THE INFLUENCE OF ASPIRATION ON VOWEL DURATION

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ABSTRACT

In the present paper an attempt is made to put forward the results of an electro-glottographic study on the influence of aspiration on vowel duration in Maithili — a modern Indo-Aryan language spoken by a total of about 21 million people both in Nepal and India. The main aim of our study was to investigate whether phonation types other than voicelessness and voicing also affect the length of vowels preceding a consonant. Our results clearly show that the aspiration of the following consonant does affect vowel duration in Maithili. In fact, in Maithili the features of both voice and aspiration do independently lend increments of length to the preceding vowel.

INTRODUCTION

There have been in the past quite a few studies on vowel duration in various languages of the world. One of the major findings of most of these studies has been that, other things remaining the same, vowels are longer before voiced consonants than before voiceless ones. This phenomenon has usually been considered [e.g. 1; 2; 3] to be due to an inherent property of the speech production mechanism. And a number of different proposals have so far been made as to what precise mechanism is responsible for this lengthening of vowels. Some proposals [e.g. 4; 5] aim only to account for the lengthening of vowels before voiced and voiceless consonants, while others also aim to account for such factors as: the degree of opening of the vowel [e.g. 6;7; 8]; place, manner and force of articulation [e.g.9; 10; 11] of the following consonants; the structure of the syllable in which the vowel occurs [e.g. 12], the nature of the phonemic contrasts employed by the language in question [e.g. 13], and the degree of glottal opening [e.g. 5; 14] as well as the airflow rate [e.g. 15; 16] of the following consonants. It has to be admitted that comparatively little has so far been published on the effect of aspiration on vowel duration. Relatively recently, Maddieson and Gandour [17] studied the effect of aspiration on the duration of the Hindi vowel /a/ — as spoken in Delhi — and found some interaction between aspiration and vowel duration. In a later study [18], Maddieson investigated five languages — i.e. Hindi, Bengali, Assamese, Marathi and Eastern American — and came to the conclusion that vowel lengthening before aspirated consonants is not universal.

In the present paper an attempt is made to put forward the results of an electro-glottographic study on the influence of aspiration on vowel duration in Maithili — the vowels studied here are those of a variety of the 'standard' dialect of this language. The main aim of the paper is to investigate whether phonation types other than voicelessness and voicing also affect the length of vowels preceding a consonant.

EXPERIMENTAL METHOD

Test Utterances

For the purpose of the present study, appropriate test utterances — as given in Table I — were prepared. This table lists 24 monosyllabic test utterances containing the following six Maithili oral vowels: /i e a ə o u/, each followed by phonologically contrasting series of four stop or affricate consonants — i.e. voiceless unaspirated, voiceless aspirated, voiced unaspirated and voiced aspirated. Where complete minimal series of words containing all the stops with differing phonation types in a given place of articulation did not exist, nonsense utterances — i.e. utterances which are not available in the Maithili lexicon and which therefore do not mean anything in this language — were added to fill the gaps in distribution. Only three such nonsense items were required for the purpose of this study: i.e. *[gə:p^h], *[so:g^h] and *[ku:d^h], as given in Table I. It must also be pointed out that all the nonsense utterances thus added in this table are phonologically possible items in the Maithili language.

Table I: Test words containing six Maithili oral vowels followed by voiced and voiceless, aspirated and unaspirated consonants.

Vowels	Words with glosses
/i/	[bi:č] "centre"
	[bi:č^h] "pick up (imp.)"
	[bi:ǰ] "seed"
	[bi:ǰ^h] "rust"
/e/	[se:p] "saliva"
	[se:p^h] "safe (n)"
	[se:b] "to serve"
	[se:b^h] "shave"
/a/	[sa:t] "seven"
	[sa:t^h] "together"
	[sa:d] "longing"
	[sa:d^h] "capacity"
/ə/	[gə:p] "talk"
	*[gə:p^h] (a nonsense word)
	[gə:b] "seedlings made ready for transplantation"
	[gə:b^h] "pregnancy — a metaphorical use"
/o/	[so:k] "sorrow"
	[so:k^h] "swallow"
	[so:g] "distress"
	*[so:g^h] (a nonsense word)
/u/	[ku:t] "amount of grain given by tenants to landlords"
	[ku:t^h] "push breath out of lungs"
	[ku:d] "jump"
	*[ku:d^h] (a nonsense word)

Apparatus Used

Each test utterance was afterwards put in a normal conversational sentence context, the frame of the sentence being ['p^{h}e:ro . . . 'učča:rən kə'ru:] "please . . . pronounce again". Each test utterance was said in the same frame so as to make sure that the differences are not due to variations in the rate of utterance. The sentences were first randomised and then spoken in a relaxed informal style at a normal conversational speed, without putting any contrastive stress on the test utterances. The pronunciation represented in this work is entirely the author's own. Sixteen tokens of each test utterance, each token embedded in the above sentence frame, were recorded in a soundproof studio of Essex University. All recordings were made on a Revox B 77 tape-recorder. The glottal signal was obtained using an Electroglottograph F-J Electronics Type EG 830. Oscillomink tracings of waveform and amplitude produced from the recorded readings were obtained using a Mingograf Type EM 34T. Calculations relating to the 'mean', the 'standard deviation'(SD) and the 'coefficient of variation'(v) of all tokens of each test utterance were made using a Tektronix 31 calculator.

Duration Measurements

Of the sixteen tokens of each test utterance, the first two as well as the last two tokens were ignored, and all the remaining twelve tokens of the middle were used to obtain the duration measurements of all the vowels investigated in this study. The first measurements of vowel duration were made from the start of the vowel in question to the closure of the following consonant. In the case of words beginning with voiced stops and even voiceless unaspirated stops and fricatives, the measurement was begun at the release of the concerned initial stop or fricative.

Afterwards, a simple arithmetic mean of the actual measured values of all the 12 tokens of each test utterance was worked out. In order to ascertain the reliability of the arithmetic mean as a quantified abstract value representing the realisation of the speaker's intention, the range of the variability occurring in all the 12 tokens of every test utterance was also taken into account. For this, the standard deviation of each test utterance was worked out. To relate the variation between the different sets of data presented in this paper, the duration values of all test utterances were normalised by obtaining a coefficient of variation of each test utterance, the equation used being: $v = \frac{SD}{mean} \times 100$.

RESULTS AND DISCUSSIONS

Since from a preliminary survey of some published sources [e.g. 19; 13; 10; 8; 6; 7] preceding consonants exhibit no readily discernible patterns of environmental influence on the duration of the following vowels, in the present study we have restricted ourselves to the influence of the following consonants on the duration of preceding vowels. Table II presents the results of this study [see 20, pp. 344-45, for more details]. It shows the mean duration values of the six oral vowels as obtained from the 12 tokens of each test utterance, the standard deviation of the 12 tokens of each test utterance, the coefficient of variation

Table II: Mean duration values, standard deviation, coefficient of variation, and the duration-ratio of the six Maithili oral vowels followed by voiced and voiceless, aspirated and unaspirated consonants.

Vowel	Word	Mean	SD	v	Ratio
/i/	[bi:č]	165	5	3	1.00
	[bi:čʰ]	183	5	3	1.15
	[bi:ǰ]	210	5	3	1.27
	[bi:ǰʰ]	224	5	2	1.35
/e/	[se:p]	174	5	3	1.00
	[se:pʰ]	195	5	3	1.12
	[se:b]	218	4	2	1.25
	[se:bʰ]	240	5	2	1.37
/a/	[sa:t]	202	6	3	1.00
	[sa:tʰ]	226	7	3	1.11
	[sa:d]	240	5	2	1.18
	[sa:dʰ]	275	6	2	1.36
/ə/	[gə:ɔ]	104	4	4	1.00
	*[gə:pʰ]	120	5	4	1.15
	[gə:b]	134	6	5	1.28
	[gə:bʰ]	159	4	3	1.52
/o/	[so:k]	166	5	3	1.00
	[so:kʰ]	180	8	4	1.08
	[so:g]	204	8	4	1.22
	*[sc:gʰ]	239	6	3	1.43
/u/	[ku:t]	155	5	3	1.00
	[ku:tʰ]	175	4	2	1.12
	[ku:d]	220	5	2	1.41
	*[ku:dʰ]	240	5	2	1.54

of every utterance as well as the ratio of the duration of vowels preceding voiced and aspirated consonants to the duration of vowels preceding voiceless unaspirated consonants. A diagrammatic representation of the mean duration values of this table is given in Figure 1. The horizontal axis of this figure shows postvocalic stop and affricate consonants of various places of articulation, while its vertical axis shows the duration of the six oral vowels in milliseconds (ms).

Both Table II and Figure 1 clearly show that all the six vowels investigated in this study have longer mean durations before voiced and aspirated stop as well as affricate consonants than before their voiceless unaspirated counterparts. The mean duration-measurements and their diagrammatic illustrations given in Table II and Figure 1, respectively, amply show that the aspiration of the following consonant does affect vowel duration in Maithili. The present data sufficiently reveals that the overall pattern found

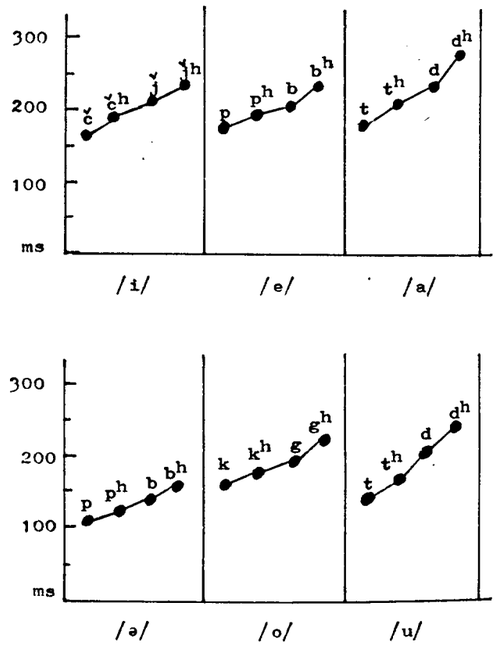

Figure 1: The mean duration of the Maithili oral vowels as spoken in monosyllabic minimal word pairs, each word of the pair differing only in the final consonant.

between the relative durations of the six Maithili oral vowels — each vowel preceding consonants of four different phonation types — is very similar, and that in this language:

1. vowels are relatively longer in duration before voiceless aspirated consonants than before voiceless unaspirated consonants;
2. vowels preceding voiced unaspirated consonants are relatively longer in duration than those preceding either voiceless unaspirated or voiceless aspirated consonants;
3. vowels are relatively longer in duration before voiced aspirated consonants than before voiced unaspirated consonants; and
4. in general, other things being equal, open vowels are relatively longer than close vowels.

Our results of the present study suggest that two rules, perhaps 'low-level phonetic rules' operate in Maithili. These may be written as in (1) below:

(1) a. vowel adds 1 increment of length before aspiration; and
b. vowel adds 2 increments of length before voicing.

Applying these rules gives the results shown in (2) below:

(2) vowel before voiceless unaspirates: 0 increment
vowel before voiceless aspirates: 1 increment
vowel before voiced unaspirates: 2 increments
vowel before voiced aspirates: 3 increments

These findings offer support for the traditional grouping of the Maithili obstruents — like perhaps the obstruents of most other Indo-Aryan languages — not only into voiced and voiceless categories but also into aspirated and unaspirated. The most interesting aspect of our results is the challenge presented to the various proposed 'explanations' [e.g. 4; 5; 9; 11; 21; 22; 23; 19] of the cause of the intrinsic length of vowels before consonants of different phonation types [see 20, pp. 163-67, for more discussions in this respect].

CONCLUSION

To conclude, the present study clearly shows that phonation types other than voicelessness and voicing also affect the relative duration of the vowel preceding a consonant. We have found that the features of both voice and aspiration independently lend increments of length to the preceding vowels in Maithili. This clearly means that the 'explanations' proposed in the literature so far to account for vowel lengthening before voiced and voiceless obstruents cannot be extended to account also for vowel lengthening before both voiceless and voiced aspirated obstruents. We therefore hope that the results of our study will urge a rethinking of recent and current explanations of the interaction of phonation type and vowel duration, and will assist in the formulation of new theories predicting the influence of the following aspirated/unaspirated consonants on the relative duration of preceding vowels.

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