A Phonetic Investigation of the Affricate-Rhotic Cluster in Wobé

Ebitare F. Obikudo[a], Kolawole Adeniyi[b], Ezekiel T. Bolaji[c], Catherine Efeti Mokoko[d], Paule Jessica Nguele Dindo[e] , and Abdul-Rahman Fusheini[f]

[a]University of Port Harcourt, [b]Obafemi Awolowo University, [c]Lagos State University of Education, [d]University of Buea, [e]German International School, Yaounde, [f]University of Education, Winneba

Abstract. This paper investigates the phonetic nature of the rhotic observed in Wobé, a Kru language spoken in Côte d'Ivoire, West Africa. Contrary to earlier investigations that Proto Kru has no rhotic, this study shows that Wobé has two types of CCV structures – Type A where C_1 is a labial consonant while C_2 is a lateral and Type B where C_1 is an affricate and C_2, a rhotic. Three tokens each of words that contain the affricate-rhotic cluster, consisting of both voiced and voiceless post alveolar affricates, in word-initial position were recorded using a Marantz PMD 671 digital audio recorder and a Shure SM 10A head-mounted microphone. The spectrograms, duration of the vocalic transition between the affricate and the rhotic and duration of the rhotic closure for each token were analyzed using Praat. The mean and standard deviations for the durations of the vocalic transitions and the rhotic closures were calculated using the Excel software. Findings reveal that the affricate and the rhotic are often separated by a fleeting period of vocalic transition, the mean being less than 0.04 seconds for [dʒr] and less than 0.03 seconds for [tʃr]. The rhotic is shown to be very short in duration, which is consistent with it being a tap. The study concludes that there is one rhotic type in Wobé, which is a tap /ɾ/ and the presence of the tap in this cluster type may point to an ongoing process of change in the Wobé language where the tap is gradually attaining the status of a phoneme.

Keywords: Acoustic Analysis, Affricate-Rhotic Cluster, Rhotic Closure, Vocalic Transition

Languages: Wobé, Kru

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1.0 Introduction[1]

This is a phonetic study of affricate-rhotic clusters in Wobé, a Kru language spoken in Côte d'Ivoire, with a focus on the investigation of two research questions. First, we set out to determine the phonetic nature of the cluster. Here, the hypothesis is that there are affricate-rhotic clusters in Wobé containing both the voiceless and voiced post alveolar affricates. Our impression of the affricate-rhotic cluster is that there is a phase of vocalic transition between the affricate and the rhotic. By 'vocalic transition,' we refer to a period between the articulation of the affricate and the rhotic that is perceived as a very short vowel. This is similar to what Adeniyi (2015: 15) refers to as 'transitional sonority' between clusters of obstruents in semi-nativized words in Yoruba.

Another question we set out to answer is: "What are the phonetic properties of the rhotic following the voiceless and voiced affricates?" In other words, does the rhotic differ in different voicing contexts? The hypothesis here is that there are two rhotic variants following affricates in Wobé conditioned by the duration of the vocalic transition which differs in different voicing contexts.

2.0 The Kru Languages

The Kru languages belong to the North Volta-Congo language family within the Niger-Congo phylum and are found in Liberia and Côte d'Ivoire, West Africa (Williamson and Blench, 2000). Kru languages are subdivided into western, eastern and an unclassified language group made up of three language isolates, viz. Kuwaa, Tiegba and Abrako (collectively known as Aizi), and Sɛmɛ (Bendor-Samuel, 2009, Williamson and Blench, 2000). The Western Kru language group has one-million speakers and comprises the Grebo Complex, Guere Complex, Bassa and Klao. Wobé belongs to the Grebo sub-group (see figure 1). The population of Wobé speakers is estimated to be 301,000 (Eberhard, Simmons and Fennig, 2023). The Kru language family tree and map are shown in Figures 1 and 2, respectively. On the map, the Kru languages are indicated in green.

1 This research was carried out at the Polythenique de Felix Houphouet Boigny, Yamoussoukro, Côte d'Ivoire during the 4th African Linguistics School (ALS). The authors are grateful to the ALS organizers – Akin Akinlabi, Chris Collins, Enoch Aboh and John Singler and the sponsors of the School for the oportunity to be ALS4 participants. We also acknowledge the helpful comments and contributions of our project coordinator, Amanda Miller.

Figure 1: *Kru Language Family Tree (Bendor-Samuel 2009:624)*

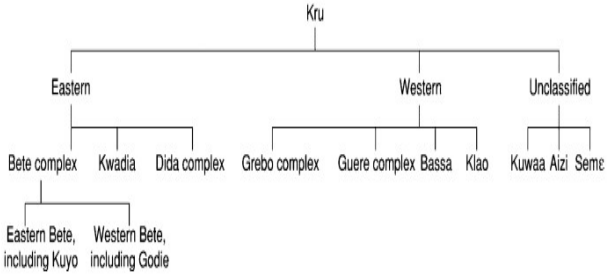
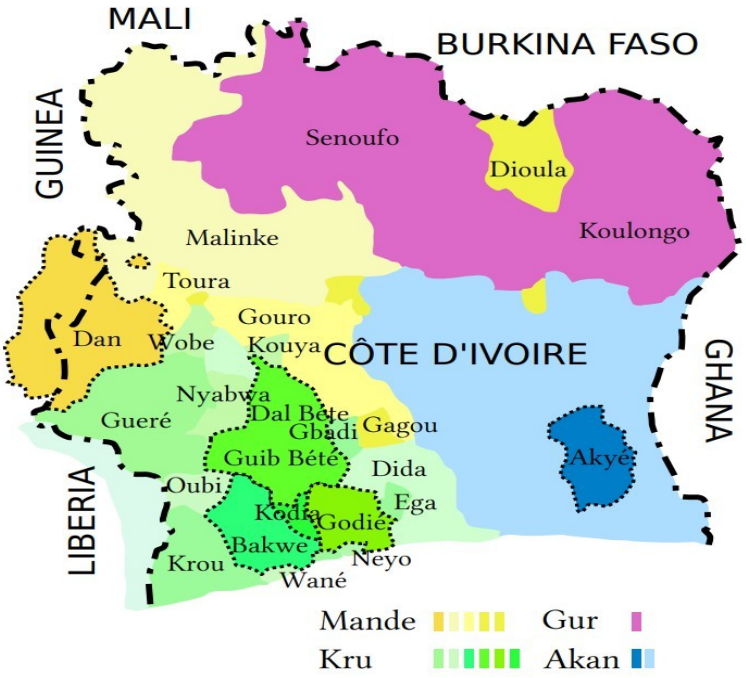


Figure 2: *Kru Language Map (Zogbo 2019:745)*



Some linguistic features associated with the Kru languages include a vestigial noun class system, verbal extensions, postpositions, both SVO and SOV word orders, and a human versus non-human distinction in pronouns. A feminine distinction in the second- and third-person singular pronouns is also attested in Niaboua and Wobé languages (Williamson and Blench, 2000: 25). According to Zogbo (2012, 2019), Kru languages have at least nine (9) oral vowels that divide into two harmonic sets based on the Advanced Tongue Root feature (ATR). Contrary to Eastern Kru, Western Kru attests distinctive nasalized vowels. Proto Kru oral vowels include [i e ɛ a ɔ o u] while Proto Western Kru nasalized vowels include [ĩ ɛ̃ ã ɔ̃ ũ].

Zogbo (1989, 2012) suggests a basic proto-*CV syllable for Kru with most roots reconstructing to *CVCV, including diachronic cases of CCV. she posits a proto-consonant system comprising voiceless and voiced

stops [p b t d k g kp gb], fricatives [f v s z], a bilabial implosive [ɓ], and an alveolar implosive [ɗ] that is probably a reflex of *l. Diachronically, distinctive labialized and palatalized consonants are reflexes of proto alveolar or velar consonants followed by either a high back or a high front vowel and any other vowel. In addition, the glottal fricative [h] is a recent innovation in Western Kru that has developed from proto *s. She asserts that "Proto-Kru certainly has no *r" (Zogbo 2012:1). However, in a more recent publication, Zogbo (2022:91) states, "Kru languages typically have up to thirty (30) contrastive consonants, including p, t, c, k, kp, kw, b, d, j, g, gb, gw, implosive ɓ and ɗ (the latter being rare), w, y, l (with a flap [r] variant), m, n, ɲ, ŋ, ŋw." She deviates from the earlier assertion that there is no rhotic in Proto-Kru and claims that there is a flap that presents as a variant of the lateral. This recent claim is more in line with the present study.

2.1 Wobé Language and Phonology

Found in Cote d'Ivoire, West Africa, Wobé (ISO code: wob) is one of approximately fifty (50) other languages, including French and other local varieties of French, such as Moussa or Dago French (Ahoua, 2006). It is a Western Kru language spoken in the western part of Côte d'Ivoire (Ahoua, 2016) and its alternative names are Ouobe and Wèè (pronounced *wèɛ̀*).

Based on a preliminary analysis of the data collected for the study, the following phonological features were observed. There are seven oral vowels [i e ɛ a ɔ o u] with four nasal counterparts [ɛ̃ ã ɔ̃ ũ] in Wobé. There are long vowels perceived in both oral and nasal vowels as shown in the examples in (1) and (2), respectively. The investigation of vowel length, however, is not within this paper's scope.

(1) a. kpɔ̀ɔ́ ‘maize’
b. kóò ‘rice’
c. páá ‘cassava’
d. ɓɛ́ɛ́ ‘pepper’
e. sàà ‘choose’

(2) a. kʷɛ̀ɛ̂ ‘groundnuts'
b. sɔ̀ɔ̃́ ‘chicken’

The consonant inventory gathered from the data shows an inventory of nineteen (19) consonants consisting of seven plosives [p b t d kp gb kʷ], one implosive [ɓ], three nasals [m n ɲ], two fricatives [f s], two affricates [tʃ dʒ], three approximants [l j w], and one rhotic [r]. Note that the phonetic symbol [r] is used in the data presented in this study to represent a rhotic whose phonetic properties are yet unknown. This consonant inventory may not be exhaustive, as it is based on the data gathered; however, it is not very different from what is prototypical of Kru languages, as shown in the consonant chart below.

Table 1: *Phonemic Inventory of Kru languages (Adapted from De Melo, 2005)*

	Bilabial	Labiodental	Alveolar	Palatal/Palato-Alveolar	Velar	Labial-Velar
Stop	p b ɓ		t d		k g	k͡p g͡b
Fricatives		f v	s z			
Affricates				tʃ dʒ		
Liquid			l			
Nasals	m		n	ɲ	ŋ	
Glides	w			j		

Wobé is known in the literature for its complex tone system (Bearth and Link 1980, Singler 1984). According to Bearth and Link (1980), the Wobé language has fourteen contrasting tones, comprising four level tones, five rising tones, four falling tones, and one rising-falling tone. Distributional restrictions are imposed on the tones. For example, falling tones occur on morpheme-final vowels (this corresponds with our word-final HL), whereas rising tones are restricted to the initial vowel. However, Singler (1984) provides a simplified analysis of the tone system. The tonemes observed from our data reveal three level tones: high (H), low (L), and mid (M), plus a word-final falling contour tone (HL) as seen in examples (3) through (6).

(3) a. sɛ́ ‘snake’ **High Tone**
b. sɔ́ ‘two’
c. kpé ‘black/blue/green’

(4) a. blòwɛ̀ ‘rabbit’ **Low Tone**
b. sàà ‘choose’
c. kʷɛ̀ ‘chimpanzee’

(5) a. tū ‘tree’ **Mid Tone**
b. nɛ̄ ‘fire’
c. gbɛ̄ ‘dog’

(6) a. gbɪ̂ɪ̂ ‘son’ **Falling Contour Tone**
b. tòô ‘termite’

Like other Kru languages, Wobé operates with an open-syllable structure, and we observed two basic syllable types from the data collected: (i) a consonant followed by a vowel (CV) or (ii) a consonant cluster followed by a vowel (C_1C_2V). This does not mean that these are the only syllable types in Wobé. According the Zogbo (2019: 36), the typical syllable structures in Kru languages “are V, CV, CVV, CCV (where C_2 is a liquid or sonorant).” This statement holds true for Wobé.

The consonant cluster in the CCV structure in Wobé can be grouped into two types. In Type A, C_1 is a labial consonant while C_2 is a lateral. In

Type B, C_1 is an affricate while C_2 is a rhotic. The syllable types are represented in examples (7) through (9) below.

(7)	a. nímí	'meat'	**CV Syllable**
	b. dʒábá	'onion'	
	c. sɛ́	'snake'	
(8)	a. flɛ́	'eggplant'	**C_1C_2V (Type A) Syllable**
	b. blòwɛ̀	'rabbit'	
	c. blà	'rice'	
(9)	a. tʃrɔ̀ɔ́	'frog'	**C_1C_2V (Type B) Syllable**
	b. dʒrá	'marriage'	
	c. dʒrú	'head'	

The data in the above examples reveal a consonant cluster characterized by an affricate and a rhotic whose phonetic properties are unknown. In other words, we do not know if this rhotic is a trill, a tap, or an approximant. According to Zogbo (2012), Proto Kru has no rhotic. However, De Melo (2005) states that the bilabial implosive /ɓ/ is often realized as a tap/flap [ɾ] *except* when it occurs word-initially. The corpus presented in this study shows that the affricate-rhotic cluster occurs word-initially with the rhotic as the second consonant in the cluster. This is in contradiction of the above claims by De Melo (2005) and Zogbo (2012). This study examines the nature of the Type B C_1C_2V structure in Wobé by carrying out acoustic phonetic analyses of the affricate-rhotic cluster.

3.0 Method

This study was carried out by a team of six researchers who were participants at the 4th African Linguistics School (ALS4) held at the Polythenique de Felix Houphouet Boigny, Yamoussoukro, Côte D'Ivoire. The Wobé language was chosen for phonetic investigation because it is spoken in the locality and evidence of a rhotic was observed in the speech of speakers despite the claim that Proto-Kru is devoid of rhotics. Data were elicited from three native speakers of Wobé, code-named AM, HV and US, who reside in Yamoussoukro. The data elicited revolved around core vocabulary. From the general data, a list of fourteen words was generated. These words contained the affricate-rhotic cluster in word-initial position, seven words contained the voiceless post-alveolar affricate [tʃ] (cf. Example 10), and the remaining seven contained the voiced post-alveolar affricate [dʒ] (cf. example 11).

(10)	a. tʃrèwû̃	'knife'	**Data Containing [tʃr]**
	b. tʃráā̃	'please' (V)	
	c. tʃrèjí	'insult'	
	d. tʃrã́	'oil'	
	e. tʃrìŋnɛ̀	'python'	
	f. tʃrìjá	'pull'	
	g. tʃrɔ̀ɔ́	'frog'	
(11)	a. dʒrá	'marriage'	**Data Containing [dʒr]**
	b. dʒràŋnɔ̃	'married woman'	
	c. dʒríjā	'steal'	
	d. dʒrìjɔ́ɔ̀	'eye'	
	e. dʒré	'gazelle'	
	f. dʒrū	'sun'	
	g. dʒrú	'head'	

Three repetitions of each word (referred to as tokens 1, 2 and 3 in Tables 2 and 3) were recorded with a Marantz PMD 671 digital audio recorder and a Shure SM 10A head-mounted microphone. Three tokens of every lexical item were recorded, resulting in a total of twenty-one (21) tokens for words containing the voiceless post-alveolar affricate and the rhotic [tʃr], and another twenty-one (21) tokens for words containing the voiced post-alveolar affricate and the rhotic [dʒr]. The spectrograms for all forty-two (42) tokens were analyzed using Praat (Boersma and Weenink, 2015). The duration of the vocalic transition between the affricate and the rhotic for each token was measured using Praat. The duration of the rhotic closure for each token was also measured in Praat. The mean and standard deviations for the durations of the vocalic transitions and the rhotic closures were calculated with the Microsoft Excel software.

4.0 Results

The results of the findings are presented in two sections. First, we present an auditorily-based description of the affricate-rhotic cluster based on our impressions of the words elicited from our Wobé language consultant. The second section presents the acoustic measurements for the voiceless and voiced affricate-rhotic clusters.

4.1 Impressionistic Description

In all fourteen words recorded, the affricate-rhotic cluster in Wobé is found in word-initial position. The affricate is perceived to be released before the realization of the rhotic. There is a sonorous vowel transition that makes it seem as if there is a short vowel between the affricate and the rhotic. We have, therefore, termed this phase a 'vocalic transition.' The rhotic is perceived as a trill when it follows [dʒ] and as a tap after [tʃ]. The different

percepts of the rhotic when it follows the voiced and voiceless affricates motivated the acoustic study.

4.2 Acoustic Analysis

In the acoustic analyses, spectrograms of the elicited words were studied to see if there was acoustic support for the perceived vocalic transition. With the aid of Praat, we observed that, in the words containing the voiced affricate, there is visible vocalic transition between the affricate and the rhotic. This is illustrated in Figure 3 where the duration of the Vocalic Transition (VT) after a voiced affricate, which is 0.395 seconds, is apparently longer than the duration of the rhotic and less than half of that of the following vowel. The length of VT is comparatively shorter in Figure 4 where the affricate is voiceless.

Figure 3: *Spectrogram of dʒrá ('marriage') with VT Indicated*

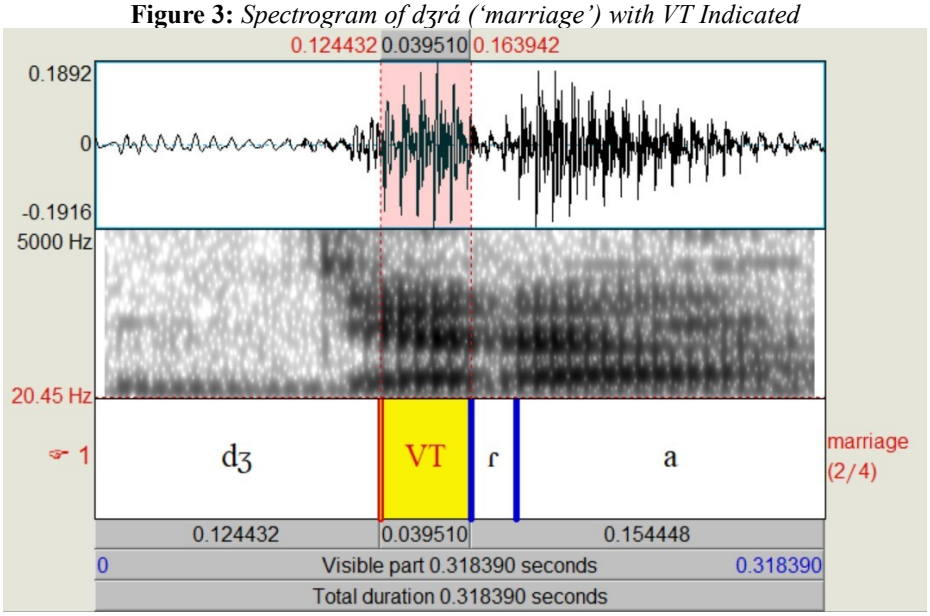
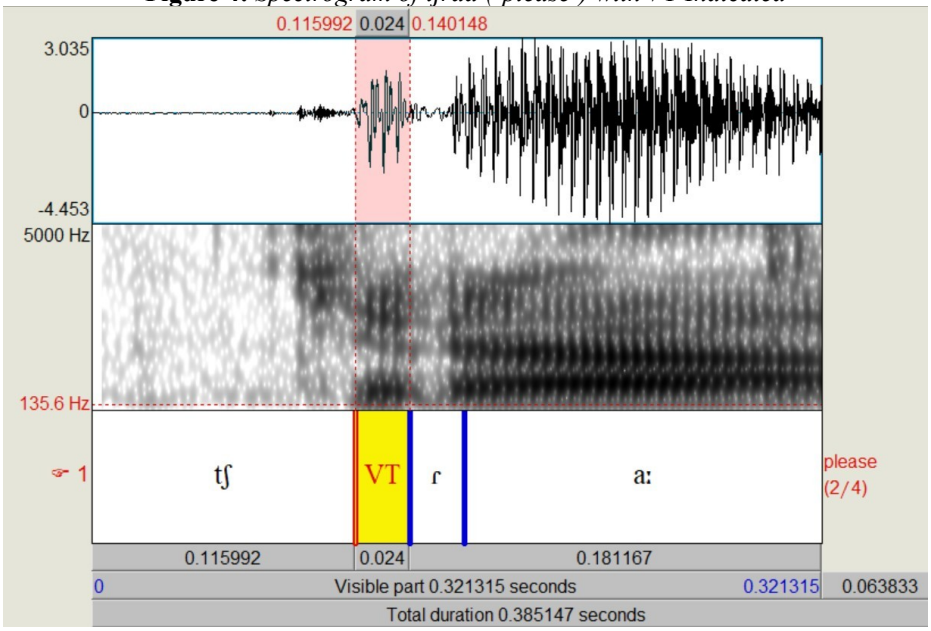


Figure 4: *Spectrogram of tʃráā ('please') with VT Indicated*



The durations of the VT interval and rhotic closure for each token are presented in Tables 2 and 3 below. The mean and standard deviation values are also presented. In some items in the data, the VT interval is not seen after voiceless affricates. This is evident in Table 3: item 8, tokens 2 and 3, and token 2 of items 10 and 12. Table 3 shows further that item 12, tokens 1 and 3, as well as item 13, tokens 1 and 2, record VT as short as 0.01 seconds. These add up to 38.1% of items involving voiceless affricates having no or very marginal vocalic transition. Such was not observed in the items with voiced affricates.

Table 2: *Mean and Standard Deviation of Tokens with Voiced Affricate-Rhotic Cluster*

[dʒ]			Token 1		Token 2		Token 3	
s/n	Word		VT	DRC	VT	DRC	VT	DRC
1	dʒrā	'marriage'	0.039	0.024	0.041	0.039	0.02	0.032
2	dʒràɲɔ̃	'married woman'	0.049	0.023	0.035	0.02	0.022	0.021
3	dʒríjā	'steal'	0.039	0.012	0.033	0.023	0.023	0.018
4	dʒrìjɔ́ɔ̀	'eye'	0.031	0.014	0.04	0.013	0.036	0.018
5	dʒré	'gazelle'	0.039	0.022	0.044	0.018	0.052	0.013
6	dʒrū	'sun'	0.035	0.015	0.027	0.014	0.046	0.017
7	dʒrú	'head'	0.035	0.013	0.041	0.016	0.051	0.011
	x̄		0.038143	0.017571	0.037286	0.020429	0.035714	0.018571
	SD		0.00564	0.005192	0.005908	0.008886	0.014151	0.006803

Table 3: *Mean and Standard Deviation of Tokens with Voiceless Affricate-Rhotic Cluster*								
[tʃ]			Token 1		Token 2		Token 3	
s/n	Word		VT	DRC	VT	DRC	VT	DRC
8	tʃrèwû̂	'knife'	0.029	0.024	0	0.034	0	0.029
9	tʃráā	'please' (v)	0.031	0.017	0.021	0.019	0.025	0.016
10	tʃrèjí	'insult'	0.029	0.021	0	0.019	0.028	0.019
11	tʃrā́	'oil'	0.043	0.016	0.04	0.011	0.037	0.014
12	tʃrìɲè	'python'	0.013	0.03	0	0.017	0.018	0.013
13	tʃrìjá	'pull'	0.019	0.018	0.019	0.032	0.03	0.023
14	tʃrɔ́	'frog'	0.032	0.019	0.03	0.018	0.037	0.015
	x̄		0.028	0.020714	0.018333	0.021429	0.02916	0.018429
	SD		0.00964	0.004889	0.016194	0.008384	0.012884	0.005769

The results of the total mean values show that at 0.037048 seconds, VT is longer after [dʒ] than after [tʃ] which is 0.022905 seconds. The total mean value for the duration of the rhotic closure (DRC) after [dʒ] is 0.018857 seconds, whereas it is 0.02019 seconds after [tʃ]. This shows that the long VT after [dʒ] is followed by a short rhotic closure. The standard deviation values also largely support the mean values; at 0.001852 seconds, the duration of the rhotic closure remains shorter after [dʒ] than after [tʃ] which is 0.006554 seconds. But the standard deviation value for VT shows that it is shorter after [dʒ] (0.009008 seconds) than after [tʃ] (0.013605 seconds). Figures (5) and (6) provide a visual representation of the duration of the vocalic transitions and rhotic closures, respectively, based on the measurements presented on Tables 2 and 3.

Figure 5: *Duration of VT for Affricate-Rhotic Clusters*

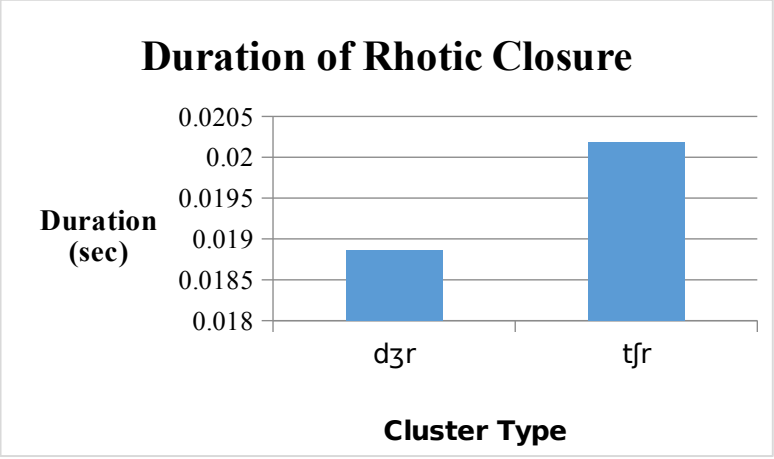
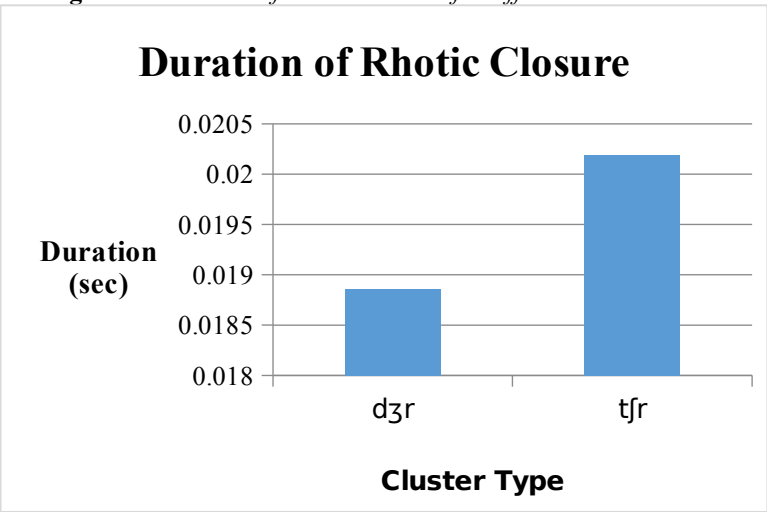


Figure 6: *Duration of Rhotic Closure for Affricate-Rhotic Clusters*



5.0 Discussion

The results show that [dʒ] is followed by longer vocalic transition (0.037 seconds) while [tʃ] is followed by shorter vocalic transition of 0.023 seconds (see Fig. 3). The duration of the rhotic closure in all tokens containing both the voiced and voiceless affricates is always short; 0.019 seconds mean for [dʒr] and 0.020 seconds mean for [tʃr] (see Fig. 4). Generally, these figures show that the rhotic is shorter after [dʒ] than after [tʃ]. The short duration of the rhotic closure after both affricates suggests that the rhotic is a tap [ɾ] and not a trill [r]. A similar impression is obtained of VT in both cases; it appears too short to be regarded as a vowel. The fact that VT is sometimes entirely absent after [tʃ] lends support to this impression.

The long vocalic transition between the voiced affricate and the rhotic explains why the rhotic in this cluster is impressionistically perceived as a trill. On why VT may be longer after [dʒ] than after [tʃ], the difference is apparently due to the voicing states of the two sounds. In the [dʒ]-VT-rhotic sequence, the vocal folds vibrate all through which makes the transition between the sounds easier than in the [tʃ]-VT-rhotic sequence. This difference is also linked to the fact that a voiced affricate is more sonorous than a voiceless one (Davenport and Hannahs, 2010: 75), and will thus be more easily co-articulated with a vocalic sound. The comparatively short VT after the voiceless affricate may be attributed to the onset of vocal folds vibration, which can introduce a lag during the [tʃ]-VT transition. This lag will be absent after the voiced affricate, and this may account for the difference in duration.

5.1 Change in Progress?

Evidence from Zogbo (2012) shows that the C_1C_2V syllable where C_2 is a lateral, that is CLV, is well attested in Kru languages. For instance, the term 'tooth' is realized as glē in Godié, glɛ̄ in Bete, glɛ̀ in Bakwé and gla in Kouya, all Eastern Kru languages while klà means 'person' in Krahn and ɲlí means 'name' in Nyabwa, both Western Kru languages. The C_1C_2V syllable type where C_2 is a rhotic is less common. Zogbo (2022) posits that the flap or tap is a variant of the lateral. This agrees with Newman's observation of Grebo, a Kru language spoken in southeastern Liberia. He observed in the speech of his consultant that CCV words where the cluster /l/ was followed by a rounded vowel, it was pronounced as an r-like tap rather than as a lateral as in the words brɔ 'frog', pro 'neck' and pr̃ũ 'to boil' (Newman, 1986: 177). This confirms Zogbo's claim that the tap/flap is a variant of the lateral in Kru languages. However, in the Wobé data presented in this study, the affricate-rhotic cluster is followed by both unrounded and rounded vowels viz; i, e, a, ɔ, and u. Therefore, it is not the case in Wobé that the tap/flap is a variant of the lateral that occurs in the CCV cluster before a rounded vowel.

It has already been noted that proto-Kru has no rhotic (Zogbo, 2012). This implies that the presence of a rhotic in Wobé is itself a departure from the proto form, and an innovation. That the rhotic is participating in consonant clustering of an unusual nature may therefore suggest a state of on-going change in Wobé where the rhotic gradually attains the status of a phoneme.

It is usual for all natural languages to change over time. Although language change may be observed while in-progress, it is often after it has reached an advanced stage that it becomes obvious. Many instances of change in-progress have been reported in African languages and within the languages in the Niger Congo phylum. Obikudo (2008) described a process of vowel merging in Nkọrọọ (Eastern Ijoid, Niger-Congo), that has reduced the number of vowels from nine as seen in Proto-Ijoid to seven. Adeniyi (2018) reported a case of ongoing changes that affected the syllable structure of Yoruba (Yoruboid, West Benue-Congo, Niger-Congo) in such a way that the historically disallowed consonant clusters are now freely attested, while Adeniyi and Olaogun (2020) presented an empirical picture of how many lexical items are gradually being eroded in Yoruba. The pattern observed in Wobé also points in the direction of change in progress, and it is worth tracking how the change evolves.

6.0 Conclusion

This paper examined the nature of Wobé affricate-rhotic clusters in word initial position. Data collected show that contrary to earlier reports that Proto Kru does not have rhotics, Wobé has a rhotic that forms a consonant

cluster with the voiceless and voiced post alveolar affricates [tʃ] and [dʒ] respectively. Based on auditory impressions, the rhotic was perceived as a trill when it followed [dʒ] and as a tap after [tʃ]. These perceptions necessitated acoustic investigations. Using the Praat software, the durations of the vocalic transition and rhotic closure were observed, and the spectrograms of the tokens recorded were analyzed.

The findings reported that the affricate and the rhotic are often separated by a fleeting period of vocalic transition in Wobé. The short duration of this vocalic transition indicates that it cannot be accorded the status of a vowel. Also, the rhotic is shown to be noticeably short in duration, which is consistent with it being a tap or flap. The study thus concludes that there is one rhotic in Wobé that can be found in the affricate-rhotic cluster, which is a tap or flap /ɾ/. This means that there is one, not two rhotic types in Wobé. The paper further posited that although the tap has been reported to be a variant of the lateral in Kru, especially in the consonant cluster that is followed by a rounded vowel as in Grebo, this is not the case in Wobé where the tap is followed by both unrounded and rounded vowels. It suggested that the presence of the tap in the affricate-rhotic cluster may point to an ongoing process of change in the Wobé language where the tap is changing phonetic status from being a variant of another sound to attaining the status of a phoneme.

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