



# A comparative acoustic analysis of Korean vowels by native and non-native speakers

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## 1. Background

Adult second language (L2) learners have difficulties acquiring non-native vowels in a target language.

- **Contrastive Analysis Hypothesis (CAH, Eckman 2004)**  
Identical phonemes in both L1 and L2 are believed to not pose problems, whereas new phonemes, which do not exist in L1, would cause errors.
- **Speech Learning Model (SLM, Flege 1995, 1996)**  
L2 learners have more difficulty in acquiring an L2 sound that is similar to a sound of their native language, while new phonemes present fewer problem for the learners.

## 2. Goals

- To present acoustic vowel characteristics of three languages (Korean, English, Mandarin) with different vowel inventory systems.

Korean	Mandarin	English
7-8 vowels	5 vowels	11 vowels
/a, (ɛ), e, i, o, u, ɨ, ʌ /	/i, y, ʏ, u, a /	/i, ɪ, æ, e, ε, a, ʌ, ɔ, o, ɔ, u /

- To compare acoustic characteristics of Korean vowels produced by native Korean speakers with those produced by Mandarin and English learners of Korean and to predict which Korean vowels are relatively difficulty or easy to produce.

## 3. Questions & Hypotheses

- **Research question:** Does L1-L2 acoustic relationship influence non-native vowel production?
- **Hypothesis 1 (Based on CAH)**  
The higher the degree of acoustic similarity between L1 (Korean) and L2 vowels (Mandarin, English), the easier it is for adult learners of Korean to accurately produce Korean vowels.
- **Hypothesis 2 (Based on SLM)**  
Late learners of Korean have more difficulty in producing Korean vowels which are similar to sounds of their L1, while new Korean vowels which do not exist in their L1 present fewer problems for the learners.

## 4. Methodology

### Experiment 1: A comparative acoustic study of Korean, English and Mandarin vowels by native speakers

- **Participants:** 68 female speakers  
37 Mandarin, 23 English, 8 Korean native speakers (mean age =22 years old)
- **Stimuli:** 7 Korean vowels in the /hVda/ context  
5 Mandarin vowels in the /hVdɑ/ context (Tone 1)  
11 English vowels in the /hVd/ context.
- **Procedure:** Participants were asked to read words, including target vowels, three times in isolation.
- **Acoustic measurements:** Formant frequencies (F1 and F2) of vowels (522 tokens for English vowels, 472 tokens for Mandarin vowels and 146 tokens for Korean vowels) were extracted and analyzed in Praat (Boersma & Weenink 2011).

### Experiment 2: Production of Korean vowels by native speakers of Korean and non-native speakers

- **Participants:** 68 female speakers  
**Target group:** 37 Mandarin- and 23 English- speaking learners of Korean  
**Comparison group:** 8 native Korean speakers
- **Stimuli:** 7 Korean vowels in the context of /hVda/
- **Procedure:** The data collection procedure was the same as in Experiment 1.
- **Acoustic measurements:** 14,288 tokens (7 stimuli \* 3 repetitions \* 68 speakers) were analyzed acoustically (F1 and F2) in Praat.

## 5. Results of Experiment 1: A comparative acoustic of Korean, English and Mandarin vowels by native speakers

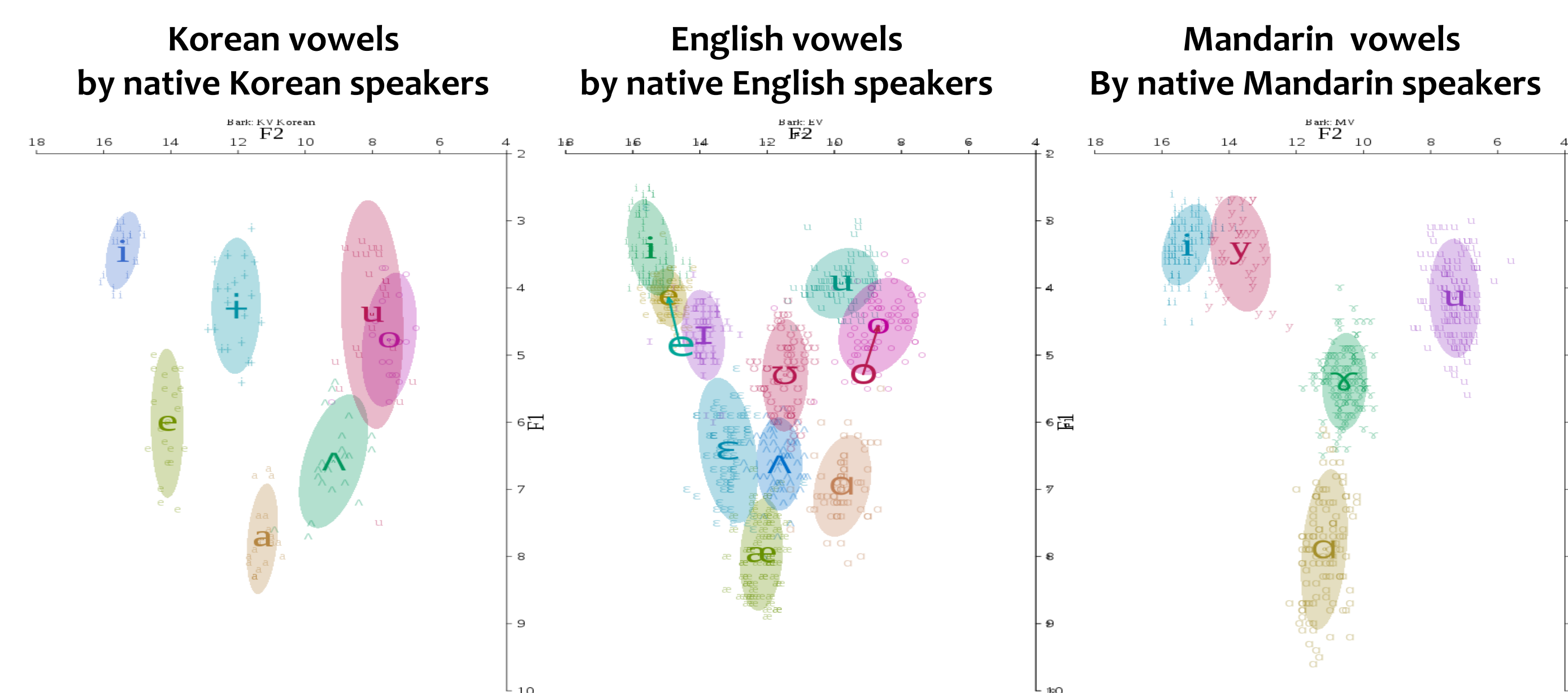


Figure 1. L1 vowel distribution produced by native female speakers of Korean, English and Mandarin

- All monophthongs are clearly separated from each other in English and Mandarin; however, Korean [u] and [o] overlap substantially.
- The finding confirms that Korean vowels /u/ and /o/ are merged in young Korean speaker's speech (Chae 1999, Kim et al 2006, Han & Kang 2013, Y. Kang 2015).

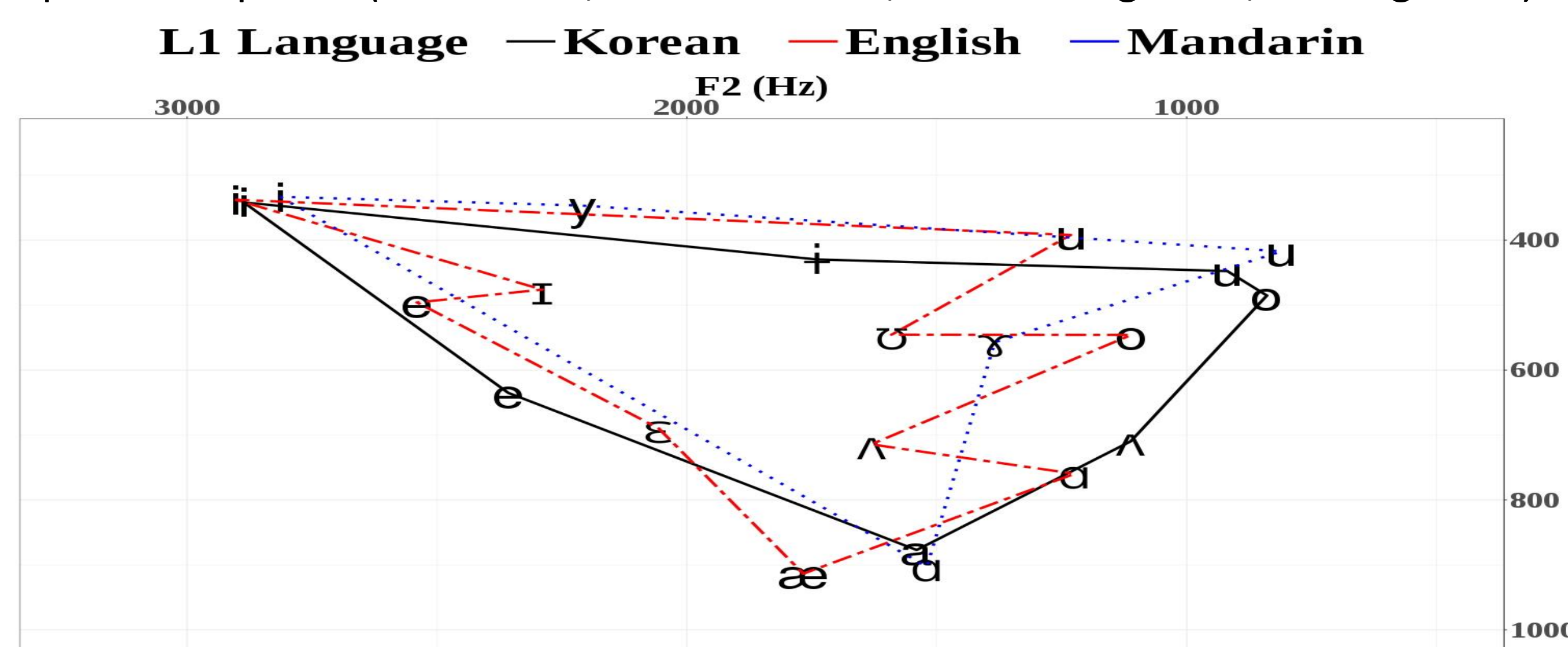


Figure 2. Average F1 and F2 values (Hz) of Korean vowels (black), English vowels (red) and Mandarin vowels (blue) produced by Korean, English and Mandarin female native speakers

#### Comparison of Korean and Mandarin vowels

- Korean [i] and [a] are acoustically most similar to Mandarin /i/ and /a/ respectively.
- Both Korean [o] and [u] are very close to Mandarin [u].
- There are no Mandarin vowels corresponding to Korean [e, ʌ, ɨ], and no Korean vowels corresponding to Mandarin [ɻ, y].

#### Comparison of Korean and English vowels

- Korean [i] is acoustically most similar to English [i].
- Korean [e] is located between English [e] and [æ].
- English [u] is between Korean [ɨ] and [u].

## 6. Results of Experiment 2: Production of Korean vowels by native and non-native speakers

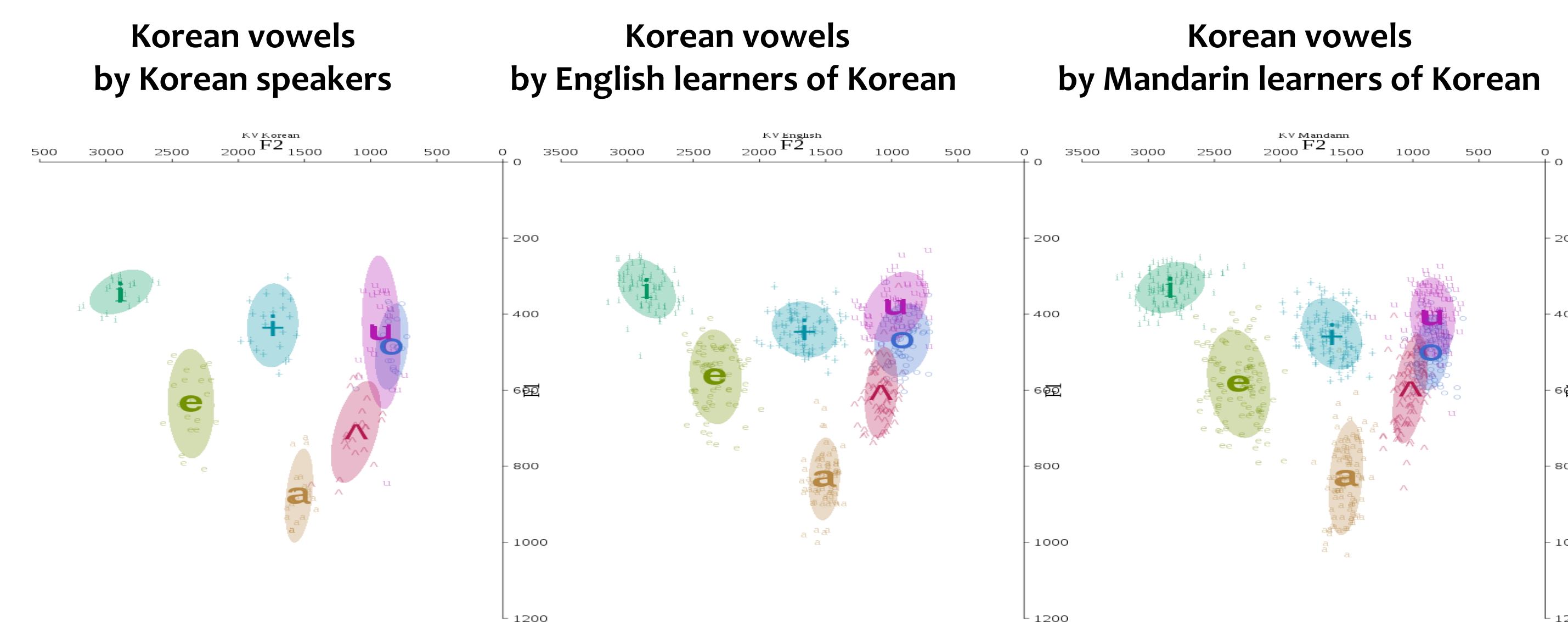


Figure 3. Comparison of Korean vowels produced by native speakers of Korean, English and Mandarin

- Both Mandarin and English learners of Korean show similar vowel production patterns for [i, e, a, ɨ] as Korean native speakers do, although [ɨ] is not present in their native languages.
- Young female Korean speakers have a high degree of merging with [u] and [o] while adult learners of Korean show that the three vowels [u, o, ʌ] are slightly overlapped each other.

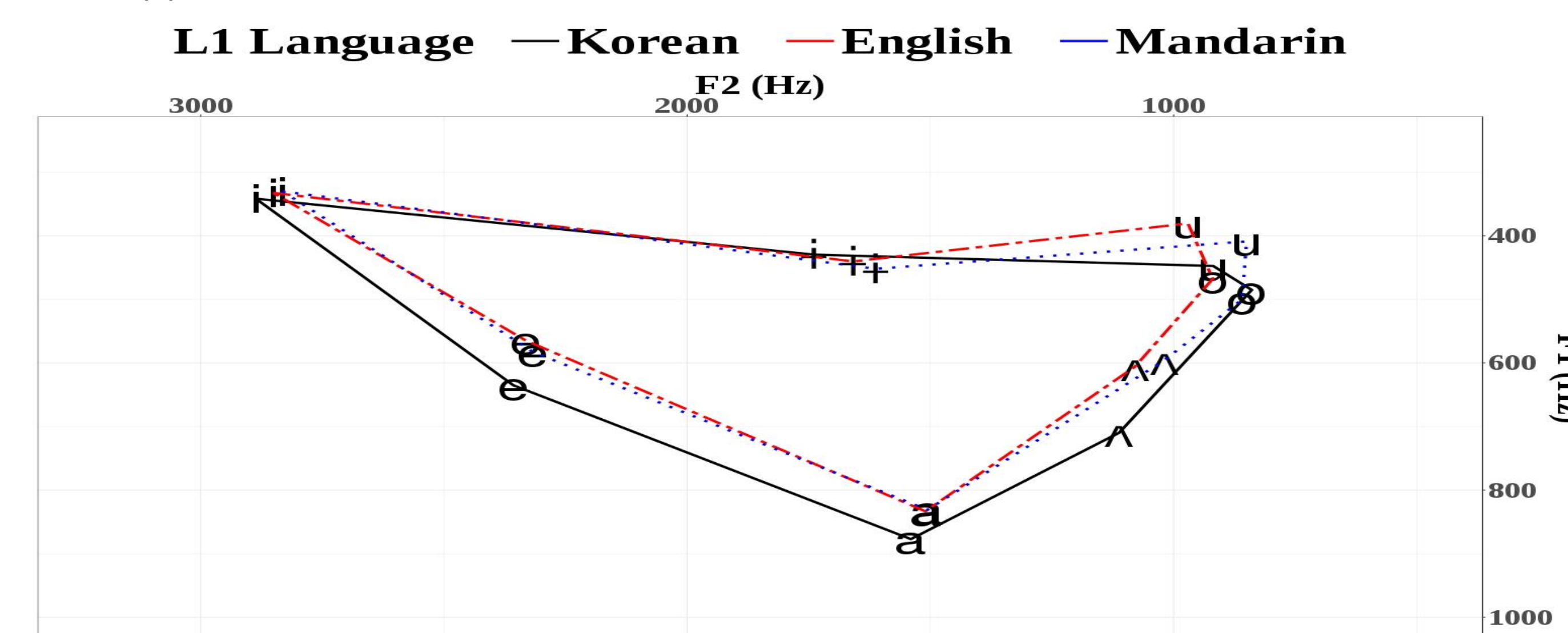


Figure 4. Average F1 and F2 values (Hz) of Korean vowels produced by native speakers of Korean (black), English (red) and Mandarin (blue)

- Korean [a, e, i] produced by English and Mandarin speakers have similar F2 values to L1 Korean.
- Korean [o, u, ʌ] produced by English and Mandarin speakers have relatively lower F1 values than L1 Korean.

## 7. Implications and Discussion

- Adult English- and Mandarin-speaking learners of Korean successfully approximate Korean [ɨ], although it does not exist in their native languages. It reveals that new L2 phonemes are easier to acquire, as SLM posits.
- There would be no difficulty for English and Mandarin learners of Korean to acquire Korean [i], since Korean [i] is acoustically most similar to both English and Mandarin [i].
- Due to the small acoustic distance between Korean [o] and [u], Mandarin [u] can correspond to both of them, which would lead to confusion for Mandarin speakers when discriminating these two vowels.
- English /u/ appears to be acoustically intermediate between Korean [ɨ] and [u]. It can be predicted that English learners of Korean have difficulty distinguishing the Korean [u]-[ɨ] contrast.