LABIAL COARTICULATORY RESISTANCE TO VOWEL HARMONY IN TELUGU

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Abstract

Experimental studies of vowel harmony report that vowel harmony facilitates speech production by increasing speech rate and reducing number or errors. Telugu is described as a vowel harmony language in which vowel fronting is seen frequently. A speech production experiment has been conducted with ten Telugu speakers to check whether vowel harmony in Telugu facilitates speech production. Harmony type and Consonant are the predicting variables for speech and error rates. Results of the study show that vowel harmony does not facilitate speech production. Errors occur for predicting variables 'harmony type' and 'consonant type' randomly. Priming of rounding feature a long with back feature in the stimuli of back harmony type is predicted to be a reason for decreasing speech rate for back harmony type. This phenomenon is considered as labial coarticulatory resistance to back harmony in Telugu. Results of height harmony type are ignored due to non existence of height harmony in Telugu. Speech rate does not alter for consonantal influences. The experiment was conducted with five female and five male speakers belonging to the age group between 21and 30 years. Each speaker produced 108 phrases of the type 'CVCV' la 'CVCV'. These CVCV nonsense words were formed with 'back harmony', 'height harmony' and 'back and height disharmony' types and consonants /p/, /   /, /k/. Report of one way ANOVA test for harmony type as a predictor show a significant effect on speech rate ($F(2, 210) = 3.645$, $p<0.03$ *). Results of the Post hoc Tukey ANOVA for harmony type show that there is a significant difference between Back harmony and disharmony types ($p<0.03$*) but there is no significant difference between height harmony and disharmony type. The report of number of errors ($F(2, 210) = 0.738$, $p >0.04$), with high 'p' value, and a very low F value, show that there is no significant difference between means. Consonantal influences on number of errors ($F(2, 210) = 0.168$, $p >0.05$) show that there is no significant difference between means. Consonantal influence on speech rate also show that ($F(2, 210) = 0.633$, $p>0.05$) there is no significant difference between means.

1. Introduction

Descriptive and typological studies of vowel harmony report that it facilitates speech production. Experimental studies on Spanish and Korean show that priming back feature (back harmony) facilitates speech production by reducing articulatory complexity [1], [5] and [6]. We report on a study where Telugu speakers repeated phrases of nonsense words classified into back harmony, height harmony and disharmony types. The primary object of this study is to examine whether back harmonic type can be produced more quickly and/or with fewer errors compared to disharmonic type.

Telugu has been described as a vowel harmony language; [3], [7] and [8]. Given that the presence of vowel harmony and especially back harmony in case of Telugu , facilitation of speech production should lead to reduction in the number of errors and/or increasing speech rate for back harmony type stimuli compared to disharmony type. Since Telugu exhibits only back harmony, height harmony type stimuli are not expected to be affected by the task.

In addition to Harmony type, the intervening consonant is also one of the control variables in this study. We also report on the interactions between consonant type and speech error rates to ascertain if a particular consonant interacts with speech or error rate for any particular harmony type. Rounding feature, which is primed in the stimuli of back harmony type, is expected to influence the results of either speech or error rate of back harmony type compared to disharmony type. It is expected that rounding feature reduces speech rate.

Results of the speech production experiment show that disharmony type increases speech rate and/or reduces the number of errors compared to back harmony type. Vowel harmony in Telugu does not facilitate speech production. Consonant as a predictor type does not yield any significant results for speech and error rates. Experimental procedures are discussed in section 2. Results of the data are interpreted in section 3 and in section 4 we present a detailed discussion on the results and implications for further study.

2. Experiment

2.1. Subjects

Five male and five female Telugu speakers of Coastal Andhra dialect participated in the speech production experiment at the Media and Communication laboratory, EFL University. All speakers were the residential students of EFL University and were between 21-30 years of age.

2. 2. Materials

Nonse words of syllable structure CVCV were inserted into the carrier phrase '_____ la _____'. These disyllabic words were formed with combinations of vowels {/i/,/e/,/o/ and /u/} and voiceless consonants{/p/, / /, /k/} which were chosen to control factors like voice onset time, place of articulation and manner of articulation. Table 1 gives a description of the stimuli sets.

Table 1 Description of the stimuli sets

Group	Description	Vowel pairs	No. of forms
HH	height harmony, back disharmony	i-u, u-i, e-o, o-e	36
BH	height disharmony, back harmony	i-e, e-i, u-o, o-u	36
DD	height disharmony, back disharmony	i-o, o-i, u-e, e-u	36

There were four different vowel combinations in each harmony type. For each harmony type, three consonants were combined with each vowel combination to form twelve words e.g., 'titu', 'popi' etc. These twelve nonse words for each harmony type were combined with other nonse words to form 36 phrases, e.g., 'pipu la pepo'. Thus, the stimuli comprise of one hundred and eight (108=36 * 3) phrases for all the three harmony types.

2.3. Methods

The text phrases were displayed on a Dell 14" laptop using power point presentation. Each phrase was displayed for five seconds provided by a start signal and end sound signal. Speakers were instructed to repeat each phrase for duration of five seconds by following start and end sound signal. They were also instructed to repeat each phrase as quickly as possible, as many times as possible and also accurately to the possible extent for the duration of five seconds. Recorded data for each speaker was coded for speech rates and error rates. Speech rates were coded as number of syllables produced per second (number of syllables/ sec. (per each 5sec duration of each phrase)) and error rates were coded as number of errors made per number of syllables (number of errors/number of syllables (per each 5sec duration of each phrase)).

3. Results

3.1. Speech and error rates of harmony type

Here, mean values of speech rates and error rates are calculated and coded in Table 2. Data is interpreted for both.

Table 2 Error Rates of Harmony Type

Harmony Type	Back Harmony (BH)	Height Harmony (HH)	DisHarmony (DD)
Mean Speech Rates	4.83%	5.11%	5.31%
Mean Error Rates	13.73%	14.7%	12.40%
Counted Tokens	81/360	68/360	64/360

3.2. Analysis of speech rates of harmony type

Speech rates for 36 trials of each harmony type for ten speakers are calculated and coded in Table 2. The order of rise of speech rates is DH>HH>BH. Speech rates of both back harmony and height harmony type are less compared to that of disharmony type. One way ANOVA test is conducted to check whether the difference among means of speech rates of back harmony, height harmony and disharmony types are significant or not. Results of ANOVA are reported in Table 3.

Table 3 Speech Rate for Harmony Type

	F	Sum Sq	Mean Sq	F value	Pr(>F)
HarType	2	8.42	4.211	3.645	0.0278 *
Residuals	10	242.64	1.155		

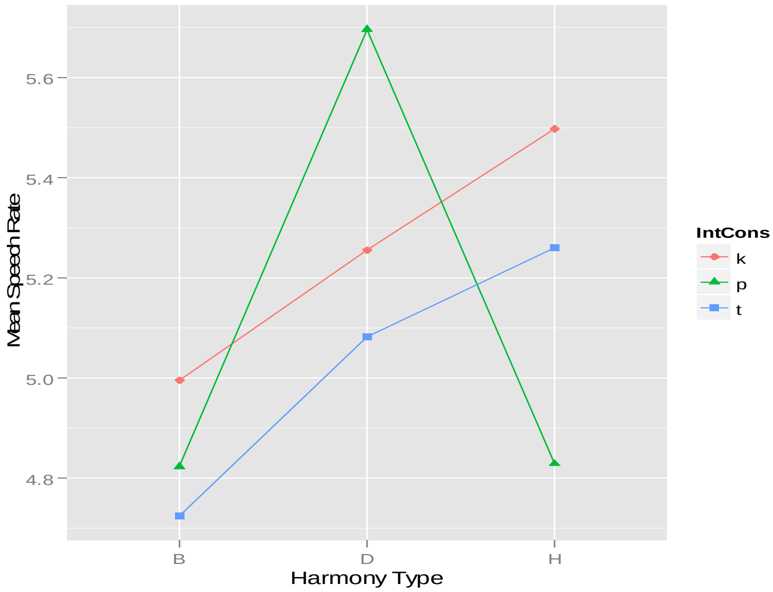

Fig 1 Speech Rate of Harmony Type

The difference among speech rates of back harmony, height harmony and disharmony types is significant with respect to the 'p' values as shown in Table 3. One way ANOVA does not help to discern whether the difference between the means of back harmony and disharmony types and/or height harmony and disharmony types is significant. Post hoc Tukey ANOVA test is conducted to check this phenomenon.

Table 4 Post Hoc results of Speech Rate of Back Harmony Type.

	Difference	**Lower**	**Upper**	**P value**
D-B	0.4791414	0.05479393	0.9034889	0.0224860
H-B	0.2795706	-0.13774656	0.6968878	0.2559606
H-D	-0.1995708	-0.64145920	0.2423177	0.5362103

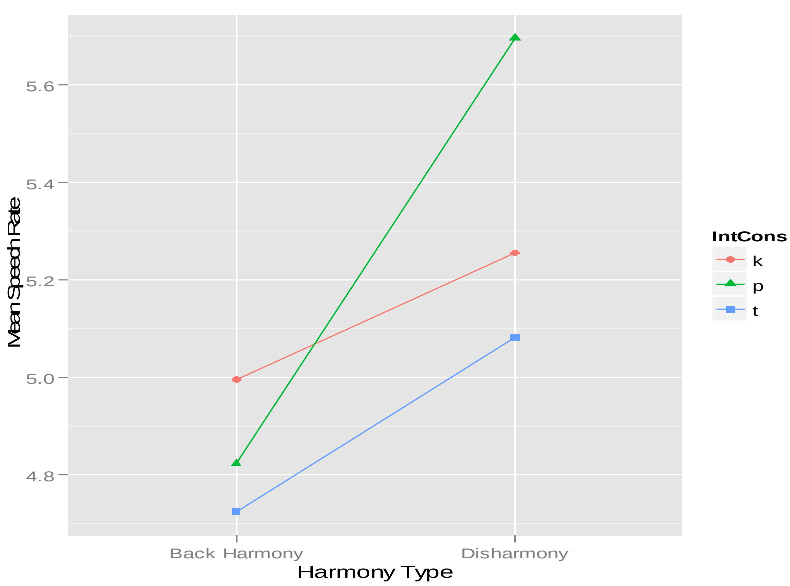

Fig 2 Post Hoc: back and disharmony.

Results of the Post Hock Tukey ANOVA in Table 4 show that there is a significant difference between the speech rates of back harmony and disharmony sequences but there is no significant difference between height harmony and disharmony sequences. Disharmony sequences significantly increase speech rate compared to back harmony sequences.

3.3. Analysis of error rates of harmony type

Error rates which are reported in the Table 2, show the order, DH<BH<HH. Error rate of both back harmony and height harmony types are high compared to that of disharmony types. One way ANOVA test is conducted to check whether the difference among means of error rates of back harmony, height harmony and disharmony types is significant. Results of one way ANOVA are reported in Table 5.

Table 5 Mean values of number of errors for Harmony Type

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Harmony Type	2	8.1	4.071	0.738	0.479
Residuals	210	1158.4	5.516		

The difference among error rates of back harmony, height harmony and disharmony types is not significant with respect to the 'p' values as shown in Table 5.

3.4. Consonantal influence on harmony type:

One way ANOVA test is conducted to check the consonantal influence on both speech rates and error rates as shown in Table 6. Results of one way ANOVA test in Table 6 show that consonantal influence on error rates and speech rates are insignificant due to high p-values, ($p>0.05$).

Table 6 Mean Number of Errors for Intervening Consonant

	F	Sum Sq	Mean Sq	F value	Pr(>F)
IntCons	2	1.9	0.929	0.168	0.846
Residuals	10	1164.7	5.546		
Speech Rate of Intervening Consonant					
	F	Sum Sq	Mean Sq	F value	Pr(>F)
IntCons	2	1.5	0.7518	0.633	0.532
Residuals	210	249.6	1.1884		

4. Discussion

Overall results of the study show that disharmony sequences significantly increase speech rate and reduce number of errors compared to back harmony types. These results suggest that vowel harmony, doesn't necessarily aid speech production as reported in earlier studies.

A critical analysis of the vowel combinations used of the stimuli presented in Table 1 of section 2.2 reveals the fact that the stimuli of back harmony differ from the stimuli of both disharmony and height harmony. Rounding feature is primed in the stimuli of back harmony type along with back feature. Stimuli of height and disharmony type don't have any scope for priming rounding feature. Telugu vowel inventory has two front unrounded vowels; two back rounded vowels and one unrounded low vowel. There aren’t any front rounded and back unrounded vowels in Telugu. Due to this reason, it is not possible to avoid priming rounding in the stimuli of back harmony type. This might be a reason for decreasing speech rate of back harmony Type. This phenomenon can be addressed as labial coarticulatory resistance to vowel harmony in Telugu. Disharmony type tend increase speech rate, which resulted in facilitating speech production. Spanish is another language like Telugu, which has a vowel inventory with 5 vowels having two front unrounded and two back rounded vowels. In spite of this fact, experimental studies of [5] on Spanish report that back harmony type facilitates speech production. The stimuli used for the previous experiment on Spanish is the same for the one used for Telugu. Though Spanish and Telugu have the same vowel inventory, Spanish facilitates speech production where as Telugu does not. In Spanish, the rounding feature does not resist back harmony but rounding feature resists back harmony in Telugu. According to the results of the study, it is interpreted that languages differ in their rounding mechanisms which may support or may not support back harmony facilitating speech production.

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