

Prosody-modulated and vowel-dependent nasal merging in Taiwan Mandarin

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Syllable-final nasals /n/ and /ŋ/ in Taiwan Mandarin (TM) is known to be undergoing merging [4, 5]. More aggressive merging has been found between /in/ and /iŋ/ (/i/N context) and between /ən/ and /əŋ/ (/ə/N context), than between /an/ and /aŋ/ (/a/N context), in which the contrast is maintained by the backing of the vowel via a rime harmony process (i.e., /an/ → [an] but /aŋ/ → [aŋ]) [8]. While the articulatory merging of the tongue position was pervasive, previous studies have shown that some speakers maintained the contrast by implementing different degrees of nasalization in the pre-nasal vowels [1, 3, 7]. That is, the gestural contrast of syllable-final /n/ vs. /ŋ/ may have gradually been replaced by a nasality contrast of the pre-nasal vowels. As gestural and acoustic contrasts may be modulated by prosodic prominence [2, 6], this study examines if the two indicators of the underlying /n/ vs. /ŋ/ would be enhanced in prosodically prominent positions, as opposed to weak positions. The hypothesis is that, if the contrast lies in the consonant gestures, more distinct tongue shapes should be observed in prominent than in weak positions. On the other hand, if the contrast lies in the nasality difference of the pre-nasal vowels, more distinct degrees of nasalization should be observed in prominent than in weak positions. Specifically, if the gestural contrast is not enhanced in prominent positions, it may be an indication of a sound change whereby the gestural contrast is replaced by the nasality contrast.

11 TM speakers (7F, 4M, aged 21-25, $M = 22.46$) were recruited to produce 72 monosyllabic words with counterbalanced nasal codas [n, ŋ] in three vowel contexts [i, ə, a], in focus and unfocus conditions (two repetitions each, resulting in 288 tokens per speaker). The acoustic and ultrasound data were recorded simultaneously. Tongue postures were captured across 10 time points of the final nasals as a measurement for the gestural merging, and nasalization of the pre-nasal vowels was measured using *aI-p0* for non-high vowels /ə, a/ and *aI-p1* for the high vowel /i/ over five time points (the lower the values, the stronger the nasalization) [9]. The results showed that focused words were longer ($M = 75$ ms) in duration than unfocused words ($M = 68$ ms, $p < .001$) and focused vowels were more cornered than unfocused ones (Figure 1), indicating the modulation of prosodic prominence in the speakers' production. Tongue trace results showed that, while a gestural contrast in the /a/N context was enhanced in focus condition (Figure 3 and Figure 4), no such enhancement seems to be found in the /i/N and /ə/ contexts, supported by the estimated non-linear difference using Generalized Additive Mixed Models. The corresponding acoustic results (Figure 2), however, showed that speakers consistently implemented a larger difference in nasalization of the pre-nasal vowels in /i/N context. The same trend was found, but to a lesser degree, in the other two vowel contexts.

The results, taken together, suggest that 1) the /n/ vs. /ŋ/ contrast remained consistent in the /a/N context, manifested by different tongue shapes and degrees of nasalization in pre-nasal vowels and that 2) the gestural contrast may have been replaced by pre-nasal vowel nasality in the /i/N and /ə/ contexts, supported by the enhancement of the degree of nasalization but the lack of enhancement of tongue shapes across the two focus conditions.

