

An articulatory study on the syllable-final nasal merger in Southwestern Mandarin

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Introduction: In Chinese languages, at least two nasal consonants can occur in syllable-final position: /n/ and /ŋ/. Ongoing merger between these two syllable-final nasals has long been reported across Chinese languages [1, 2, 3] and has been extensively studied through both acoustic and articulatory investigation [4, 5]. Southwestern Mandarin (SWM), the most widely spoken Mandarin variety with 250 million native speakers, also exhibits /n/-/ŋ/ merger in coda position [6]. However, previous studies on SWM nasal merger have relied primarily on impressionistic transcription and acoustic analysis, leaving the articulatory dynamics of this merger underexplored. The present study examines the kinematics of syllable-final nasals in one SWM variety using electromagnetic articulography (EMA), aiming to better understand the nature of the syllable-final nasal merger in SWM and other Chinese languages. Specifically, we investigate whether the merger is uniform across vowel contexts and whether articulatory differences persist even when perceptual distinctions have been neutralized.

Method: This study examines syllable-final nasals in a SWM variety from the Chengdu-Chongqing dialect group, spoken in western Hubei. Data from four native speakers in their twenties (2 male) were collected using the NDI Wave system at a 200 Hz sampling rate. Acoustic data were simultaneously recorded using a Sound Devices MixPre mixer and a Sennheiser unidirectional shotgun microphone at a 24 kHz sampling rate. Materials consisted of monosyllabic words with coda /n/ and /ŋ/ combined with the vowels /a, i, e/, embedded in the carrier phrase, “*pa* __ *pa*,” (give __ SFP) and produced at a normal speech rate. Stimuli were presented on a computer screen in a sound-attenuated recording room. The wordlist is shown in Table 1. Each token was repeated six times in randomized order, yielding 144 tokens (6 words × 6 repetitions × 4 speakers). Segmentation was performed in Praat [7], with nasal consonant boundaries identified based on acoustic landmarks and corresponding articulatory trajectories. Statistical analysis employed linear mixed-effects models with nasal category and vowel context as fixed effects and speaker and item as random effects.

Results: (1) Transcription of the audio data revealed a vowel-dependent merger pattern: the syllable-final nasal merger occurs only when the preceding vowel is /i/ or /e/, while the /n/-/ŋ/ distinction is maintained following /a/. Moreover, the merger direction is /ŋ/ → [n]; that is, /iŋ/ and /eŋ/ become [in] and [en]. (2) The EMA results, illustrated in Figure 1, show that tongue movements for /pin/ vs. /piŋ/ and /ken/ vs. /keŋ/ are similar, whereas a clear contrast between /pan/ and /paŋ/ is evident, with /paŋ/ showing prominent tongue dorsum retraction compared to /pan/. (3) Statistical analyses reveal significant differences in both vertical and horizontal dimensions between /n/ and /ŋ/ following /a/ across tongue tip (TT), tongue body (TB), and tongue dorsum (TD), but no significant differences following /e/. Following /i/, significant differences emerge only in the vertical dimension.

Discussion: Our finding of vowel-dependent merger parallels the pattern reported for Taiwanese Mandarin [5]: merger occurs when the preceding vowel is /i/ or /e/, while the alveolar-velar contrast is preserved following /a/. The tongue movement trajectories further confirm the vowel-dependent nature of the nasal merger in SWM. The statistical results suggest an ongoing merger process: significant vertical and horizontal differences across TT, TB, and TD in the /a/ context confirm the maintained [an]-[aŋ] distinction, while the absence of differences in the /e/ context indicates completed merger of /eŋ/ to [en]. However, /n/ and /ŋ/ show significant vertical differences across TT, TB, and TD in the /i/ context, suggesting that the merger may not yet be complete articulatorily, even though the distinction is no longer perceptible. This finding raises the possibility that subphonemic articulatory differences may persist even after perceptual neutralization.

Table 1. Recording materials of the present study.

	/n/	/ŋ/
a	搬 <i>ban</i> /pan/	帮 <i>bang</i> /paŋ/
e	跟 <i>gen</i> /ken/	更 <i>geng</i> /keŋ/
i	宾 <i>bin</i> /pin/	冰 <i>bing</i> /piŋ/

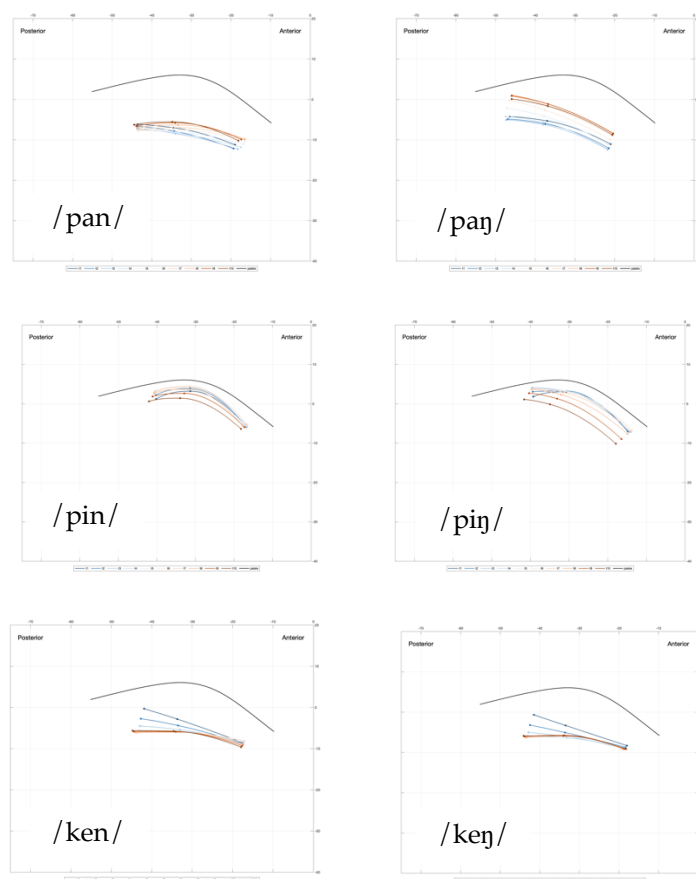


Fig. 1. Temporal changes in lingual configuration during the production of the rimes of /pan/, /paŋ/, /pin/, /piŋ/, /ken/ and /keŋ/ by speakers S03. Subject orientation is rightward, with blue lines representing articulation onset and red lines representing endpoint.

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