Comparison of Acoustic and Physiological Measures of Coarticulation

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01. BACKGROUND INFORMATION

- Coarticulation is a metric which describes how one sound affects a nearby sound and how articulatory movements are coordinated during speech production.
- Comprehensive descriptions of the speech production process are provided by acoustic and physiological metrics.
- Present study considered locus equation as acoustic measure and ultrasound imaging technique (UIT) as physiological method

02. AIM OF THE STUDY

- The aim of this study was to compare the acoustical and physiological coarticulatory measures across adult Malayalam speakers

03. OBJECTIVES

To compare the acoustical and physiological coarticulatory measures

To analyze coarticulation across consonants

04. METHOD

PARTICIPANTS → 10 native speakers

STIMULUS → 6 vowel-consonant-vowel (VCV) combinations (/aṭa /, /aḍa /,/aṭa/, /aḍa/, /aka/ and /aga/)

INSTRUMENTATION AND ANALYSIS

ACOUSTIC

- Praat software was used to record and analyse acoustic measures
- F2 onset and F2 mid points of the following vowels were noted for the calculation of locus equation (Sussman, Mccaffrey & Matthews, 1991).

PHYSIOLOGICAL

- An inbuilt Articulate Assistant Advanced (AAA) software was used to record and analyze ultrasound tongue images
- Extent of coarticulation was measured using ultrasound imaging based on the equation given by Zharkova et al. (2009).
- 10 repetitions of each target syllable were recorded and tongue contours were drawn in AAA software.
- Root mean square (RMS) distance was measured as the distance between the Average tongue contour of consonant and vowel for each place of articulation.

05. RESULTS

- Highest mean F2 onset and midpoint were for dentals and least were for velars.
- Lesser slope value is indicated as less extend of coarticulation and it can indirectly be proportional to the difference between the F2 onset and midpoint
- When the difference between F2 onset and F2 vowel midpoint is more, then the slope value reduces .greater coarticulation for retroflex and velars than dentals was seen based on acoustic measures.

Descriptive statistics of F2 onset and mid-points of dentals, retroflex and velar consonants in /a/ context

	Mean	Median	STD	IQR
t̪V2 F2 onset	1921.66	1967.00	129.59	199.00
t̪V2 F2 mid-point	1571.38	1550.00	113.87	179.00
d̪V2 F2 onset	1914.09	1915.00	138.26	169.00
d̪V2 F2 mid-point	1557.14	1543.00	168.98	179.00
ṭV2 F2 onset	1765.71	1788.00	79.26	80.00
ṭV2 F2 mid-point	1469.47	1465.00	138.95	233.50
ḍV2 F2 onset	1832.00	1840.00	166.92	139.00
ḍV2 F2 mid-point	1487.61	1450.00	129.75	180.00
kV2 F2 onset	1524.19	1550.00	186.23	347.50
kV2 F2 mid-point	1448.33	1504.00	146.48	258.00
gv2 F2 onset	1591.85	1562.00	132.30	225.00
gv2 F2 mid-point	1361.38	1390.00	95.83	126.50

*STD: Standard Deviation

Locus equation values of dental, retroflex and velar constants in /a/ context

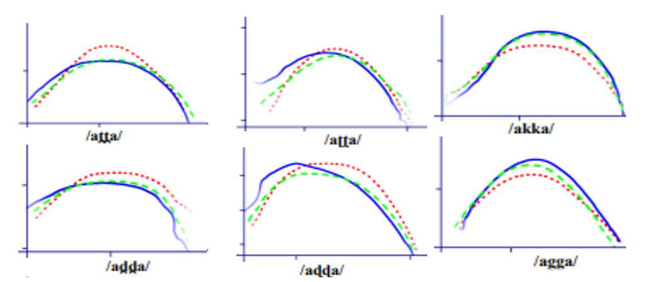
	R^2	Intercept	Slope	Standard Error
t̪V2	0.072	1989.90	0.153	78.36
d̪V2	0.223	1312.74	0.386	125.06
ṭV2	0.404	785.49	0.723	102.68
ḍV2	0.038	146.48	0.750	168.00
kV2	0.416	812.11	0.759	122.54
gv2	0.231	689.23	0.663	119.06

Extent of coarticulation of dental, retroflex and velar consonants in /a/ vowel context (RMS distance in mm between C to V2)

	Mean	Median	STD
t̪V2	0.44	0.31	0.16
d̪V2	0.32	0.32	0.12
ṭV2	0.36	0.32	0.18
ḍV2	0.39	0.34	0.25
kV2	0.34	0.27	0.21
gv2	0.32	0.42	0.24

*STD: Standard Deviation

- Coarticulation distance was less than 0.5 and it showed more coarticulation across all three place of articulation
- Similar trend was seen in Figure 1 where tongue contour of following vowel (green line) was almost mimicing the tongue contour of consonants (blue line).
- Non parametric Friedman test was administered and results showed no significant difference in extent of coarticulation across consonants



06. DISCUSSION AND CONCLUSION

Present study showed that locus equation is a robust acoustic measure, which had similar results as physiological study.

Retroflex showed greater coarticulation which is in consensus with previous studies that showed higher complexity of tongue dynamics leads greater coarticulation and it exhibit influence of preceding and following phonemes

07. REFERENCE

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