INTERACTION OF VARIABLES IN THE CIVILI VOWEL DURATION

Hugues Steve Ndinga-Koumba-Binza

Centre for Text Technology, North-West University, Potchefstroom, South Africa
22602569@nwu.ac.za

ABSTRACT

This paper investigates the interaction between phonetic environments and syntactical positions in the determination of vowel duration in Civili. The paper will mainly report on the statistical analysis that followed a measurement procedure of vowel duration from a specific set of speech data.

Keywords: Civili, vowel duration, variables interaction

1. INTRODUCTION

The nature of vowel duration is an issue in the phonological system of Civili (cf. [9, 10]), a developing Bantu language spoken in Gabon and neighboring countries, although a number of studies have established the existence of short and long vowels on the basis of minimal pairs occurring in the language [2, 4, 5, 7, 8]. Table 1 below gives the set of Civili vowels in their respective phonological representations.

Table 1: Civili Vowels: phonological representations.

	Front		Central		Back	
	Sh	Lg	Sh	Lg	Sh	Lg
1st degree	/i/	/i:/			/u/	/u:/
2nd degree	/e/	/e:/			/o/	/o:/
3rd degree			/a/	/a:/		

However, the determination of the vowel duration characteristics was mostly based on unverified data with impressionistic analytic procedures rising out the complexity of the phenomenon [9]. Moreover, the analysis in [10] failed to investigate thoroughly the interaction between the variables that include phonetic environments (or contexts) as well as three syntactical positions (or positions) of the word that contains the concerned vowel.

This paper addresses the interaction of these variables at the segmental level. It is herewith hypothesized that the interaction between these variables has definite influence on the Civili vowel duration. This paper adopts a common method of an analysis comprising a measurement procedure of natural duration and a statistical analysis of measurement results. The paper will mainly report on the statistical analysis.

2. VARIABLES: CONTEXTS AND POSITIONS

In this paper, the term "context" is mostly used to refer to the phonetic environment and the term "position" to the syntactic position in the sentence or phrase.

This study is particularly concerned with the following factors:

(i) The position of the word to which the studied vowel belongs, i.e.,
   a. the word in isolation
   b. the word as object in a phrase or sentence
   c. the word as subject in a phrase or sentence
(ii) The context or environment of the vowel, i.e. the immediate or direct phonological context consisting of preceding adjacent segments and/or following adjacent segments.

It should be noted that at the syntactical level, Civili is a Subject-Verb-Object language with the specifications known for many Bantu languages (cf. [2, 7]).

According to certain views of the phonology of Civili, variation in duration could occur in the following environments:

(i) /C_NC/ (a vowel is long when it is followed by a nasal cluster).
(ii) /CG_C/ (a vowel is long when it follows a consonant-glide sequence).

In fact, a number of phonological descriptions and analyses (cf. [1, 3, 6, 13] to name a few) have stated that any vowel is lengthened or is long when

(i) it precedes a nasal segment, leading to the following formalism:

   (1) $V \longrightarrow [+long] \: / \: \_\_N$

(ii) it follows a consonant-glide segment, thus leading to the following formalism:

   (2) $V \longrightarrow [+long] \: / \: CG\_\_$

These claims apply to Civili, as could be seen from most of the previous studies by various

authors such as [2, 4, 5, 7, 8]. However, this paper also took into consideration the following contexts that broaden the above theoretical formalized contexts.

(i) /C_N/ (when the vowel is followed by a single nasal consonant).

(ii) /C_C/ (when the vowel precedes a consonant stop).

(iii) /C_L/ (when the vowel precedes a liquid consonant).

3. METHOD AND ANALYSIS

Speech data were collected on the basis of a constructed representative but limited corpus recorded from 4 Civili native speakers (of which one was a female) ranging from 31 to 73 years old. The corpus was captured according to the specifications of contexts and positions presented above in order to enable to perform focused acoustic analyses and duration measurements. It consisted of a range of words containing long-sounding and short-sounding vowels, on the one hand, and a range of simple sentences and phrases containing the same words in both syntactical positions of subject and object, on the other hand. The corpus contains 384 entries of single words in isolation and 768 sentences and phrases. The view by [12] was adopted in determination of duration within the identified contexts and the syntactical positions in the corpus.

Vowel length in Civili occurs only on the first stem vowel. Therefore, only the first stem vowel of the target word was measured regardless of the syntactical position. Values of measurement results were used as data for this statistical analysis using STATISTICA with the aim to determine the interaction between contexts and positions (CONTEXT*POS) and the significance of this interaction. The interaction effect (CONTEXT*POS) was tested on the basis of that differences in vowel duration might be due to the context-position interaction. It was hypothesized that for the CONTEXT effect, all five contexts have the same value and that for the POSITION effect, all three positions have the same value

When the hypothesis is rejected on the grounds of a p-value of less than 0.05, it leaves room for an alternative hypothesis, namely that at least one of the means differs from others. The analysis on the effect CONTEXT*POS does not test the differences in the means, but rather the similarity of the changes in the different contexts. The

research question of this test is stated as follows: Are those changes in the means the same in the different contexts? If there is no interaction, the differences in the positions are then the same for all the contexts. If there is interaction, the differences between the positions are dependent on the context. The remaining question would then be what this context is. Table 2 gives a summary of the statistical results. The variables for the effect CONTEXT are the five various contexts previously identified, whereas the variables for the effect POS are the three syntactical positions. The variables for the effect CONTEXT*POS are the variables of the two previous effects implicated in the context-position interaction.

Table 2: Summary of statistical results.

V	Effects	P-value	Means	Dependent Variables
a	POS	0.02	0.10	Isolation
e	CONTEXT	0.001	0.10	C_N
ee	CONTEXT	0.000001	0.10	CG_C
	POS	0.04	0.16	Isolation
i	POS	0.02	0.09	Isolation
ii	CONTEXT	0.007	0.15	CG_C
	POS	0.04	0.20	Isolation
	CONTEXT*POS	0.04		Variables interaction
o	CONTEXT	0.05	0.09	C_C
u	CONTEXT	0.04	0.09	C_N
	POS	0.01	0.07	Subject
aa	CONTEXT	0.0001	0.15	C_L
	CONTEXT*POS	0.001		Variables interaction
oo	POS	0.002	0.18	Isolation
uu	CONTEXT	0.03	0.14	C_C

Table 2 allows for the following observations:

1. The effect CONTEXT is significant for the seven vowels /e/, /ee/, /ii/, /o/, /u/, /aa/ and /uu/.

2. The effect POS is significant for the six vowels /a/, /ee/, /i/, /ii/, /u/ and /oo/.

3. The effect CONTEXT*POS is significant for only the two vowels /ii/ and /aa/.

4. All three effects can be significant for the same vowel without any further interaction (i.e. multiple significances). This happened only once, but it happened three times that two effects were significant for the same vowel without any further interaction (a situation of double significance).

5. When the effect CONTEXT is significant, the three variables /C_N/, /CG_C/ and /C_C/ play a role for two vowels each, whereas the variable /C_L/ plays a role for only one vowel.

6. When the effect POS is significant, only the two variables Isolation and Subject play a role respectively for only one vowel and for five vowels

7. The effect CONTEXT*POS is only significant in situations of multiple or double significance.

Table 3 gives a summary of these observations.

Table 3: Significance of statistical results.

Sounding	Effect	V	Variables
Long	CONTEXT	ee	CG_C
		ii	CG_C
		aa	C_L
		uu	C_C
	POS	ee	Isolation
		ii	Isolation
		oo	Isolation
	CONTEXT*POS	aa	Variables interaction
		ii	Variables interaction
Short	CONTEXT	e	C_N
		o	C_C
		u	C_N
	POS	a	Isolation
		i	Isolation
		u	Subject

Table 3 allows for the following observations:

1. The effect CONTEXT*POS is not significant for short-sounding vowels since a third sub-row is missing from the main row of short-sounding vowels.

2. The effect CONTEXT*POS is only significant for the two long-sounding vowels /aa/ and /ii/.

3. The effect CONTEXT is significant for the three short-sounding vowels /e/, /o/ and /u/. The variables implicated are /C_N/ for the vowels /e/ and /u/ and /C_C/ for the vowel /o/.

4. The effect POS is significant for the three short-sounding vowels /a/, /i/ and /u/. The variables implicated are Isolation for the vowels /a/ and /i/ and Subject for the vowel /u/.

5. The effect CONTEXT is significant for the four long-sounding vowels /ee/, /ii/, /aa/ and /uu/. The variables implicated are /CG_C/ for the first two vowels, /C_L/ for the vowel /aa/ and /C_C/ for the vowel /uu/.

6. The effect POS is significant for the three long-sounding vowels /ee/, /ii/ and /oo/. The only variable implicated here is Isolation.

Both Table 2 and Table 3 show that for the effect CONTEXT*POS dependent variables are in interaction. It appeared relevant to identify which variables are in interaction for this effect. The

significant interactions observed are displayed in Table 4 below.

Table 4: Significant context-position interactions for vowels /ii/ & /aa/.

		1 ISOLATION	2 OBJECT		3 SUBJECT
1	CG_C	ii	ii	aa	ii
2	C_C	ii	ii	aa	ii
3	C_L	ii	ii	aa	ii
4	C_N	aa	ii	aa	aa
5	C_NC	aa	aa	ii	aa

The following observations can be made from the results in Table 4 above:

1. Except for context 5, interaction is significant for all contexts with position 2.

2. Interaction between position 1 and contexts 1, 2 and 3 is significant for /ii/ but not for /aa/. Likewise, interaction between position 3 and contexts 1, 2 and 3 is significant for /ii/ but not for /aa/.

3. Interaction between position 1 and contexts 4 and 5 is significant for /aa/ but not for /ii/. Likewise, interaction between position 3 and contexts 4 is significant for /aa/ but not for /ii/.

For the sake of generalization, it is important to look at these results from different angles. A closer look allows the groupings given in Tables 5 to 7. Each table groups vowels according to their height (High/Mid/Low) in three rows, and their tongue position (FRONT/BACK) in two columns. In each column, and where the effect is significant for both short and long-sounding vowels, the short-sounding vowels are placed on the left of the column and the long-sounding ones on the right.

Table 5 shows vowels affected by the effect CONTEXT, which is sensitive to both tongue position and vowel height. It is neither significant for High FRONT short-sounding vowels nor Mid BACK long-sounding vowels.

Table 5: Vowels for the effect CONTEXT.

	FRONT		BACK	
High		ii	u	uu
Mid	e	ee		o
Low			a	aa

Table 6 displays vowels affected by the effect POS. The effect POS is also sensitive to both vowel height and the tongue position. It is significant neither for High and Low BACK long-sounding vowels nor for Mid FRONT and BACK short-sounding vowels.

Table 6: Vowels for the effect POS.

	FRONT		BACK
High	i	ii	u
Mid		ee	oo
Low			a

Table 7 presents vowels affected by the effect CONTEXT*POS. As can be seen from this table, the effect CONTEXT*POS is mainly sensitive to the vowel height. It is not significant for any Mid vowel.

Table 7: Vowels for the effect CONTEXT*POS.

	FRONT	BACK
High	ii	
Low		aa

4. FINDINGS AND CONCLUSION

Deductions from the acoustic analysis and the statistical analysis recognize the existence of both short and long (or lengthened) vowels in the Civili vowel system. It is then left to a proper phonological approach, which would integrate these phonetic data, to determine whether long-sounding vowels are naturally long vowels or lengthened vowels. An analysis was conducted on the basis of the phonological claim that any vowel can be lengthened or is long:

(i) due to the effect of a certain syntactic position (Isolation, Subject or Object);

(ii) when it is in a certain phonetic environment (Contexts)

Results from the statistical analysis made of the quantitative acoustic results permit the following observations:

(i) The results do not confirm any effect of the phonetic environment /C_NC/ on the duration of vowels in Civili.

(ii) The results confirm that the phonetic environments /CG_C/ and /C_L/ has an effect on vowel duration, but only that of long-sounding vowels.

(iii) The results confirm that the phonetic environments /C_N/ and /C_C/ has an effect on vowel duration, but most often on that of short-sounding vowels (cf. Table 7).

In conclusion, the Civili vowel system records natural short and long vowels. However, a lengthening process of short vowels occurs in certain phonetic environments and/or syntactic positions. This confirms results from spectral observations by [10] which deny any sequence of identical adjacent vowels.

5.   REFERENCES

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