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

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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 /pʰan/ 빤 /p͈an/
- Fortis stops most closely resembled listeners' existing English voiced stop categories: /p͈/ ≈ /b/ /t͈/ ≈ /d/ /k͈/ ≈ /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

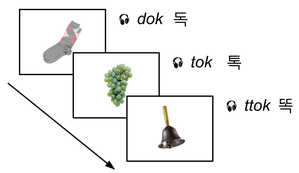
Training Procedures

- 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)

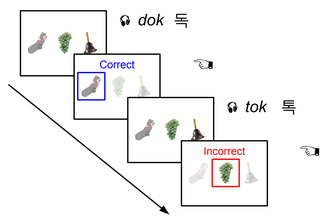
Training Vocabulary

Hangul	Rev.Rom.	IPA	Target
반	ban	/pan/	seashell
빤	ppan	/p͈an/	cow
판	pan	/pʰan/	hammer
빔	bim	/pim/	lamp
삠	ppim	/p͈im/	bus
핌	pim	/pʰim/	desk
독	dok	/tokˀ/	sock
똑	ttok	/t͈okˀ/	bell
톡	tok	/tʰokˀ/	grapes
덥	deop	/tʌpˀ/	box
떱	tteop	/t͈ʌpˀ/	brush
텁	teop	/tʰʌpˀ/	goldfish
갯	gaet	/kɛtˀ/	parrot
깻	kkaet	/k͈ɛtˀ/	car
캣	kaet	/kʰɛtˀ/	camera
궁	gung	/kuŋ/	hat
꿍	kkung	/k͈uŋ/	chair
쿵	kung	/kʰuŋ/	fork

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



Active Practice
24 trials / minimal triplet
Corrective feedback provided

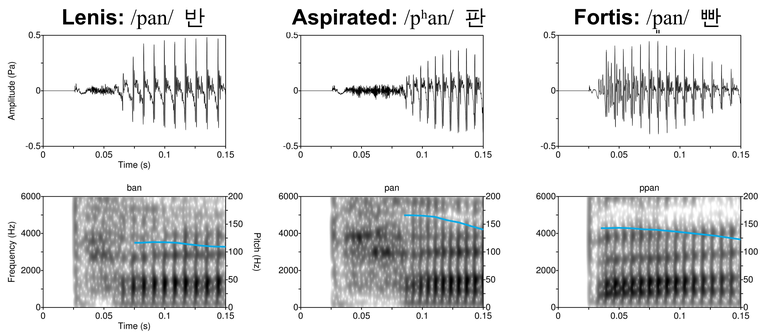


Acoustic Phonetics

Korean Plosive Categories

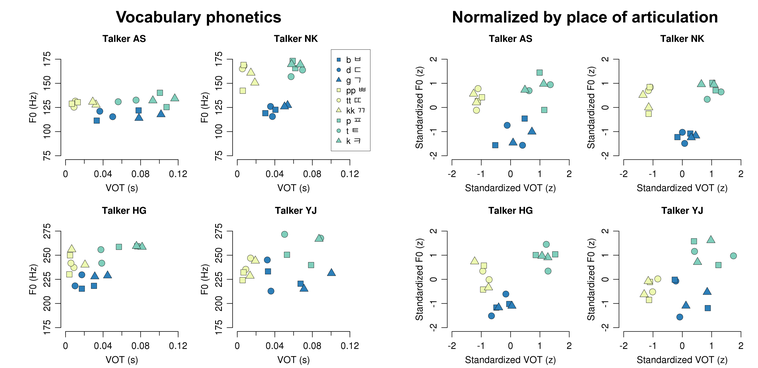
Stop consonants in Korean are distinguished by a 3-way laryngeal contrast. This contrast involves trading relations between voice-onset time (VOT) and onset F0.

- **Lenis** stops have a positive VOT, aspiration, and low onset F0.
  - *IPA:* /p͈/ /t͈/ /k͈/ *Revised Romanization:* "b" "d" "g" *Hangul:* ㅂ ㄷ ㄱ
- **Aspirated** stops have a long positive VOT, aspiration, and a modal onset F0.
  - *IPA:* /pʰ/ /tʰ/ /kʰ/ *Revised Romanization:* "p" "t" "k" *Hangul:* ㅍ ㅌ ㅋ
- **Fortis** stops have a short positive VOT, no aspiration, and a modal onset F0.
  - *IPA:* /p͈/ /t͈/ /k͈/ *Revised Romanization:* "pp" "tt" "kk" *Hangul:* ㅃ ㄸ 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

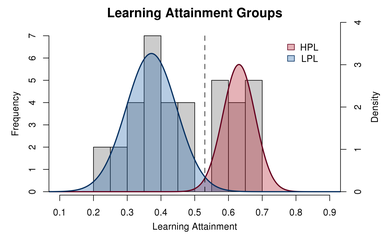
Learning Outcome

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%

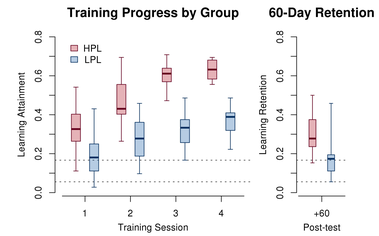


Patterns of Acquisition

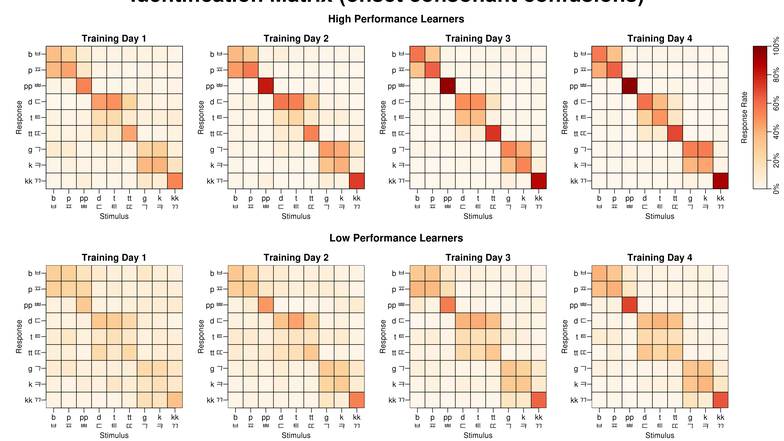
HPL: fortis (83% ± 12%); lenis (55% ± 12%); aspirated (51% ± 11%)

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)



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