PERCEIVED VOWEL DURATION IN CIVILI: MINIMAL PAIRS AND THE EFFECT OF POST-VOCALIC VOICING

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ABSTRACT

Vowel duration has been an issue in the study of Civili. Although minimal pairs based on vowel duration can be established at both perceptual and physical level, vowel lengthening still occurs in the context of voiced consonants in the language. A comparison between a measured physical duration and an experimentally perceived duration confirms the phonemic distinctiveness of vowel length and indicates the voicing effect of the post-vocalic consonant at the microphonetic level.

Keywords: Civili, vowel duration, perception, voicing, minimal pairs

1. INTRODUCTION

It is known that vowel duration variation occurs (physically or perceptually) in the context of voiced consonants (cf. [5, 6, 7, 18] for English). This claim also applies to Civili, a minority African language of the Bantu phylum.

Vowel duration has been an issue in the study of this language for the past few years (cf. [14, 15, 16]), although various phonological studies had previously confirmed the existence of long vowels that are opposed to short vowels (see [3, 8, 12, 13]). However, the determination of rules for vowel lengthening was based on impressionistic phonetic data and rather raised the complexity of the phenomenon [14].

This paper reflects on the question whether voicing is not a factor for variation in duration in [+voice] contexts observed in the language. Ndinga-Koumba-Binza [15], and later Ndinga-Koumba-Binza and Roux [16] eluded the implication of voicing following the perceptual experiment.

This paper adopts the framework of laboratory phonology known for addressing problematic phenomena with experimental methods. A clear distinction is made between the physical duration and the perceived duration, the same way Malmberg [9] had to distinguish the physical duration from distinctive length. In the context of minimal pairs, this distinctiveness has been established experimentally at the perceptual level but it is expected to be ascertained at the physical level by means of acoustic measurements.

2. PERCEIVED DURATION

Experimental data analyzed in this paper were retrieved from a perception experiment conducted for [15] as well as from the analyses suggested in [16]. The experiment included 'a variety of random stimuli presented to the subject, who had to identify one according to set criteria' [2].

The experiment sought to determine the nature of perceived vowel duration in the context of minimal pairs. A total of 100 stimuli were administered to 68 subjects (37 males and 31 females) within three perceptual tests (one identification A/B and two discrimination AB and ABX tests) in Mayumba and Libreville, Gabon. The participants in the perception tests were Civili native listeners. The selection of the participants was based on their readiness to cooperate.

A statistical analysis of the perception results was conducted with the aim to determine whether the participants were able identify and/or discriminate between vowels of different duration (long versus short) in minimal pairs. The mean percentages were calculated from the perception results. They are shown in the three tables below for each of the three perception tests respectively.

Table 1: Mean percentages for A/B test (Test I).

Vowels	**Answers**		
	% Correct	% Wrong	% Uncertain
Vowel /a/	50	35.7	13.4
Vowel /e/	40.6	42.6	16.9
Vowel /i/	38.8	50.7	10.7
Vowel /o/	51.6	41.4	7.00
Vowel /u/	41.4	50.7	7.9

Table 2: Mean percentages for AB test (Test II).

Vowels	**Answers**		
	% Correct	% Wrong	% Uncertain
Vowel /a/	54.5	39.5	6.00
Vowel /e/	59.00	30.00	10.5
Vowel /i/	57.00	40.00	3.00
Vowel /o/	58.5	37.5	4.00
Vowel /u/	79.00	20.00	1.00

Table 3: Mean percentages for ABX test (Test III).

Vowels	**Answers**		
	% Correct	% Wrong	% Uncertain
Vowel /a/	39.00	52.5	8.5
Vowel /e/	51.5	44.00	4.5
Vowel /i/	86.5	13.00	1.00
Vowel /o/	47.00	51.00	2.5
Vowel /u/	85.5	13.5	1.00

These results broadly indicate that the Civili native speakers make consistent distinctions between vowels they perceive as short and vowels they perceive as long. Thus, it was presented in [16] that a number of figures show large consistency for the Civili native listeners' ability to discriminate between short and long vowels in the context of minimal pairs. This leads to the consideration of the physical duration of the components of the minimal pairs.

3. PHYSICAL DURATION

Effort was made to withdraw minimal pairs within the phonetic environments established for physical measurements from [15] for the specific two theoretical contexts mentioned earlier. Ohala [17] indicates that the "common practice within phonetics of making a given measurement (e.g., vowel duration, formant frequency) on multiple tokens and reporting the means of these measurements is evidence that phonetics seeks some sort of pronunciation norm which is more abstract than any given speech token". This view was followed in determining the duration of Civili vowels involved in minimal pairs, and vowel duration in the identified contexts and positions.

However, the method of labeling and segmentation combined both an auditory procedure and a visual inspection procedure. PRAAT was used to measure the duration of each target phoneme. Thus, measurements of vowel duration were made using synchronized spectrogram and waveform displays in TextGrids generated in PRAAT.

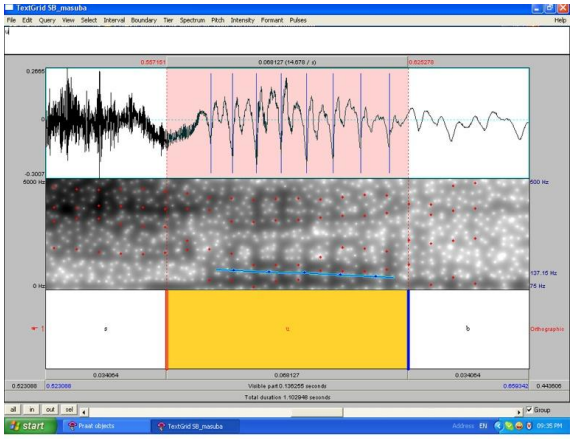
The procedure was first to determine the start and the end of the target sound in order to set boundaries, one when the sound begins and the other when the sound ends. The commencement boundary was set after the consonant release. This is "the point in the waveform where the decline in wave amplitude and complexity ended" [10].

All measurements were made at the zero crossing line. When the studied vowel preceded a stop, the boundary was set at the last discernable period; when preceding a nasal or a liquid the boundary was set at the zero crossing line where there is distinctive change in the sound wave pattern as well as in the formant pattern; when preceding a fricative, the boundary was set at the zero crossing line of the first detection of stridency in both the waveform and the spectrum.

For the vowel onset, the boundary was set at the zero crossing line where appears the first clear indication of discernable formant frequencies given by the system. Once boundaries were set, a tag or label could be inserted. For each tag that is selected, PRAAT shows the time, in seconds, at which the particular sound commences and ends. Finally, the duration of the target vowel was calculated as the time difference between the boundary for that vowel and the next boundary.

The screenshot in Figure 1 below shows the annotation of the vowel [u] in the word "masuba" (*urine*). The physical duration of the vowel under investigation is clearly identified in a visible part: 0.068127 seconds. The duration was recorded as 0.068 seconds in the results tables.

Figure 1: Screenshot for the vowel [u] in "masuba".



Results of the measurement process confirm the previously established distinction between long sounding and short sounding vowels as shown Table 4 and Table 5 below. This distinction was also based on the calculation of the duration averages across vowel qualities per speaker and mainly supported on the perception-based physical measurements (visually as well as auditorily).

In Table 4, amongst the short sounding vowels, the average duration of the shortest vowel is 0.053 seconds, whereas the average duration of the longest one is 0.148 seconds. In Table 5, amongst the long-sounding vowels, the average duration of the shortest vowel amongst these is 0.068 seconds, whereas the average duration of the longest one is 0.276 seconds. The last column of each table

contains the average durations calculated across all four speakers (Sp).

Table 4: Measurement results of short sounding vowels.

	Sp 1	Sp 2	Sp 3	Sp 4	All
i	0.069	0.075	0.073	0.128	0.086
e	0.083	0.076	0.071	0.126	0.089
a	0.078	0.077	0.085	0.144	0.096
o	0.085	0.080	0.083	0.145	0.098
u	0.072	0.076	0.071	0.127	0.087
Average	0.077	0.077	0.077	0.134	0.091
Shortest	0.039	0.047	0.035	0.091	0.053
Longest	0.107	0.145	0.117	0.223	0.148

Table 5: Measurement results of long sounding vowels.

	Sp 1	Sp 2	Sp 3	Sp 4	All
ii	0.173	0.173	0.151	0.218	0.179
ee	0.153	0.140	0.124	0.175	0.148
aa	0.179	0.163	0.158	0.219	0.180
oo	0.162	0.135	0.169	0.221	0.172
uu	0.135	0.149	0.135	0.200	0.155
Average	0.077	0.161	0.152	0.148	0.207
Shortest	0.039	0.081	0.054	0.046	0.092
Longest	0.107	0.256	0.275	0.277	0.296

4. VOICING CONTEXT

The two sections above ascertain a phonemic length contrast in vowels at both perceptual and physical levels. This section seeks to investigate the contrast at the microphonetic level with a comparative analysis of the physical duration opposed to the perceived duration within the post-vocalic environment.

4.1. Comparative analysis in voicing context

Table 6 summarizes the analytical observation of physical versus perceived duration with 12 cases withdrawn from both the perceptual stimuli and the physically measured tokens. Column 1 numbers the minimal pairs. Column 2 presents the words of each minimal pair. Column 3 indicates whether the vowel in the pair was acoustically measured short or long. Column 4 designates whether the vowel in the pair was perceived short or long. In Columns 3 and 4, the value (X) specifies the duration (short or long) concerned. Column 5 presents results of the comparison. The positive value (+) indicates whether the perceived duration is identical to the acoustic duration.

Table 6: Comparative Analysis: Physical vs. Perceived Duration.

	Words	Physical Duration		Perceived Duration		Results
		Sh	Lg	Sh	Lg	
1	Biima		X		X	+
	Bima	X			X	-
2	Mbeela		X		X	+
	Mbela	X			X	-
3	Baana		X		X	+
	Bana	X		X		+
4	N'tootu		X		X	+
	N'totu	X		X		+
5	Mbuusa		X		X	+
	Mbusa	X		X		+
6	Saalu		X		X	+
	Salu	X			X	-

It is shown that:

(i) in pairs 1, 2 and 6 the short sounding part of the minimal pair is acoustically measured as short, but perceived as long (thus 3 out of 6 cases);

(ii) in pairs 3, 4 and 5 the short sounding of the minimal pair is acoustically measured as short and also perceived as short (thus 3 cases out of 6);

(iii) the long sounding part of the minimal pair is acoustically measured long and perceived as long in all cases (thus 6 out of 6 cases).

4.2. Discussion

The three cases where the perceived duration does not match the acoustic duration concern the two phonetic environments:

(i) /C_N/ (the vowel precedes a nasal).

(ii) /C_L/ (the vowel precedes a liquid).

In these cases, vowels measured as short are perceived as long.

On the contrary, 9 out of 12 cases show that the perceived duration is identical to the physical duration. One might consider that these cases are not significant to the study in the determination of the effect inducing variation in vowel duration. It should however be noticed that cases in pairs 4 and 5 record a phonetic environment C_C whereby the subjacent consonant is [-voice]. This context serves as for comparative verification.

In comparison with other experimental studies on the effect of voicing over vowel duration (e.g. [1, 4, 20] to name a few), the difference between the physical duration and the perceived duration does not seem significant enough to deny the existence of minimal pairs based on duration in these two phonetic contexts.

5. CONCLUSION

In conclusion, the comparative analysis not only confirms the phonemic distinctiveness of vowel duration in Civili minimal pairs, but also indicates the voicing effect of the post-vocalic consonant within specific phonetic environments at the microphonetic level. It can be concluded that in Civili any vowel is perceived long when it is preceding a voiced consonant. Voicing is therefore one of the factors that influences vowel duration in perception. Although a phonological rule could be formalized as follows:

(1) $V \longrightarrow [+long] / \_\_ C$ [+cons, +voiced]

It fails to express the existence of an underlying assimilatory process.

6. REFERENCES

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