

**Compatibility, antagonism, and the nature of Coarticulation:
SaySiyat Pharyngeals**

Peter Guekguezian and Khalil Iskarous

Coarticulatory variability is one of the least understood forms of variation in phonetics. The magnitude of **compatibility** and **antagonism** between the vocal tract gestures of contiguous segments has been argued to determine their degree of coarticulation. For instance, if one segment requires the lips be open and a contiguous one closed, the two segments are making antagonistic demands on the same vocal tract organ. Early research (e.g., Henke, 1966; Bell-Berti and Harris, 1981) had argued that antagonism prevents or lowers the degree of coarticulation, whereas more current research (e.g., Recasens, Pallares, and Fontdevila, 1997; Recasens, 2016) has argued that antagonism may actually promote coarticulation. However, the consonants and vowels analyzed in most coarticulation studies make somewhat different demands on the vocal tract articulators, making it difficult to investigate true antagonism between contiguous segments. A major exception is the alveopalatal nasal /ɲ/ in Catalan, which has been well-studied because it conflicts with some contiguous vowels (Recasens, Pallares, and Fontdevila, 1997). For a more thorough understanding of coarticulation, more cases of true compatibility and antagonism need to be investigated.

In this study, we investigate the coarticulation between the pharyngeal consonant /ħ/ and contiguous vowels in the endangered Austronesian language SaySiyat (also known as Saisiyat). SaySiyat has only a few hundred fluent speakers remaining in NW Taiwan, divided into two dialects, Ta'ay (north) and Tungho (south) (Li 1978). Pharyngeal consonants require the retraction of the tongue root, which is also retracted during low vowels /æ a/ but advanced for high front vowels /i/. Articulatory imaging of pharyngeals (Ladefoged and Maddieson, 1996; Catford, 1993) has also revealed tongue bunching, similar to rhotic bunching, in the oral region. The tongue bunching gesture is incompatible with the oral flattening in low back vowels /a/, but is compatible with fronting in low front vowels /æ/. In SaySiyat, therefore, there is a spectrum from compatibility to antagonism between the vowels /a/, /æ/, and /i/, and the pharyngeal /ħ/ (Table 1).

Table 1. Compatibility and Antagonism between Vowels and Pharyngeal /ħ/

Vowel	Tongue Root (Pharyngeal) Gesture	Tongue Body (Oral) Gesture
/a/	Compatible with /ħ/	Antagonistic to /ħ/
/æ/	Compatible with /ħ/	Compatible with /ħ/
/i/	Antagonistic with /ħ/	Compatible with /ħ/

Because SaySiyat has all four segments [a æ i ħ], it allows investigation of the different predictions of existing theories of coarticulation. SaySiyat has four phonemic vowels /i ə a o/. These vowels are described as having phonetic variants adjacent to the pharyngeal /ħ/: /a o/ are fronted to [æ ø], while /i/ is lowered to [e] or [ɪ] (e.g., Li 1978; compare (1-4) from our fieldwork)

(1) /i a/ in non-pharyngeal contexts

- a. /iðik/ → [i.ðik] “NEG”
- b. /paparay/ → [pa.pa.ray] “in the middle”

(2) /i a/ → [e~ɪ æ] next to pharyngeal /ħ/

- a. /CVC-panaβih/ → [pan.pa.na.βeh]~[pan.pa.na.βih] “story”
- b. /hayðah/ → [hæyðæh] “exist, have”

(3) /a/-fronting and /i/-lowering are productive (Ca- “instrument” and <in> “perfective”)

- a. /Ca-koko:/ → [ka.ko.ko:] “razor, shovel”
- b. /p<in>ayakai?/ → [pi.na.ya.kai?] “voice”
- c. /Ca-hila/ → [hæ.hɪ.la] “sun”
- d. /h<in>əmhəm/ → [hɪ.nəm.həm]~[he.nəm.həm] “ghost sound”

These descriptions show that the **antagonistic** gestures between /h/ and /i a/ seem to become **compatible** gestures: [he~hɪ] and [hæ].

We have investigated the formant structure of sequences of /h/ and the vowels /a i/. We transcribed six short SaySiyat narratives (about 20 minutes total), recorded in the summer of 2013 from a single male informant in Taipei. We annotated the narratives manually for occurrences of /h/ adjacent to the vowels /i/ or /a/, and found 124 tokens, made of 45 different words (some words occurred multiple times). We analyzed the spectrograms in Praat (Boersma and Weenink 2015) to calculate the formant values. We made the following findings (Table 2).

Table 2. Formant Transitions between /h/ and /i a/

/h/-adjacent Vowel	F3	Other Formants
/i/ → [e~ɪ]	Same Values for [h] and [e~ɪ]	Not present in [h], no effect on [e~ɪ]
/a/ → [æ]	Same Values for [h] and [æ]	[h] F1 value higher than [æ]

First, we found that F3 is present in [h] with **the same value** as the F3 of the adjacent vowel. While [h] has a noisy spectrum, showing that it has true consonantal articulation, it has an F3 value that is identical to that of the neighboring vowel, showing coarticulation. Moreover, since the F3 value is related to the position of the tongue body, as an indicator of front cavity length (Kuhn, 1975), the identical F3 value shows that the oral tongue bunching gesture of [h] is **strongly coarticulated with the compatible tongue body gesture** of the front vowels [e~ɪ] and [æ]. Since [æ] is the result of fronting /a/ next to /h/, the identical F3 values of [h] and [æ] show that the vowel [æ] has assimilated to the consonant [h], which is counter to the usual typology of assimilation. We suggest that assimilation of a vowel to a consonant is possible when the consonant and vowel share gestures that may be compatible or antagonistic.

Second, we found that the **F1 value for [h] is not present** next to [e~ɪ], and **present but higher** than the F1 value for [æ]. The F1 value is related to the position of the tongue root (Alwan, 1986). The tongue root gestures of /h/ and /i/ are **antagonistic** (Table 1), and are coarticulated in response: the **vowel gesture retracts**, lowering to [e~ɪ] and changing its F1 value, while the **consonant gesture does not reach its target**, so there is no separate F1 value. The tongue root gestures of /h/ and /æ/ are **compatible**; instead of assimilation, **both the vowel and consonant gestures reach their targets**, and have slightly different F1 values. This shows a difference between the tongue body (oral) and tongue root (pharyngeal) gestures of /h/: while the oral gesture shows strong coarticulation of the compatible vowel gesture, the pharyngeal gesture only shows coarticulation with the antagonistic vowel gesture, not the compatible one. This suggests that the oral and pharyngeal gestures of /h/ in SaySiyat are independent and play different roles.

References:

- Alwan, A. 1986. *Acoustic and perceptual correlates of pharyngeal and uvular consonants*. MIT Dissertation.
- Bell-Berti, F. and Harris, K. 1981. A temporal model of speech production. *Phonetica*, 38, 9-20.
- Henke, W. 1966. *Dynamic Articulatory Model of Speech production using Computer Simulation*. MIT Dissertation.
- Kuhn, G. 1975. On the front **cavity resonance** and its possible role in speech perception, *JASA*, 58, 428–433
- Li, P. J-K. 1978. A comparative vocabulary of Saisiyat dialects. *BIHP* 49.2: 133-199.
- Recasens, D. 2016. A study of coarticulatory resistance and aggressiveness for front lingual consonants using ultrasound. *Journal of Phonetics*, 59, 58-75.
- Recasens, D., Pallares, M., and Fontdevila, J. 1997. A model of lingual coarticulation based on articulator constraints. *JASA*, 102, 544-561.