Vowel–glide distinction in high vocoid diphthong structures in Squliq Atayal: An ultrasound and acoustic study

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Vowel–glide ambiguity in Squliq Atayal

1. Background:
   a. Squliq Atayal is a dialect of Atayal, an Austronesian language spoken in the central and northern parts of Taiwan, with a native speaker population of about 10,000.
   b. Squliq Atayal sound inventory: 5 vowels (/a/, /i/, /u/, /e/, /o/), and 19 consonants (/p/, /t/, /k/, /q/, /ʔ/, /β/, /s/, /z/, /x/, /ɣ/, /ħ/, /ts/, m, n, /ŋ/, /l/, /r/, /w/, /j/).
2. In Squliq Atayal, VV dipthongs are not allowed [1].
   → higher vowel becomes a glide, while the lower vowels (e.g., /a/, /e/, and /o/) stay as the nuclei:
   /otoβ**ai**/ → [otoβ**aj**] 'motocycle'
3. However, when both VV are high, there is an ambiguity:
   a. /β**ui**/ → [β**uj**] or [β**wi**] 'shoot.IMPER.'
   b. /lə**liu**/ → [lə**liw**] or [lə**lju**] PN

Such an ambiguity further causes orthographical discrepancy. A consistent criterion to distinguish the high vocoid diphthong structures would thus be optimal in both linguistic and practical senses.

Previous studies

1. Durations of vowels & glides: In [2], duration is observed to distinguish vowels and glides in other Formosan languages.
2. Intensity & sonority:
   a. In [3], intensity is found to be a function of sonority
   b. higher intensity → higher sonority → more likely to be vowels
3. Articulation: Little attention has been given to the articulation of vowels/glides, which may provide useful information.

This study thus tackles this issue from articulatory and acoustic angles, and hopes to provide novel perspectives regarding the Squliq Atayal syllabic structures.

Method

Measurements

1. Tongue contours
2. Duration
3. Intensity

Participant One naïve female native speaker of Squliq Atayal (Nahuy, Taiwan) in her 70s.

Materials Words that contain in the last syllables:

1. Targets: /ui/, /iu/
2. Baselines:
   a. singleton vowels: /u/, /i/
   b. phonologically disambiguous glides: /ju/ (e.g., /tɕjux/ progressive marker) and /wi/ (e.g., /kwiʔ/ 'little insect')

Apparatus

1. Portable ultrasound machine (CGM OPUS 5100)
   a. Transvaginal electronic curved array probe (CLA 651)
   b. Frame rate: 37 fps
   c. Scanning rate: 6.5 MHz
2. microphone: Audio–Technica carcoid AT2035 + a portable audio interface (USBPre 2)

Data processing

→ Segments labeled in Praat

→ Tongue contours of segments traced with Matlab's GetContours [4], and fitted through generalized additive mixed models [5]

→ Acoustic information (formants, intensity, and duration) extracted with Python's Parselmouth automatically for each segments, with 101 points each

→ the segments in the diphthongs are then divided according to the F1 & F2 from the baselines, and a t-test was run for the duration measurement

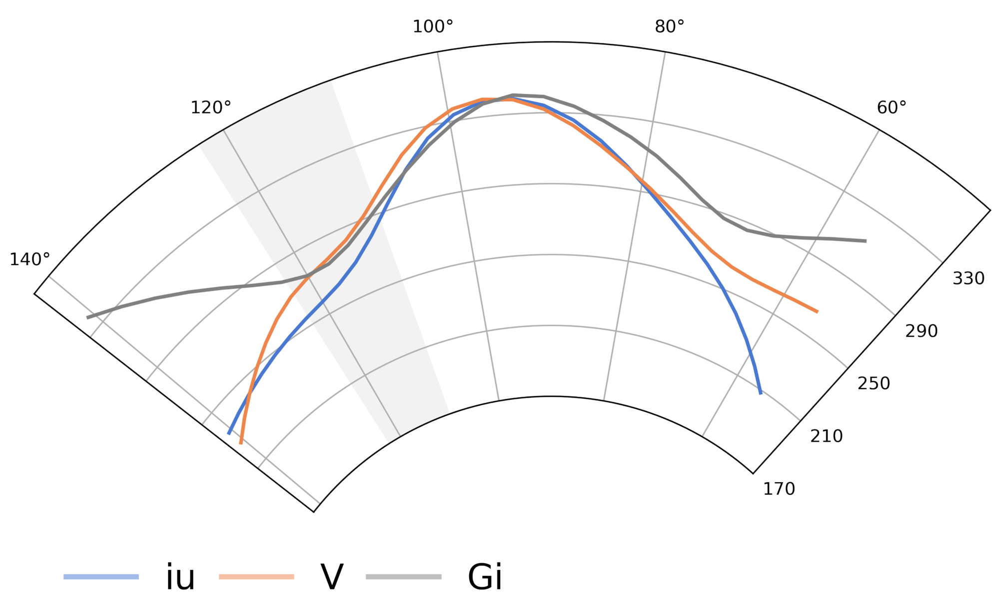
→ SSANOVA was run for the intensity measurement

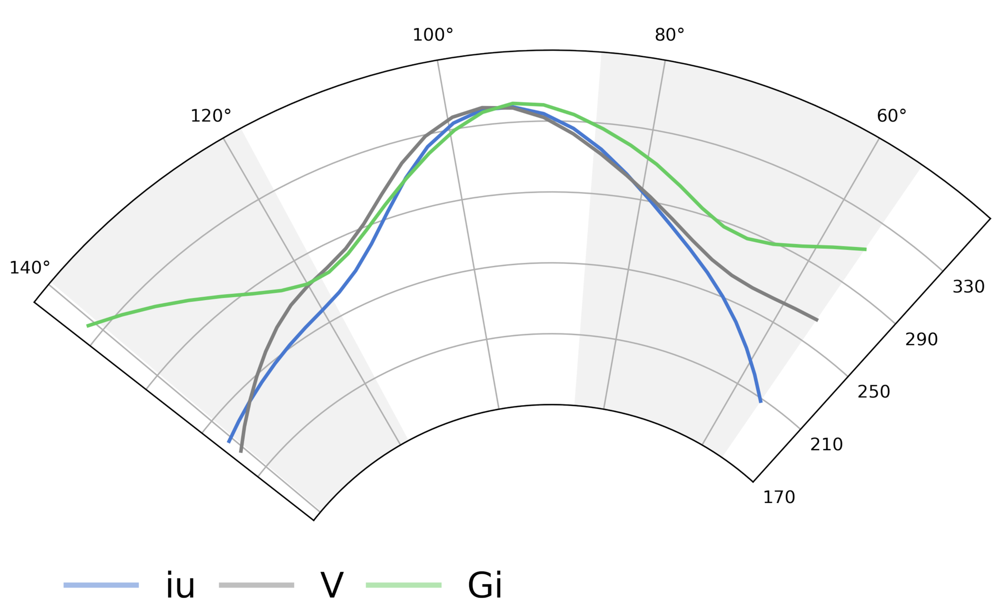
Results

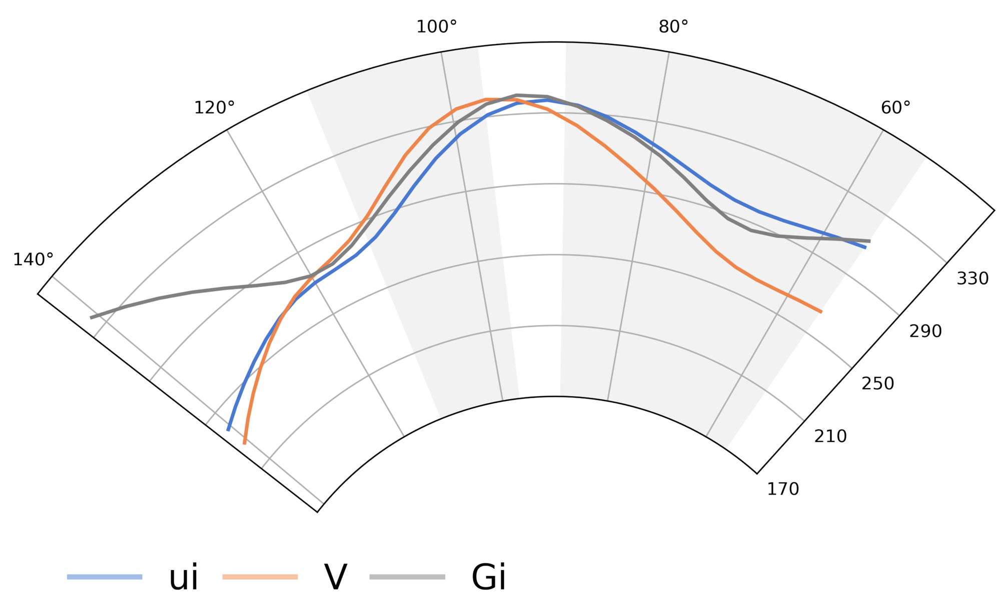
Tongue contours

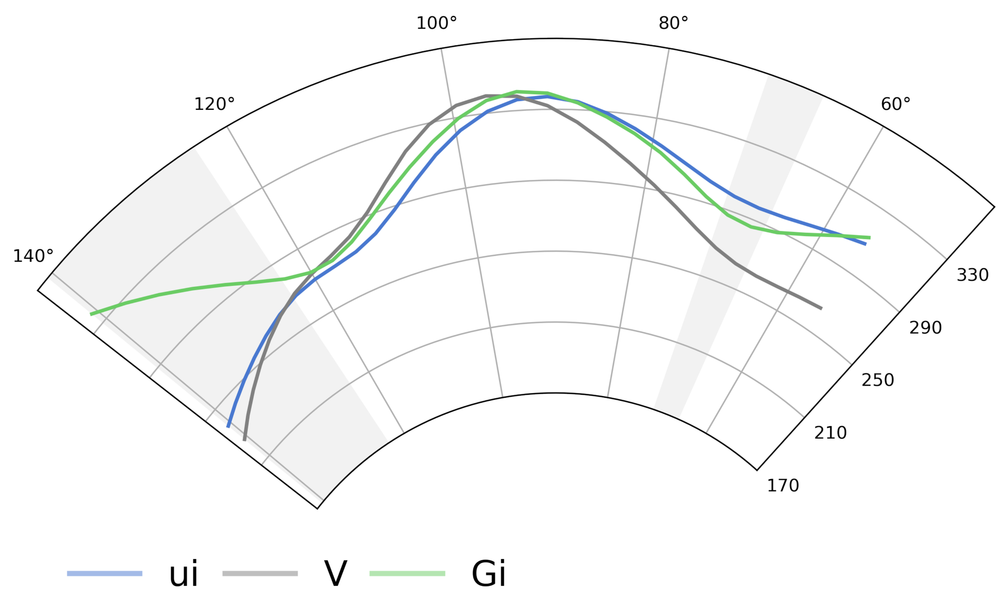
/u–w/ Group:

back front

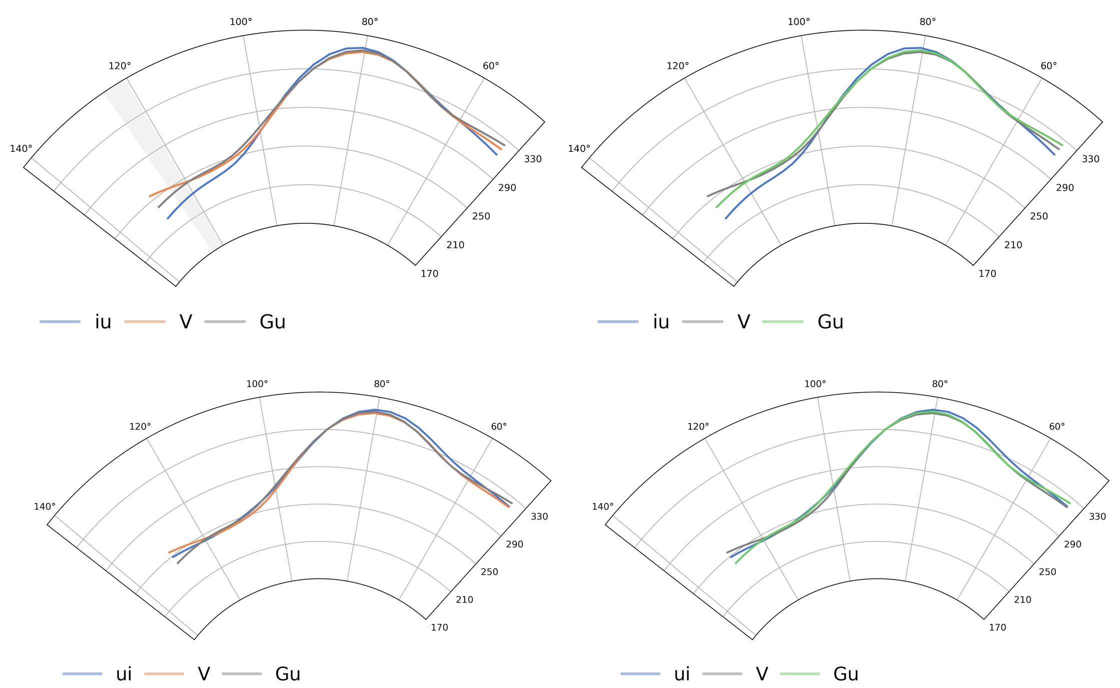






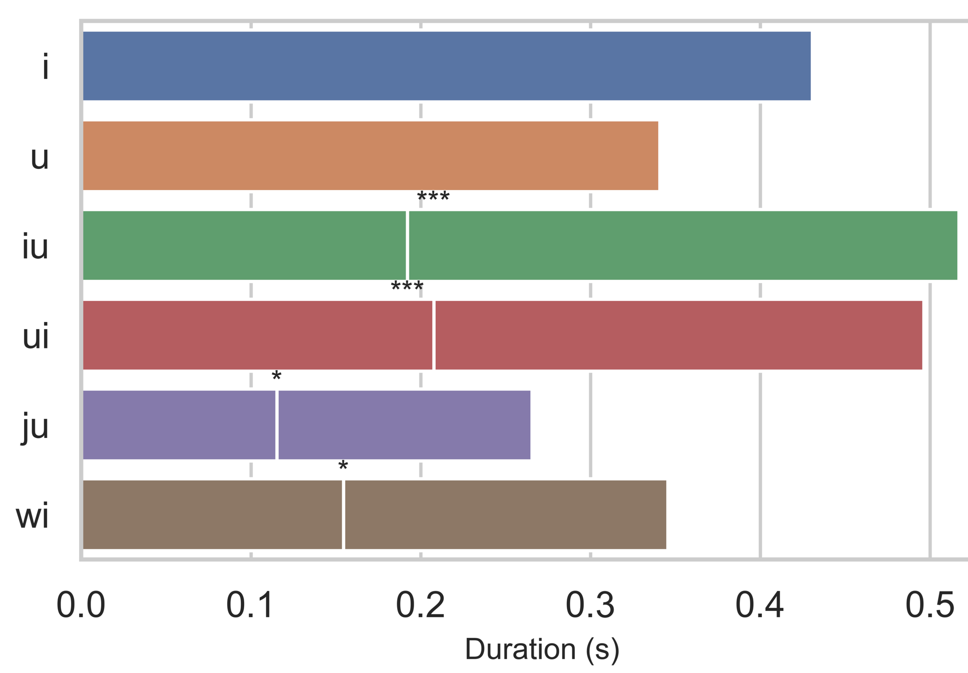


/i–j/ Group:



Duration

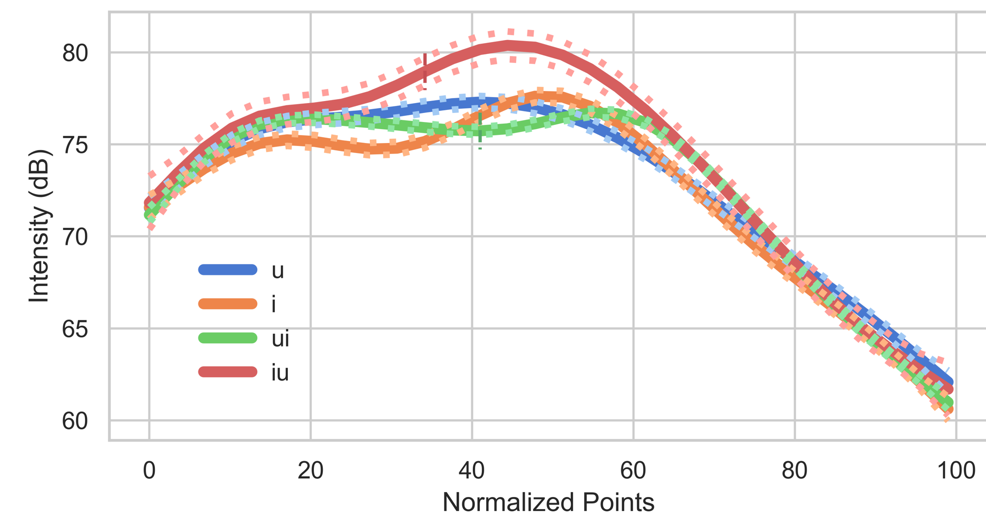
V > G



Intensity

V: sonority ↑ → intensity ↑

G: sonority ↓ → intensity ↓



Discussion

Coarticulatory Resistance of /i/

1. /i/ group tongue contours are rather identical, in contrast with those of /u/ group.
2. The innate resistance against coarticulation of /i/ as a high front vowel [6]

Sequential order over vocalic segmental distinction

Q: In other Taiwan Hakka, and Taiwan Southern Min, it is found that /i/ is the nuclei in such ambiguous structures, why Squliq Atayal consistently prefers GV instead of choosing either /i/ or /u/ as the vowel?

1. Squliq Atayal has only 5 vowels → sparsely–distributed voewl space → larger vowel variability (cf. [7])
2. Such larger variance of vowels may lead speakers to rely more on other (supra)segmental features such as syllabic structures, thus opting for a consistent GV structure.

Open syllable over closed syllable

Q: Why GV instead of VG?

1. A rather reasonable result of the cross-linguistic preference of human languages for open syllables.
2. Such a preference can also be observed in the glottal stop dropping in Squliq Atayal when it is in the word–final position.

In summary, our study finds that Squliq Atayal follows a sequential order of GV when deciding the vowel–glide roles of high vocoid diphthongs, whether they be /iu/ or /ui/, a potential result of loose vowel space and preference for open syllables.

References

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