

Articulation and syllabic affiliation of prenuclear glide in Taiwan Mandarin

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The syllabic affiliation of prenuclear glide (pre-NG) in Mandarin has long been a controversy in the literature. While the traditional view holds that the pre-NG forms a part of the rhyme (cf. Wang & Chang, 2001), a number of theories and empirical studies suggest otherwise. Based on loanword adaptation, Duanmu (2011) proposes that pre-NG in Chinese languages serve as a secondary articulation of the onset. Some studies even suggest that pre-NG glides' belonging to rhyme or onset may vary from one secret language to another (Chao, 1931), and that pre-NG forms an intermediate level between the onset and the rhyme (Wan, 2002). Wan (2002) looks at both acoustics and speech errors and found that while acoustically, the pre-NG is obviously closer to the onset, the affiliation of it in speech errors is generally with the rhyme, and is affected by the place of articulation of the onset. By examining the tongue movements of pre-NG, Li (2019) shows that the pre-NG aligns with both the onset and rhyme. This study employs ultrasonography and electromyography (EMG) with an attempt to examine whether lip and tongue postures could provide supports to the belongings of pre-NG in Mandarin syllables.

Subjects & materials Data were collected from four native Mandarin speakers (1 female). Stimuli included CV, CGV(N), and GV syllables. In Mandarin, there are three pairs of glides/vowels: /i; j/, /u; w/ and /y; ɥ/. For this study, we examine only the /u; w/ pair, for two reasons: 1) the rounding feature of /w/ as a secondary coarticulation is more measurable and quantifiable compared with /j/, and 2) this pair has a wider word net in Mandarin than the other two. All the stimuli except for the GV syllables were disyllabic, with the target syllable falling on the second. The tones were controlled to be a level tone, and the vowels in CV and CGV(X) were /a/. To ensure the starting tongue configuration of the glides in CGV(X) and GV syllables are the same, the subject the GV syllables were preceded by syllables ending with /n/ and /ŋ/ codas respectively.

Methods A portable ultrasound machine was used to record the tongue configuration, with the probe fixed onto a headset at a 30° angle away from participants' chests. EMG electrodes were attached to the right corner of the orbicularis oris. Acoustic data were recorded and labeled in Praat (Boersma, 2014). The EMG lip movement onsets were determined by following Magda (2015). Tongue movement onsets were determined with the acoustic data. Tongue surface was automatically traced by DeepEdge (Chen, et al., 2020), and then fitted through GAMMs (give citation).

Results Linear-mixed model of lip rounding results (shown in Fig 2) among the three types of /u~w/ revealed no significant differences in the onset timing of lip rounding (all $p > .15$). In terms of tongue configuration (Fig 3.), it is seen that the vowels /u/ generally had higher, more constricted tongue shapes, while the glides /w/, whether it be canonical or prenuclear, are slightly more to the front, and less constricted. In this regard, it is likely that prenuclear glides are no different from canonical glides in the articulatory dimension, and likely are not merely secondary coarticulation but proper phonemes. Indeed, a post-hoc hierarchical clustering analysis of the ultrasound imaging grouped the two types of glides more often than with the vowels (Fig 1.). Therefore, our results seem to not be in favor of Duanmu's account. However, it should be noted that such results do not outthrow the possibility of pre-NG being part of the onsets, only as true phonemes, rather than secondary coarticulation.

Figure 1: Hierarchical clustering analysis results of alveolar group (subject 1).

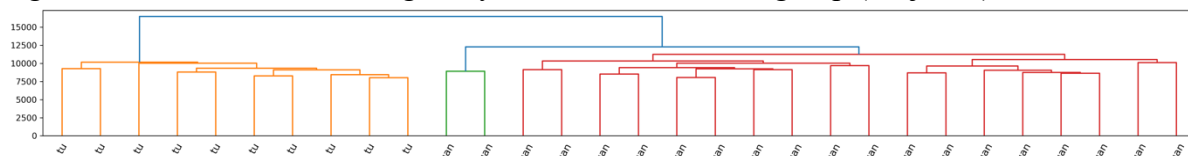


Figure 2: Temporal differences between the onsets of lip rounding and acoustic signal among the three types of /u~w/.

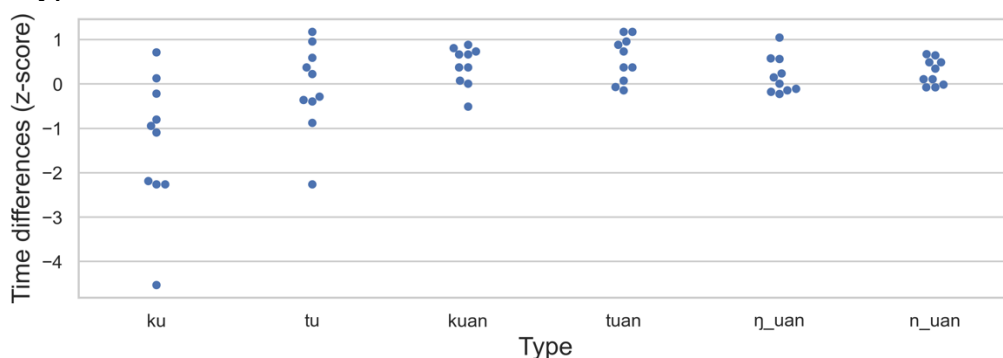
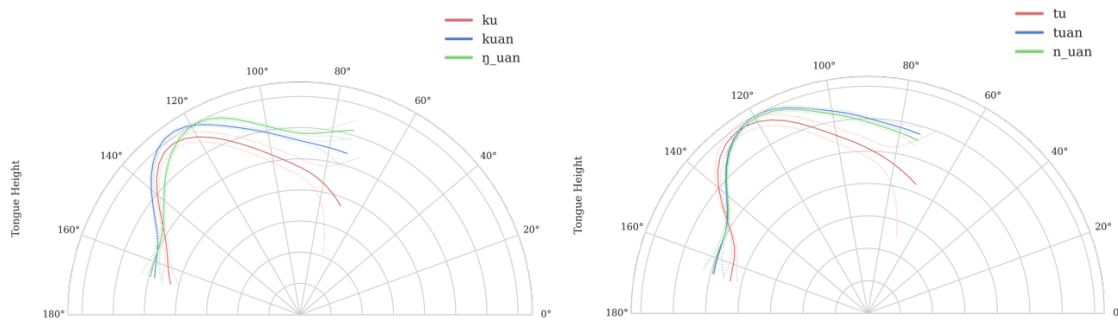


Figure 3: Tongue configuration of the three types of /u~w/ (left: velar group; right: alveolar group, subject 1).



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