkey sp.’, /top.kak/ ‘bow’, /i.dop.tʃi/ ‘bow’
	f.	**nm, np, nŋ, nt** /pon.mi/ ‘land snail’, /mun.po/ ‘mouse sp.’, /mon.ŋat/ ‘owl sp.’, /ta.bun.tet/ ‘soft’
	g.	**ktʃ, kt, kp** /tʃa.rok.tʃa.ro/ ‘parrot sp.’; /kok.ton/‘cicada’, /kok.po/‘fruit sp.’
	h.	**ŋn, ŋk, ŋtʃ, ŋr, ŋm, ŋp** /eŋ.nan/ ‘nose, beak’, /pu.raŋ.ko.um/ ‘mouse sp.’, /tʃiŋ.tʃi.po.um/ ‘wide dog’, /ɛŋ.ru/ ‘eye’, /u.raŋ.mo/ ‘child’, /koŋ.po/ ‘rain’
	i.	**mp, mn, mk, mr, mt, mtʃ** /um.pa.pa/ ‘stingray’, /im.nu/ ‘meat, body’, /tam.ko/ ‘elderly’, /ɛ.ɖɛ.gum.ri/ ‘knee’, /am.tet̃/ ‘rope’, /i.mum.tʃi/ ‘head’

Obligatory Contour principle (McCarthy, 1986 apud Clements and Hume, 1995) applies in Arara, since adjoining identical segments have not been observed. Nor were sequences of voiced and voiceless plosives within single word morphemes attested. At morpheme boundaries, it would seem that adjacent plosives agree in voicing; both plosives are either voiceless or voiced (see examples in (17)).

(17) /uk-pɛt-kom/ [ukpɛtˀkõm] ~ [ugbɛtkõm]
1PL-leg-PL
'our upper leg'

/t-ɛp-naŋri/ [tɛptãŋɾi] ~ [tɛmnãŋɾi]
2SG-come-PROG
'she is coming'

5.2.1 Sequences of heterosyllabic consonants and liquids: special topic I

Many Cariban languages present vowel elision in sequences of consonants involving liquids. For instance, this process was attested in Ikpeng (Pachêco, 2001), Macushi (Abott, 1991), Carib (Hoff, 1968). In this respect, a dialectal difference needs to be cleared up in Arara. In *Laranjal* dialect, speakers comment that a full vowel is deleted in fast speech; however, in *Cachoeira Seca*, the available data does not show the presence of a full vowel between these consonant sequences.

The phonetics of plosives or nasals and liquids in adjacent position shows a transitional vowel between the articulation of each consonant. This phonetic process has been described in a number of languages like French, English (Hume and Bromberg, 2005), Dutch (Nespor and Vogel, 1986), Mundurukú (Picanço, 2005). The epenthetic vowel is a phonetic phenomenon caused by a delay between the articulatory gestures of adjacent segments. Since there is no impedance between the release of a plosive and the constriction of the following liquid, the vocal folds can vibrate which originates an epenthetic vowel of predictable quality.

In Arara, this vowel is mostly a schwa-like segment [ə]. Figure 12 illustrates the acoustic space of each phonemic vowel, in non-final position, in relation to the epenthetic vowel. There were

analyzed 100 tokens of phonemic vowels and 61 tokens of epenthetic vowels, all pronounced by three male speakers who speaks the *Cachoeira Seca* dialect.

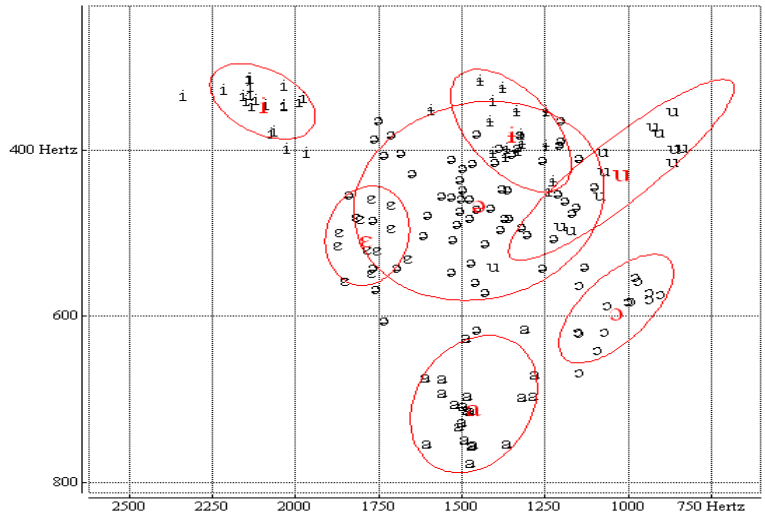


Figure 12. Dispersion of the phonemic vowels /a, e, ï, o, u/ and of the phonetic swha [ə].

The schwa insertion is observed in sequences of voiced or voiceless plosives and liquids, and nasals and liquids. The epenthetic, non-syllabic vowel can be perceived, for instance, in words like [pᵊɾa] NEG, [wɛbᵊˈɾukˀ] **‘**toad sp’, [jɛdɛgumᵊˈɾi] ‘my knee’. The spectrogram and waveform in Figure 13 illustrates the sequence g + ᵛ + ɾ.

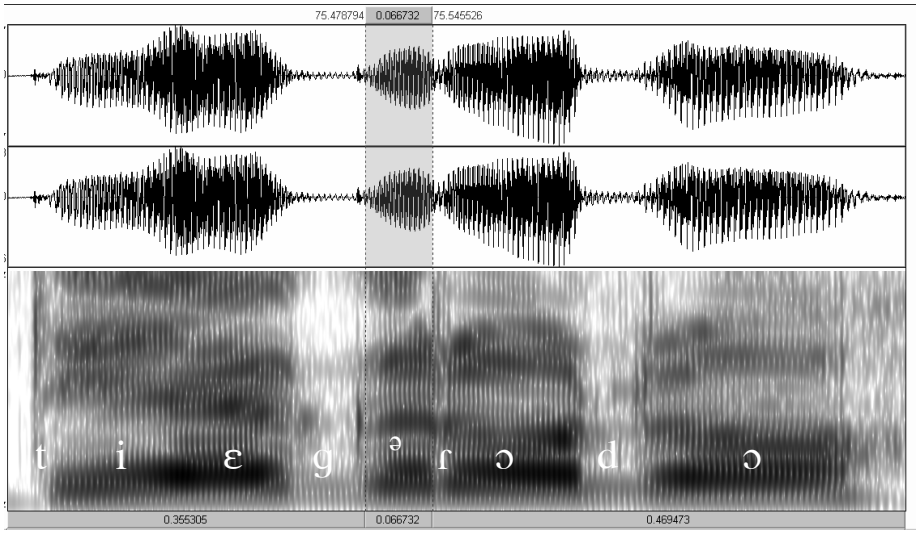


Figure 13 . [tiɛgᵊrɔdɔ] ‘woodpecker sp.’ (TB-CS-m)

The same insertion process is observed between the sequence m+ ᵛ + r, as illustrates Figure 14.

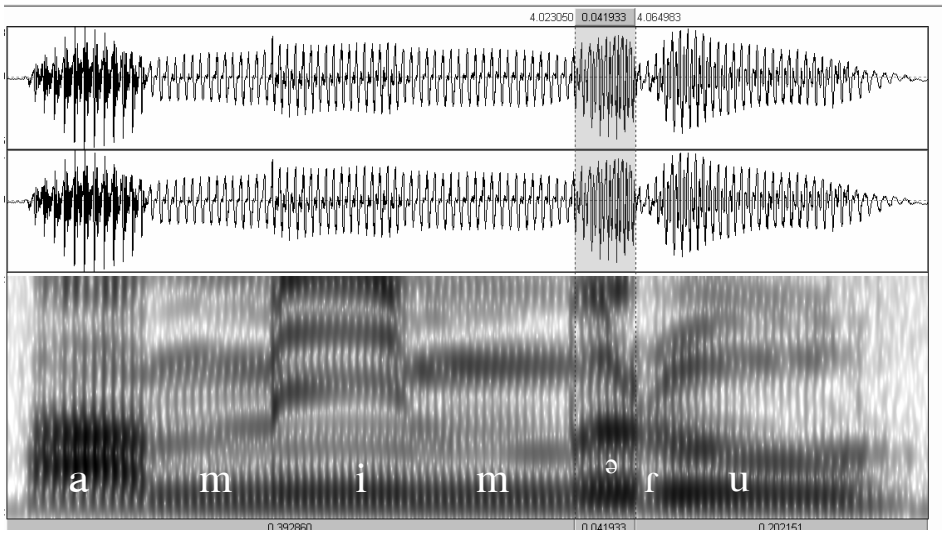


Figure 14. [amimᵊɾu] ‘my belly’ (JA-CS-m)

The main difference between a transitional vowel and a full vowel lies in their length. This last vowel has a greater duration than a transitional one (average length of 61 tokens: 46 ms, s.d. 13 ms). Figure 15, below, shows the duration of about 141 ms of the third [ɔ] in the word [kɔrɔ̃ŋkɔ̲ɾɔ] ‘toad sp.’, while the duration of the transitional [ᵊ] in [tiɛgᵊɾɔdɔ] ‘woodpecker sp.’ is 66 ms and in [amimᵊɾu] ‘my knee’ is 41 ms.

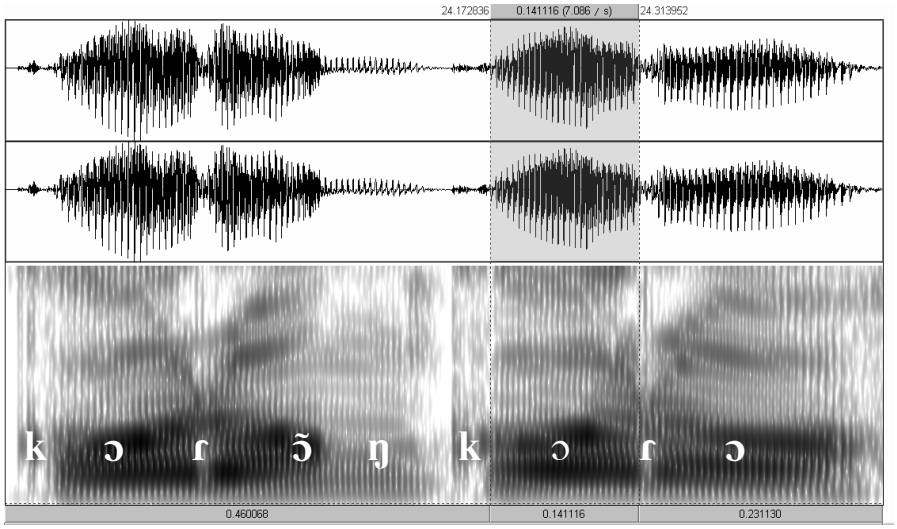


Figure 15. [kɔrɔ̃ŋkɔ̲ɾɔ] ‘toad sp.’ (TB-CS-m)

5.2.2 Sequences C.w: special topic II

One single example of a complex onset could be the sequence [kw] in the word [kwaˈɾɨ] ‘straw’. However, in this case, the labiovelar glide is considered a phonetic allophone of /u/.

Therefore, the word is syllabified as /ku. a. ɾɨ/. This is reasonable in the present description, since there is no strong evidence to consider labialization as a distinctive feature in the language, and either there is a reason to insert a complex onset in the syllable structure. Additionally, the corpus contains the verbal form [kwãndʒa] ‘I will carry you’, whose root is *–an,* and verbal affixes are *ku-* and *–tʃa* (or [-dʒa] in the *Laranjal* dialect). That is, this prefix also indicates that the sequence [kw] is merely a phonetic realization. Examples of heterosyllabic sequences involving the labioverlar glide are in (18):

(18)	/jɛŋ.wam/	[jɛŋˈwãm]	‘I know’
	/ɔd.wat/	[ɔdˈwatˀ]	‘hammock’
	/ɔd.wap/	[ɔdˈwapˀ]	‘laid’
	/kɔ.dɛg.wat/	[kɔdɛgˈwatˀ]	‘cotton’
	/kut.kug.wi/	[kutkugˈwi]	‘eagle’
	/ka.bɔg.wa/	[kabɔgˈwa]	‘bee sp.’
	/tɔg.wam.tɛ/	[tɔgwamˈtɛ]	‘you sat’

6. Allomorphs of first person plural prefix: special topic III

The form of the allomorphs of the first person plural prefix /uk-/ is predictable according to the phonological form of the word to which it is attached. The form [ug-] is used before vowels and the approximants [w-, l-], [uŋ-] occurs before nasals, and [ugu-] was observed before consonant sequences and before the flap. The unmodified underling form [uk-] is used in roots that start with voiceless plosives. See examples in (19):

(19)	Possessed form		Absolutive form	
[ug-]	[ug+ɛ̃ŋˈɾu]	‘our eye’	/eŋˈru/	‘eye’
[ug-]	[ug+wɨnkɨn̄ɨŋˈmõ]	‘we slept’	/wɨnˈkɨ/	‘sleep’
[ug-]	[ugˠ+lũŋˈmo]	‘our tongue’	/iˈlu/	‘tongue’
[uk-]	[uk+tukˀtõn]	‘our field’	/tukˈtɔ/	‘field’
[uŋ-]	[uŋ+ˈmɛ̃n]	‘our cloth’	/iˈmen/	‘cloth’
[ugu-]	[ugu+pˈtʃĩn]	‘our leg’	/ipˈtʃin/	‘leg’
[ugu-]	[ugu+ɾɛtˀputˀ]	‘our hair (of the head)’	/iretˈput/	‘hair’

In cases of inalienable possessed nouns, the underling form /uk-/ neutralizes the voicing feature that plosives assimilate from the intervocalic environment, as illustrate the examples in (20):

(20)	Possessed form		Absolutive form	
	[uk+panãn'kõm]	‘our ear’	/iba'nan/	‘(his/her) ear’
	[uk+tɛ̃ntʃitpɨn'kõm]	‘our neck’	/identʃit'pɨn/	‘(his/her) neck’
	[uk+pɔɾɨŋ'mo]	‘our lip’	/ibo'ri/	‘(his/her) lip’

The motivations to assume that the underling form of this prefix is the voiceless variety relies on the fact voicing assimilation is the most frequent process observed in the language (as seen in section 2.1.2) and sequences of voiced plosives are avoided.

7. Conclusion

As it is typical for the Cariban linguistic family, Arara presents a small contrastive sound system of 14 consonants /p, t, k, b, d. g, tʃ, m, n, ŋ, l, r, j, w/ and 6 vowels /a, e, i, ɨ, o, u/. The status of the voiced plosives is an interesting feature of the Arara system: they apparently became fully independent phonemes through recent developments.

Furthermore, there is voicing assimilation across morpheme boundary and within the morpheme. Across morpheme boundaries, voicing assimilation is a general phenomenon in both dialects. Word boundary plosives in intervocalic contexts have a voiced realization. On the other hand, within the morpheme, voicing assimilation is restricted to post-nasal positions. A nasal causes a following voiceless obstruent to be voiced. Voicing in nasal contexts is also restricted to the *Laranjal* dialect. Place of articulation is not assimilated between consonants.

There is no strong evidence of stress pattern in the language. Vowel quality, articulatory accuracy by means of VOT are not correlated to stress. The role of pitch (F0) is still unclear. Duration shows the most regular pattern: the last syllable of the word is consistently longer than the other syllables of the word. However, it was not possible to know whether the lengthening is due to prominence-relation or phrasal-final effect.

Arara presents a simple syllable structure illustrated by the template (C)V(C). There are no complex syllables or diphthongs; rather, there are heterosyllabic consonant clusters and vowel sequences.

In general, there are a number of unexplored issues in the language. For instance, are there marginal segments such as the ones usually found in onomatopoeic words and recent loan words? To which degree are vowels and consonants affected by nasalization spreading? Are there prosodic differences between the two dialects? The phonology beyond the word level needs to be investigated and the prosodic hierarchy of Arara remains unknown. Further studies of acoustic cues should include the investigation of how pitch accent may be related to the intonational grammar of the language.

Ultimately, I emphasize that the present study is a tentative one, which will likely be subject to revision in the light of a larger and more substantial dataset. While certain gaps remain to be filled in, I hope that the analysis here presented reflects a basic picture of the current sound system of the Arara language.

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Errata

Page 16 -- Instead of the following phrase ‘*bacaba* juice is bitter’, read ‘*Açai* juice is thick’
Page 26 -- Instead of ‘your your upper leg’, read ‘your upper leg’
Page 30 -- ‘marapa’ means ‘boat oar’
Page 34 -- ‘o.du.et’ should have been omitted