

Acoustic Characteristics of Stop Consonants during Fast and Normal Speaking Rate in Typically Developing Malayalam Speaking Children

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Abstract

Stops consonants (plosives) are marked by having a complete closure in the oral tract, with the result that the acoustic record will display a measurable period of silence equivalent to this closure. The present study investigated the acoustic characteristics of stop consonants across 2 different rate of speech i.e. normal and fast rate in 7-9 years typically developing Malayalam speaking children. A total of 10 subjects participated in the study. These subjects were native speakers of Malayalam with no history of speech, language, and hearing problems. The subjects were asked to repeat back the words presented in normal and fast speaking rate. The response was recorded using PRAAT software. The acoustic parameters including mean pitch, jitter, shimmer, SNR and HNR were acoustically analysed for normal and fast rate of speech. The results indicated that there is no significant difference for acoustic characteristics of stop consonants during normal and fast rate of speech.

Key words: Stop consonants, Malayalam language

Introduction

Speech is the vocalized form of human communication. Each spoken word is formed out of the phonetic combination of a limited set of consonants and vowels speech sound unit. A vowel is a sound in spoken language, articulated with an open vocal tract so that there is no build-up of air pressure at any point above the glottis. A consonant is a speech sound that is pronounced with complete or partial closure of the vocal tract.

A stop (plosive) is an oral occlusive, a consonant in which the vocal tract is blocked so that all airflow ceases. The occlusion may be made with the tongue blade ([t], [d]) or body ([k], [g]), lips ([p], [b]), or glottis ([ʔ]). Stops contrast with nasals, where the vocal tract is blocked but airflow continues through the nose, as in /m/ and /n/, and with fricatives, where partial occlusion impedes but does not block airflow in the vocal tract. Plosives are marked by having a complete closure in the oral tract, with the result that the acoustic record will display a measurable period of silence corresponding to this closure. On a spectrogram, silence is shown by the absence of any marking throughout the frequency range; therefore all voiceless plosives will be accompanied by such a blank section on the spectrogram. Care must be taken here, however a blank section on a spectrogram will not always mean a plosive is being marked: affricates also have this feature, and of course it may well correspond to simple pauses in the utterance in question.

Speech rate is the term given to the speed at which you speak. It's calculated in the number of words spoken in a minute. A normal number of words per minute (wpm) can vary hugely. Schmidt and Flege (1996) stated that speaking rate effects stops produced by Spanish and English monolinguals and Spanish/English bilinguals but the speaking rate changes exerted less effect on the VOT in stops spoken by the Spanish than the English monolinguals, whereas English monolinguals produced the stops /p,t/ with shorter VOT at a fast than at a normal rate. Many Spanish monolinguals showed a trend in the opposite direction. As expected, all 10 early bilinguals produced English stops with VOT values that were similar to the English monolinguals.

Kuwabara and Nakamura (2000) examined the acoustic and perceptual properties of syllables in continuous speech as a function of speaking rate and suggested that individual syllables do not have enough phonetic information to be correctly identified especially for the fast speech.

Miller, Green and Reeves (1986) studied the speaking rate and segments: A Look at the relation between speech production and speech perception for the voicing contrast. Two main findings emerged. First, as speaking rate became slower and overall syllable duration became longer, the VOT value of the consonant, especially that of the voiceless /p/, also became longer. Second, and most important, the VOT value that optimally separated the /b/

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and /p/ VOT distributions also changed with rate, increasing with increasing syllable duration. However, the magnitude of the boundary shift obtained for these production data was greater than that typically found in perceptual experiments. This suggests the existence of constraints on the extent to which the perceptual system can accommodate for alterations due to rate of speech.

Savithri (2000) studied the acoustic characteristics of whispered stops in Kannada and found that among transition duration, burst duration, burst amplitude, closure duration and total duration closure duration appears to contrast voicing in whisper followed by total duration. Velayudhan (1975) carried out a study in Malayalam, to study the durational aspects of Malayalam vowels in isolation as well as in a variety of phonetic contexts. The results revealed that the short and long vowel tend to keep their ratio in the range of 1:2.

Manjunath, Sneha and Narasimhan (2010) investigated the changes in VOT for voiceless and voiced stop consonants in Kannada language across different speaking rates and found that VOT values were more at slower rate and lesser values at faster rates. Lohith (2010) studied the effect of speaking rate on acoustic characteristics and perception of voiced stop consonants in adult (20-24 years) Kannada speakers. The results indicated, in within speaker there was greater differences on word duration in all the rates of speech, in second formant duration in normal vs. fast and slow vs. fast, other parameters did not show any significant differences.

Studies in India have focused on perception, voice onset time for voiced and voiceless consonants in Kannada and other languages for different speaking rate and studies using acoustic parameters on stop consonants in different speaking rate have also been reported in Kannada and no studies on speaking rate have been reported in Malayalam language. Malayalam language has different accents across Kerala and people uses normal and fast rate of speech which causes difficulty for perceiving speech by listeners. Hence an attempt has been made to study the acoustic characteristics of stops during normal and fast rate of speech in typically developing Malayalam speaking children.

Aim

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To analyse the acoustic characteristics of stop consonants during normal and fast rate of speech of 7-9 years typically developing Malayalam speaking children.

Methodology

Subject selection

10 Malayalam speaking normal children in age range 7-9 years participated in the present study.

Inclusion criteria

- Participants were within the age group of 7-9 years.
- Participants had the medium of instruction as Malayalam.
- First language (L1) was Malayalam.

Exclusion criteria

- The subjects selected not have any otological, neurological, psychological, ophthalmic problems or any other cognitive motor deficits.
- Academically average students were selected as per teachers report.
- All the subjects were from the same socio economic background.

Stimulus preparation

- Words were formulated using stops such as /p/, /b/, /t/, /d/, /k/, /g/.
- Selected words consisted of stops in initial, medial and final position.

Recording environment

Noise free environment was selected for recording the response. At a time one child was selected for recording. Each child was comfortably seated and asked to repeat the words which were presented to him.

Procedure

The child was asked to repeat words in a normal rate which the child usually uses and was asked to repeat the words in fast rate while collecting sample for normal and fast rate of

speech respectively. The stimulus was presented verbally. Voice samples were recorded using external microphone connected to the acer laptop. PRAAT voice recording and analysis software 4.6.16 version was used to analyse and record the speech samples.

Analysis

The obtained data was statistically analysed as follows:

- The acoustic characteristics of stops consonants in normal rate
- The acoustic characteristics of stops consonants in fast rate
- Comparison of acoustic characteristics of stops in normal and fast rate of speech

Mean pitch, jitter, shimmer, SNR, HNR were analysed in initial medial and final position. t- Test was used to see the significant difference between normal and fast rate of speech.

Results and Discussion

The study attempts to understand the acoustic characteristics of stops during normal and fast speaking rate in 7-9 years old typically developing Malayalam speaking children.

Each syllable was analysed for different acoustical parameters such as mean pitch, jitter, shimmer, SNR and HNR. t- Test was used to note the significant difference between normal and fast rate of speech.

The obtained data was statistically analysed and results are discussed below:

The results are given according to the following sections:

1. Comparison of each parameters in the initial position for normal and fast speaking rate.
2. Comparison of each parameters in the medial position for normal and fast speaking rate.
3. Comparison of each parameters in the final position for normal and fast speaking rate.

Group Statistics

Rate		N	Mean	Std. Deviation	Std. Error Mean
Initial	Normal Rate	300	5.9347076E1	1.07514959E2	6.20737906
	Fast Rate	300	6.0701100E1	1.08518223E2	6.26530253
Medial	Normal Rate	300	1.5762889E2	1.71928866E3	99.26317726
	Fast Rate	300	6.0872067E1	1.09558159E2	6.32534327
Final	Normal Rate	300	6.6744465E1	1.42921784E2	8.25159307
	Fast Rate	300	6.0547800E1	1.08942791E2	6.28981498

Table 1: Showing the mean, standard deviation, and standard error mean of stop consonants in the initial, medial, and final position for normal and fast speaking rate.

From the above table it is clear that the mean for normal rate in the initial position is 5.93 seconds and in the medial position is 1.57 seconds and in final position it is 6.67seconds. And for fast speaking rate the mean in initial position is 6.07seconds and in medial is 6.08 seconds and in the final position is 6.05seconds. The standard deviation for normal rate in the initial position is 1.07 seconds and in the medial position is 1.71 seconds and in final position it is 1.42seconds. And for fast speaking rate the mean in initial position is 1.08secods in medial is 1.09 seconds and in the final position is 1.08seconds.

The standard error mean for normal rate in the initial position is 6.20 seconds and in the medial position is 99.26 seconds and in final position it is 8.25 seconds. And for fast speaking rate the mean in initial position is 6.26 seconds in medial is 6.32 seconds and in the final position is 6.28 seconds.

		Levene's Test for Equality of Variances				
		F	Sig.	T	Df	Sig. (2-tailed)
Initial	Equal variances assumed	.151	.698	-.154	598	.878
	Equal variances not assumed			-.154	597.948	.878

Medial	Equal variances assumed	2.477	.116	.973	598	.331
	Equal variances not assumed			.973	301.428	.331
Final	Equal variances assumed	1.948	.163	.597	598	.551
	Equal variances not assumed			.597	558.762	.551

Table 2: Showing the degree of significance between normal rate and fast rate in the initial, medial and final position.

From the above table it is clear that there is no significant difference between normal rate and fast rate as far as initial, medial and final factors are concerned at 5% level of significance.

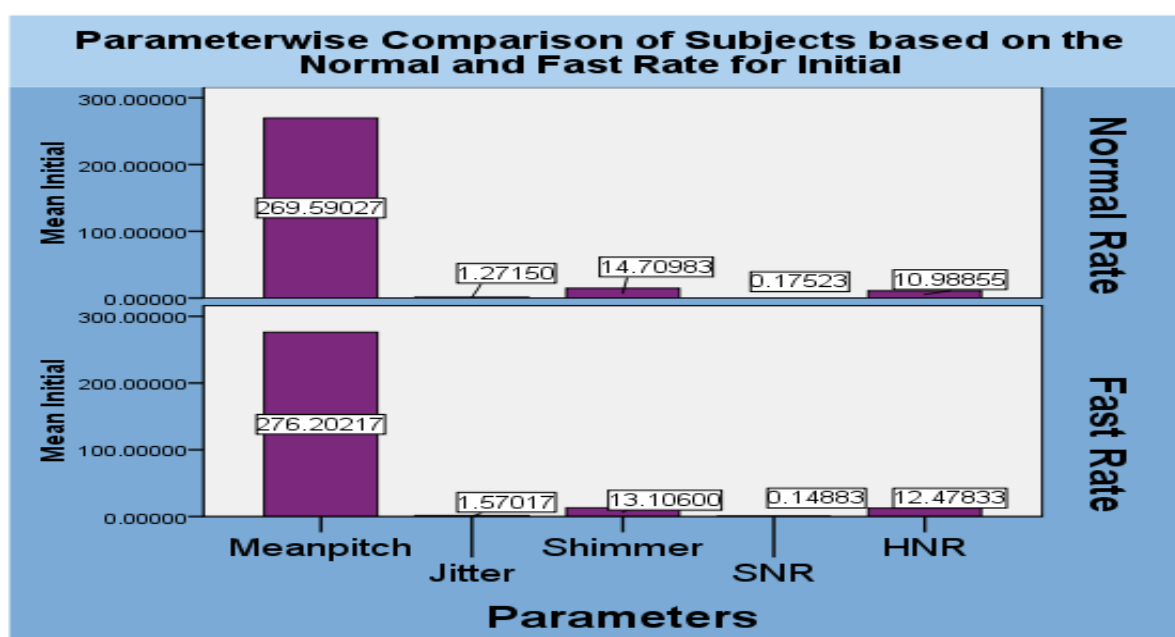


Figure 1: Showing the comparison of acoustic parameters of stops such as mean pitch, jitter, shimmer, SNR and HNR in normal and fast speaking rate in the initial position.

From the above figure, it is clear that there is no much difference in mean pitch, jitter, shimmer, SNR and HNR for normal and fast speaking rate in the initial position of the stops. Slight difference is there in mean pitch, shimmer and HNR for normal and fast speaking rate.

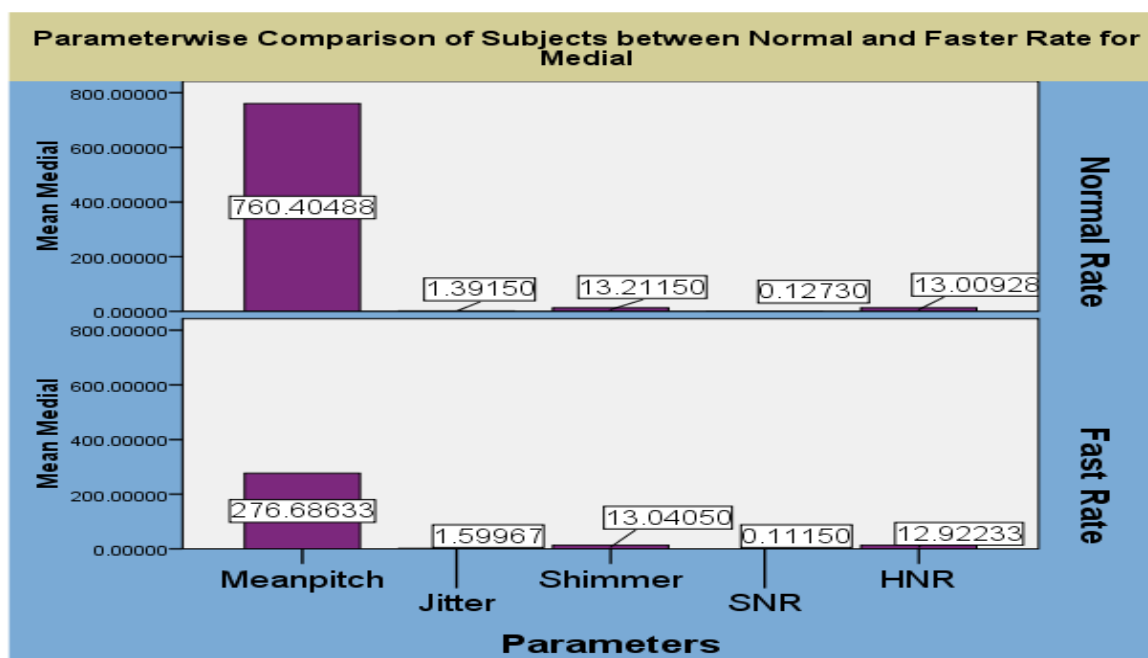


Figure 2: Showing the comparison of acoustic parameters of stops such as mean pitch, jitter, shimmer, SNR and HNR in normal and fast speaking rate in the medial position.

From the above figure, it is clear that there is greater difference between the mean pitch for normal and fast speaking rate in the medial position. And there is no much difference in jitter, shimmer, SNR and HNR for normal and fast speaking rate.

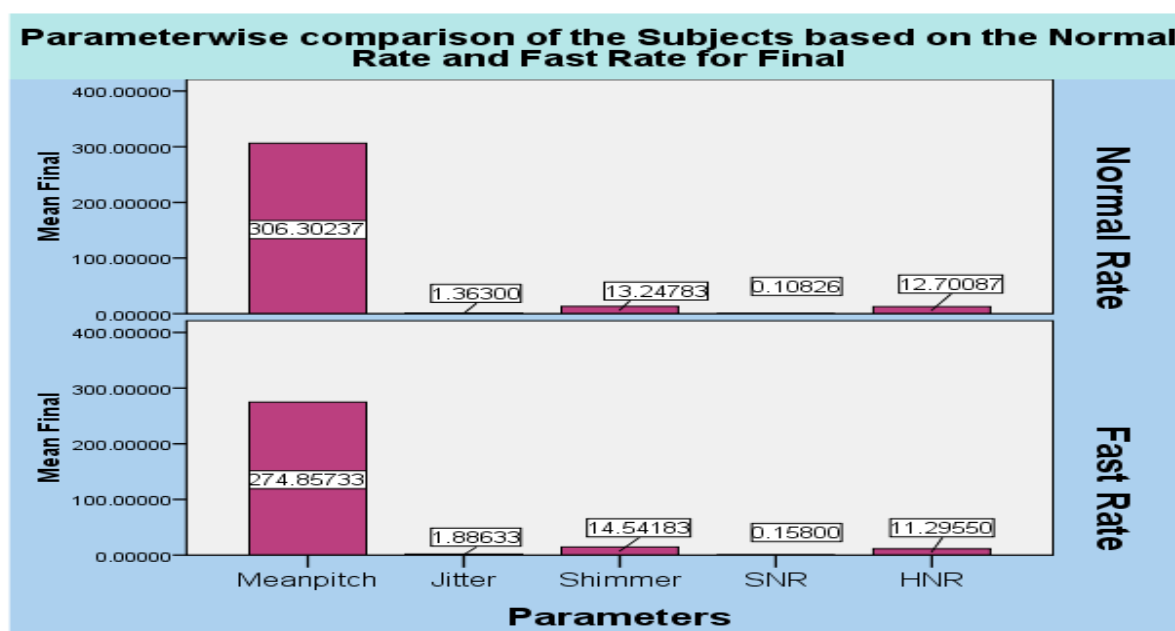


Figure 3: Showing the comparison of acoustic parameters of stops such as mean pitch, jitter, shimmer, SNR and HNR in normal and fast speaking rate in the final position.

From the above figure, it is clear that there is slight difference in the mean pitch, shimmer and HNR for normal and fast speaking rate in the final position. And there is no much difference in the jitter and SNR for normal and fast speaking rate.

Discussion

The aim of the study was to understand the acoustic characteristics of stops during normal and fast rate of speech in 7-9 years of typically developing Malayalam speaking children.

From the given values it is evident that there is slight difference in mean pitch, shimmer and HNR of normal and fast rate of speech.

The result shows that there is no much difference between normal and fast speaking rate in acoustic parameters such as Mean pitch, Jitter, Shimmer, SNR and HNR.

This study is in accordance with the study of Lohith (2010) which shows that there is no significant difference between fast and normal rate of speech.

Summary and Conclusion

The study geared to understand the acoustic characteristics of stop consonants across 2 different rate of speech i.e. normal and fast rate in 7-9 years typically developing Malayalam speaking children. A total of 10 subjects participated in the study. These subjects were native speakers of Malayalam with no history of speech, language, and hearing problems. The subjects were asked to repeat back the words presented in normal and fast speaking rate. The response was recorded using PRAAT software. The acoustic parameters including mean pitch, jitter, shimmer, SNR and HNR were acoustically analysed for normal and fast rate of speech. The results indicated that there is no significant difference for acoustic characteristics of stop consonants during normal and fast rate of speech.

Clinical Implication

The results of the present study shows that, there is no much difference between the acoustic characteristics of stops in normal and fast speaking rate only some difference is there in the mean pitch, shimmer and HNR of the stops.

Limitation

1. The number of sample words was limited due to paucity of time.
2. Perceptual comparison was not done.
3. The obtained data was recorded in a more artificial set up compared to speech, which occurs in a more natural setting.

Future Directions

1. Similar studies on other types of consonants can be continued
2. Rate of speech can be better controlled for sample preparation
3. Acoustic analysis can be compared with other data for external validity
4. Study can be conducted in other Indian languages
5. Can compare across various age groups

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6. Effect of dialectal variations can be considered
7. Effect of socio economic status can be considered

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