Distributional learning of non-native contrasts in speakers of two languages, English and Korean

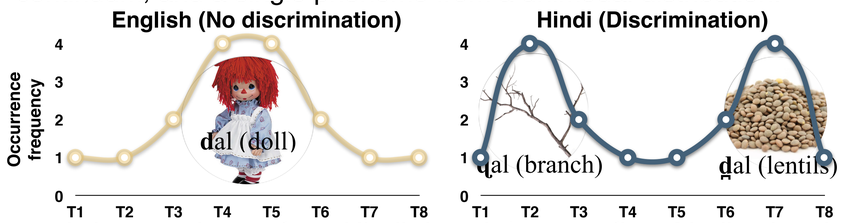
Mihye Choi[1], Yoonsung Kim[2], Youngon Choi[2], Mohinish Shukla[1]

[1]Baby Lab, Psychology Dept., University of Massachusetts Boston, MA, USA

[2]Child Development Lab, Psychology Dept., Chung-Ang University, Seoul, Korea

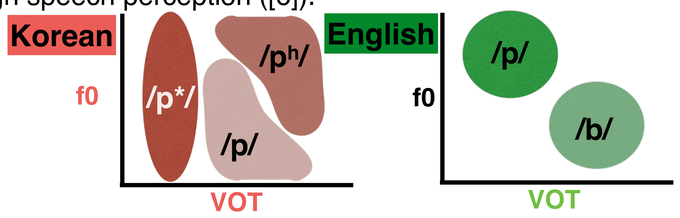
INTRODUCTION & CURRENT STUDY

- Sensitivity to distributional properties of phonetic tokens, distributional learning, has been hypothesized to induce appropriate underlying phonemic categories ([1],[2]), such that listeners infer two underlying phonemes from a bimodal distribution of tokens along an acoustic continuum, and a single phoneme from a unimodal distribution.



*x axis is a continuum from Hindi dental **ḍ to** retroflex **ḍ** indicating the variability around the pronunciation of "d". Examples are from [3]*

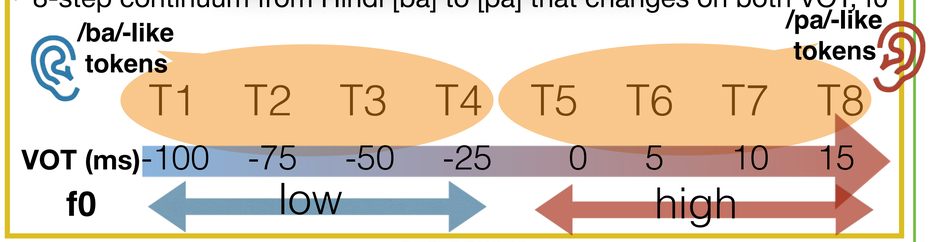
- Separately, Korean and American English speakers differ in their use of voice-onset time (VOT) and fundamental frequency (f0) to classify stop consonants ([4],[5]) and the native speech experience can affect foreign speech perception ([6]).



- **Experiment 1**: examined how Korean and English speakers discriminate a Hindi continuum that changes on both VOT and f0.
  - Possibility 1: Koreans would be worse than English speakers to discriminate the continuum
    - Having 3 different categories may cause more interference (perceptual assimilation model, [6]).
  - Possibility 2: Koreans would be better than English speakers
    - Attending multiple cues (VOT, f0) can be advantageous
- **Experiment 2**: tested if the group difference in Experiment 1 leads Korean speakers to have sensitivity to distributional learning of the non-native Hindi contrast.

AUDITORY CONTINUUM

- 8-step continuum from Hindi [ba] to [pa] that changes on both VOT, f0



REFERENCES

(1) Maye, J., Werker, J. F., & Gerken, L. (2002). Infant sensitivity to distributional information can affect phonetic discrimination. *Cognition*, *82*(3), B101-B111.
(2) Maye, J., & Gerken, L. (2001). Learning phonemes: How far can the input take us. In *Proceedings of the 25th annual Boston University conference on language development* (Vol. 1, p. 480). Somerville, MA: Cascadilla Press.
(3) Werker, J. F., Yeung, H. H., & Yoshida, K. A. (2012). How do infants become experts at native-speech perception?. *Current Directions in Psychological Science*, *21*(4), 221-226.
(4) Lisker, L., & Abramson, A. S. (1964). A cross-language study of voicing in initial stops: Acoustical measurements. *Word*, *20*(3), 384-422.
(5) Cho, T., Jun, S. A., & Ladefoged, P. (2002). Acoustic and aerodynamic correlates of Korean stops and fricatives. *Journal of phonetics*, *30*(2), 193-228
(6) Best, C. T., McRoberts, G. W., & Goodell, E. (2001). Discrimination of non-native consonant contrasts varying in perceptual assimilation to the listener's native phonological system. *The Journal of the Acoustical Society of America*, *109*(2), 775-794.

METHODS

EXPERIMENT 1: IDENTIFICATION & DISCRIMINATION TASK

Participants: 23 native Koreans (f=17, age ranged from 18-31) and 23 native English speakers (f=15, age ranged from 19-38)

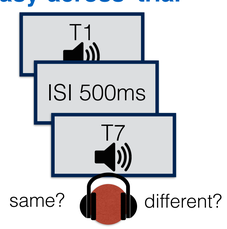
IDENTIFICATION TASK

- **Stimulus presentation:** Each token from continuum was randomly presented (total 160 trials, 4 blocks of 40 trials)
- **task**: two-alternative forced choice

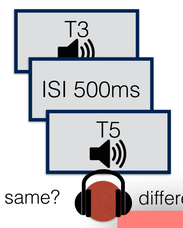
DISCRIMINATION TASK

- **Stimulus presentation** (40 trials of 4 block)
  - Easy across: token 1-7, 2-8
  - Hard across: token 3-5, 4-6
  - Within: token 1-3, 2-4, 5-7, 6-8
- **Task:**

An example of 'easy-across' trial



An example of 'hard-across' trial



EXPERIMENT 2: DISTRIBUTIONAL LEARNING IN KOREAN SPEAKERS

Participants: 32 Korean speakers

- Bimodal condition: n= 16 (f=12, age ranged from 18-28)
- Unimodal condition: n=16 (f=8, age ranged from 19-25)

PRACTICE (10 trials)

- **Stimulus presentation:** 10 pairs of Korean words
  - half the trials were '*same*' trials and the other half was '*different*' trials
- **Task:** Participants judged whether the sound pair heard was same or different by pressing appropriate keys

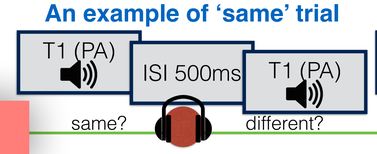
ACQUISITION PHASE (Bimodal vs. Unimodal)

- ***Stimulus presentation:*** the continuum was presented in psuedo-random order in either bimodal or unimodal distribution (16 tokens of 12 blocks, ISI of 500ms)
  - **bimodal**: the 8 tokens on the continuum were presented in a bimodal frequency distribution (similar to *Fig*. 1, right graph)
  - **unimodal**: the same tokens in a unimodal distribution (similar to *Fig*. 1, left)
- **Task**: One filler sound 'ma' was presented per block and participants were asked to press [space bar] when they heard a 'ma' sound

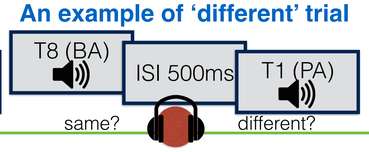
TEST (40 trials)

- **Stimulus presentation :** Only token 1 (T1) and token 8 (T8)
  - '*same*' trial: a pair of T1 or T8, '*different*' trial: a pair of T1 & T8 (or T8 & T1)
- **Task:**

An example of 'same' trial

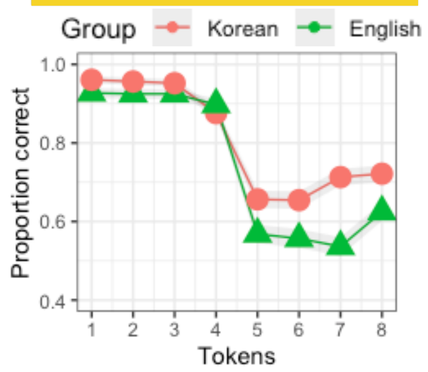


An example of 'different' trial



RESULTS

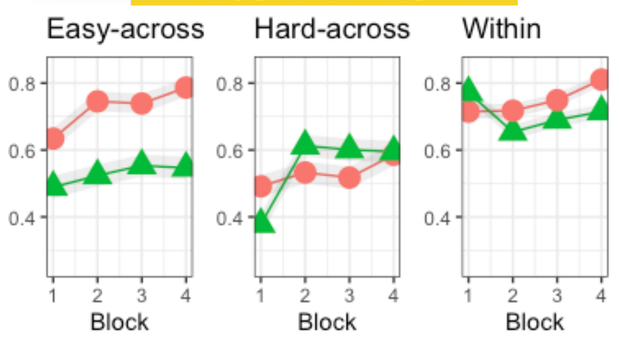
IDENTIFICATION



Identification accuracy

- Significant effects of language group (estimate = -0.43, SE = 0.061, z = -7.131, **p < .001**) and of tokens (estimate = -0.37, SE = 0.015, z = -25.149, **p < .001**)

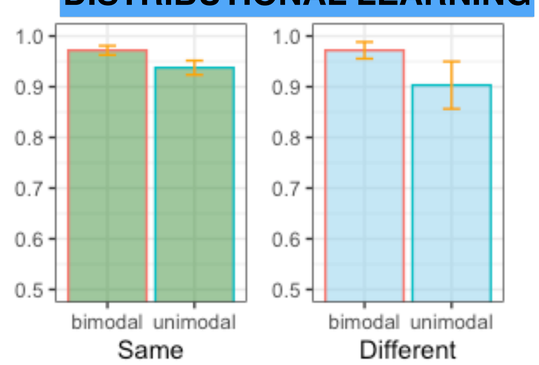
DISCRIMINATION



Discrimination accuracy

- Significant effects of language group (estimate =-.31, SE= .05, z= -6.10, **p < .001**), and block (block 1-3, estimate = .18, SE=.07, z= 2.60, p= .009; block 1-4, estimate = .35, SE=.07, z= 4.96, **p < .001**), and pair type (easy-hard, estimate = -0.37, SE=.07, z= -5.49, **p < .001**; easy-within, estimate= 0.47, SE=0.06, z= 7.63, **p < .001**)

DISTRIBUTIONAL LEARNING



Distributional learning

- *No signifiant differences on same trials between two conditions, but marginally significant different on different trials (p=.07)*

- **In Exp. 1, Koreans discriminated Hindi /ba/ and /pa/ contrast better than English speakers, supporting Possibility 2. And it may lead Korean speaker to be sensitive to distributional learning of non-native contrast in Exp. 2.**
- **Testing English speakers' sensitivity to distributional information will further address if the findings indeed results from the difference of two groups of speakers in their use of phonetic cues.**