

Summary

- We investigated perceptual learning of the Korean three-way plosive contrast (lenis, aspirated, and fortis) by native English speakers.
- Unlike VOT continua in other languages, this contrast is distinguished by complex trading relations between VOT and pitch.
- Participants learned a vocabulary of 18 Korean pseudowords comprised of six minimal triplets, e.g.: 반 /pan/ 판 /p^han/ 뽀판 /p⁺an/
- Fortis stops most closely resembled listeners' existing English voiced stop categories: /p/ ≈ /b/ /t/ ≈ /d/ /k/ ≈ /g/
- Lenis and aspirated stops were harder to distinguish because both were encompassed by listeners' existing English voiceless stop categories.
- Low proficiency learners acquired the fortis stop, but did not differentiate the lenis and aspirated stops.
- High proficiency learners acquired the fortis stops, and exhibited progress at distinguishing the lenis and aspirated stops.
- Both groups acquired these contrasts most accurately for bilabial stops and least accurately for alveolar stops.

Methods

Participants

- N = 37 English monolinguals (12 M, 25 F)
- Mean age 23.1 years (18-33, sd=3.7)
- No prior experience with Korean

Stimuli

- 18 Korean pseudowords in 6 triplets
- Produced by 4 native Korean speakers (2M, 2F); (all English bilinguals from Seoul)
- Each word was associated with a distinct photograph of an object

Training Procedures

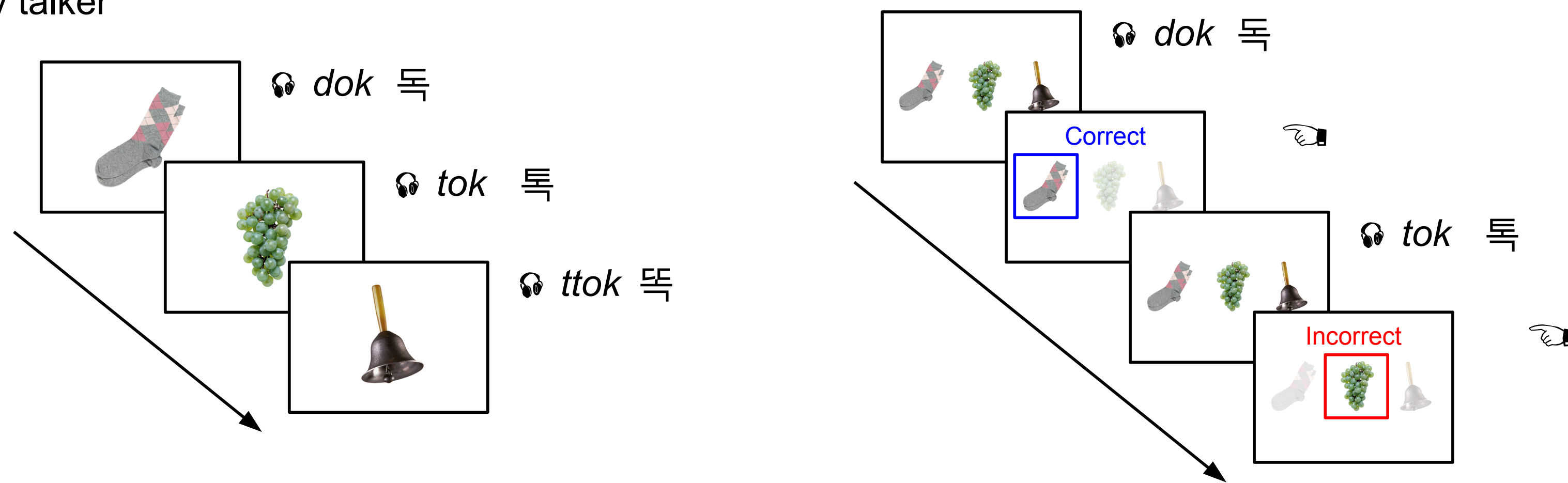
- 4 computer-based training sessions:
- Daily familiarization of items in minimal triplets, including active practice with feedback
- Daily attainment test with no feedback on the entire vocabulary (18 words × 4 talkers = 72 trials)
- 60 day follow-up (attainment test only)

Familiarization

24 trials / minimal triplet
(3 words × 2 repetitions × 4 talkers)
Blocked by talker

Active Practice

24 trials / minimal triplet
Corrective feedback provided



Training Vocabulary

| Hangul | Rev.Rom. | IPA | Target |
|--------|----------|----------------------|----------|
| 반 | ban | /pan/ | seashell |
| 뽀판 | ppan | /p ^h an/ | cow |
| 판 | pan | /p ^h an/ | hammer |
| 빔 | bim | /pim/ | lamp |
| 뽀빔 | ppim | /pim/ | bus |
| 빔 | pim | /p ^h im/ | desk |
| 독 | dok | /tokˀ/ | sock |
| 톡 | ttok | /tokˀ/ | bell |
| 톡 | tok | /t ^h okˀ/ | grapes |
| 덥 | deop | /təpˀ/ | box |
| 뽀덥 | tteop | /təpˀ/ | brush |
| 텃 | teop | /t ^h əpˀ/ | goldfish |
| 갇 | gaet | /kətˀ/ | parrot |
| 갇 | kkaet | /kətˀ/ | car |
| 캣 | kaet | /k ^h ətˀ/ | camera |
| 궁 | gung | /kuŋ/ | hat |
| 궁 | kkung | /k ^h uŋ/ | chair |
| 궁 | kung | /k ^h uŋ/ | fork |

Acquisition of the complex three-way Korean plosive contrast by native English speakers

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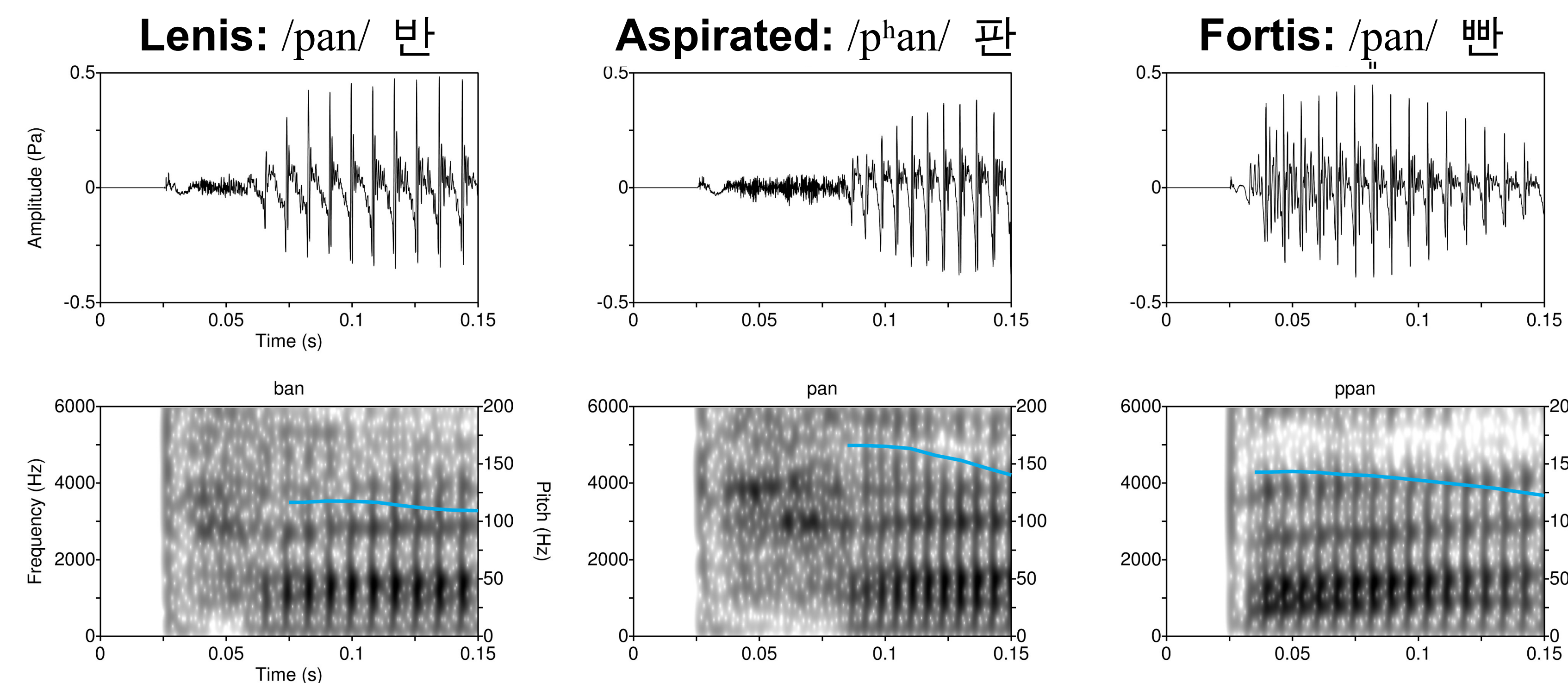
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Acoustic Phonetics

Korean Plosive Categories

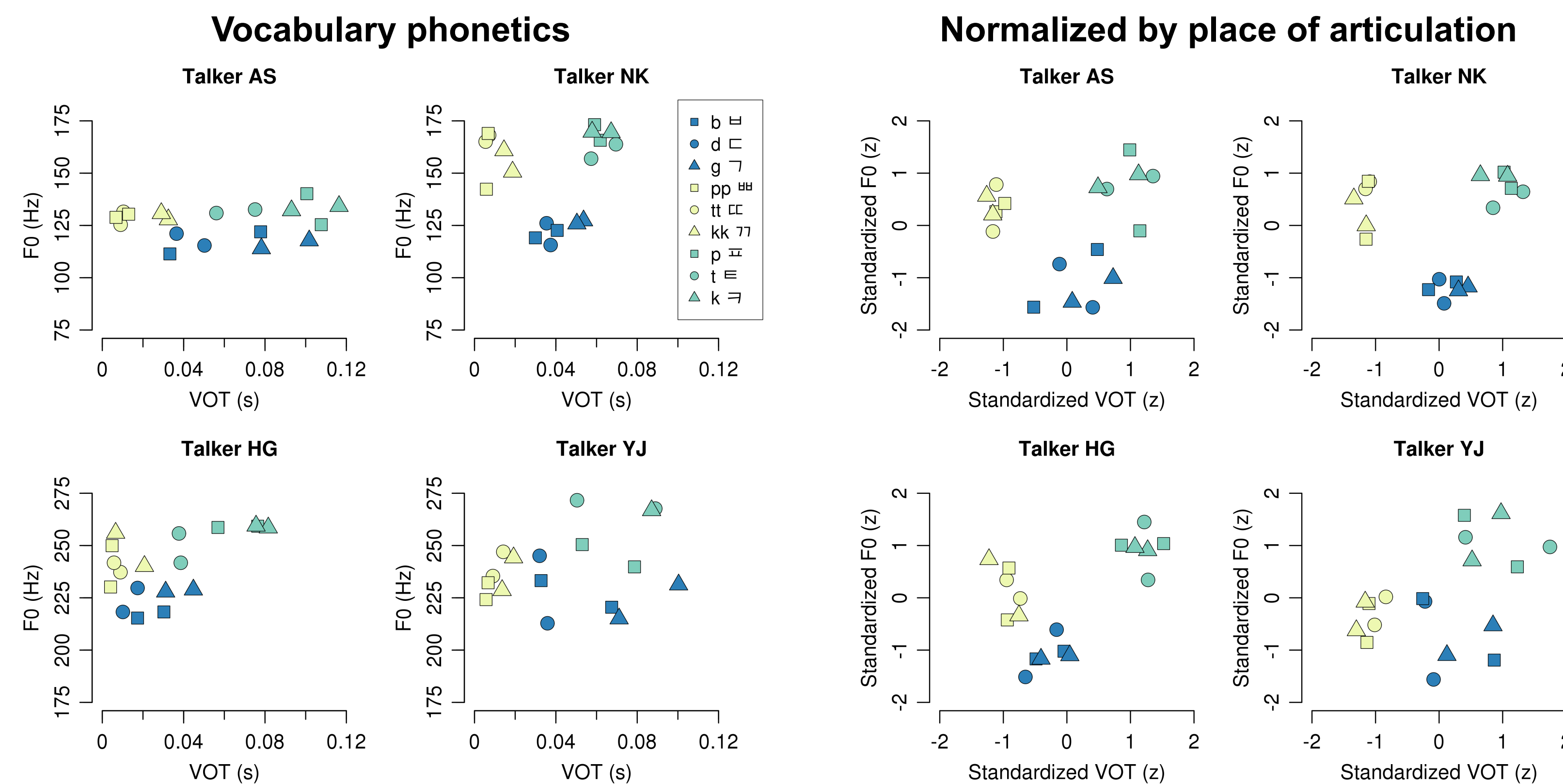
Stop consonants in Korean are distinguished by a 3-way laryngeal contrast. This contrast involves trading relations between voice-onset time (VOT) and onset F0.

- Lenis** stops have a positive VOT, aspiration, and low onset F0.
 - IPA: /p/ /t/ /k/ Revised Romanization: “b” “d” “g” Hangul: ㅂ ㄷ ㄱ
- Aspirated** stops have a long positive VOT, aspiration, and a modal onset F0.
 - IPA: /p^h/ /t^h/ /k^h/ Revised Romanization: “p” “t” “k” Hangul: ㅍ ㅌ ㅋ
- Fortis** stops have a short positive VOT, no aspiration, and a modal onset F0.
 - IPA: /p/ /t/ /k/ Revised Romanization: “pp” “tt” “kk” Hangul: ㅃ ㅆ ㄲ



Training Vocabulary Phonetics

- The acoustic-phonetics of our training vocabulary were consistent with the ranges reported in the literature.
 - Onset F0 differed across the 3 laryngeal contrasts: $F_{2,6} = 14.8$; $p < 0.005$, $\eta^2 = 0.061$
 - VOT differed across the 3 laryngeal contrasts: $F_{2,6} = 62.6$; $p < 0.0001$, $\eta^2 = 0.83$
 - VOT also significantly related to place of articulation $F_{2,6} = 14.0$; $p < 0.006$, $\eta^2 = 0.46$



Vocabulary Learning

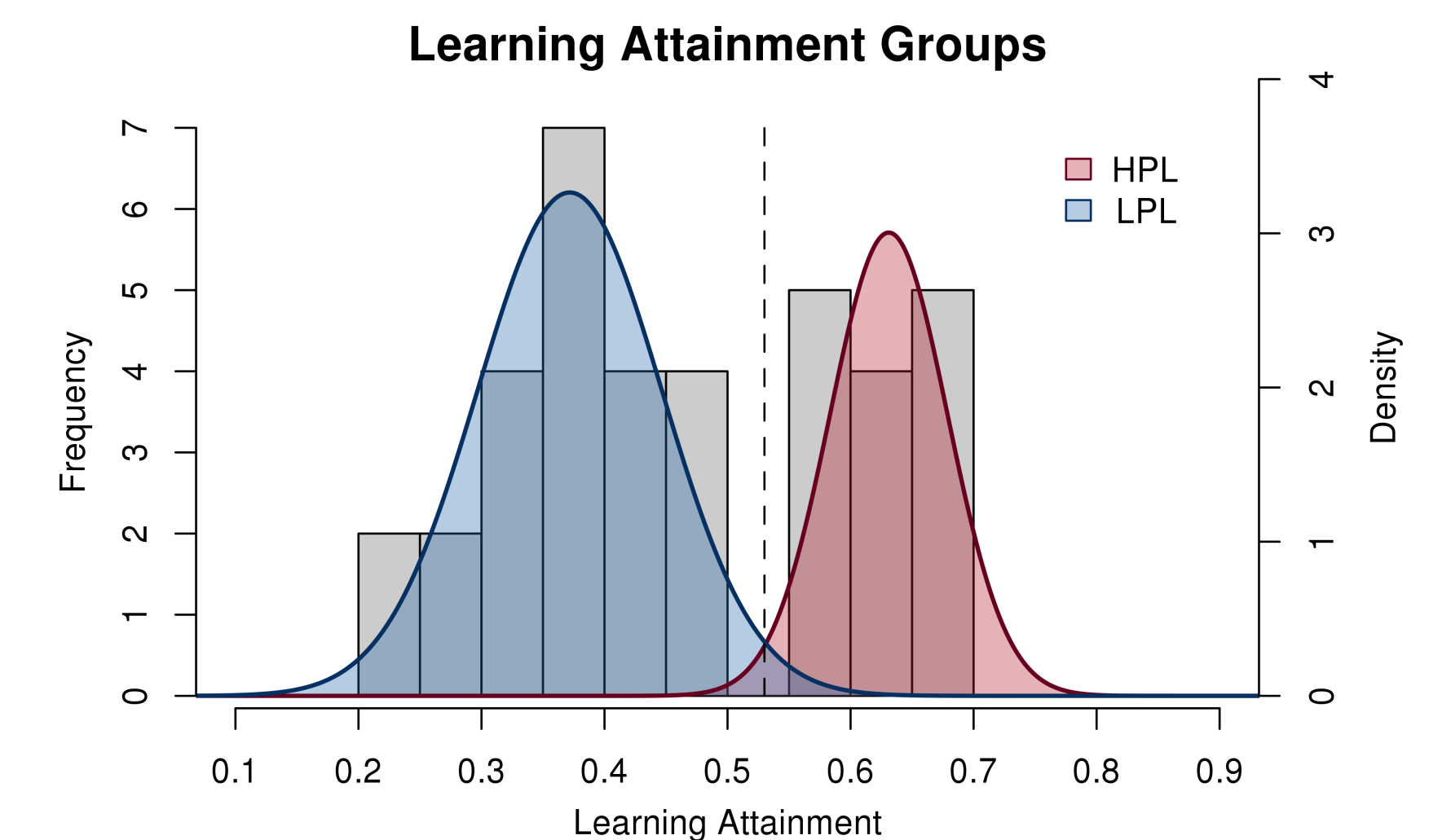
Learning Outcome

All learners improved after training, but individual attainment was highly variable:

- Attainment range: 22% - 69%

Mixture-model analysis of day 4 learning attainment suggests 2 learner groups:

- High proficiency learners (HPL)**
 - N=14, mean vocabulary acquisition: 63% ± 5%
- Low proficiency learners (LPL)**
 - N=23, mean vocabulary acquisition: 37% ± 7%

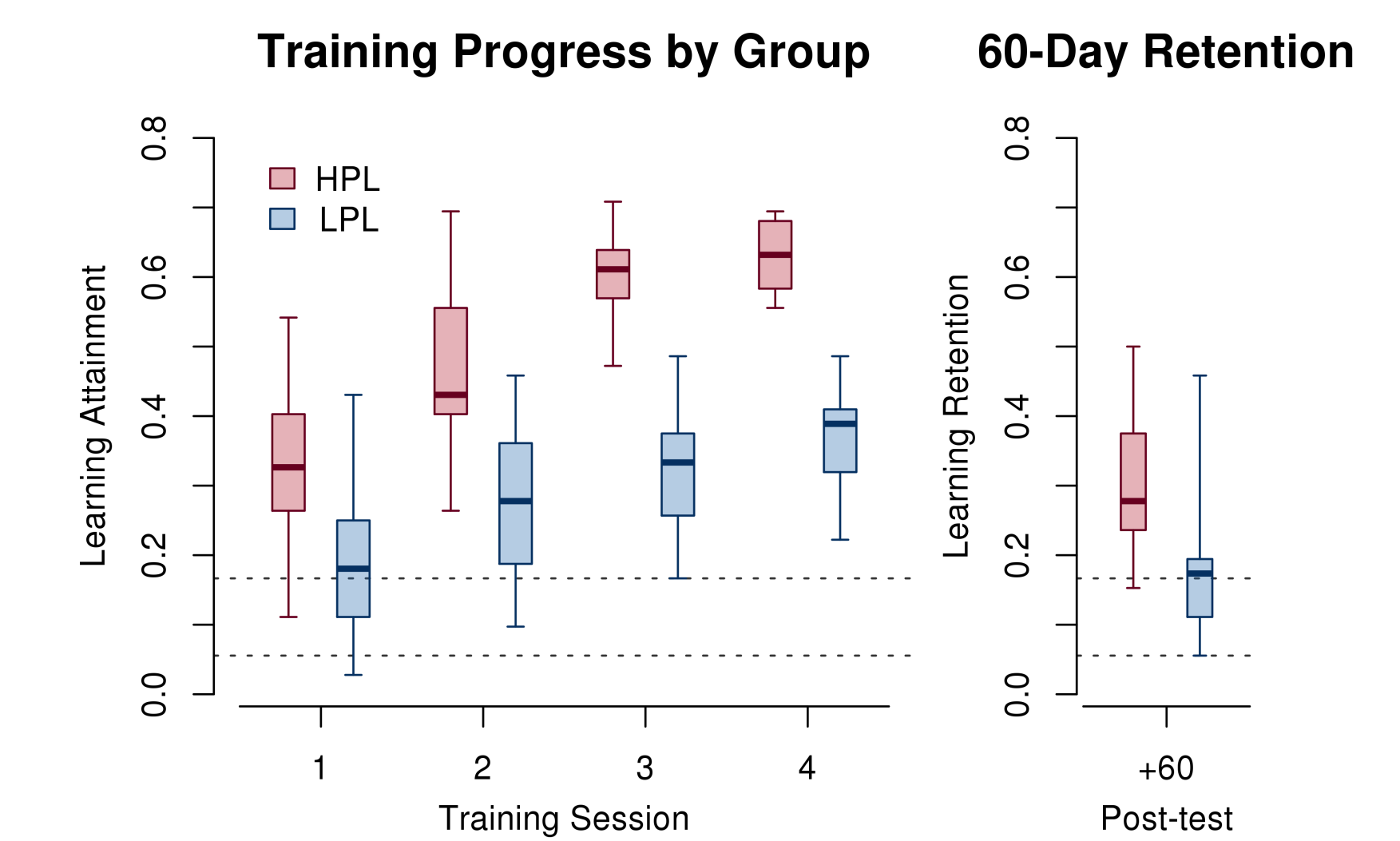


Patterns of Acquisition

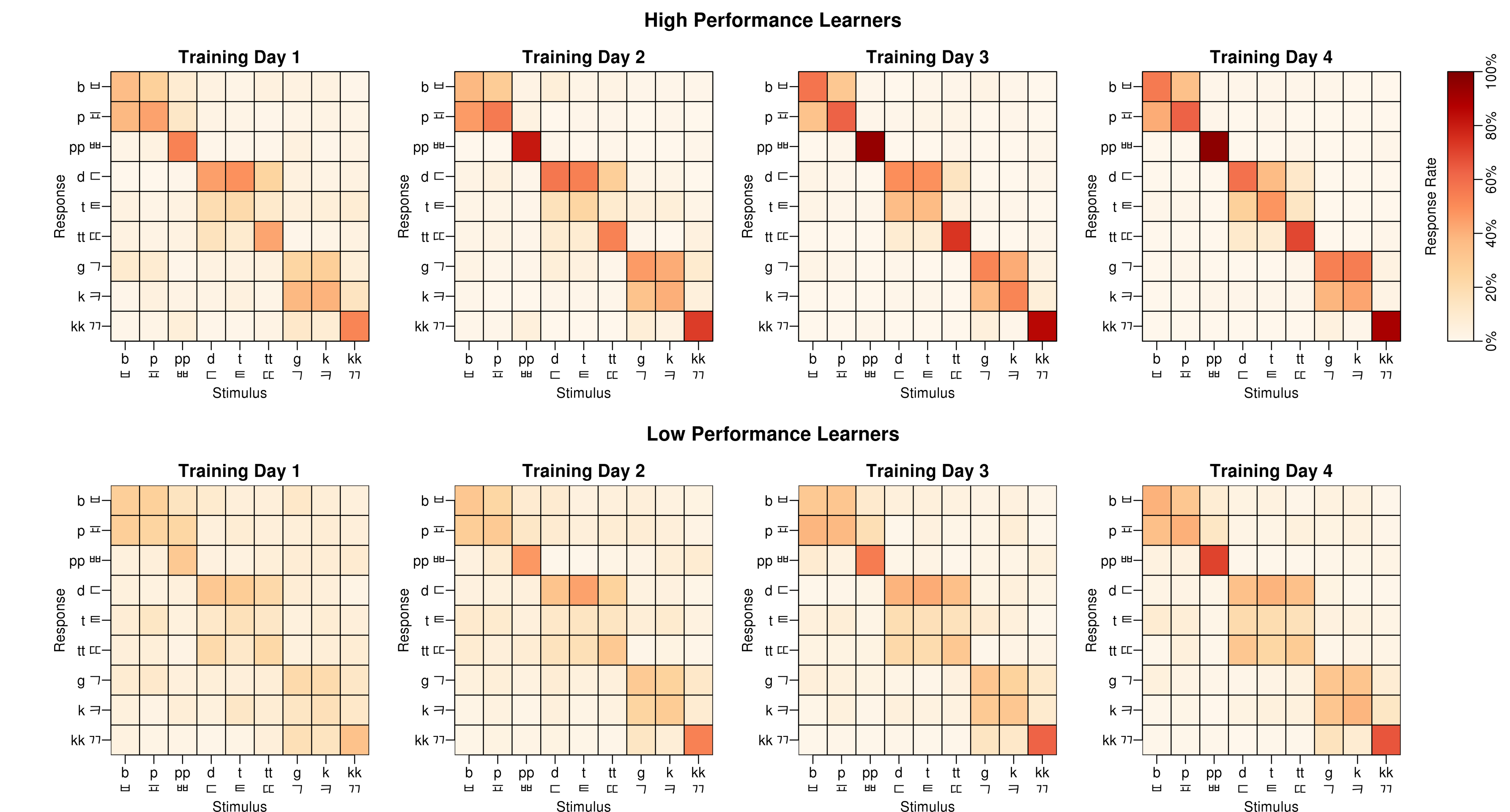
HPL: fortis (83% ± 12%); lenis (55% ± 12%); aspirated (51% ± 11%)

LPL: fortis (50% ± 17%); lenis (32% ± 11%); aspirated (30% ± 15%)

Both groups learned bilabial stops best (HPL: 70%; LPL: 44%); then velar (HPL: 63%; LPL: 44%); and both found alveolar (HPL: 57%; LPL: 22%) most challenging.



Identification Matrix (onset consonant confusions)



We thank Nayeon Kim, Zhenghan Qi, Hyowon Gweon, Nathaniel Kim, Yea Jin Kaeser-Woo, Abraham Shin, and Arim Choi Perrachione.

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