

# VOWEL HARMONY AS A COARTICULATORY PHENOMENON IN NANAY

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## ABSTRACT

The present paper reports on interaction of the context (vowel harmony), target gesture and suprasegmental factor (stress). It is argued here that the notion of stable gestures and anticipatory gestures can account much of the variability of the context, given certain assumptions about the effect of stress.

An experiment was designed to evaluate the role of coarticulation and tempo on the dynamics of vowel articulation. It is shown here that motor plan for a particular segment remains the same regardless of the varying phonetic context and timing conditions.

## 1. INTRODUCTION

Coarticulation is defined as the influence of segmental context on the articulatory/acoustic realization of a target segment. It is assumed that because of perceptual or articulatory constraints on target and surrounding segments, there are limits on the temporal extent of coarticulation.

There are two particular speech production frameworks: the "look-ahead" models [6] and the "coproduction" models [5], [1], [4]. According to the coproduction model the underlying motor control structure for a particular segment remains essentially the same regardless of the phonetic identity of surrounding phones. In contrast to the look-ahead models changes in the observed patterns of movement in different contexts stem from local interactions between context and target gestures rather than from any change in the motor plan for the target segment. According to the look-ahead model the motor plan for the target segment and consequently the time at which coarticulation begins are revised

and adapted to the context since every different context poses a different set of conditions.

The present paper supports the point of view that was put forward by Bladon & Al-Bamerni [2], who proposed that observed coarticulatory patterns might be a combination of anticipatory feature spread plus stable gestures.

In the present paper we examine coarticulation presented by vowel harmony phenomenon as an interaction between target gesture with the context. According to preliminary auditory analysis the adjustment of Nanay consonants to a certain harmonic class of vowels manifests itself in the use of dental allophones of affricates [ts], [dz] with the vowels of the first harmonic series /a/, /o/, pronounced with low jaw position and palatal allophones [dʒ], [tʃ] with vowels of the second harmonic series /i/, /e/ pronounced with high jaw position: otsoqa 'small fish', əʃəkə 'uncle'.

The velar allophones [k], [g], [x] are used with the vowels of the second harmonic series [ə], [u] and uvular allophones [q], [g], [χ] with the vowels of the first harmonic series [a], [o]: χaLa 'tribe', xələ 'stutterer'.

Most investigators of this problem mention that the influence of context upon vowels is regularly manifested as a displacement of vowel-formant frequencies away from their target frequencies [9]. An experiment was therefore designed to study vowels pronounced under varying timing conditions and in systematically varied consonantal environments.

## 2. PROCEDURE

To investigate the displacement of consonant articulations from their bull's-

eye patterns X-ray pictures of consonants in varied vowel environments were made. To study the displacement of vowel formant frequencies away from their target frequencies, measurements were made of the first, second and third formant frequencies of vowel /a/ in three consonant environments: /p-p/, /t-t/, /x-x/ under varying timing conditions. F1, F2 and F3 of the investigated vowel were plotted against vowel segment duration, then the first and the second formant target frequencies were determined by plotting F1 and F2 against vowel duration for the three contexts of the vowel simultaneously [7].

The influence of stress and tempo on vowel properties was studied by the manipulating of the word order and rhythm of the carrier sentence frames: 'CVC -----; ----- CVC -----'. Each sentence pattern was pronounced four times.

The speech material was read by a native male speaker of Nanay, and was analyzed by MacSpeech Lab 2.

## 3. RESULTS

X-ray pictures show the adjustment of consonants to the near vowels.

Dental affricates are characterised as flat and have a decrease of frequency components of release (the concentration of noise is at 2500 - 3000 Hz). It promotes reducing of the timber of the near vowel.

Palatal affricates may be called sharp and are characterised by high intensity of the upper frequency components (about 4000 - 6000 Hz). Articulatory palatal sounds are produced with wide pharyngeal cavity. X-ray pictures show that the constriction location of palatal affricate [tʃ] is at the zone of alveolar and hard palate, whereas constriction location of [dz] is limited by dental zone (fig. 1-2).

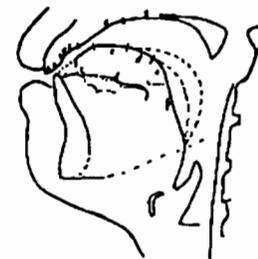


Figure 1. X-ray picture of dental affricate [dz] pronounced in the syllable [adza] by Nanay male speaker N 3.



Figure 2. X-ray picture of the affricate [tʃ] in the syllable [əʃəkə] pronounced by Nanay male speaker N 3.

X-ray pictures of allophones [q] and [k] show that their constriction location depends on the articulation of the near vowel. Vowels pronounced with low jaw position promote the shift of constriction location from velum to uvula (fig.3). Vowels pronounced with high jaw position /ə/, /u/ initiate a constriction location of the near consonant /k/ at velum (fig.4).

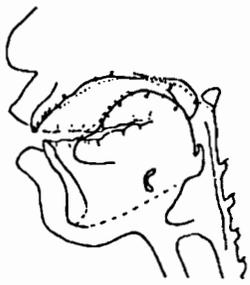


Figure 3. X-ray picture of [q] in the word d'aqa 'thing' pronounced by Nanay male speaker N 2.

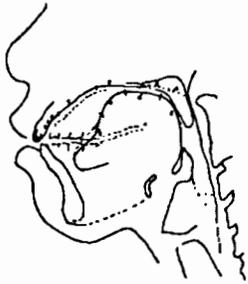


Figure 4. X-ray picture of [k] in the word d'ukən 'hardly' pronounced by Nanay male speaker N 2.

In all these cases of assimilation there are no changes at higher levels: Supra, Vocal Tract, Oral remain the same, changes undergo only at a low level: the place of location. This slight transition of the place of articulation seems not to change motor plan for target gesture, non-significant changes in gesture movements are the results of local interactions between context and target gesture.

The adjustment of vowels to the varied phonetic context is displayed in figures 5 - 6.

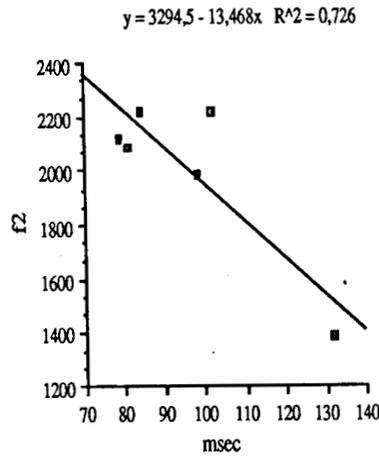


Figure 5. F2 data plotted against vowel segment duration in the context [tat] pronounced by Nanay male speaker.

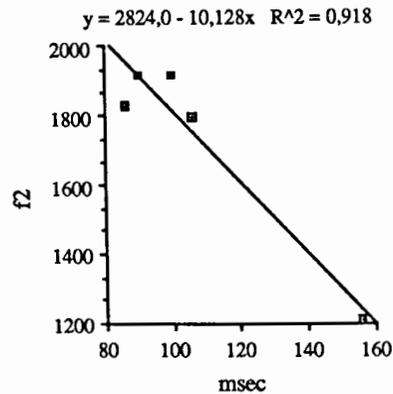


Figure 6. F2 data plotted against vowel segment duration in the context [pap] pronounced by Nanay male speaker.

Figures 5 - 6 show the values that vowel /a/ assumes for the three contexts under variable time conditions. The vowel seems to preserve its target frequency values in a variable context. The grouping of the points approximates a straight line which shows a correlation of vowel duration and formant frequency values of

the vowel. The shorter duration of vowel segment is the higher values of F2 the segment assumes. This tendency is preserved irrespective of consonantal context. The values show that a target has been found to be independent of consonantal context and duration and can thus be considered to be invariant.

#### 4. DISCUSSION

The discussed cases of coarticulation in Tungus may be viewed as realization of anticipatory speech model. Coarticulation is the result of local interaction of overlapping gestures: jaw lowering or jaw rising during the production of a vowel effects the articulation of the consonant. It is proved by a number of experimental research works that onset of jaw lowering for a vowel will start during a preceding consonant [8]. Vowel harmony may be viewed as constraints imposed by the context on the realization of a target gesture.

The changes in the segmental context are predictable and usually set up as phonotactic rules. They reflect the range of possible variability of the target gestures in a different context. The motor plan for target gestures seems to be done beforehand and changes in gesture movements in different contexts stem from local interactions between context and target gestures.

#### 5. CONCLUSION

The present paper reports on a pilot study of vowel harmony in Tungus languages. Preliminary results have shown that restrictions imposed by a context do not change essentially a motor plan for a target gesture. A number of questions are raised that future research is supposed to answer. These questions are: what restrictions are there imposed by a context (vowel harmony) on the realization of a target gesture?; what relations are there between vowel harmony, target gesture and stress?; to what extent can context change a target gesture?

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