

An articulatory investigation of Labov's Gender Paradox in Cantonese vowel production – an electromagnetic articulography study

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Introduction: The intersection of social identity and phonetic realization is a central concern in sociolinguistics and laboratory phonology. While anatomical differences in vocal tract morphology [1] partly account for gendered speech, social factors (e.g., gender) play a critical role in shaping articulatory behavior [2,3]. Labov's gender paradox [4] argues that women tend to lead linguistic change yet also conform more closely than men to sociolinguistic norms that are overtly prescribed. This paradox is also visible in phonetic implementation: women often produce speech that is both innovative and articulatorily more precise.

Despite extensive research in English [5,6,7] and other languages [8,19], articulatory variation in Cantonese remains understudied. To address this gap, we investigate kinematic variability in the production of three Cantonese corner vowels, /a:/, /i:/, and /u:/, among male and female speakers from Hong Kong. Specifically, we investigate: (1) Is variability in one vowel correlated with variability in another?; (2) Does gender significantly influence articulatory variability?; (3) Which articulators (e.g., tongue, lips) contribute most to gender-related differences?

Method: We collected electromagnetic articulography data (Carstens AG501) from 30 young adult Cantonese speakers from Hong Kong (15 female, 15 male, mean age = 27.61 years, SD = 4.0). In varied CV settings, participants produced 70 Hong Kong street names containing corner vowels /i:/, a:/, u:/ with each vowel articulated over 10 times per speaker. Sensors were affixed to the tongue dorsum (TD), tongue tip (TT), tongue lateral (TL), upper lip (UP), lower lip (LP), and lip corners (LC) with reference sensors on the nasion and bilateral mastoids. Following Whalen et al. [10], we define articulatory variability (dashed lines in Figure 1) at each articulatory location for each speaker as the Euclidean distance between each repetition of a vowel production and the mean position for that vowel. Figure 1 shows TT frontness and height variability for a single speaker's three corner vowels, with mean values as colored diamonds and repeats as dots. We fitted linear mixed-effects models¹ in R to investigate gender-related cross-vowel variability [11].

Results: For RQ 1 female speakers' corner vowels had significant correlation (Figure 2), indicating that female speakers with higher variability in one vowel tended to exhibit higher variability in others. In contrast, no significant inter-vowel correlations were observed for male speakers. For RQs 2 and 3, For RQs 2 and 3, female speakers exhibited slightly lower overall articulatory variability than males ($\beta = -0.2$, $p = 0.15$). However, *post-hoc* comparisons of individual articulators revealed significant gender differences in tongue movement variability. Specifically, female speakers showed significantly less variability than males in TD, TT and TL ($ps < .05$).

While anatomical factors contribute to differences in speech, social motivations and identity construction play a pivotal role. Hyper-articulated speech, characterized by increased clarity and precision, emerges as a strategic asset [12], particularly for women who often face heightened societal pressures to conform to normative linguistic standards and display prestige. The results suggest that female speakers employ more linguistically conservative and precise articulatory strategies, resulting in systematically reduced variability. In contrast, male speakers exhibit greater variability associated with hypo-articulation. This pattern of intentional hyper-articulation among women not only reflects their leadership in linguistic innovation, as described by Labov, but also underscores the complex interplay between socio-phonetic identity and the negotiation of social status within the speech community.

¹ (fixed effects: vowel, gender, articulator; random effects: speaker, word)

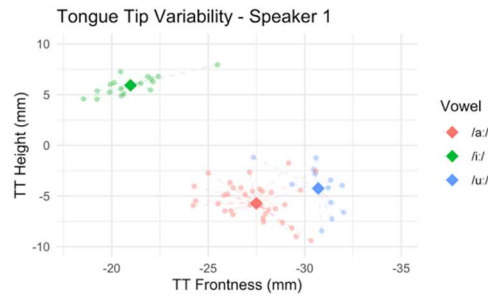


Fig. 1. TT frontness and height variability for Speaker 1 during the production of three corner vowels (/a:/, /i:/, /u:/). Each coloured dot represents a single repetition, and coloured diamonds indicate the mean position for each vowel. Dashed lines connect each repetition to its mean, illustrating articulatory variability as defined by the Euclidean distance from each repetition to the mean.

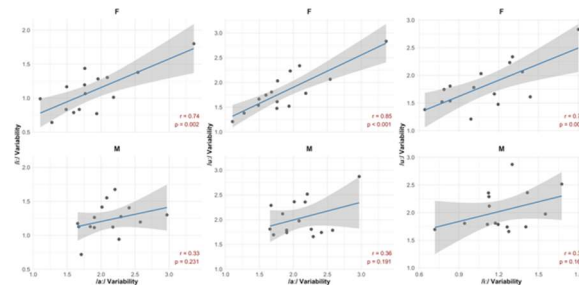


Fig. 2. Mean variability correlation among three corner vowels for male and female speakers respectively.

References

- [1] Simpson, A. P. (2001). Dynamic consequences of differences in male and female vocal tract dimensions. *The Journal of the Acoustical Society of America*, 109(5), 2153–2164. <https://doi.org/10.1121/1.1356020>
- [2] Li, F., Rendall, D., Vasey, P. L., Kinsman, M., Ward-Sutherland, A., & Diano, G. (2016). The development of sex/gender-specific/s and its relationship to gender identity in children and adolescents. *Journal of Phonetics*, 57, 59–70.
- [3] Stuart-Smith, J. (2007). Empirical evidence for gendered speech production: /s/ in Glaswegian.
- [4] Labov, W. (2001). *Principles of linguistic change: Volume 2: Social factors* (p. 293). Blackwell.
- [5] Blackwood Ximenes, A., Shaw, J. A., & Carignan, C. (2017). A comparison of acoustic and articulatory methods for analyzing vowel differences across dialects: Data from American and Australian English. *The Journal of the Acoustical Society of America*, 142(1), 363. <https://doi.org/10.1121/1.4991346>
- [6] Lawson, E., Stuart-Smith, J., & Scobbie, J. M. (2008). Articulatory insights into language variation and change: Preliminary findings from an ultrasound study of derhotization in Scottish English. *University of Pennsylvania Working Papers in Linguistics*, 14. <https://test-ereasearch.qmu.ac.uk/handle/20.500.12289/142>
- [7] Yunusova, Y., Rosenthal, J. S., Rudy, K., Baljko, M., & Daskalogiannakis, J. (2012). Positional targets for lingual consonants defined using electromagnetic articulography. *The Journal of the Acoustical Society of America*, 132(2), 1027–1038. <https://doi.org/10.1121/1.4733542>
- [8] Wieling, M., Tomaschek, F., Arnold, D., Tiede, M., Bröker, F., Thiele, S., Wood, S. N., & Baayen, R. H. (2016). Investigating dialectal differences using articulography. *Journal of Phonetics*, 59, 122–143. <https://doi.org/10.1016/j.wocn.2016.09.004>
- [9] Chang, Y. S. (2024). Acoustic and articulatory variation of Mandarin diphthong /ou/. *Concentric. Studies in Linguistics*, 50(1), 1–19. <https://doi.org/10.1075/cons1.00032.cha>
- [10] Whalen, D. H., Chen, W.-R., Tiede, M. K., & Nam, H. (2018). Variability of articulator positions and formants across nine English vowels. *Journal of Phonetics*, 68, 1–14. <https://doi.org/10.1016/j.wocn.2018.01.003>
- [11] R, core team. (2022). *RStudio: Integrated Development for R* [Computer software]. RStudio, Inc. <http://www.rstudio.com/>
- [12] Lindblom, B. (1990). Explaining phonetic variation: A sketch of the H&H theory. In W. J. Hardcastle & A. Marchal (Eds.), *Speech production and speech modelling* (pp. 403–439). Kluwer Academic.