



Effect of Aspiration on Vowel Duration for Voice and Voiceless Unaspirated (Garhwali Hindi) Consonants

S. K. Adhikari*

sheshkant@rediffmail.com

Abstract

In this paper, an attempt has been made to study of Vowel durations for voice and voiceless unaspirated consonant. An experiment is described to study vowel duration of 10 vowels (Garhwali Hindi) with different unaspirated consonants. Ten Garhwali vowels word in /CVC/ syllables as spoken three times by ten males and ten females Garhwali speakers were recorded in system in the free field of partially acoustically treated room. SFS/PRRAT software is used to digitize and analyze the data. Linear predictive coding (LPC) spectra were obtained for each of vowels and vowel duration was measured. Then we found that vowel duration of voice unaspirated consonant is greater than voiceless unaspirated consonants.

Keywords: Vowels, vowel duration, consonant, voice, voiceless, unaspirated, speaker.

Introduction

Aspiration can be defined as “glottal friction produced with (for voiceless sounds) glottal pulsing (due to air flow through the glottis) while the glottis is narrowly or widely opened and the supra glottal vocal tract is unobstructed” (Fant, 1970). Acoustically, aspiration can be described as noise (random stippling) mostly at the frequencies near second and third formants of the following or preceding vowels, (Fant, 1970). The sound / p^h, t^h, t̪^h, k^h; b^h, d^h, g^h / are designated as aspirated sounds while the rest / p, t, t̪, k; b, d, d̪, g / are unaspirated.

It is observed that vowel duration (time interval from the offset of vowel transition of initial consonants to offset of vowel transition of final consonants) in Hindi CVC sounds is large when the following stops are voiced whereas it is comparatively short for tokens terminating in voiceless stops (duration ratio is 1.15:1). However the distinction is not as pronounced as observed for English vowels by Denes (1955) and Peterson et al. (1960). Peterson et al. found that the ratio of the vowel duration ending with voiced stops to those ending with voiceless stops was roughly close to 3:2. There vowel durations were, however, measured from the onset of the vowel transition of initial consonant to the offset of the vowel transition of final consonant. Peterson et al. also found that the vowel duration in CVC tokens are not affected by initial consonant. Hogan et al. (1980) also observed that ratio of vowel durations for vowels preceding the voiced stops to that followed by voiceless stops are substantially large. They observed, in synthetic speech, that the vowel duration serves as a voicing cue for voicing distinction when following sounds are either fricatives or are stop clusters but not stop consonants.

* Dr. Adhikari is Lecturer in Physics at Birendra Multiple Campus (Tribhuvan University)

Ahmad et al. (1985) in a study of Hindi consonant in CVC syllable final position also found that vowel duration (steady state vowel) preceding voiced stops is greater than that of vowels preceding voiceless stops and the ratios are found to be 1.33:1. Upadhyay (1993) found this ratio to be 1.13:1. In their perceptual study using Electronic Segmentation Technique, Ahmad, Rizvi and Gupta found that vowel duration unlike Raphael (1972). In an acoustic study of Telugu vowels Majumder et al. (1973) also observed that the vowel duration is large if following consonants, are voiced compared to the case when following consonants are voiceless. However, they reported some exceptions. In similar study of Telugu sounds, Nagamma (1988) observed that the vowels followed by voiceless consonants are not always shorter in duration than the same vowels followed by voiced consonants. The durations of vowel and closure are not affected if the place of the following consonant is changed. Peterson et al. (1960) also observed similar effect for the duration of vowels in English. The vowel durations are not affected by aspiration feature of the following consonant.

Subjects

Twenty subjects (10 males and 10 females) of 20-25 years (adults) were considered. These 12 subjects were selected on the criteria that they had Garhwali dialect of Hindi as their mother tongue, able to read Garhwali and normal speech, language and hearing function.

Test materials

In the present study, the ten vowels of Garhwali Hindi language i.e. /ʌ/, /a/, /ɪ/, /i/, /U/, /u/, /e/, /ɛ/, /O/ and /ɔ/ were analyzed. The vowels were in the environment of 8 consonants /p, t, ʈ, k, b, d, ɖ, g/ the test material consist of a list of 80 meaningful monosyllabic word with a /CVC/ formant.

Observation:

Table: - 1: Effect of aspiration on vowel duration (in m sec.) for voice and voiceless consonants in isolation for male speakers

Vowel	Voice				Voiceless			
	Labial	Dental	Retro-flex	Velar	Labial	Dental	Retro-flex	Velar
/ʌ/	137.98	120.22	127.09	149.23	094.21	115.33	123.21	122.08
/a/	217.81	186.38	243.31	187.40	207.89	171.22	207.63	157.48
/ɪ/	110.14	116.25	094.42	133.02	096.29	096.88	096.07	098.93
/i/	185.33	163.30	180.19	183.22	155.35	149.22	129.61	130.86
/U/	131.12	130.93	091.63	126.02	092.79	129.66	091.19	100.37
/u/	190.90	143.87	132.54	189.68	181.12	135.36	129.17	187.94
/e/	188.98	163.44	208.47	169.45	141.04	148.43	145.86	150.76
/ɛ/	222.22	223.78	217.38	217.23	198.13	206.82	169.12	182.84
/O/	216.63	221.59	207.57	199.21	180.25	209.37	194.98	187.29
/ɔ/	210.75	239.64	251.30	237.95	177.19	219.68	203.25	201.98
Avg.	181.19	170.94	175.37	179.24	152.33	158.20	147.01	152.05

Procedure

The subjects were instructed to read, the token written on the flash card as naturally as possible. The recording was done in partial acoustically treated room for individual subjects by presenting one flash card at a time using a SANYO voice activated recording system (TRC- 860C). This was connected to the computer (Pentium IV) having SOFT-WARE OF PRRAT. The speech signal was digitized at the sampling frequency of 16 KHz.

Table:-2: Statistical analysis of vowel duration (in msec.) for unaspirated voice and voiceless consonants for male speakers.

Vowels	Voice consonants	S.D	C.V	Voiceless consonants	S.D	C.V	Ratio of voice and voiceless	Calculated t-test value
/Λ/	133.63	11.01	0.082	113.71	11.65	0.103	1.18	1.30
/a/	208.68	23.63	0.113	186.06	22.24	0.120	1.12	
/I/	113.46	13.82	0.122	097.04	01.13	0.012	1.17	
/i/	178.01	08.69	0.049	141.26	11.24	0.080	1.26	
/U/	119.93	16.46	0.137	103.50	15.49	0.149	1.16	
/u/	164.29	26.35	0.160	158.40	26.33	0.166	1.04	
/e/	182.59	17.68	0.097	146.52	03.61	0.025	1.25	
/e/	220.15	02.90	0.013	189.23	14.44	0.076	1.17	
/O/	211.25	08.58	0.041	192.97	10.81	0.056	1.09	
/ɔ/	234.91	14.87	0.063	200.28	15.17	0.076	1.17	
Avg.	176.69	3.92	0.022	152.90	03.96	0.026	1.16	

Table: -3: Effect of aspiration on vowel duration (in m sec.) for voice and voiceless consonants in isolation for female speakers.

Vowel	Voice				Voiceless			
	Labial	Dental	Retro-flex	Velar	Labial	Dental	Retro-flex	Velar
/Λ/	141.77	129.97	151.57	154.78	084.21	114.67	123.69	142.27
/a/	240.95	236.56	252.18	247.19	200.41	207.79	238.39	151.67
/I/	116.71	133.29	100.84	122.39	096.51	89.42	090.73	103.74
/i/	182.654	242.27	234.01	171.57	159.58	155.66	140.22	141.00
/U/	133.12	128.07	99.13	114.06	088.53	120.14	099.41	117.45
/u/	155.66	136.90	135.32	148.00	153.05	131.66	129.70	133.71
/e/	221.63	159.63	156.50	181.09	163.32	130.48	140.45	161.11
/e/	228.56	184.52	219.87	249.57	200.62	183.65	206.38	183.32
/O/	278.93	242.24	239.88	271.82	216.88	237.69	211.97	196.88
/ɔ/	277.09	275.45	272.22	288.82	177.93	202.43	220.33	182.88
Avg.	197.71	186.89	187.15	194.83	154.10	157.36	160.13	151.40

Table:-4: Statistical analysis of on vowel duration (in msec.) for unaspirated voice and voiceless consonants for female speakers.

Vowels	Voice consonants	S.D	C.V	Voiceless consonants	S.D	C.V	Ratio of voice and voiceless	Calculated t-test value
/ʌ/	144.52	09.67	0.067	116.21	20.98	0.181	1.24	1.55
/a/	243.97	05.95	0.024	199.57	31.10	0.156	1.22	
/ɪ/	118.31	11.71	0.099	095.10	05.66	0.059	1.24	
/i/	207.63	30.90	0.149	149.12	08.62	0.058	1.39	
/U/	118.60	13.23	0.116	106.38	13.02	0.122	1.11	
/u/	143.97	08.33	0.058	137.03	09.36	0.068	1.05	
/e/	179.71	25.99	0.146	148.84	13.85	0.093	1.21	
/ɛ/	220.63	23.48	0.106	193.49	10.21	0.053	1.14	
/O/	258.22	17.36	0.067	215.86	14.60	0.068	1.20	
/ɔ/	278.40	06.27	0.023	195.89	16.82	0.086	1.42	
Avg.	191.40	04.74	0.025	155.75	03.29	0.021	1.23	

Fig.1: Graph between voice and voiceless unaspirated consonants with different vowels for male speaker.

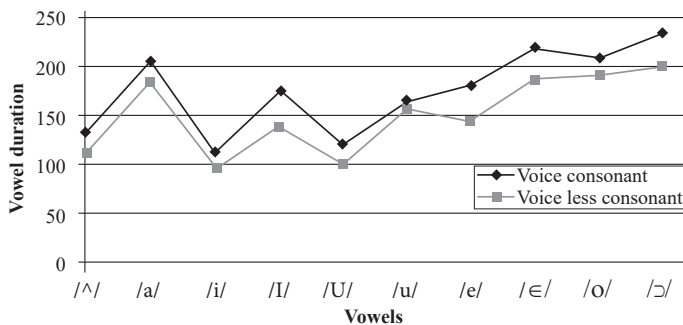
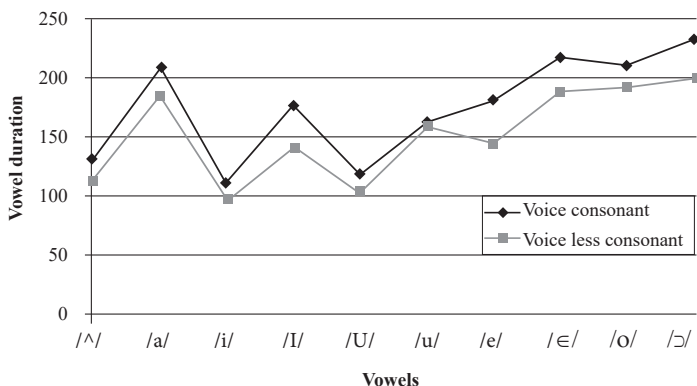


Fig.2: Graph between voice and voiceless unaspirated consonants with different vowels for female speaker.



Result and discussion:

For male speakers: - Effect of place of articulation on vowel duration was studied by analyzing the data presenting in table- 1. It has been found that the average duration of all vowels followed by voiced consonants is largest for the labial (Avg. 181.19 m sec.) followed in descending order by velar (Avg. 179.24 m sec), retroflex (175.37 m sec) and dental (Avg. 170.94 m sec.) sounds. The order for voiceless consonant is dental (Avg. 158.2 m sec.) followed by labial (Avg. 152.33 m sec.), velar (Avg. 152.05 m sec.) and retroflex (Avg. 147.01 m sec.) sounds. The ranges of vowel duration for unaspirated voiced and voiceless consonant are from 91.63 to 251.30 m sec. and 91.19 to 219.68 m sec. respectively. It has been found from Table-2 that vowel duration of voiced consonants (Avg. 176.69 m sec.) is greater than the vowel duration of voiceless consonants (Avg. 152.90 m sec) and ratio of voice to voiceless is 1.16 for unaspirated consonants.

Fig. 1 shows that variation of vowel duration of voice and voiceless unaspirated consonants of male speakers. It has been found from graph that vowel duration of voiced consonants is greater than the vowel duration of voiceless consonants of male speakers.

For female speakers: -Effect of place of articulation on vowel duration was studied by analyzing the data presenting in table-3. It has been found that the average duration for all vowels followed by voiced consonants is largest for the labial (Avg. 197.71 m sec.) followed in descending order by velar (Avg. 194.83 m sec), dental (Avg. 186.89 m sec) and retroflex (Avg. 187.15 m sec.) sounds The order for voiceless consonant is retroflex (Avg. 160.13 m sec.) followed by dental (Avg. 157.36 m sec.), labial (Avg. 154.10 m sec.) and velar (Avg. 151.40 m sec.) sounds. The ranges of vowel duration for unaspirated voiced and voiceless consonant are from 99.13 to 288.82 m sec. and 84.21 to 237.69 m sec. respectively. It has been found from table-3 that vowel duration for voiced consonants (Avg. 191.40 m sec.) is greater than the vowel duration of voiceless consonants (Avg. 155.75 m sec.) and ratio of voice to voiceless is 1.23 of unaspirated consonant.

Fig.2 shows that variation of vowel duration of voice and voiceless unaspirated consonants of female speakers. It has been found from graph that vowel duration of voiced consonants is greater than the vowel duration of voiceless unaspirated consonants of female speakers.

From above discussion it conclude that vowel duration of voice unaspirated consonants is longer than voiceless unaspirated consonants of male and female speakers. The ratio of voice to voiceless is 1.16 and 1.23 of male and female speakers respectively.

Tabulated value for 5% of level of significance 18d.f is 2.10 which is greater than calculated value 1.30 of male speakers and 1.55 of female speakers. Hence null hypothesis accepted and which shows that there is connection between vowel duration of voice and voiceless unaspirated consonants.

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