The effects of native phonetic categorization on L2 sound acquisition

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In order to successfully process speech, listeners must be able to recognize the categories of sounds they are hearing. Recently, there has been debate around the nature of these categories and accumulating evidence suggests within-category acoustic differences play a role in perceptual categorization [1] and production [2], and speech categories are in fact gradient in nature. In the L2 speech learning literature, models such as the SLM-r [3] and the PAM-L2 [4] predict that sensitivity to within-category acoustic details in the L1 can facilitate learning novel sound contrasts. However, the functional roles of native categorization in L2 speech acquisition have not been clearly established. Therefore, the current study aims to test how i) gradient perception of L1 acoustic cues and ii) category precision in L1 production can facilitate the perception of L2 contrasts.

Participants were L1 English learners of Korean. Korean was chosen for two reasons. First, Korean has a three-way stop contrast (i.e., aspirated, lenis, fortis), in which both the fortis and lenis categories are perceptually assimilated into the English unaspirated stop category (e.g., [5]), making them difficult to discriminate and acquire. Second, while L1 English speakers use voice-onset time (VOT) as the primary cue in discriminating stop contrasts, native Korean speakers use both VOT and fundamental frequency (F0). Successful acquisition of Korean stops thus requires native-English speakers to learn a new cue-weighting strategy in Korean. Therefore, this population allows us to test whether participants' sensitivity to within category acoustic details in their L1 facilitates learning a difficult new sound contrast, and if so, whether effects can be attributed to speakers' flexibility in cue-weighting strategies in L1.

We recruited 29 undergraduate English monolingual students in first-year Korean classes. Their sensitivity to within-category variability in English was assessed with a Visual Analogue Scale (VAS) to elicit gradient speech categorization [6]. In the VAS task, participants listened to an English word with different stop onsets that varied orthogonally on F0 and VOT continua (e.g., [XʌM]). Participants clicked on a line with voiced and voiceless onset words at each extreme (e.g., gum-come) to rate how *gum*-like versus *come*-like the stimulus was. We also collected English production samples via a brief paragraph reading task, and their syllable-initial stop tokens were extracted for acoustic analysis. Participants' identification of Korean stops was assessed in a 3AFC task, in which they heard a Korean monosyllable (e.g., /ka/, /k'a/, or /k^ha/) and chose which sound the stimulus was.

The data analysis is on-going. The data from the VAS task of each participant was fitted in a rotated logistic regression [7], and the fitted parameter of Slope was used to quantify the participant's native perceptual gradiency [1]. Individual participant's native production precision was quantified by the standard deviation of both the VOT and F0 measures of each stop category. Our preliminary results confirm individual variability in the use of different acoustic cues in both L1 production and perception. The results of the 3AFC task revealed that participants were most accurate in identifying the aspirated stop in Korean, significantly more accurate than in the fortis and lenis stops, whereas their accuracies were comparable between the fortis and lenis stops (Fig. 1). Furthermore, linear regression models revealed that the effects of L1 category precision and gradiency on L2 perception were modulated by L2 categories. Specifically, both the precision of VOT production (Fig. 2A) and perception gradiency (Fig. 2C) in English had a facilitative effect on the accuracy of the lenis stop classification in Korean but interfered with the accuracy of the fortis and/or aspirated stops. On the other hand, the precision of F0 production in English (Fig. 2B) had facilitative effects on the classification accuracy of all Korean categories.

In conclusion, these findings support a role for a relation between L1 category gradiency and L2 category perception, but also suggest that the L1-L2 assimilation patterns also play a strong role.

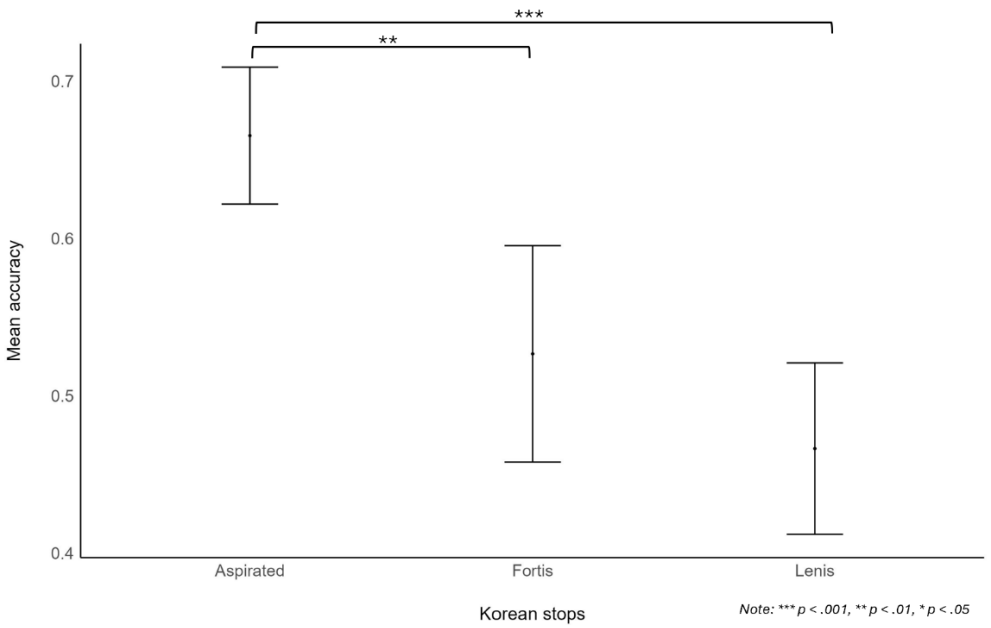

Fig. 1. Average accuracy of the 3AFC task, split by Korean stop category.

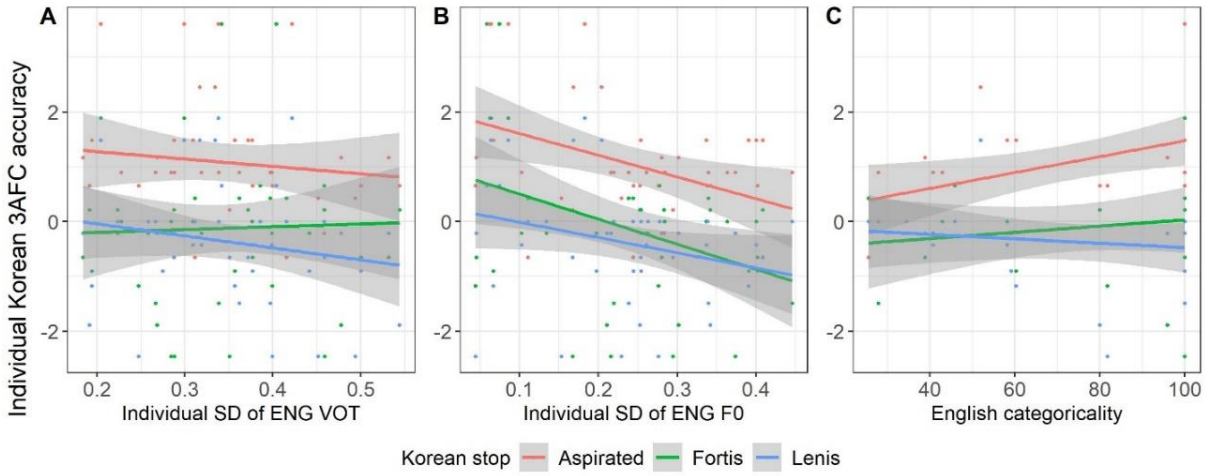

Fig. 2. The effects of L1 categorization on L2 perception accuracy in different Korean stops. Panel A and B plot the effects of English production precision, and Panel C plots the effect of English perceptual gradiency. Empirical logit accuracy was used to measure L2 accuracy.

References

[1] Kapnoula, E. C., Winn, M. B., Kong, E. J., Edwards, J., & McMurray, B. (2017). Evaluating the sources and functions of gradiency in phoneme categorization : An individual differences approach. *Journal of Experimental Psychology : Human Perception and Performance*, 43(9), 1594-1611.

[2] 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, 1246.

[3] Flege, J. E., & Bohn, O. S. (2021). The revised speech learning model (SLM-r). *Second language speech learning: Theoretical and empirical progress*, 3-83.

[4] Best, C. T., & Tyler, M. D. (2007). Nonnative and second-language speech perception. In O.S. Bohn & M. J. Munro (Eds.), *Language Experience in Second Language Speech Learning: In honor of James Emil Flege* (pp. 31-52). John Benjamins Publishing Company.

[5] Francis, A. L., & Nusbaum, H.C. (2002). Selective attention and the acquisition of new phonetic categories. *Journal of Experimental Psychology : Human Perception and Performance*, 28(2), 349. \

[6] Apfelbaum, K. S., Kutlu, E., McMurray, B., & Kapnoula, E. C. (2022). Don't force it ! Gradient speech categorization calls for continuous categorization tasks. *The Journal of the Acoustical Society of America*, 152(6), 3728-3745.

[7] McMurray, B. (2017). *Nonlinear curvefitting for Psycholinguistics* (Version 33). Retrieved from https://osf.io/4atgv/