

English Affricates as Pronounced by Telugu-English Speakers

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Abstract

This is an articulatory and acoustic study of English affricates / tʃ/, / dʒ / as spoken by Telugu speakers of English in terms of acoustic features such as time duration and amplitude, as well as, its articulatory features. Speech produced by eight informants of Telugu speaking background formed the basis of the study. It was noticed that the articulatory as well as the acoustic features the Telugu speaking informants produced were very distinctly different from the English affricates.

Key words: English Affricates, pronunciation, Telugu speakers

Introduction

In this paper we are going to analyse the articulatory and acoustic features of English Affricates / tʃ /, / dʒ /. Speech sounds may be broadly divided into two categories, namely, vowels and consonants. During the production of consonant sounds, there is friction or restriction of air passing out of the oral cavity. Affricates are consonants. They may be described as Palato-alveolars There are two affricates in English / tʃ /, / dʒ / A speaker of English should be able to articulate each of these sounds correctly.

Articulation of Affricates

Affricates are mostly said to be stops with a fricative release. In English, they are said to be homorganic - as a distinct individual type of a sound and not as a combination of two sounds - post alveolar. They have a combination of stop and fricative characteristics that is closure and burst followed by short silence and then frication. The affricates can be distinguished from the fricatives by the presence of closure and by the duration of noise which is longer for the fricatives. The shorter the duration of noise, the shorter is the silence necessary to elicit an

affricate response. Affricates have a shorter rise time than fricatives. Rise time is the time from onset to peak intensity of frication. Voicing is similar to the voicing for fricatives, but, Voice Onset Time applies as well. Hence an affricate is seen as a sound which combines the articulation of stop and fricative characteristics - closure, burst followed by short silence and then frication.

Acoustic Dimensions of Affricates

Consonants are produced with a constriction of the vocal cords at one place or the other so they have a weaker resonance, they can be produced as periodic / voiced, aperiodic / voiceless for affricates - the laryngeal and vocal tract forms the main sources of sounds Affricates are stops with a fricative release that is homorganic. In English, they are post alveolar or palato-alveolar.

Duration

Time or duration is an important dimension in assessing the acoustic and articulatory analysis of the segmental aspects of sounds, it depends mostly on manner and place of articulation and also on the position it appears in a word as well as in connected speech. In this study the duration was measured based on acoustic and perceptive measures, it was measured from the data of the waveform, recorded in milliseconds, the duration variation for the different sounds as well as variations among speakers are studied. The claim is that the same duration patterns are universally associated with the same syllable structures (Lehiste (1970); Maddieson (1985), Ladefoged (2001), Fischer-Jorgensen, (1955), Nagamma Reddy, (1988).

Description of Frequency of sounds F0, F1, F2 and F3

A speech signal has many acoustic features from which measurements can be taken. Beginning as a vibration at the vocal cords, the speech signals have a pitch or fundamental frequency, denoted **F0**, which is determined by the mass, length and tension of the speaker's vocal cords. Articulation changes the sound that exits in the mouth simply because it changes the shape and size of the air cavities used for speech. In the context of speech production, the resonance frequencies of the vocal tract tube are called formant frequencies or formants. The formant frequencies depend upon the shape and dimensions of the vocal tract, each shape being characterized by a set of formant frequencies. (Stevens and House, 1955; Fant, 1960).

F1- transition indicates the manner of articulation. The first formant provides important acoustic information about the voicing characteristics. **F1** is very low during complete closure. **F2 & F3-** transition indicate place of articulation they can also provide information about manner and place of articulation (Öhman, 1966; Fant, 1973; Cassidy & Harrington, 1995).

Description of Amplitude of Affricates

Amplitude is the objective measurement of the degree of change, positive or negative, in air pressure or the compression and rarefaction of air molecules caused by sound waves. Acoustic intensity is a measure of corresponding loudness. Intensity is proportional to the average size or amplitude of the variations in the air pressure, measured in highest intensity. In any utterance the actual intensity of a segment depends on factors such as its position in the sentence, degree of stress on each word and the personal characteristics of a speaker's speech. According to Laver (1994) and Stevens (1993), the voiceless sounds have low intensity in comparison to voiced sounds.

Methodology

The study involved collecting the data by audio recording the speech as read by the informants, The informants for the data collection were eight. Four of them were male and the other four female. The eight speakers represented the four dialectal zones of Andhra Pradesh. Analysis and description of the speech data was made by using a software tool Wave Surfer. It consisted of the affricate sounds occurring in all the entire word positions - initial, medial and end in different phonetic contexts directly spoken by the informants. The data was collected on the basis of English word-lists prepared by the scholar for the purpose. The words were in isolation and in connected speech. The articulatory description was based on perception as well as interpretation of the articulatory information derived from spectrograms.

Three methods of acoustic analysis chosen are:

- 1) Temporal measurements to distinguish manner of articulation.
- 2) Spectral characteristics of frequency analysis to distinguish place of articulation.
- 3) Amplitudinal analysis of frequency bands as a dynamic approach to place of articulation

Procedure

The speech by the informants was recorded onto the computer through the speech analysis software 'Wave Surfer' and saved onto a hard disk the recording speed was at f LIN-16 and digitized at 16,000 KHz and the recording was done through the software with the parameters already set in. Spectrograms were drawn using Wave Surfer with panes for spectrogram, waveform, duration, pitch contour, frequency and amplitudes and a Linear Predictive Coding (LPC) analysis was done. The speech wave for each sound was hand labeled. The entire speech of the informants was transcribed and presented in the form of broad transcripts made in International Phonetic Alphabet (IPA) made to match the speech as realized by the informants. The articulatory analysis was done based on audio recordings of the speech by the informants through the software. Wave Surfer was used to play back the speech and the transcriptions were done following the IPA broad transcript conventions

- i. The total duration taken by the speaker for the utterance of the sound in milliseconds (Ms).
- ii. The pitch contour for the entire utterance was done by assigning values for the fundamental frequency (F0) in Hertz (Hz).
- iii. The values of the first three formants for the obstruent position (F1, F2, F3) were recorded.
- iv. The time varying amplitude across the set period in decibels (Db) was recorded.

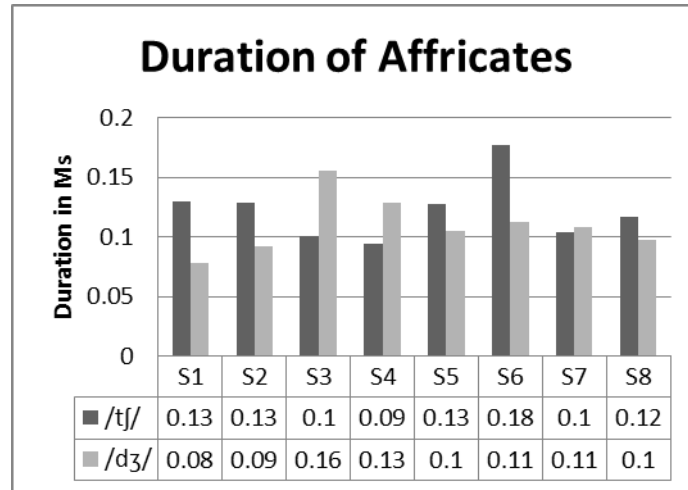
Analysis and Discussion

The mean values of duration of the sound in all word positions as well as in connected speech were recorded; the mean amplitude and the mean of the whole range of frequencies were tabulated for analysis and discussion.

The data values were tabulated and statistically the mean values were evaluated for discussion.

Duration of Affricates

Duration of affricates in all word positions and the overall mean in milliseconds as articulated by individual speakers displays comparative chart of duration of the affricates by the sample speakers shows that the duration pattern differed greatly with each individual speaker.



Duration of Affricates by Individual Speakers from s1 to s8

Affricates are realised with closure and frication, the observation of duration of the affricates shows that

- i. Voiced affricate took longer duration in its articulation in almost all positions by a majority of speakers in word initial positions / dʒ / took nearly 0.14ms while /tʃ/ took 0.12ms.
- ii. Voiceless affricate took longer by all speakers /tʃ/ 0.08ms in word medial position while voiced affricate / dʒ / took 0.08ms.
- iii. Voiceless affricate /tʃ/ took longer duration at 0.16ms and 0.11ms in word final and connected speech while the voiced affricate / dʒ / took 0.13ms and 0.10ms.

Frequencies of Affricates

Frequencies of affricates and overall mean of frequencies in Hertz as spoken by individual speakers shows that.

Voiceless Palato- Alveolar Affricate / tʃ /

The f0 ranges are between 53.3-235.7 Hz in word initial position with a mean of 116.4 Hz, between 60 - 1451 Hz in word medial positions with a mean of 270.4 Hz, in word final between 40 - 61.7 Hz with a mean of the range was 130.3 Hz, in connected speech between 71.5 - 115.5 Hz with a mean of 117.8 Hz.

The f1 ranges are between 843.7 - 1214.7 Hz in word initial position with a mean of 947.2 Hz, between 715.3 - 1255.3 Hz in word medial positions with a mean of 1185.9 H, in word final between 843.7 - 1741.3.Hz with a mean of 148.05 Hz, in connected speech between 1006.6 - 1234.9 Hz with a mean of 1169.07 the range was Hz.

The f2 ranges are between 809 - 2288.3 Hz in word initial position with a mean of 2186.5 Hz, between 1842.3 - 3469.7 Hz in word medial positions with a mean of 2186.5 Hz, in word final position between 1573.9-3609.7 Hz with a mean at 2350.6 Hz, in connected speech between 2188.7 - 2503.5 Hz and the mean was at 2405.2 Hz.

The f3 ranges are between 2970.3 - 4228 Hz in word initial position with the mean at 3452.6 Hz, between 1930 - 4023 Hz in word medial positions with the mean at 3287.2 Hz, in word final position between 2605.7 - 3901.7 Hz with the mean at 3370.8 Hz, in connected speech between 3142.3 - 3708 Hz with the mean at 3501.2 Hz

Voiced Palato-Alveolar Affricate / dʃ /

The f0 ranges are between 46.7 - 60 Hz in word initial position with the mean at 51.6 Hz, between 46.7 - 65.2 Hz in word medial positions with the mean at 55.6 Hz, in word final positions between 40 - 61.7 Hz with the mean at 51.8 Hz, in connected speech between 40 - 57.8 Hz and the mean was at 49.3 Hz.

The f1 ranges are between 148 - 708.3 Hz in word initial position with the mean at 268 Hz, between 115 - 723 Hz in word medial positions with the mean at 411.6 Hz, in word final position between 215.7 - 1160.7 Hz with the mean at 728.4 Hz, in connected speech between 256.2 - 836.7 Hz with the mean at 526.1 Hz.

The f2 ranges are between 1019 - 2072 Hz in word initial position with the mean at 1302.3 Hz, between 634.3 - 2402.7 Hz in word medial positions with the mean at 1725.2 Hz, in word final position between 856.7 - 2774 Hz with the mean at 2017.2 Hz, in connected speech between 1238.8 - 3296.4 Hz with the mean at 1840 Hz.

The f3 ranges are between 1985.3 - 3604.3 Hz in word initial position with the mean at 2410.4 Hz, between 2686.3 - 3402.3 Hz in word medial positions with the mean at 3076.8 Hz, in word final position between 1984.3 - 3685.7 Hz with the mean at 3010.3 Hz, in connected speech between 2343.1 - 3296.4 Hz with the mean at 2882.02 Hz.

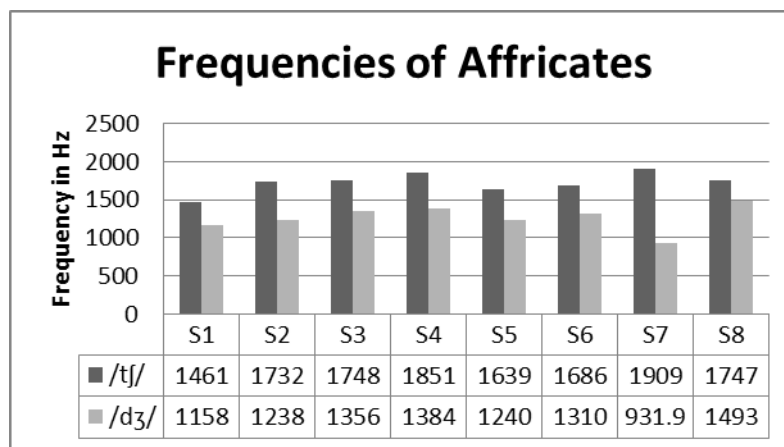


Fig. Frequencies of Affricates by Individual Speakers

The above displays the comparative chart of frequencies of the affricates by the sample speakers which shows that voiceless palato-alveolar affricate /tʃ/ has recorded higher frequencies by all the speakers, followed by its voiced counterpart /dʒ/.

1. The affricates had consistently lower f0 as in plosives.
2. Since both the affricates in English are at palato-alveolar region, the frication and noise as in fricatives was higher at f2 and f3 region.

Amplitude of Affricates

Voiceless Palato-Alveolar Affricate/tʃ/

The f0 amplitudes in word initial position ranges are from -40.1 to -53.8 dB with the mean at -47.1 dB, in word medial position from -39.4 to -56.4 dB with the mean at -46.6 dB, in word final position from -30.1 to -50.7 dB and the mean was -45.8 dB, in connected speech from -44.2 to -49.7 dB with the mean at -47 dB.

The f1 amplitudes in word initial position ranges from -51.5 to -65.1 dB with the mean at -57.4 dB, in word medial position are from -16.6 to -66.8 dB with the mean at -56.7 dB, in word final position are from -39.7 to -63.6 dB and the mean was -57.7 dB in connected speech are from -56.9 to -66.6 dB with the mean at -62.3 dB.

The f2 amplitudes in word initial position ranges from -56.4 to -63.7 dB with the mean at -60.4 dB, in word medial position are from -62.4 to -68.8 dB with the mean at -65.2 dB, in word final position are from -34.2 to -63.9 dB and the mean was -57.4 dB in connected speech are from -57.3 to -64.3 dB with the mean at -61.4 dB.

The f3 amplitudes in word initial position ranges from -46.7 to -61.8 dB with the mean at -56.5 dB, in word medial position are from -53 to -63.2 dB with the mean at -57.2 dB, in word final position are from -42.6.1 to -61.7 dB and the mean was -52.6 dB in connected speech are from -49.7 to -63.1 dB with the mean at -55.8 dB.

Voiced Palato-Alveolar Affricate / dʒ /

The f0 amplitudes in word initial position ranges from -16.3 to -63.6 dB with the mean at -30.6 dB, in word medial position are from -32.7 to -62.3 dB with the mean at -48.3 dB, in word final position are from -47.2 to -58.2 dB and the mean was -52.7dB in connected speech are from -35.1 to -55.9 dB with the mean at -43.7 dB.

The f1 amplitudes in word initial position ranges from -56.9 to -66.6 dB with the mean at -62.3 dB, in word medial position are from -15.2 to -71.8 dB with the mean at -23.3dB, in word final position are from -26.7 to -63.9 dB and the mean was -51.6 dB in connected speech are from -46.6 to -72.7 dB, with the mean at -65.2 dB.

The f2 amplitudes in word initial position ranges from -46.8 to -73.9 dB with the mean at -54.2 dB, in word medial position are from -51.8 to -69.2 dB with the mean at -63.2 dB, in word

final position are from -58.1 to -70.1 dB and the mean was -64.5 dB in connected speech are from -57.6 to -66.9 dB with the mean at -62.7 dB.

The f3 amplitudes in word initial position ranges from -52.9 to -61.5 dB with the mean at -57.2 dB, in word medial position are from -49.7 to -67.8 dB with the mean at -57.5 dB, in word final position are from -28.1 to -70.7 dB and the mean was -55.06 dB in connected speech are from -28.1 to -64.8 dB with the mean at -55.08 dB.

Fig displays comparative chart of amplitude of affricates by the sample speakers which shows that voiced palato-alveolar affricate /dʒ/ recorded greater amplitude than its voiceless counterpart /tʃ/.

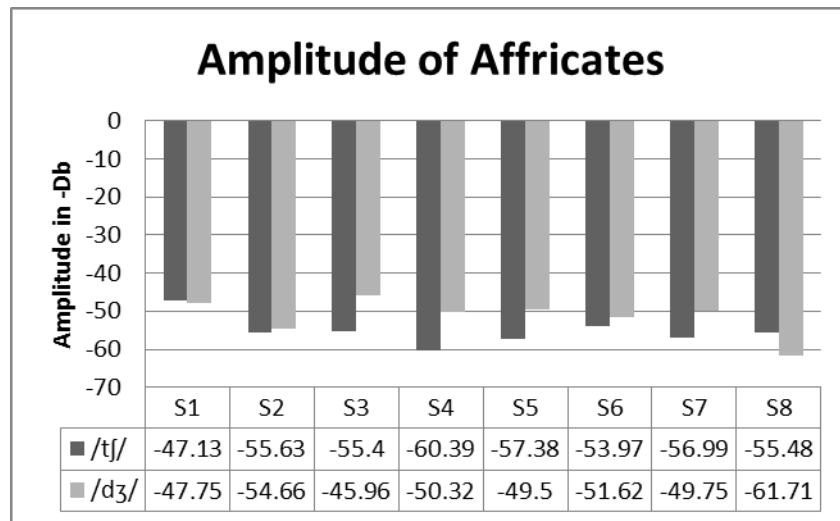


Fig Amplitude of Affricates by Individual Speakers from s1 to s8

It may be inferred from the observation of the articulation of affricates from the study that both the affricates do not have a homorganic release. They are not articulated as palato-alveolar affricates, but more like palatal affricates.

It can be inferred from the observations of amplitude of affricates from the study that

- i. The voiceless affricate showed higher relative amplitude than its voiced counterpart.
- ii. It also shows that the affricate release was not homorganic.

- iii. In connected speech the affricates showed greater amplitudes in f0s and in word initial positions than in F3 zones.

Findings

1. Palato-alveolar affricates / tʃ/. /dʒ/, homorganic were articulated as palatal fricatives
2. No two speakers' duration match perfectly with each other, yet, within the set duration of each of the informants there was a set pattern of similarity that was generalisable.
3. It was observed that voicing showed more energy in the lower frequency zones especially with alveolars than their voiceless counterparts which showed energy in higher frequency zones.
4. Voiced sounds showed higher amplitudes.
5. Connected speech showed higher amplitudes than word final position of sounds.
6. Female speakers displayed longer durations of voiceless obstruent sounds.
7. Female speakers showed greater range of frequencies of voiceless obstruent sound
8. Female speakers displayed greater amplitudes with regard to voiceless obstruents.
9. Male speakers showed higher range of frequencies, took longer and displayed greater amplitudes of voiced obstruent sound.

Conclusion

The study shows that there is a clearly discernable difference in the duration, frequencies and amplitude of individual speakers, across the speakers, not a single sound of Telugu is pronounced exactly like those of English sounds, there is absolutely no one-to-one correspondence of the phonemes of both languages. The sounds of Telugu are different from the normal English sounds there is mother tongue influence in articulation of affricate sounds by Telugu speakers of English in all word positions as well as in connected speech Affricates/ tʃ/. and /dʒ/ were not realized as palato-alveolar affricates but as a palatal fricative sounds. However, it is realized that certain speakers had relative ease at articulating palato-alveolar fricatives and voiced alveolar fricatives, which the rest of the speakers had problem in. Affricates / tʃ/. and /dʒ/

were not realized as palato-alveolar affricates but as palatal fricative sounds. It is realized that only two speakers had relative ease at articulating palato-alveolar fricatives. The rest of the six speakers had problem in articulating these sounds. The study was conducted mainly to describe “Telugu English” as it was felt that there exists no such description of “Telugu English” (Telgish).The study could serve an academic purpose to inform the teachers as well as the learners, the extent of mother tongue interference in the speech of learned/educated speakers of Telugu. Neutralization has gained an urgency and prominence in the academic scenario especially at the tertiary level as it boosts up the speakers’ employability as well as the speakers’ intelligibility could also be of diagnostic influence of errors in pronunciation and help in the therapeutic purpose of error correction in pronunciation can also be useful in identifying the areas where communication is hampered due to mispronunciation. The knowledge and reasons of this nature could bring about awareness among speakers to aid intelligible speech. Software can be specially planned and produced indigenously to handle speech/pronunciation training in English for Telugu Speakers. It could help in the compilation of online “Pronouncing Dictionaries”. It could contribute in Speech Recognition Systems as they are increasingly being built to cover a wider range of speaker accents. The need for developing a quality Indian English Text-To-Speech synthesis (TTS) is acute. TTS in Telugu- English is useful for delivering messages stored in computers and web to the Telugu users unfamiliar with Standard English accent.

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Appendices

Duration of Affricates of "Telugu English" in milliseconds										
SOUNDS		S1	S2	S3	S4	S5	S6	S7	S8	Mean
/tʃ/	W.I	0.1425	0.1508333	0.098245	0.0941667	0.0941667	0.2	0.089167	0.12167	0.12384359
	W.M	0.1125	0.115	0.093516	0.1283333	0.0916667	0.15166667	0.095	0.10917	0.11210658
	W.F	0.1191667	0.1858333	0.122937	0.085	0.1933333	0.27583333	0.12	0.18417	0.1607842
	C.S	0.1240909	0.1197727	0.095809	0.09	0.1381818	0.16090909	0.103636	0.09795	0.11629369
/dʒ/	W.I	0.1675	0.1366667	0.215753	0.1295918	0.1991667	0.14666667	0.110678	0.0530625	0.14488567
	W.M	0.0708333	0.0716667	0.047984	0.0319955	0.0608333	0.238125	0.069349	0.0567403	0.08094089
	W.F	0.1341667	0.1008333	0.128541	0.1176833	0.2141667	0.205	0.124688	0.0875493	0.13907854
	C.S	0.0979412	0.1041176	0.092524	0.0994722	0.1151471	0.14736111	0.087362	0.0836111	0.10344204

Frequencies of affricates of "Telugu English" in Hertz											
/tʃ/	W.I	F0	60.3	53.3	90.8	60.3	175.3	74	182	235.7	116.4625
		F1	911	985	890.8	1093.3	1005.3	843.7	850.3	1214.7	974.2625
		F2	2268	1903.3	2257.8	2714.3	2416	1809	1835.7	2288.3	2186.55
		F3	3260.3	2970.3	3068	3760	3739.7	3233.3	4228	3361.3	3452.613
	W.M	F0	94	60	1451	87.7	154.7	80.7	134.3	101	270.425
		F1	715.3	1140.3	2740.3	1025.3	796	1255.3	830	985	1185.938
		F2	1964	2510.7	3469.7	2558	1842.3	2200.7	1997.7	2207	2343.763
		F3	3172.7	3780	1930	3786.7	2666	3348.3	3591	4023	3287.213
	W.F	F0	54	73.7	195	67	121	141.7	330.3	60.3	130.375
		F1	870.7	1039	1329.3	1160.7	958	843.7	1741.3	1241.7	1148.05
		F2	1890	2578.7	2288	2497.7	1573.9	1977.7	3609.7	2389.3	2350.625
		F3	2605.7	3584.7	3368.3	3645	3165.7	3138.7	3901.7	3557.3	3370.888
	C.S	F0	111.9	115.5	115.4	71.4	143.2	111.9	191	82.5	117.85
		F1	1054.5	1185.1	1065.5	1146.5	1012.2	1234.9	1647.3	1006.6	1169.075
		F2	2372.8	2407.8	2374.6	2503.5	2188.7	2334.2	2763.2	2297.5	2405.288
		F3	3494	3558.6	3475.8	3613.8	3142.3	3398.2	3708	3619.4	3501.263
/dʒ/	W.I	F0	53.3	46.7	53.3	53.3	60	46.7	46.7	53.3	51.6625
		F1	202	289.7	175.3	202	148	235.7	183.7	708.3	268.0875

		F2	1248.3	1059.3	1207.7	1471	1255	1086.7	1019	2072	1302.375
		F3	2173.3	2085.3	2544.3	2686.3	2187	2018	1985.3	3604.3	2410.475
	W.M	F0	60	46.7	46.7	60	60.3	65.2	53.3	53.3	55.6875
		F1	283	209	465.3	485.3	512.7	723.5	155	459	411.6
		F2	2004.7	1566	1572.3	2402.7	1940.7	2257.5	634.3	1424	1725.275
		F3	2949.7	3445	2578.3	3402.3	3016.3	3351.5	2686.3	2686.7	3076.829
	W.F	F0	60	40	53.3	46.7	60	61.75	46.7	46.7	51.89375
		F1	445	836.7	1093	1160.7	674.7	673	215.7	728.7	728.4375
		F2	1248.7	2565	2774	2416.7	2173.3	2126	856.7	1977.7	2017.263
		F3	2490.7	2501	3685.7	3368.3	3449	2870.5	1984.3	3213.3	3010.3
	C.S	F0	45.6	40	57.8	50.1	47.1	53.4	49.5	51.2	49.3375
		F1	399.6	836.7	608.2	564.3	425.9	612.7	256.2	505.4	526.125
		F2	1465.6	2565	1877.3	1748.7	1699.2	1948.3	1238.8	2177.8	1840.088
		F3	2846.4	2501	3166.1	3076.8	2877.8	2948.7	2343.1	3296.4	2882.038

Amplitude of Affricates of "Telugu English" in decibels											
W.I	/tʃ/	F0 & Amp	-44.1	-40.1	-48.4	-51.6	-51.5	-40.6	-53.8	-46.9	-47.125
		F1 & Amp	-53.8	-57.5	-61.5	-65.1	-51.5	-54.9	-59.3	-56.3	-57.4875
		F2 & Amp	-56.4	-59.6	-59	-63.3	-63.7	-61.6	-59.3	-60.5	-60.425
		F3 & Amp	-46.7	-59.4	-52.1	-60.2	-59.8	-61.8	-55.1	-57.2	-56.5375

W.M		F0 & Amp	-45.3	-43.7	-39.4	-49.3	-56.4	-43.6	-50.1	-45.7	-46.6875
		F1 & Amp	-59.6	-60.4	-64.2	-61.6	-66.8	-16.6	-64.7	-59.8	-56.7125
		F2 & Amp	-63.9	-64	-62.4	-65.7	-68.2	-62.7	-68.8	-66.5	-65.275
		F3 & Amp	-53.1	-54.8	-53	-61.2	-63.2	-60.4	-54.7	-57.3	-57.2125
W.F		F0 & Amp	-30.1	-50.7	-50.5	-49.6	-47.4	-50	-47.6	-40.5	-45.8
		F1 & Amp	-39.7	-63.1	-63.6	-62.5	-55.5	-57.9	-63.6	-56.2	-57.7625
		F2 & Amp	-34.2	-63.9	-60.8	-61.1	-60.5	-59.8	-59.7	-59.3	-57.4125
		F3 & Amp	-42.6	-48.7	-46.7	-61.7	-56.4	-54.7	-51.3	-59.4	-52.6875
C.S		F0 & Amp	-45.5	-46.6	-48.4	-49.7	-47.5	-44.9	-44.2	-49.2	-47
		F1 & Amp	-61.9	-63.4	-63.8	-64.5	-56.9	-59.6	-66.6	-62.1	-62.35
		F2 & Amp	-61.5	-62.2	-60.75	-64.3	-61.4	-61.5	-62.4	-57.3	-61.41875
		F3 & Amp	-54.5	-53.4	-49.7	-63.1	-59.4	-54.8	-52.8	-58.7	-55.8
W.l	/d ₃ /	F0 & Amp	-27.5	-41.5	-17.4	-21.2	-27.7	-30.1	-16.3	-63.6	-30.6625
		F1 & Amp	-16.2	-38.4	-13.6	-5.2	-17.8	-15.4	-8.6	-71.8	-23.375
		F2 & Amp	-51.3	-55.4	-46.8	-52.9	-51.3	-53.1	-48.9	-73.9	-54.2
		F3 & Amp	-56.2	-52.9	-54.1	-61.5	-57.1	-58.3	-56.5	-61.2	-57.225
W.M		F0 & Amp	-32.7	-58.9	-40	-45.8	-53.4	-46.5	-46.8	-62.3	-48.3
		F1 & Amp	-26.7	-62.7	-48.2	-50.4	-61.6	-59.9	-39.8	-63.9	-51.65
		F2 & Amp	-51.8	-69	-61.5	-60.7	-65.7	-63.55	-69.2	-64.9	-63.29375
		F3 & Amp	-49.9	-58.6	-56.3	-62.3	-53.8	-49.7	-61.6	-67.8	-57.5

W.F		F0 & Amp	-49	-56	-47.2	-51.6	-57.1	-54.7	-48.3	-58.2	-52.7625
		F1 & Amp	-58.7	-70.6	-70.3	-70.1	-66.7	-66.6	-46.6	-72.7	-65.2875
		F2 & Amp	-65	-64.4	-58.6	-62.7	-68.4	-58.1	-70.1	-69.4	-64.5875
		F3 & Amp	-70	-28.1	-43.2	-60.3	-53.9	-56.1	-70.7	-58.2	-55.0625
C.S		F0 & Amp	-42.5	-55.6	-35.1	-40.3	-38.2	-41.9	-40.5	-55.9	-43.75
		F1 & Amp	-40.8	-70.6	-44.3	-40.9	-39.4	-50.2	-37.3	-58.2	-47.7125
		F2 & Amp	-62.6	-64.4	-57.6	-61.9	-60.2	-62.5	-65.7	-66.9	-62.725
		F3 & Amp	-57.2	-28.1	-53.5	-64.8	-60.6	-56.5	-63.7	-56.3	-55.0875

Relative Amplitude of Affricates

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