

# Multiple nasal mergers in Taiwan Mandarin: a case of perception-production misalignment

Sang-Im Lee-Kim<sup>1</sup>, Ssu-Ying Chen<sup>2</sup>, Lacey Wade<sup>3</sup>, and Meredith Tamminga<sup>4</sup>

<sup>1</sup>Hanyang Institute for Phonetics & Cognitive Sciences of Language, Hanyang University (Korea), <sup>2</sup>National Yang Ming Chiao Tung University (Taiwan), <sup>3</sup>University of Kansas (USA), <sup>4</sup>University of Pennsylvania (USA)

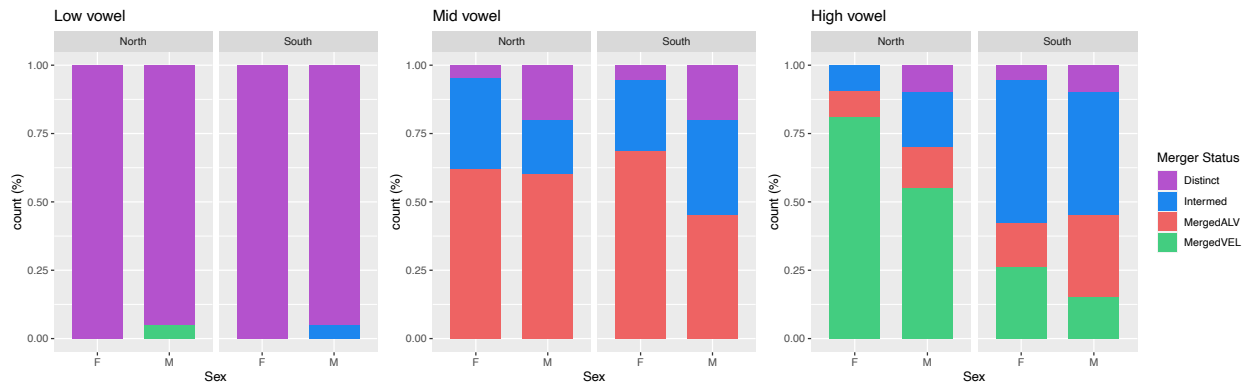
**Introduction:** The merging of categories in production often precedes the merger in perception; speakers retain some perceptual sensitivity to phonological contrasts even when they no longer maintain the distinction in production (e.g., [1] for English vowel mergers, [2] for Cantonese tone mergers). The perception-production misalignment has been attributed to merged speakers' exposure to distinct speech within a community (e.g., [1,3,4,5]). Frequent encounters with distinct exemplars could prevent the categories from being completely merged in mental representations. However, more empirical evidence is needed on the relationship between perception and production of mergers at the individual level. This study focuses on multiple nasal mergers in Taiwan Mandarin (TM) in which syllable final nasals are variably merged in non-low vowel contexts ([6,7,8]): (1) the /əŋ/-to-/ən/ merger, in which the velar nasal /ŋ/ may be merged with its alveolar counterpart in the mid-vowel /ə/ context; and (2) the /in/-/iŋ/ merger where the alveolar and velar nasals may merge in either direction after /i/. We first establish the progress of TM nasal mergers and their conditioning factors, through which we explore how individuals embrace changes-in-progress while relaxing the perception-production link to understand production patterns different from their own.

**Production:** Eighty college students counter-balanced for sex and region (North vs. South) participated in a word reading task which included twelve items for each nasal place in high and mid vowel contexts (e.g., /ta<sup>214</sup>tʂən<sup>55</sup>/ 打針 'injection' vs. /hwei<sup>35</sup>ʂəŋ<sup>55</sup>/ 回聲 'echo'), as well as those in a control low vowel context. Phonetically trained judges labeled the nasal tokens as /n/ or /ŋ/ and visually examined the vowel formant structures on the spectrograms. Speakers were classified into four categories based on their merger status: distinct, intermediate, merged<sub>ALV</sub> (merging toward alveolars), and merged<sub>VEL</sub> (merging toward velars). Above 90% or below 10% accuracies were used as a cut-off: e.g., distinct speakers showed higher than 90% accuracies for both nasal categories. Figure 1 summarizes the distribution of the merger status by sex and region across vowel context. The proportion of the /əŋ/-to-/ən/ merger in our results is higher than previous reports with no significant effects of sex and region ([9,10]), indicating this mature change has now developed into widespread merger in the Taiwanese speech community. In contrast, /in/-to-/iŋ/ merger emerged as a dominant pattern, especially among northern (female) speakers (REGION:  $p < .0001$ , SEX:  $p = .0527$ ), again higher than previously reported ([9]).

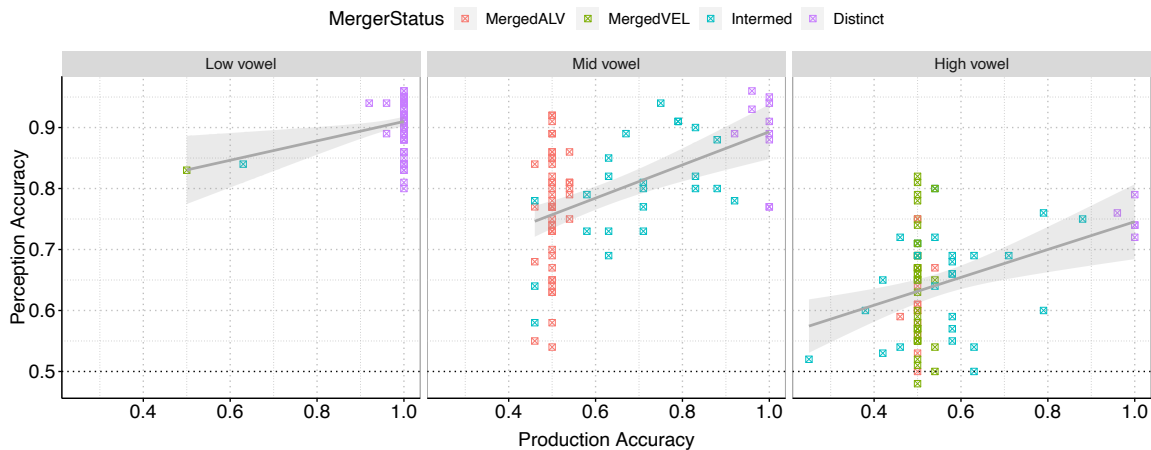
**Perception:** With the same participants, an AXB discrimination experiment was conducted, which included disyllabic pseudowords varying in the final nasals produced by three male and three female distinct talkers (e.g., [pa.teiŋ]~[pa.teiŋ]). The results of the accuracy analyzed using mixed-effects logistic regression revealed perceptual biases conditioned by vowel; participants performed the best in /a/ (mean accuracy = 89%), followed by /ə/ (78%), and the last in /i/ (63%) (Figure 2), with no significant effects of social factors and their interactions.

**Perception-production links:** Figure 2 plots perception against production accuracies of individual speakers. Production accuracies were computed by obtaining average accuracy scores drawn from the two nasal categories. Significant correlations were found, however, the degree of correlation was weak to moderate ( $r(\text{ə}) = 0.50$ ,  $r(\text{i}) = 0.37$ ). Importantly, most merged speakers performed better than chance, regardless of merging direction, and especially some merged speakers performed as well as distinct speakers did.

**Discussion:** The results of the perception task demonstrated that final nasals are more difficult to discriminate in non-low vowels, mirroring the merging patterns in their production at the group level. However, none of the social factors modulated TM speakers' perceptual sensitivity to nasal places. Furthermore, individuals' merger status was only weakly related to their perceptual behavior. Our results indicate that individuals may remain sensitive to the contrasts to some extent, presumably due to exposure to distinct speech in the speech community, resulting in an apparent mismatch between perception and production.



**Figure 1.** Distribution of multiple nasal mergers by region and sex across vowel context



**Figure 2.** Individual's perception-production accuracies across vowel context. Different colors represent the merger status of each speaker. The dotted horizontal lines mark perceptual performance at chance level.

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