

Consistency and contrast of English vowel production in Korean elementary school students

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Children are often assumed to possess a biological advantage over adults in second language (L2) speech acquisition (Lenneberg, 1967). However, fine-grained acoustic studies show that child learners, like adults, require prolonged exposure and sustained practice to establish stable L2 vowel categories (Flege, 1995; Tsukada et al., 2005). While an early age of onset may facilitate the acquisition of temporal cues such as vowel duration, improvements in vowel quality—typically indexed by first and second formant (F1/F2) patterns—emerge more slowly and depend heavily on experience and input (Park & Lee, 2024). Research on high-variability phonetic training further suggests that Korean elementary school learners demonstrate greater gains in perceptual discrimination than in production accuracy, indicating a partial dissociation between perception and production at this developmental stage (Hwang & Lee, 2015).

Against this background, the present study examines whether individual differences in fluency are associated with how Korean elementary school learners organize English vowel categories in acoustic space. Specifically, we ask whether fluency predicts (i) greater within-category consistency and (ii) clearer between-category contrast in vowel production. These dimensions reflect complementary but distinct aspects of phonetic category development and may progress unevenly in L2 learners.

Within-category consistency was assessed using vowel compactness scores (Kartushina & Frauenfelder, 2014; Oh, 2024), while between-category contrast was evaluated using Pillai scores derived from multivariate analyses of vowel distributions (Han & Lee, 2025; Stanley & Sneller, 2023). Speech data were drawn from the Children’s English Speech Data for Learning corpus, publicly available through AI Hub. The dataset comprised recordings from 94 Korean elementary school students (45 male, 49 female), each contributing more than 100 utterances. Speakers were classified into four fluency levels (F02–F05), with F05 representing the highest fluency, based on proficiency ratings provided in the corpus.

Bark-transformed F1 (F1Bk) and F2 (F2Bk) values were extracted at the midpoint of each stressed English monophthong using Praat’s To Formant (Burg) function, with five formants and a ceiling of 5,500 Hz. Vowel compactness was operationalized as the area of a one-standard deviation ellipse in the F1–F2 space. For each speaker and vowel category, centroid values were calculated and used to derive category-specific compactness values (CSV). CSV was analyzed using linear mixed-effects models with Fluency and Vowel as fixed effects and Speaker as a random intercept.

Between-category contrast was examined by computing Pillai scores separately for each speaker and six English vowel contrasts (/i–ɪ/, /ɪ–ε/, /ε–æ/, /u–ʊ/, /ʊ–ɔ/, and /ɔ–ɑ/). For each contrast, vowel category served as the independent variable and F1Bk and F2Bk as dependent variables in a MANOVA. Contrast-specific thresholds (Stanley & Sneller, 2023) were applied to classify contrasts as distinct or merged, and distinctness was modeled using logistic regression with Fluency, Contrast, and their interaction as predictors.

The results reveal a dissociation between within-category consistency and between-category contrast. Vowel compactness was strongly conditioned by vowel identity but showed no reliable effect of fluency. In contrast, the likelihood of maintaining distinct vowel contrasts increased significantly at the highest fluency level. This pattern aligns with the Speech Learning Model and its revised version (SLM/SLM-r; Flege, 1995; Flege & Bohn, 2021), suggesting that fluency is more closely associated with contrast maintenance than with the stabilization of individual vowel categories in child L2 learners.

References

- [1] Flege, J. E. (1995). Second language speech learning: Theory, findings and problems. In W. Strange (Ed.), *Speech Perception and Linguistic Experience: Issues in Cross-Language Research* (pp. 233-277). York Press.
- [2] Flege, J. E. & Bohn, O-S. (2021). The revised Speech Learning Model (SLM-r). In R. Wayland (Ed.), *Second Language Speech Learning: Theoretical and Empirical Progress* (pp. 3-83). Cambridge University Press.
- [3] Han, Y., & Lee, J-K. (2025). Testing vowel contrasts in L2 English: A threshold-based Pillai score approach. *Proceedings of the 2025 Spring Conference of the Korean Society of Speech Sciences* (pp. 75-77).
- [4] Hwang, H., & Lee, H.-Y. (2015). The effect of high variability phonetic training on the production of English vowels and consonants. *Proceedings of 18th International Congress of Phonetic Sciences*. ICPHS0466.pdf.
- [5] Kartushina, N., & Frauenfelder, U. H. (2014). On the effects of L2 perception and of individual differences in L1 production on L2 pronunciation. *Frontiers in Psychology*, 5, 1-17.
- [6] Lenneberg, E. H. (1967). *Biological Foundations of Language*. Wiley.
- [7] Oh, S. (2024). *Individual Differences of L1 Category Precision in L2 Speech Learning*. Doctoral dissertation, The University of Wisconsin-Milwaukee.
- [8] Park, M. S., & Lee, J. K. (2024). Korean ESL learners' production of English vowel contrasts: Developmental variations in L2 sound learning. *Korean Journal of English Language and Linguistics*, 24, 1318-1332.
- [9] Stanley, J. A., & Sneller, B. (2023). Sample size matters in calculating Pillai scores. *The Journal of the Acoustical Society of America*, 153, 45-67.
- [10] Tsukada, K., Birdsong, D., Bialystok, E., Mack, M., Sung, H., & Flege, J. E. (2005). A developmental study of English vowel production and perception by native Korean adults and children. *Journal of Phonetics*, 33(3), 263-290.