# L1 Category Precision Hypothesis and L2-L1 Perceptual Mapping:
## Korean Learners' English Vowels

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The revised Speech Learning Model [1] (SLM-r) hypothesizes that learners with more precisely defined categories in their native language (L1) are more adept at acquiring sounds in a second language (L2). However, due to the recency of this hypothesis, studies testing this hypothesis are still scarce. Therefore, we conducted a corpus study to investigate whether this hypothesis holds with empirical data. In testing this hypothesis, we considered the perceptual mapping patterns between L1 and L2 categories, which account much for L2 learners' production and perception patterns [2].

From the corpus comprising recordings of 30 native Korean speakers' reading and retelling *The North Wind and The Sun* in both Korean and English [3], we computed L1 compactness scores (L1CS) for vowels, operationalized as the ellipses' areas of each vowel category in F1/F2 space. Additionally, we calculated comparable scores for 20 native English vowels from the ALLSSTAR corpus [4]. Subsequently, we obtained each Korean participant's accuracy score (L2DS) for English vowels, operationalized as the Mahalanobis distance between their vowel production and that of native English speakers in F1/F2 space [5].

A mixed-effects model was employed to examine the impact of L1 category precision and L2-L1 vowel pairs on L2 production accuracy. The model incorporated participants' L1CS and vowel pairs (/a/-/ɑ/, /æ/-/æ/, /ɛ/-/æ/, /i/-/i/, /ɪ/-/i/, /ɔ/-/ə/, /u/-/u/, /ʊ/-/u/, /ʌ/-/ə/) as predictors, with a by-subject intercept. Vowel pairs were configured according to previous research [2] on the perceptual mapping between Korean and English vowels among native Koreans with less than six years of Length of Residence (LOR) in the United States.

The analysis revealed a significant effect of L1CS on L2DS ($\beta = 0.129$, $SE = 0.048$, $t(473.37) = 2.670$, $p < .01$), indicating that an increase in L1CS corresponded to an increase in L2DS. In other words, accuracies for English vowels were well predicted by the L1CS, indicating that greater variability in L1 production resulted in less accurate L2 production. Additionally, there was a significant effect of vowel pairs on L2 production accuracy; specifically pairs such as /i-i/, /u-u/, /ɔ-ə/, and /ɪ-i/ exhibited significant differences in L2DS compared to the grand mean values (see Table 1 for details). L2DSs for the /i-i/ and /u-u/ pairs were shorter than the grand mean (i.e., more accurate), whereas those for /i-ɪ/ and /ɔ-ə/ were longer (i.e., less accurate). These results seem to be related to the strength of the mapping between L2-L1 categories. According to [2], the former pairs demonstrate a strong mapping between the L2-L1 categories, as evidenced by high L1-labeling proportions to L2 categories accompanied by high goodness ratings, while the latter pairs do not exhibit such a strong mapping relationship.

Taken together, our findings support the use of individual traits observed in learners' L1 production as reliable predictors of their aptitude in acquiring L2 speech sounds. Additionally, our results shed light on the intricate interplay between individual-specific category mapping between L1 and L2 and the L1 category precision hypothesis.

**References**
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Table 1. The coefficient table from the mixed effect model in the study

| term | estimate | std.error | statistic | df | p.value | sig. |
|---|---|---|---|---|---|---|
| **(Intercept)** | 0.241 | 0.214 | 1.124 | 426.10 | 0.262 | |
| **L1CS** | 0.129 | 0.048 | 2.670 | 473.37 | 0.008 | ** |
| **/a-ɑ/** | -0.122 | 0.077 | -1.584 | 478.24 | 0.114 | |
| **/æ-æ/** | 0.012 | 0.076 | 0.160 | 482.22 | 0.873 | |
| **/ɛ-æ/** | -0.136 | 0.078 | -1.738 | 482.36 | 0.083 | |
| **/i/-/i/** | -0.227 | 0.073 | -3.125 | 470.08 | 0.002 | ** |
| **/ɪ/-/i/** | 0.573 | 0.072 | 7.991 | 469.90 | 0.000 | *** |
| **/ɔ/-/ə/** | 0.258 | 0.072 | 3.607 | 470.20 | 0.000 | *** |
| **/u/-/u/** | -0.453 | 0.080 | -5.633 | 484.41 | 0.000 | *** |
| **/ʊ/-/u/** | -0.037 | 0.087 | -0.427 | 485.54 | 0.669 | |

Note 1: The data was log-transformed due to the normality of residuals.
Note 2: To see the comparisons to the mean values of the overall data, the data was sum-coded.
Note 3: $p < .001$ ***; .01 **; .05 *
Note 4: L1CS indicates 'L1 compactness scores', and each vowel pair indicates 'L2-L1 mapping pair.'