Second Language (L2) Phonology: The effects of L1 backgrounds, L2 experience and online perceptual training on the acquisition of L2 sounds

Penn State University

Na-Young Ryu

March 17, 2022

Goals

To examine how **L1 transfer and L2 experience** affects perception of non-native sounds and provide L2 learners with effective **perceptual training programs.**

Experiment 1	Effects of L2 experience on the perception of the Korean three-way laryngeal contrast in stops and affricates by native Mandarin speakers
Experiment 2	Effects of L1 inventory size on the perception of Korean vowels and codas by native English and Mandarin speakers
Experiment 3	Effects of attention on the efficacy of web-based auditory training of Korean vowels and codas by native Mandarin speakers
Experiment 4	Effects of online auditory-only and audiovisual perception training on the perception of Korean vowels by native English-speaking speakers

Background: Acquisition of L2 Phonology

Adult L2 learners often experience difficulty acquiring non-native sounds (Flege 1995, Best et al 1996, Levey & Strange 2002 and many others).

- Japanese learners of English: English /ɹ/-/l/ contrast
  (Miyawaki et al 1975, Mackain et al 1981, Yamada & Tohkura 1992, Iverson et al 2003)

- Korean learners of English: English tense/lax vowel distinction
  (Yang 1992, 1996, Flege et al 1997, Koo 2000)

Theoretical Models in L2 Sound Acquisition

1. Speech Learning Model (SLM, Flege, 1995, 2003)

2. Perceptual Assimilation Model (PAM, Best, 1994, 1995)
& PAM-L2 (Best & Tyler, 2007)

3. Second Language Linguistic Perception model (L2LP, Escudero, 2005, 2007, 2009)

Speech Learning Model (SLM)

- L2 categories are perceived according to cross-language similarity between L1 and L2 sounds.
- Learners' perceptual difficulties can be predicted by whether the relevant sound in their target language is **"identical"**, **"new"** or **"similar"** to their L1 phonetic categories.

Predictions of acquisition difficulty

Identical	→	**Easy to acquire**
New	→	**Establish a new L2 category**
Similar	→	**More difficult to acquire**

Perceptual Assimilation Model – L2 (PAM-L2)

- Listeners assimilate L2 sounds to their native sound categories based on a comparison between L1 and L2 sounds.

Predictions of acquisition difficulty

Single-Category assimilation	➡	**Difficult to perceive**
Two-Category assimilation	➡	**Easy to perceive**

Second language speech perception

- Adult learners often struggle to acquire L2 sounds to a native-like performance level.
- Language-internal and external factors to account for the perceptual difficulty in L2 learning.

Linguistic factors	Non–linguistic factors
• **L1 transfer** (Best 1994, Flege 1995, 2003) • Markedness (Broselow & Xu 2004, Eckman 1997)	• **L2 experience** (Best & Strange 1992, Cebrian 2006) • Average age of L2 acquisition (Hyltenstam & Abrahamsso, 2003) • Length of L2 immersion (Flege, Frieda & Nozawa 1997) • Extent of daily L2 vs. L1 usage (Jia, Aaronson & Wu 2002)

• Experiment 1 •

Effects of L2 experience on the perception of the Korean three-way laryngeal contrast in stops and affricates by native Mandarin speakers

Mandarin vs. Korean stops and affricates

	Mandarin	Korean
	Two-way contrast: aspirated vs. unaspirated	**Three-way contrast:** aspirated vs. lenis vs. tense
Stops	p p^h t t^h k k^h	p p^h p’ t t^h t’ k k^h k’
Affricates	ts ts^h tʂ $tʂ^h$ tɕ $tɕ^h$	tʃ $tʃ^h$ tʃ’

Research question and prediction

Question 1

Are **more experienced Mandarin learners of Korean** more likely to have better identification and discrimination accuracy of the Korean three-way contrast in stops and affricates **than less experienced learners**?

Prediction 1

The greater the Mandarin-speaking learners' Korean language experience, the better their perception accuracy of the Korean three-way contrast in stops and affricates.

Method

- Participants:
  - 44 native Mandarin listeners differing in Korean language experience based on their amount of formal instruction at the University of Toronto.
  - 13 native Korean listeners

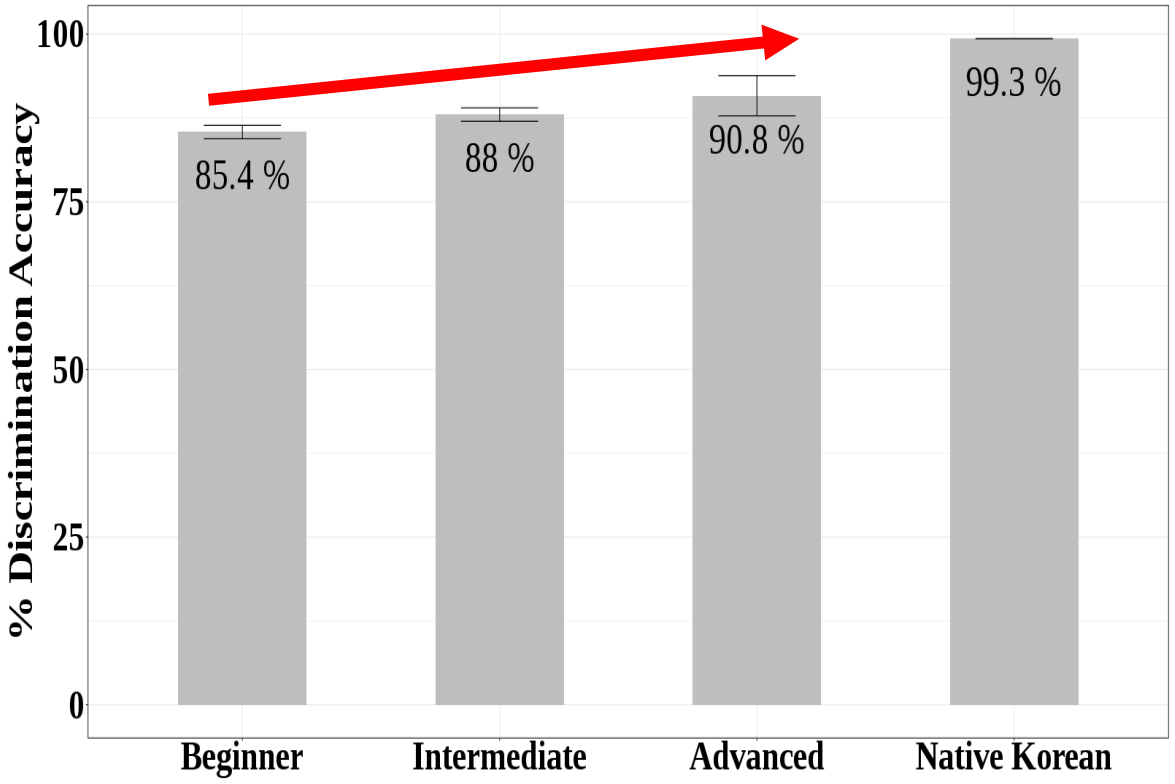
Beginner	Intermediate	Advanced	Native Korean
20	14	10	13

- Perceptual tasks and stimuli:

AX discrimination task	Identification task
16 minimal triplets of real words	16 minimal triplets of real words 16 minimal triplets of nonce words

Results of discrimination & identification task

- Mandarin listeners' ability to discriminate and identify the Koran three-way contrast increases with their Korean language experience.



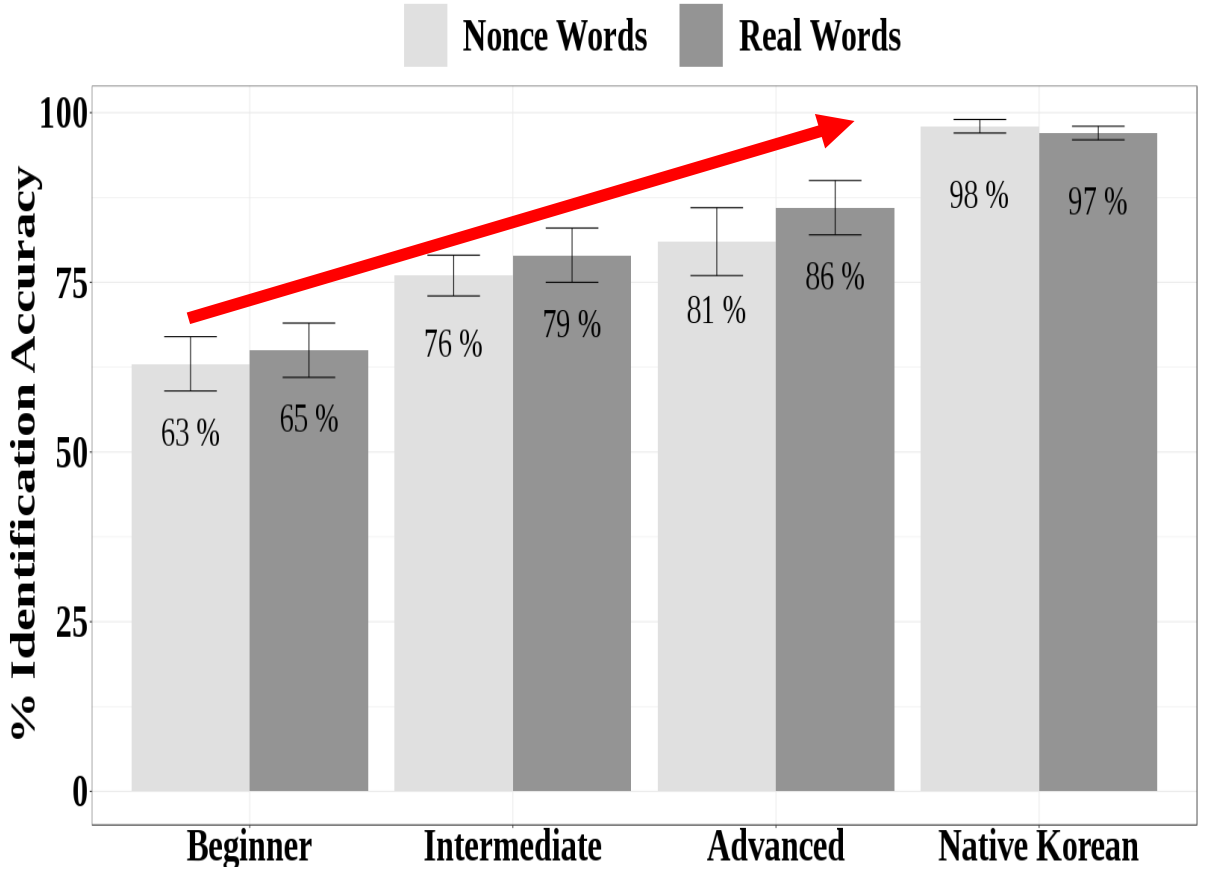


Figure1 & 2. Discrimination and identification accuracy of Korean contrasts by L2 experience

Experiment 1: Summary and discussion

Goals

Experiment 1 investigated how accurately Mandarin listeners are able to perceive the Korean three-way laryngeal contrast, **focusing on their Korean language experience.**

»»

Findings

The greater the adult learners' experience in the L2, the better their identification and discrimination accuracy.

• Experiment 2 •

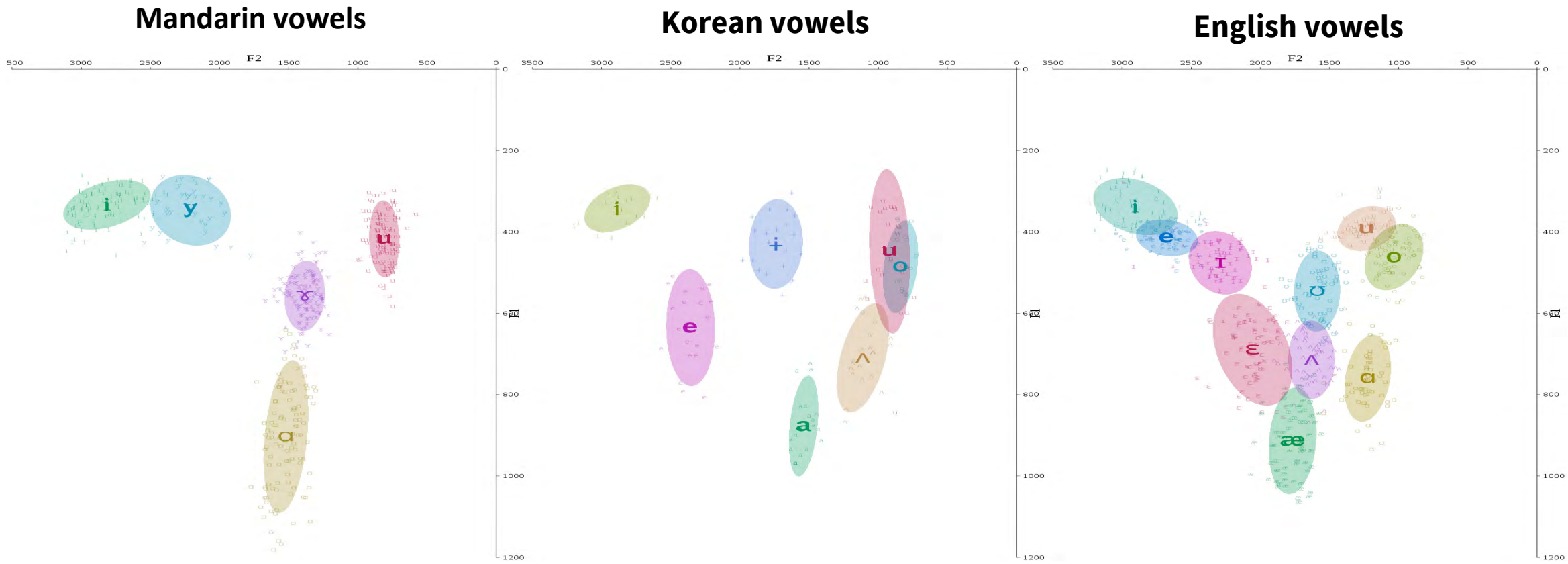
Effects of **L1 inventory size** on the perception of Korean vowels and codas by native Mandarin and English speakers

Mandarin, English and Korean vowels and codas

	Mandarin	Canadian English	Korean
Vowels	5 simple vowels /i, y, ə, u, ɑ/	10 simple vowels /i, ɪ, æ, e, ɛ, ɑ, ʌ, ʊ, o, u /	7 simple vowels /a, e, i, o, u, ɨ, ʌ /
Codas	nasals /n, ŋ/	voiceless /p, t, k, f, s, ʃ, θ, h/ voiced /b, d, g, v, z, ʒ, ð/ nasals /n, m, ŋ/ liquids /ɹ, l/	voiceless /p, t, k/ nasals /n, m, ŋ/ liquid /l/

Acoustic analysis of Korean, English and Mandarin vowels

- Korean [u] and [o] overlap substantially (Chae 1999, Seong 2004, Kim et al 2006, Han & Kang 2013, Y. Kang 2015)



Average F1 and F2 values of Korean, English and Mandarin vowels
(The ellipses represent one standard deviation from the mean)

Research question and prediction

Question 1

Does **L1 inventory size** affect the perception of Korean vowels and codas?

Prediction 1

Native Canadian English speakers, whose vowel and coda inventories are larger than those of Korean, will be more successful in perceiving Korean vowels and codas than **native Mandarin speakers**, whose vowel and coda inventories are smaller than those of Korean.

Method

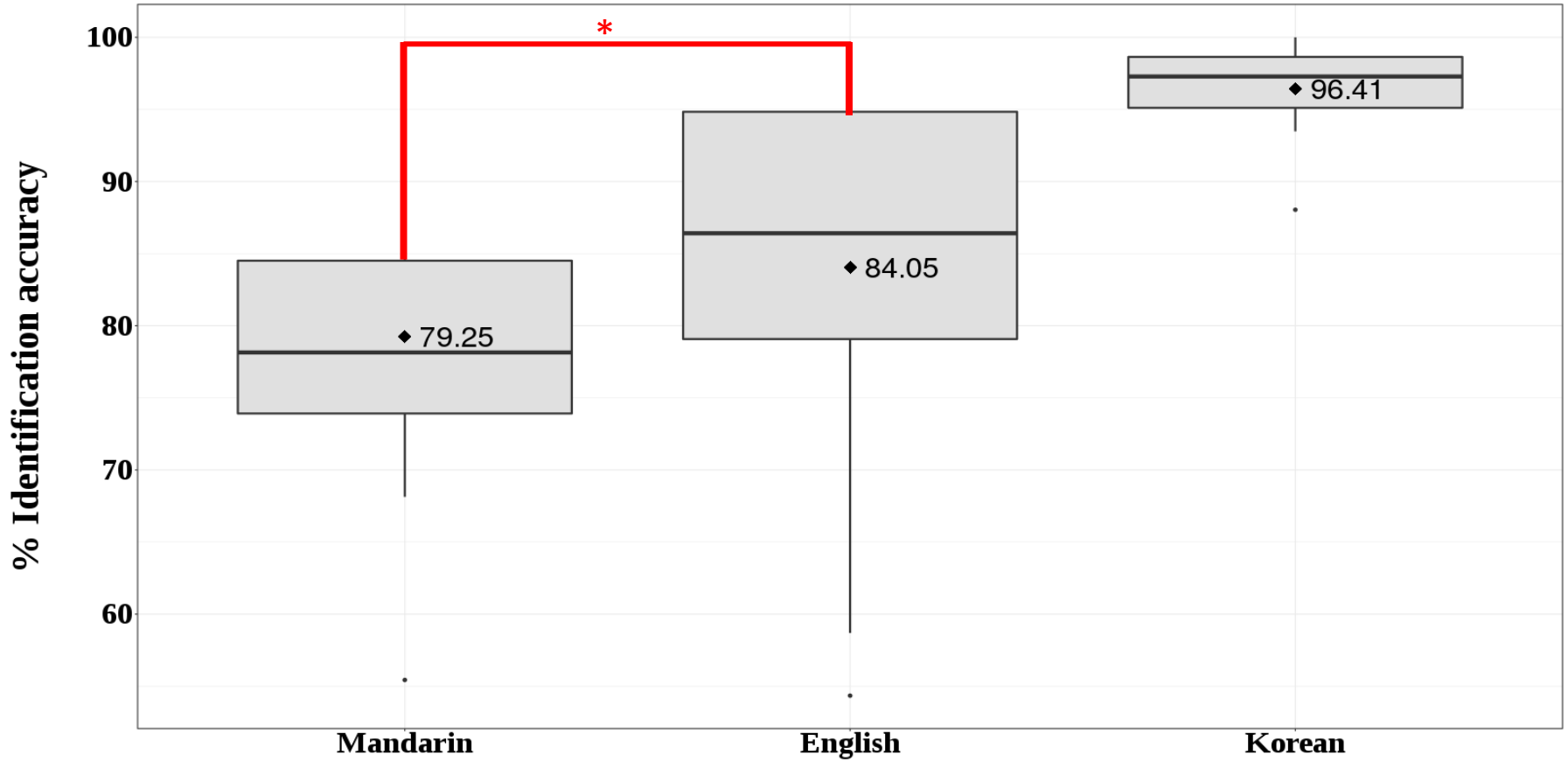
- Participants:
  - 28 native English & 28 Mandarin listeners who learn Korean as foreign language at the University of Toronto.
  - 10 native Korean listeners.

- Perceptual tasks and stimuli:

Vowel identification task	Coda identification task
96 monosyllabic Korean words including four vowels /ɨ, o, u, ʌ/	150 monosyllabic Korean words including six codas /p, t, k, n, m, ŋ/

Effects of L1 inventory size on L2 vowel perception

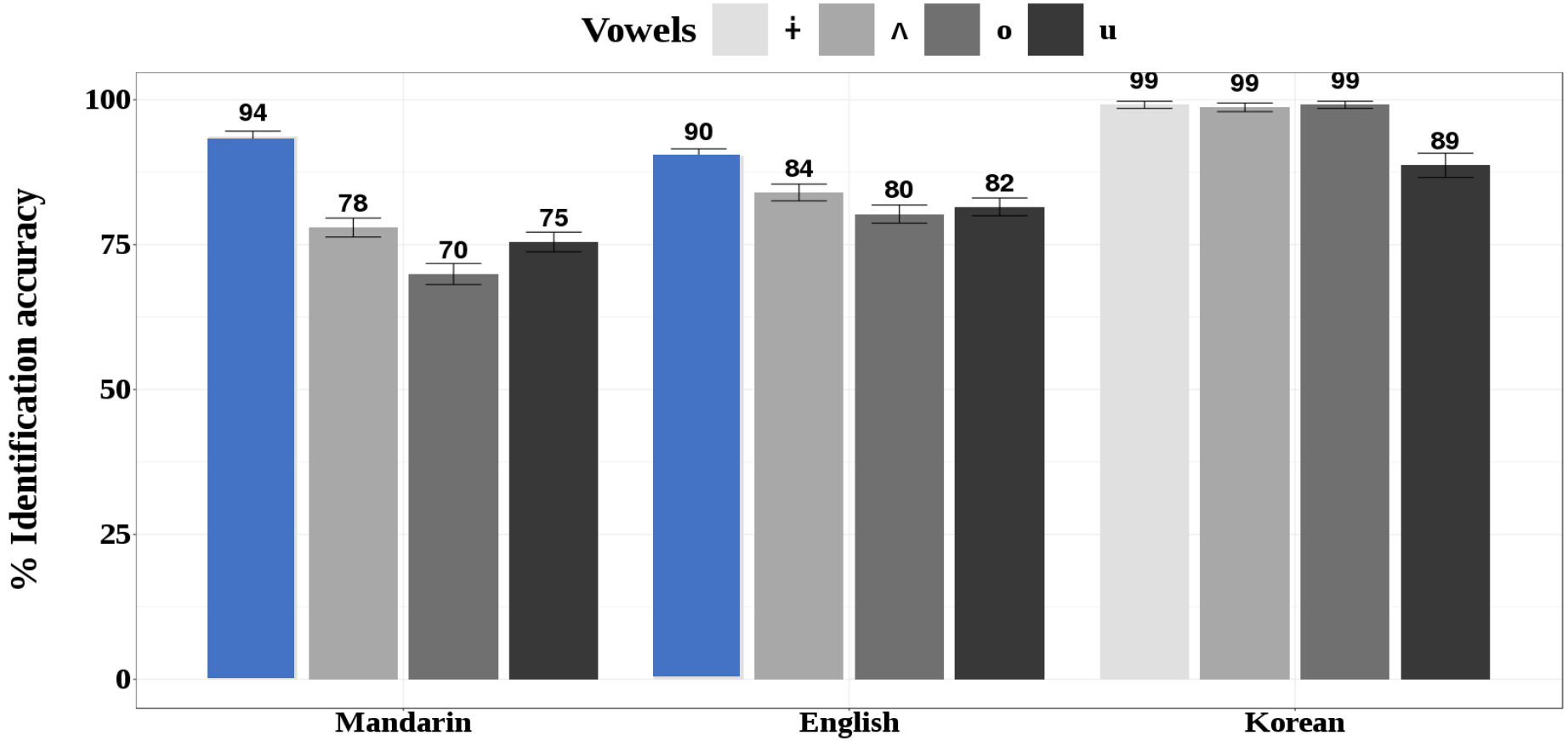
- English listeners whose vowel inventory is larger perceived Korean vowels more accurately than Mandarin listeners whose vowel inventory is smaller than that of Korean.



Boxplots of identification accuracy of Korean vowels by L1 group

Effects of L1 inventory size on L2 vowel perception

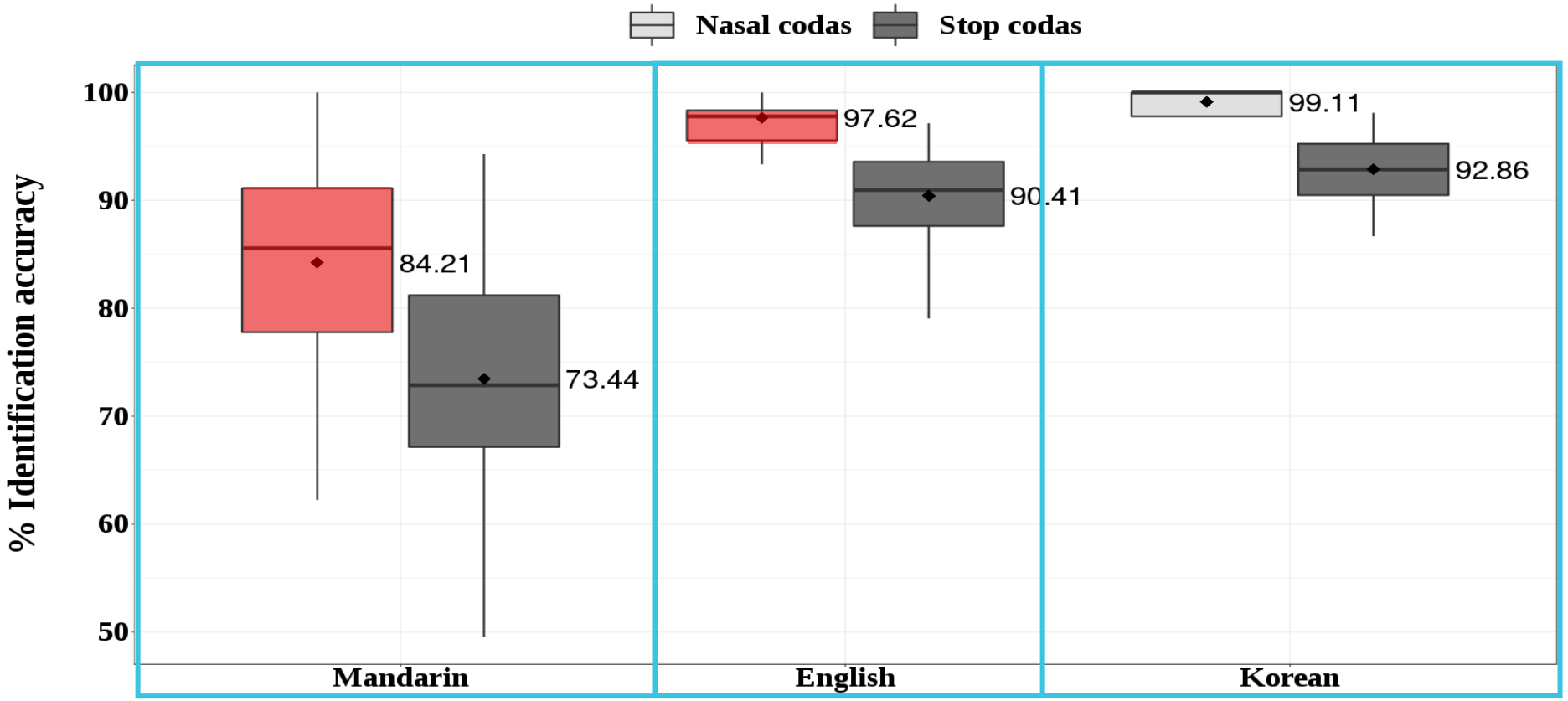
- Perceptual difficulty from the least to most difficult vowels: **ɨ > ʌ > u > o**



Identification accuracy of individual Korean vowels by L1 group

Effects of L1 inventory size on L2 coda perception

- Perceptual performance: **English listeners >> Mandarin listeners**
- Perceptual difficulty from the least to most difficult codas: **nasal >> stops**



Boxplots of identification accuracy of Korean codas by L1 group

Experiment 2: Summary and discussion

Goals

Experiment 2 examined **the effects of L1 phoneme inventory size** on the perception of Korean vowels and codas by native Mandarin and English listeners.

»»

Findings

English listeners, whose L1 has a rich vowel and coda inventory, outperformed Mandarin listeners, who have a small vowel and coda inventory.

Acknowledgements

- Professor Yoonjung Kang, Philip Monahan, Jessamyn Schertz and Ocke-Schwen Bohn for their valuable feedback.
- Professor Kyoungrok Ko and Yujeong Choi for their help recruiting participants.
- Hyoung Seok Kwon for technical support.
- Mandarin, Canadian, American undergraduate students who participated in the experiments.
- SSHRC institutional grant for experiment participant costs.
- Academy of Korean Studies (AKS) for research funding.

Second Language (L2) Phonology: The effects of L1 backgrounds, L2 experience and online perceptual training on the acquisition of L2 sounds

Penn State University

Na-Young Ryu

March 17, 2022

Experiment 3

Effects of web-based perceptual training
on the perception of Korean sounds
by Mandarin speakers

Motivation for the study

- The acquisition of Korean vowels /o, ʌ, u/ and codas /k, ŋ/ appear to be difficult for beginner Mandarin L2 learners (Ryu 2019).

Mandarin	Korean
5 monophthongs /i, y, ə, u, ɑ/	7 monophthongs /a, e, i, o, u, ɨ, ʌ /
2 coda consonants /n, ŋ/	7 coda consonants /p, t, k, n, m, ŋ ,l/

- To date, there are no studies of training effects on the perception of Korean vowels and codas by L2 learners.

Web-based perceptual training program

Web server

Develop online training program

jspsych

Learners

Research questions

Question 1	Does **web-based high variability perceptual training** enhance Mandarin L2 learners' perception of Korean vowels and codas?
Question 2	Does **explicit training** lead to greater improvement in the perception of Korean vowels and codas than **implicit training**?
Question 3	Can the training effect be **transferred** to sounds in new phonetic contexts?

Explicit vs. implicit training

Explicit training

Learners **attend to target sounds** and **they have conscious awareness of what is being learned** during perceptual training.

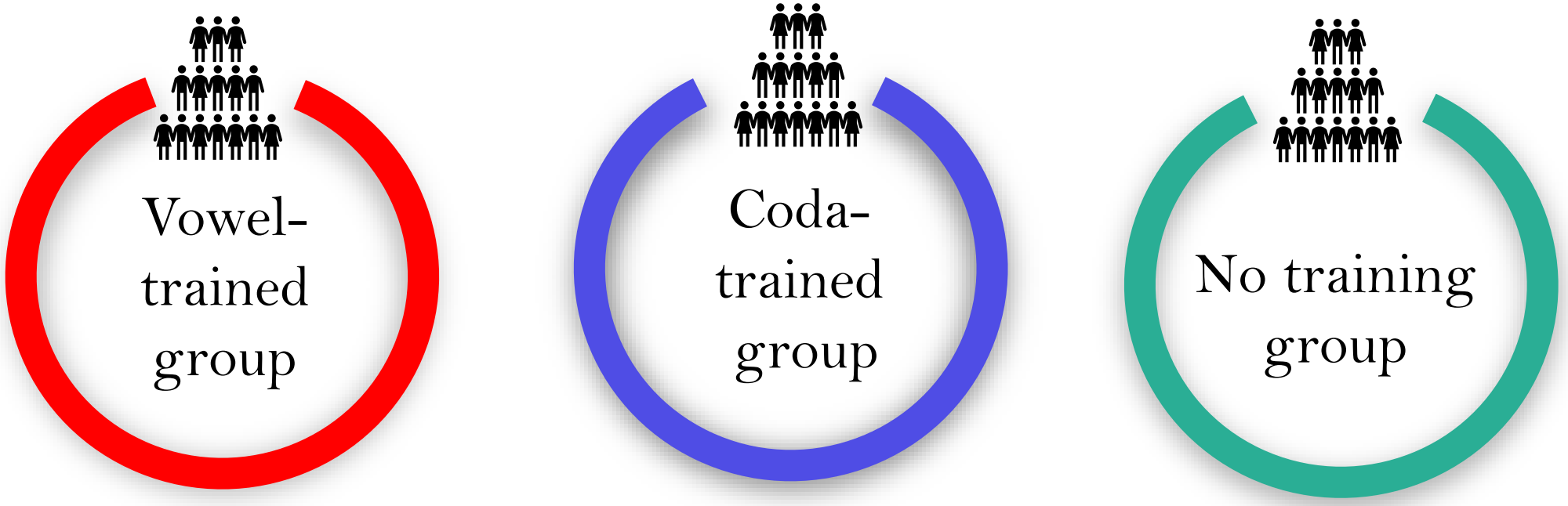
Implicit training

Learners **are passively exposed to target sounds** so that **they do not know what is being learned** during perceptual training.

Participants

- 45 native Mandarin listeners who are enrolled in beginner-level Korean courses at universities in Toronto, Canada.

- Randomly assigned to three groups of 15 each.

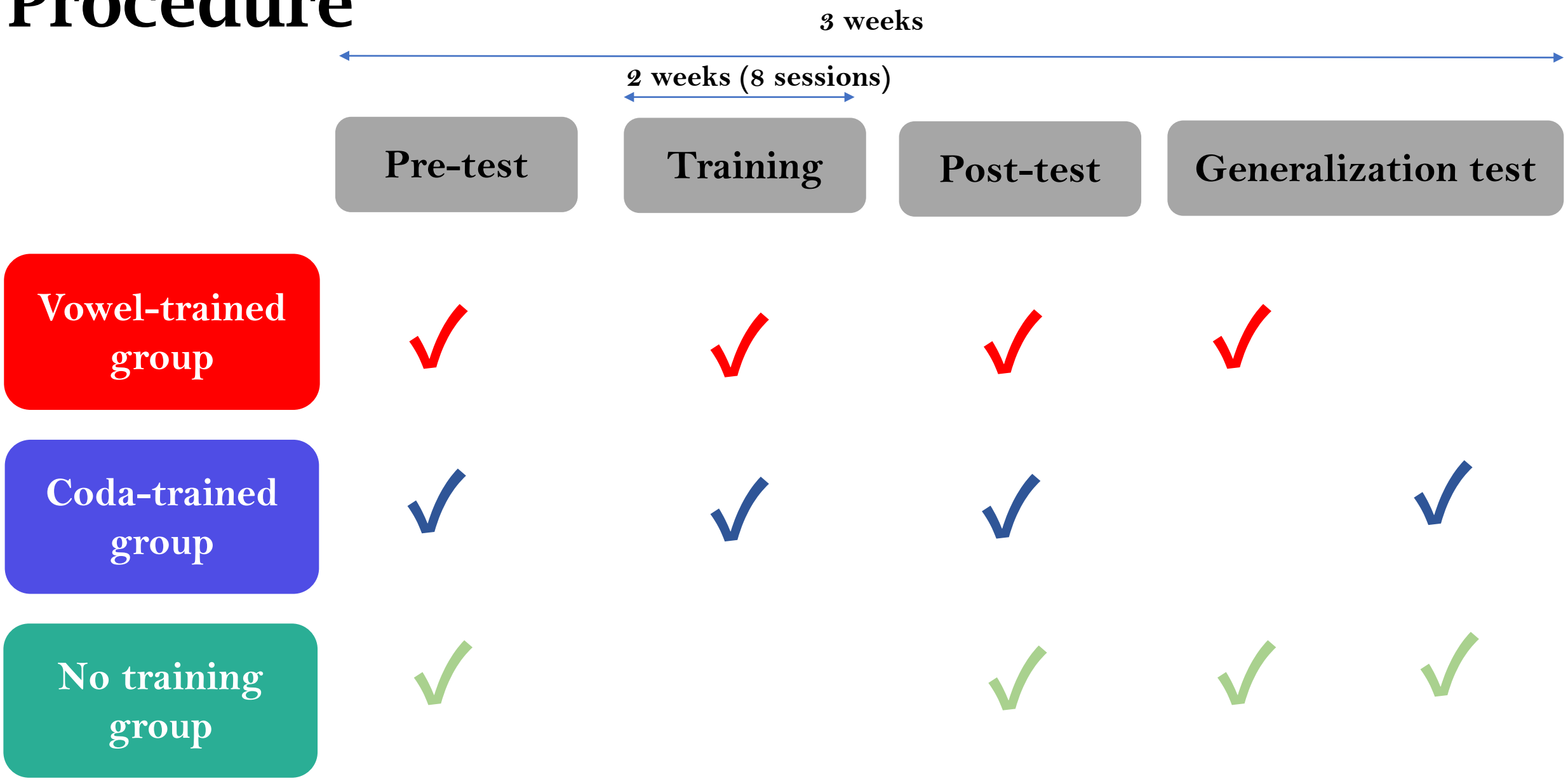


Stimuli

- 98 monosyllabic Korean words including seven target vowels and codas were naturally produced by 6 native Korean speakers.

Phase	Stimuli	Number of native Korean speakers	Number of stimuli
Training	49 words /**h**VC/	4 speakers	196 tokens
Pre-test		2 speakers	98 tokens
Post-test			
Generalization test	49 words /**k**VC/		

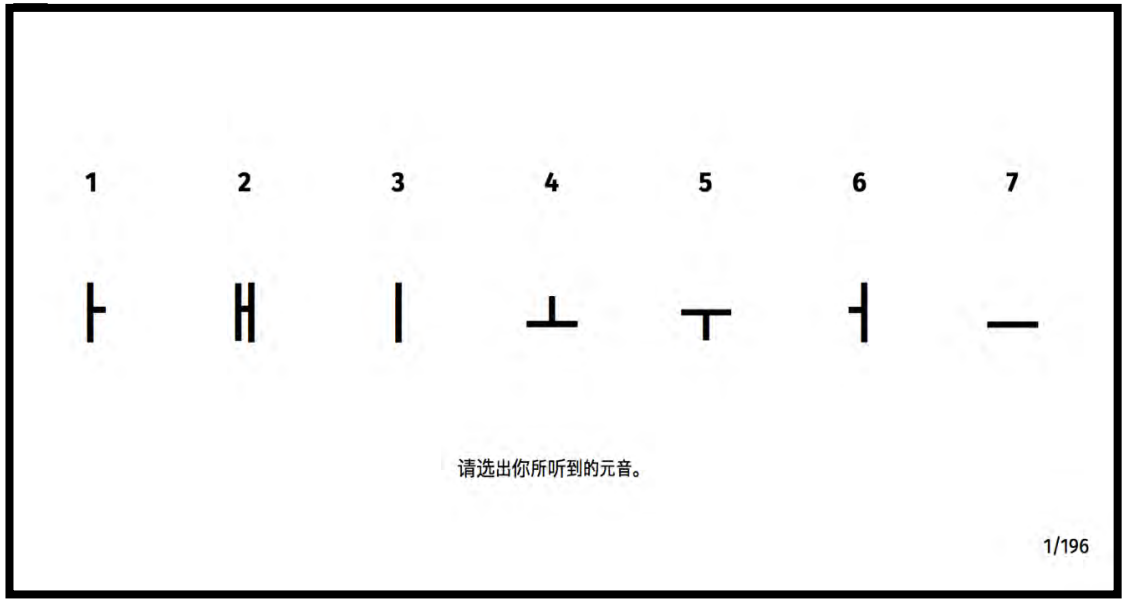
Procedure


3 weeks
2 weeks (8 sessions)
Pre-test
Training
Post-test
Generalization test
Vowel-trained group
Coda-trained group
No training group

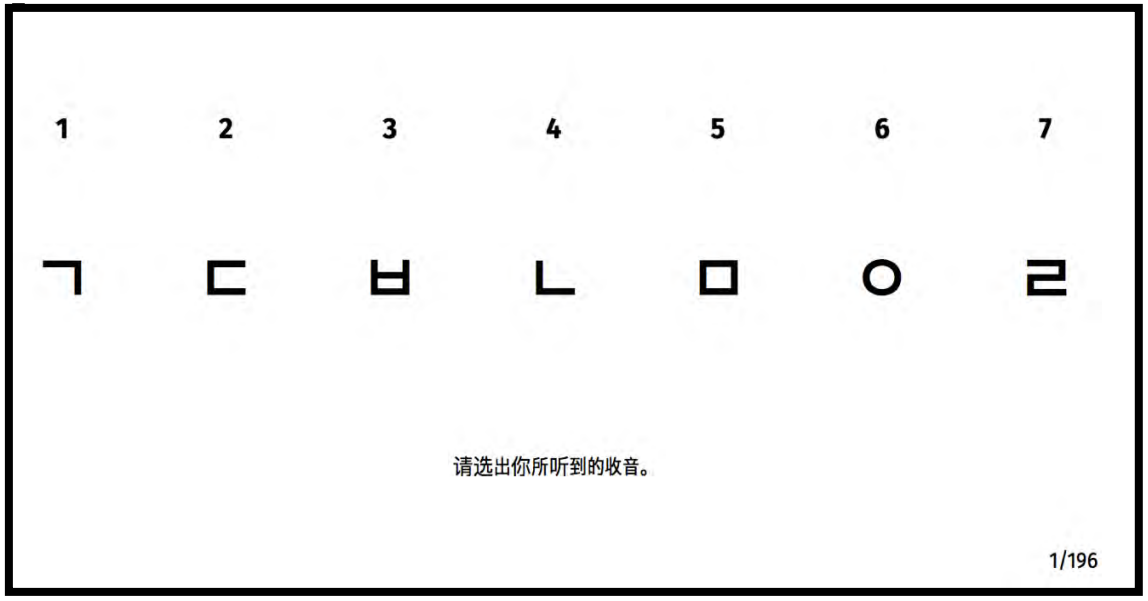
Web-based auditory training

- Both two training groups were **exposed to the same stimuli**, but focused on **different target segments**.

Vowel-trained group

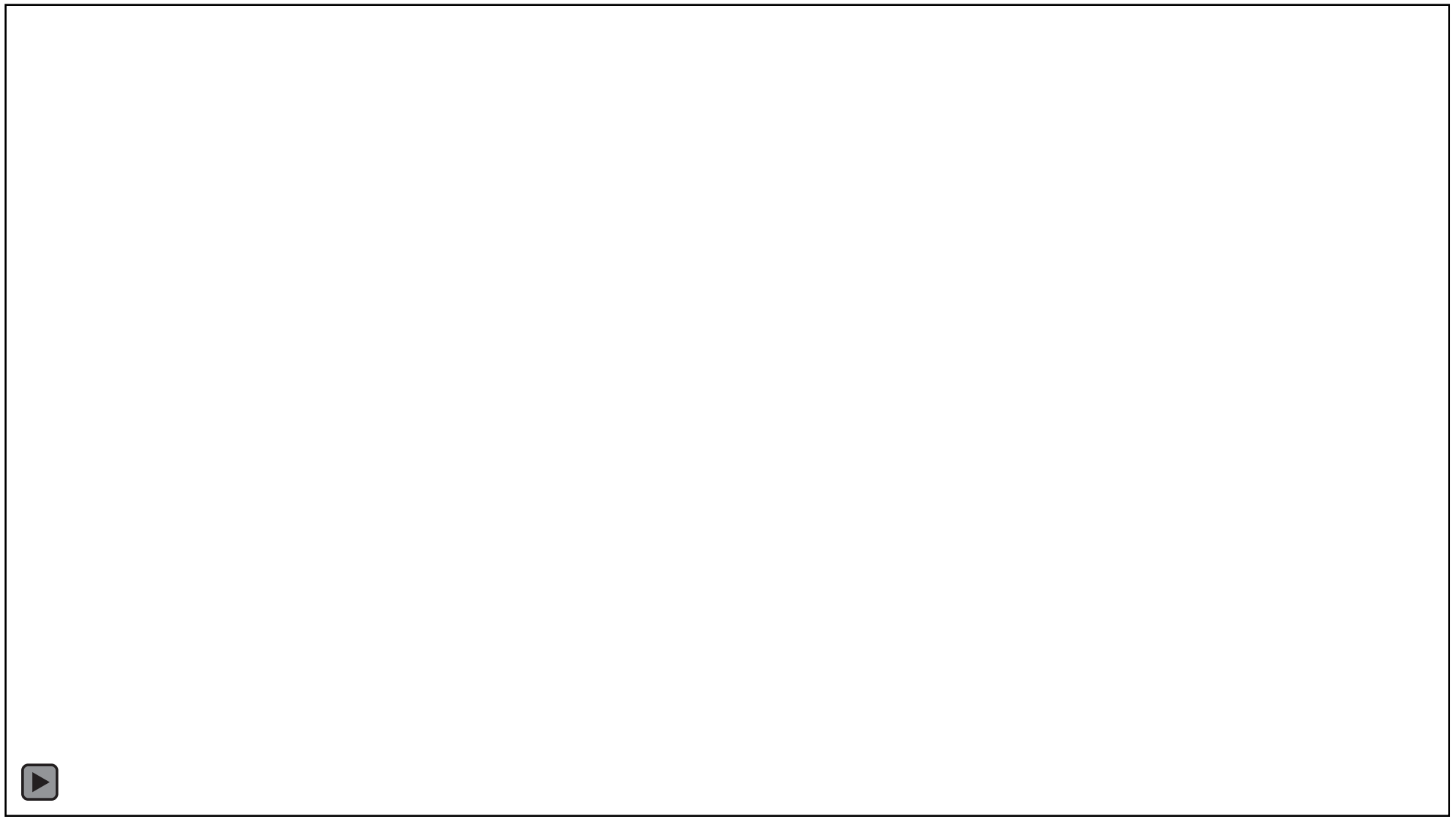


Coda-trained group

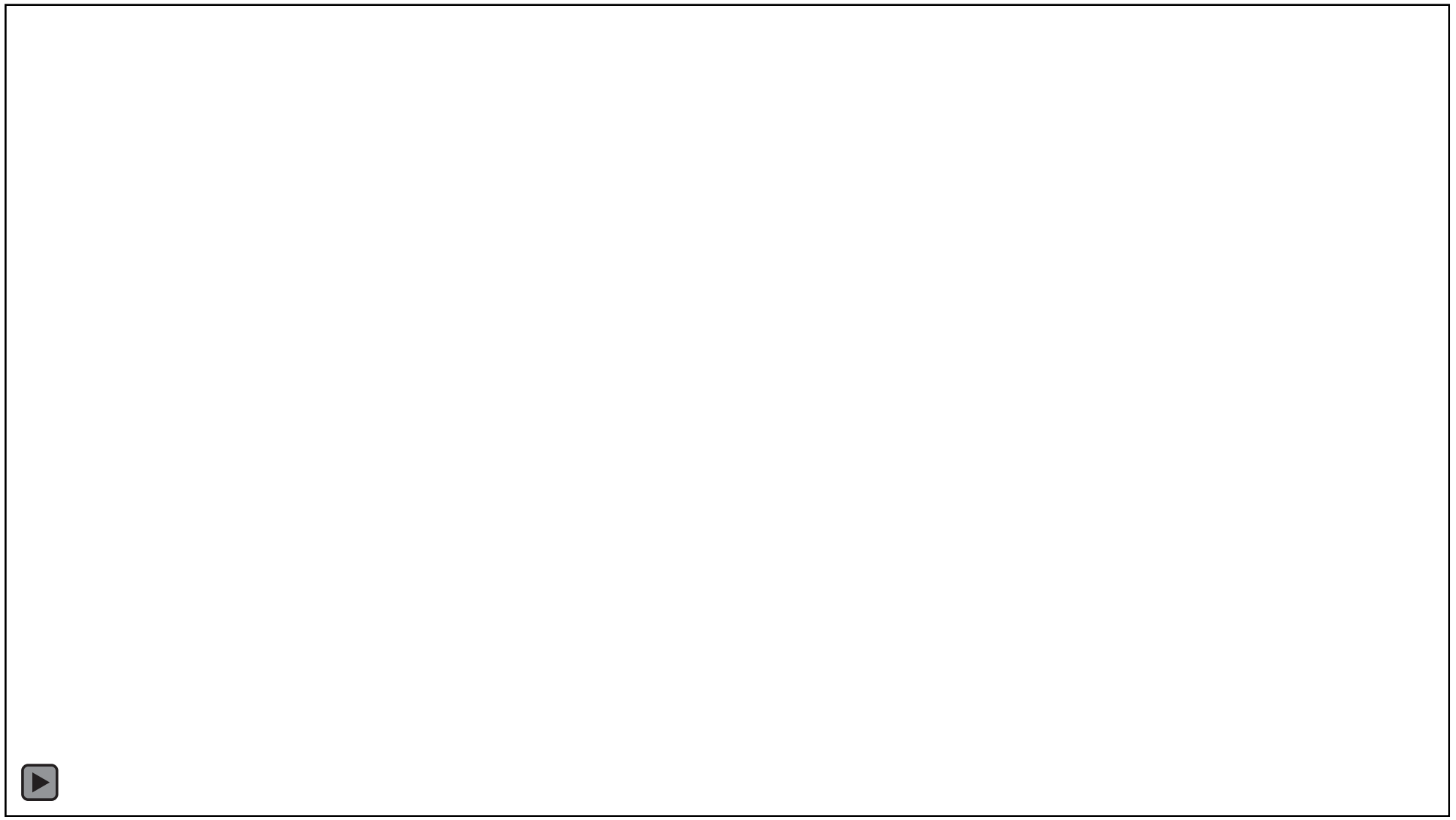


- 8 identification training sessions in a quiet place.
- Immediate feedback.

Vowel-trained group



Coda-trained group



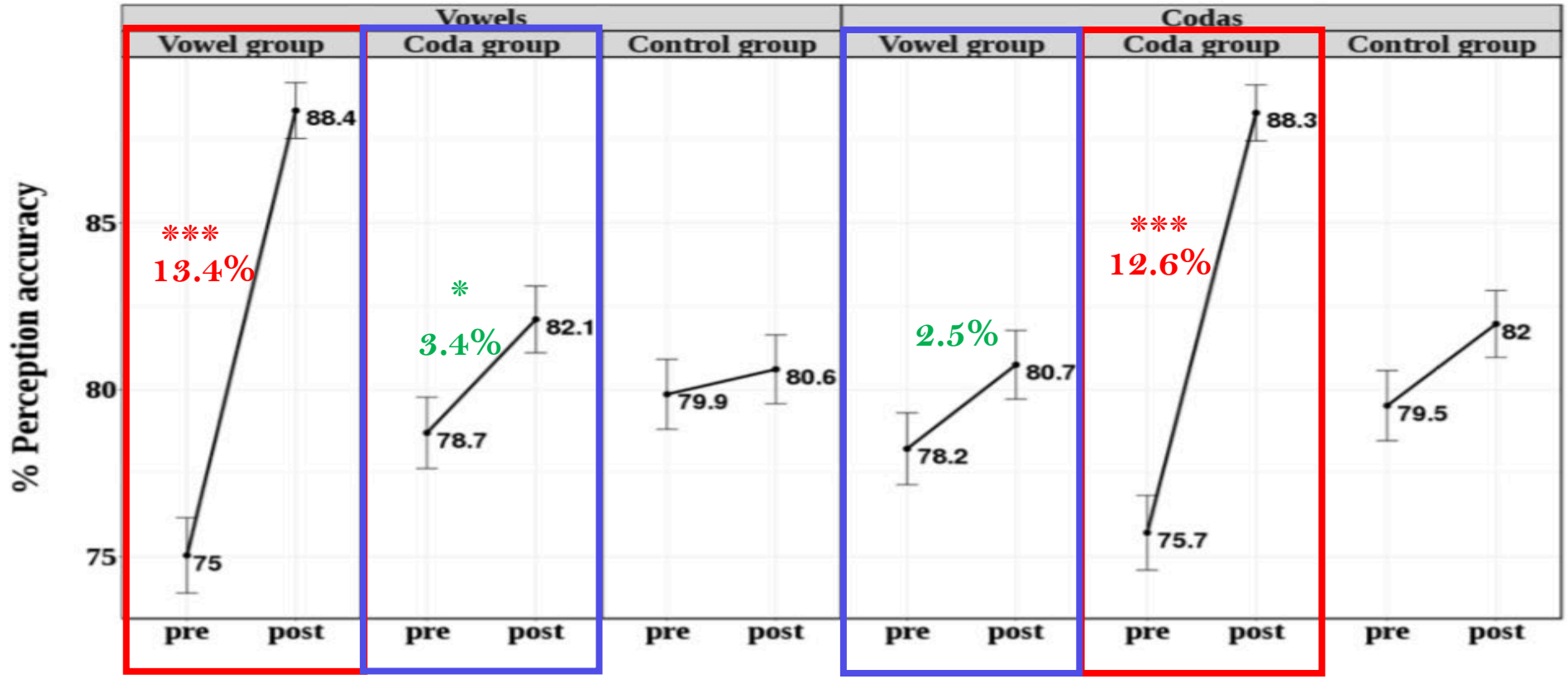
Statistical analysis

- A mixed-effects logistic model in R (Baayen 2008; R CoreTeam 2017)

  - The package *lme4* (Bates et al 2011)
  - Dependent variable: Response (correct:1, incorrect:0)
  - Fixed effects: Test (pre-test, post-test, generalization test), group (vowel-trained, coda-trained and control group), and their interactions
  - Random effects: Subject, item

Effects of explicit vs. implicit training on L2 perception

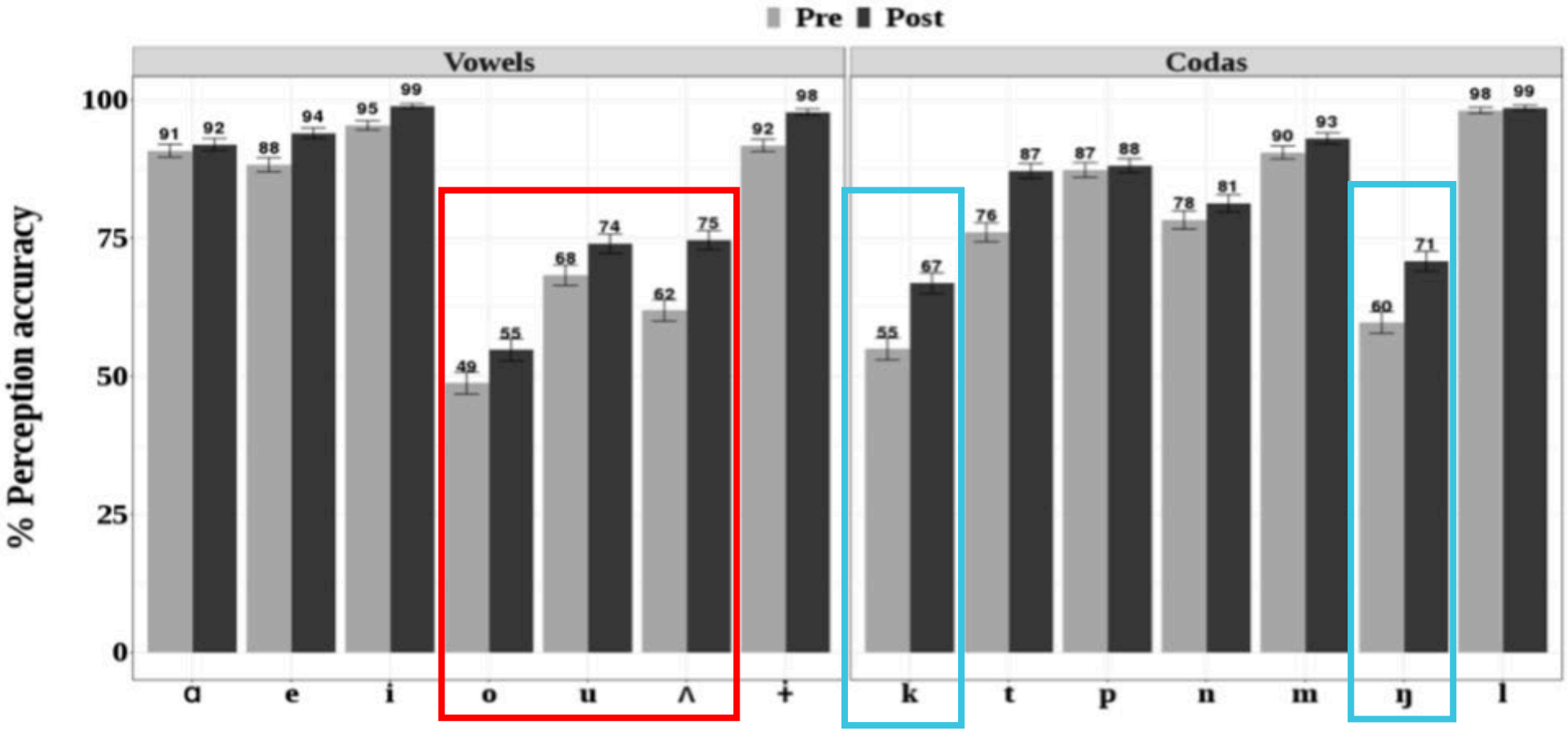
- **Explicit training**: Significant improvement for both vowels and codas.
- **Implicit training**: Significant improvement for vowels, not codas.



Identification accuracy for Korean vowels and codas across groups at pre-and post-test

Perception accuracy of Korean vowels and codas

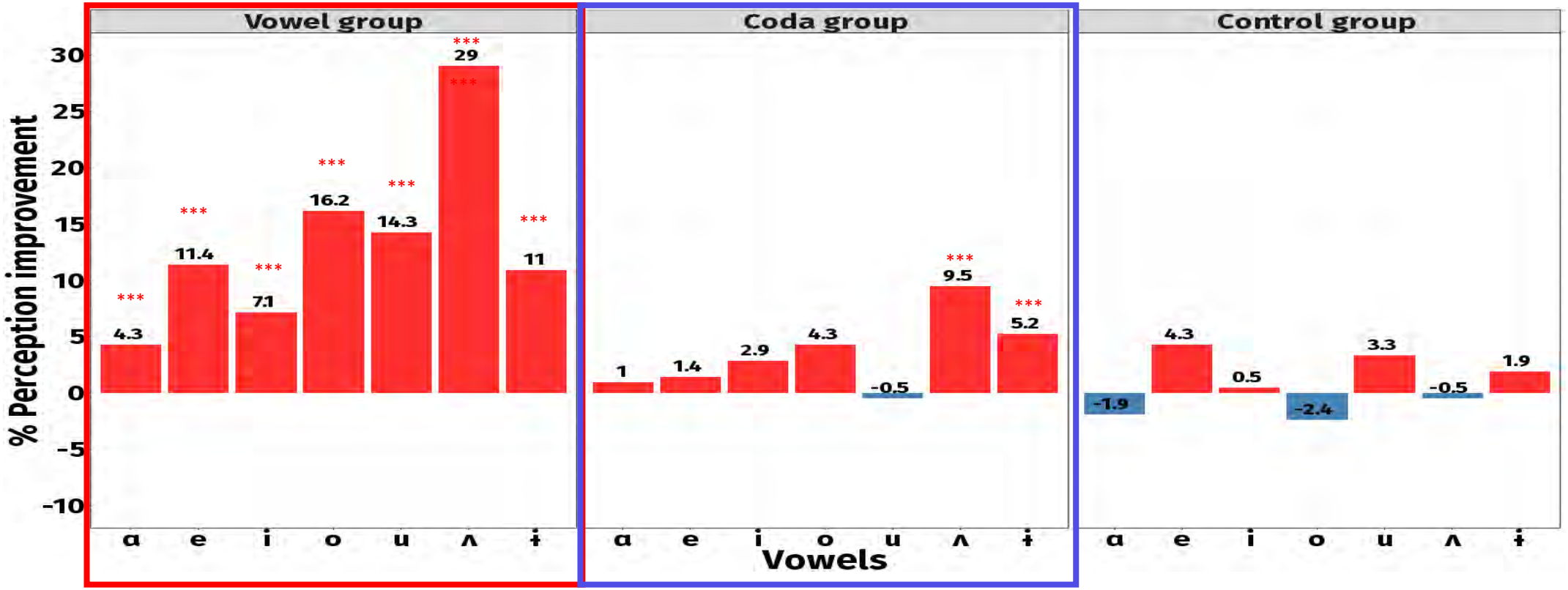
- The hierarchy of difficulty of Korean vowel perception: **o > ʌ > u > e > a, > ɨ > i**
- The hierarchy of difficulty of Korean coda perception: **k > ŋ > t> n > p> m> l**



All groups' identification accuracy of individual Korean vowels and codas at pre-test and post-test

Perceptual improvement of individual Korean vowels

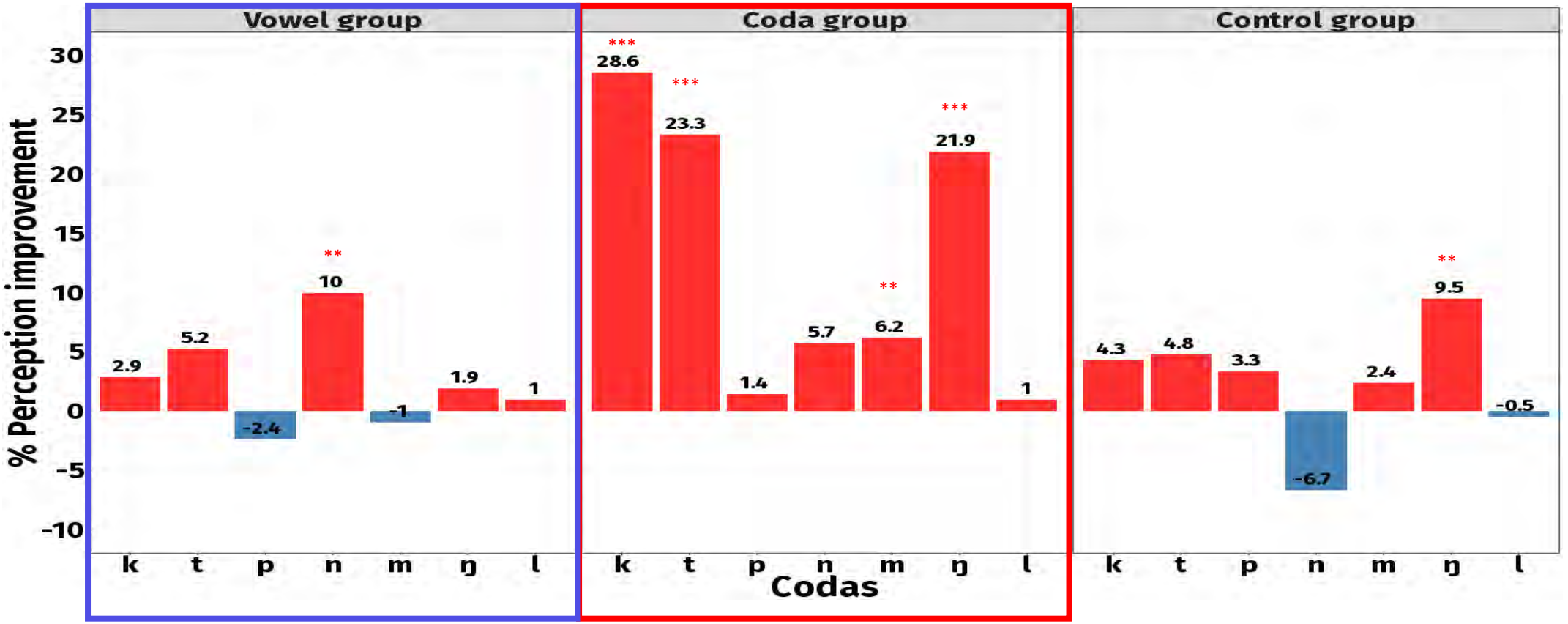
- **Explicit training**: Perception of **all Korean vowels** significantly improved.
- **Implicit training**: Perception of **vowels /ɨ, ʌ/** significantly improved.



Perception improvement of individual vowels by group

Perceptual improvement of individual Korean codas

- **Explicit training**: Perception of Korean codas /k, t, ŋ, m/ significantly improved.
- **Implicit training**: Perception of Korean coda /n/ significantly improved.



Perception improvement of individual codas by group

Generalization effects of training

- Both explicit training groups maintained their increase in accuracy with novel stimuli.

Mean accuracy scores for Korean vowels and codas at pre-test, post-test and generalization test

	Korean vowels			Korean codas		
	Pre-test	Post-test	Generalization test	Pre-test	Post-test	Generalization test
Vowel-trained group	75.03 (43.30)	88.37 (32.07)	88.64 (31.74)			
Coda-trained group				75.71 (42.90)	88.30 (32.15)	87.28 (33.33)
Control group	79.86 (40.12)	80.61 (39.55)	85.58 (35.14)	79.52 (40.37)	81.97 (38.45)	81.02 (39.23)

13%

13%

Summary of the study

Findings

1. Effects of web-based high variability phonetic training

- Two training groups enhanced their perception of the target sounds.

2. Effects of implicit vs. explicit training

- **Asymmetrical perceptual improvements in training**

  (1) Explicit training is beneficial for the perception of both L2 vowels and L2 codas.

  (2) Implicit training is effective for the perception of L2 vowels, but not L2 codas.

  - Acoustic salience of Korean codas which are obligately unreleased.
  - Stimuli-position effect: Learners likely attend to sounds before a target sounds but not after.

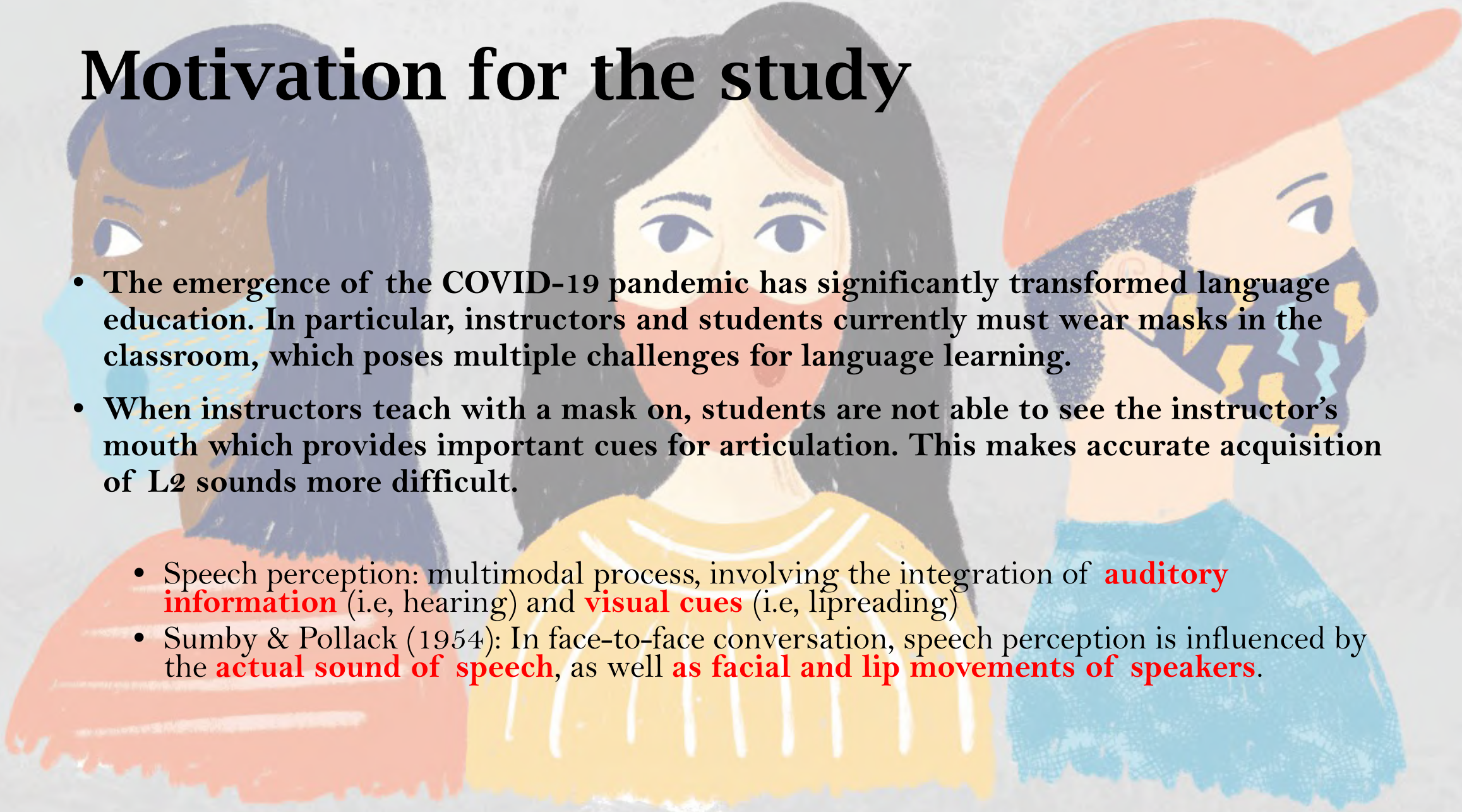
3. Generalization effect of training

Learners can generalize their learning from training to new phonetic contexts.

• Experiment 4 •

Effects of online auditory-only and audiovisual perceptual training on the perception of Korean vowels by L2 English learners of Korean

Motivation for the study



- **The emergence of the COVID-19 pandemic has significantly transformed language education. In particular, instructors and students currently must wear masks in the classroom, which poses multiple challenges for language learning.**
- **When instructors teach with a mask on, students are not able to see the instructor's mouth which provides important cues for articulation. This makes accurate acquisition of L2 sounds more difficult.**

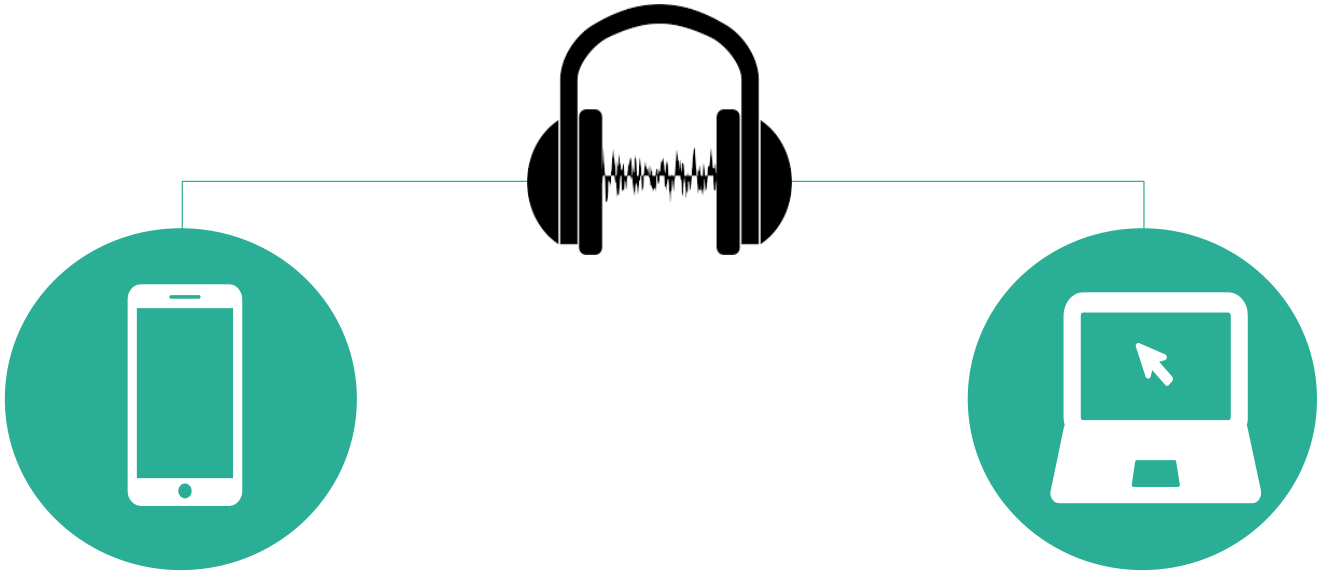
  - Speech perception: multimodal process, involving the integration of **auditory information** (i.e, hearing) and **visual cues** (i.e, lipreading)
  - Sumby & Pollack (1954): In face-to-face conversation, speech perception is influenced by the **actual sound of speech**, as well **as facial and lip movements of speakers**.

Purpose of this study

- Develop web-based audiovisual and audio-only training programs to help L2 learners of Korean improve their perception and pronunciation of Korean vowels
- Assess the effects of online auditory and audiovisual perception training on the perception of Korean vowels by second language (L2) learners of Korean
  - Whether L2 learners of Korean can benefit from online training to make better use of phonetic information in the perception of Korean vowels with and without access to visual speechreading cues.

Online perceptual training

L2 learners: Participating in online training using cellphones, IPads, or laptops



Auditory and audiovisual training in L2 speech

- Most of the auditory (AO) and audiovisual (AV) perceptual training studies have investigated L2 English and have found competing results (Hardison et al., 2003; Hazan et al., 2005, 2006; Inceoglu 2016)

  - To date, there are no studies of online auditory and audiovisual perceptual training on the perception of Korean sounds.

  - Hardison et al. (2003): **The AV training group improved more than the AO training group** in both perception and pronunciation of English /r-l/ contrast by Japanese and Korean L2 learners.

  - Inceoglu (2016) : **There were no significant differences in the perception of French nasal vowels between the L2 American English AV and AO groups**. However, the pronunciation accuracy of the audiovisual training group improved significantly compared to the AO training group, suggesting that seeing facial gestures are helpful to improve L2 pronunciation .

Research questions

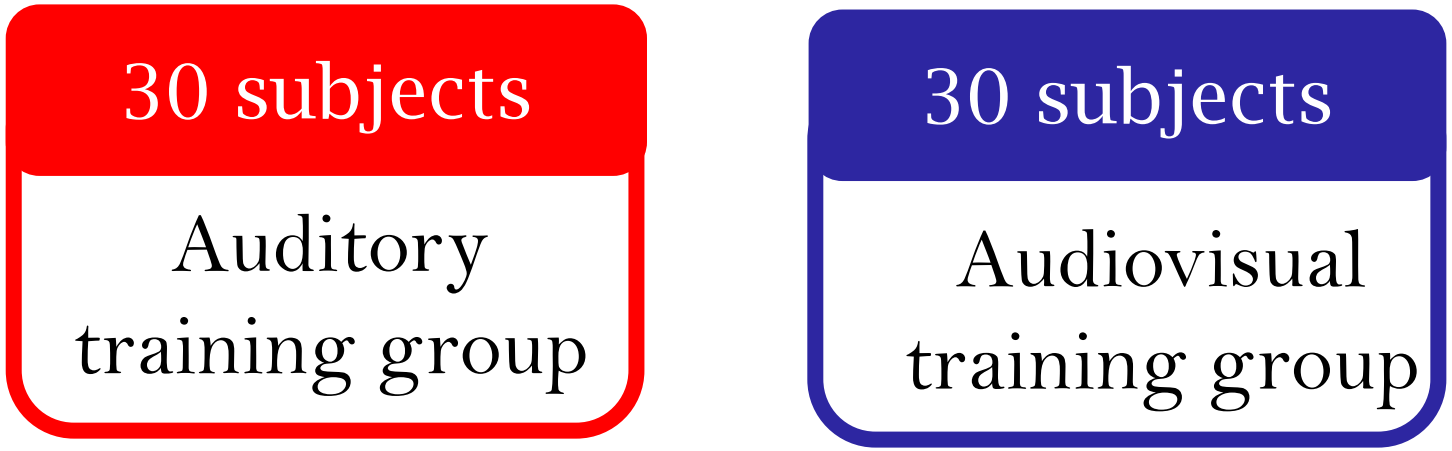
(1)Does **auditory and audiovisual perceptual training** improve L2 learners' perception of Korean vowels?

(1) Does **audiovisual perceptual training** lead to greater improvement in the perception of Korean vowels than **auditory-only perceptual training**?

Participants

- 60 native English speakers enrolled in the online Korean beginning course at the Penn State University, USA.

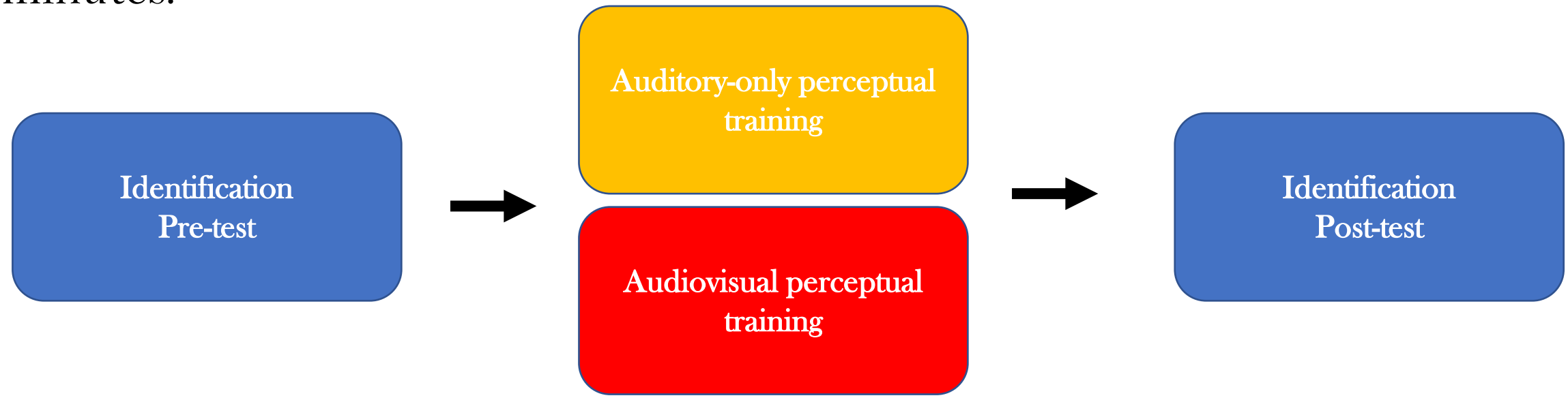
- Assigned to two groups of 30 each.



Procedure

- All groups completed online identification tasks using their mobile phones or iPads for the pre- and post-tests.

- The training groups took part in **three identification training sessions** held over a period of **approximately 1 week**, each session lasting about 20 minutes.



Speech materials

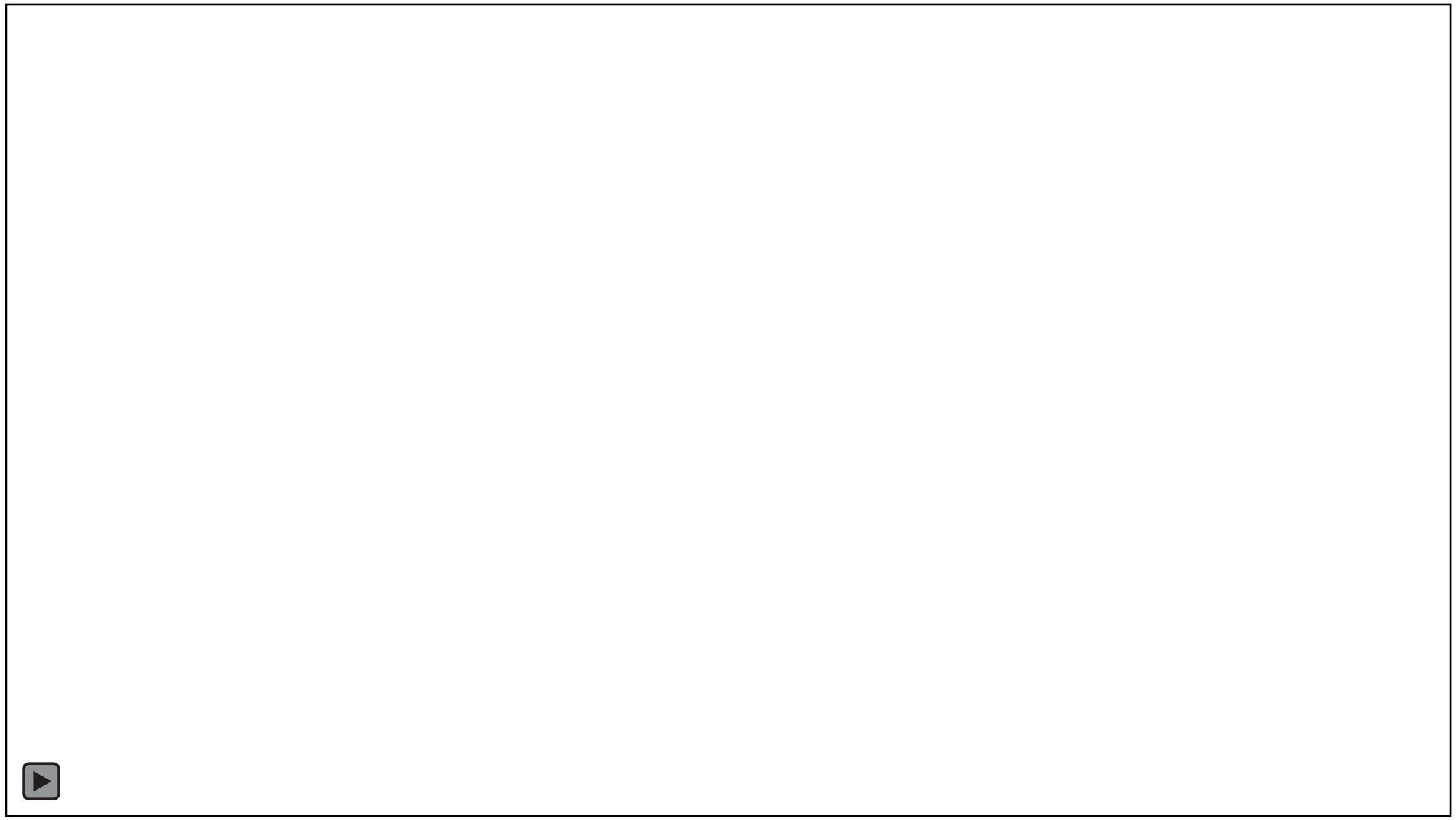
- The stimuli of pre-, post-tests and online training sessions consisted of a total number of 196 tokens.

  - 98 CV words (7 vowels * 14 consonants) * 2 speakers (1 female, 1 male)
  - All stimuli were recorded by native Korean speakers.

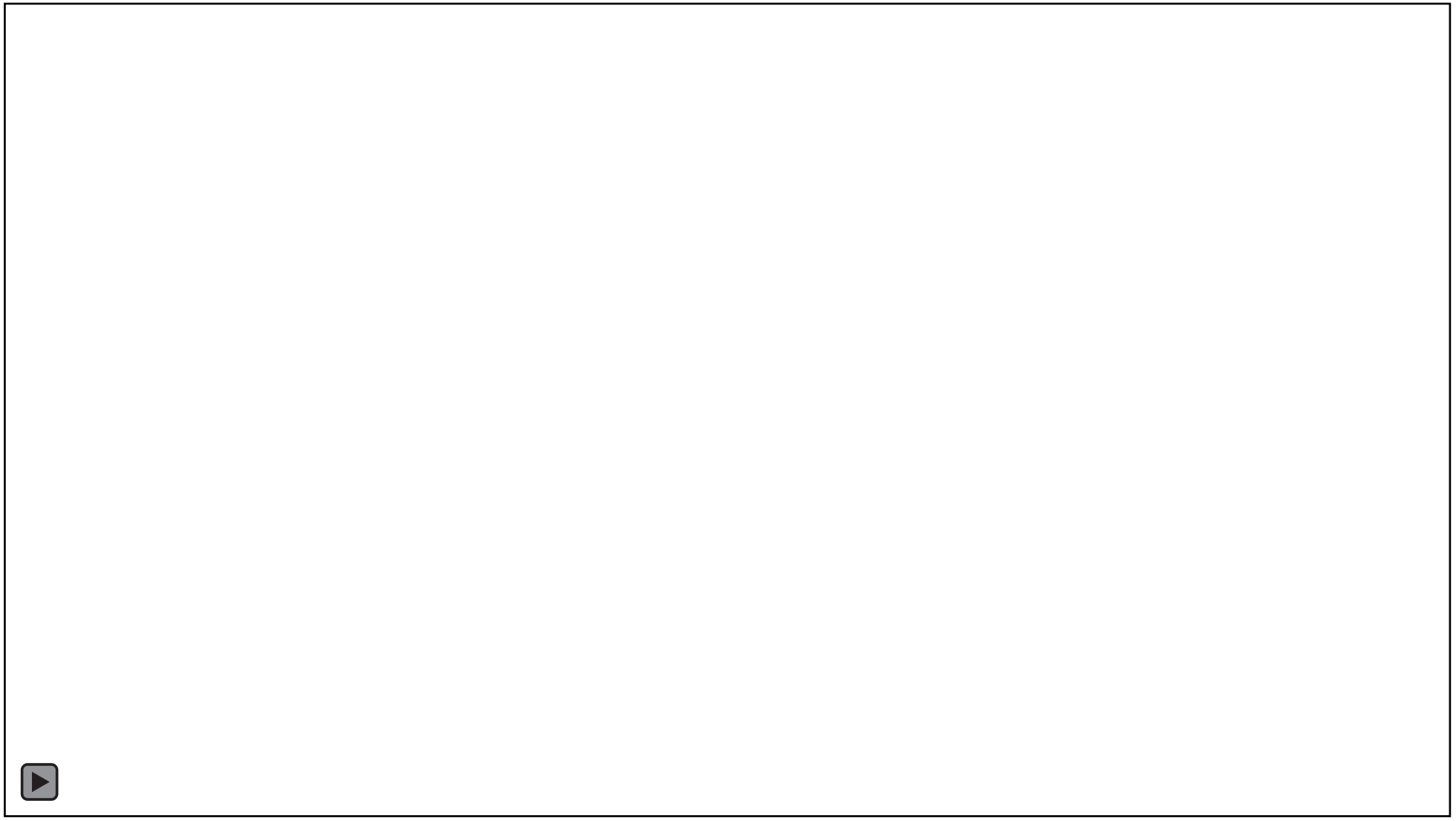
Procedure: Identification task

- In identification tasks, learners heard a sound and were asked to select the corresponding vowel on their mobile screen.

Auditory training



Audiovisual training

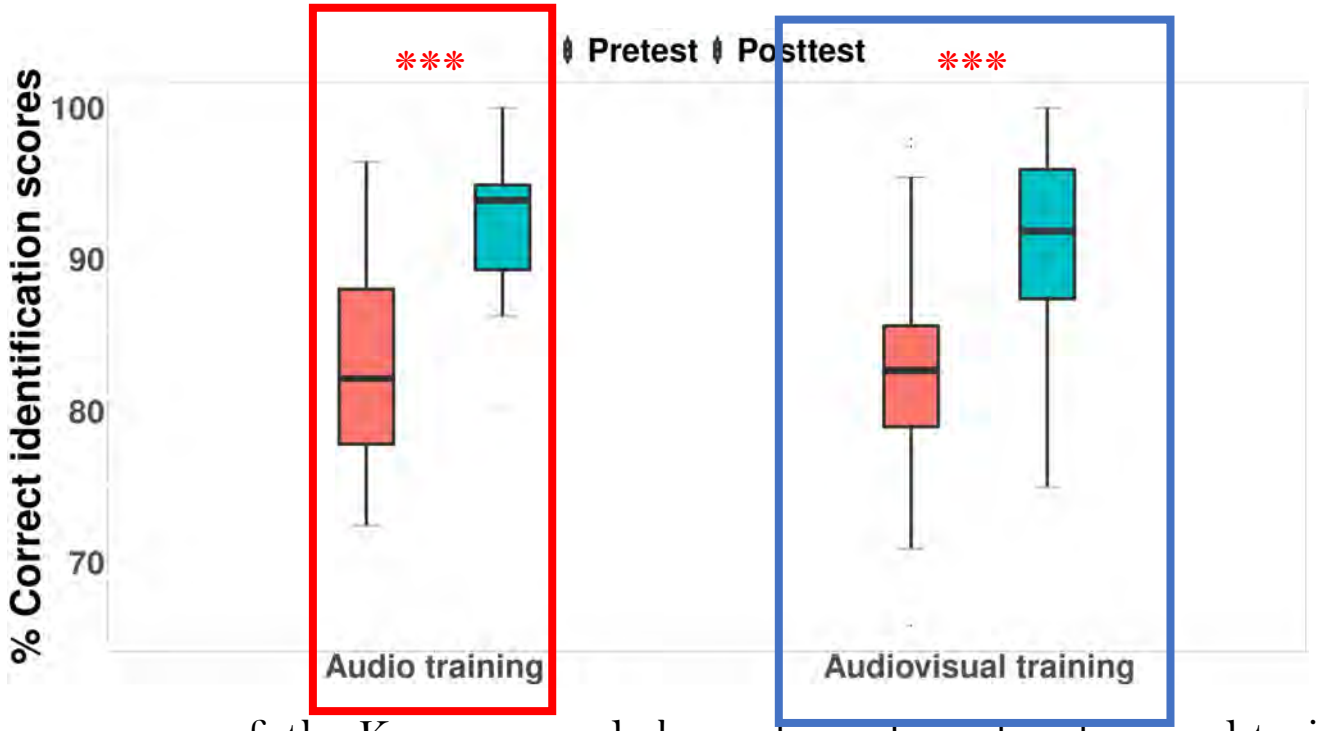


Statistical analysis

- A mixed-effects logistic model in R (Baayen 2008; R CoreTeam 2017)
  - The package *lme4* (Bates et al 2011)
  - Dependent variable: Response (correct:1, incorrect:0)
  - Fixed effects: Test (pre-test, post-test),
    training group (auditory training group, audiovisual training group),
    and their interactions
  - Random effects: Subject, item

Effects of auditory and audiovisual training

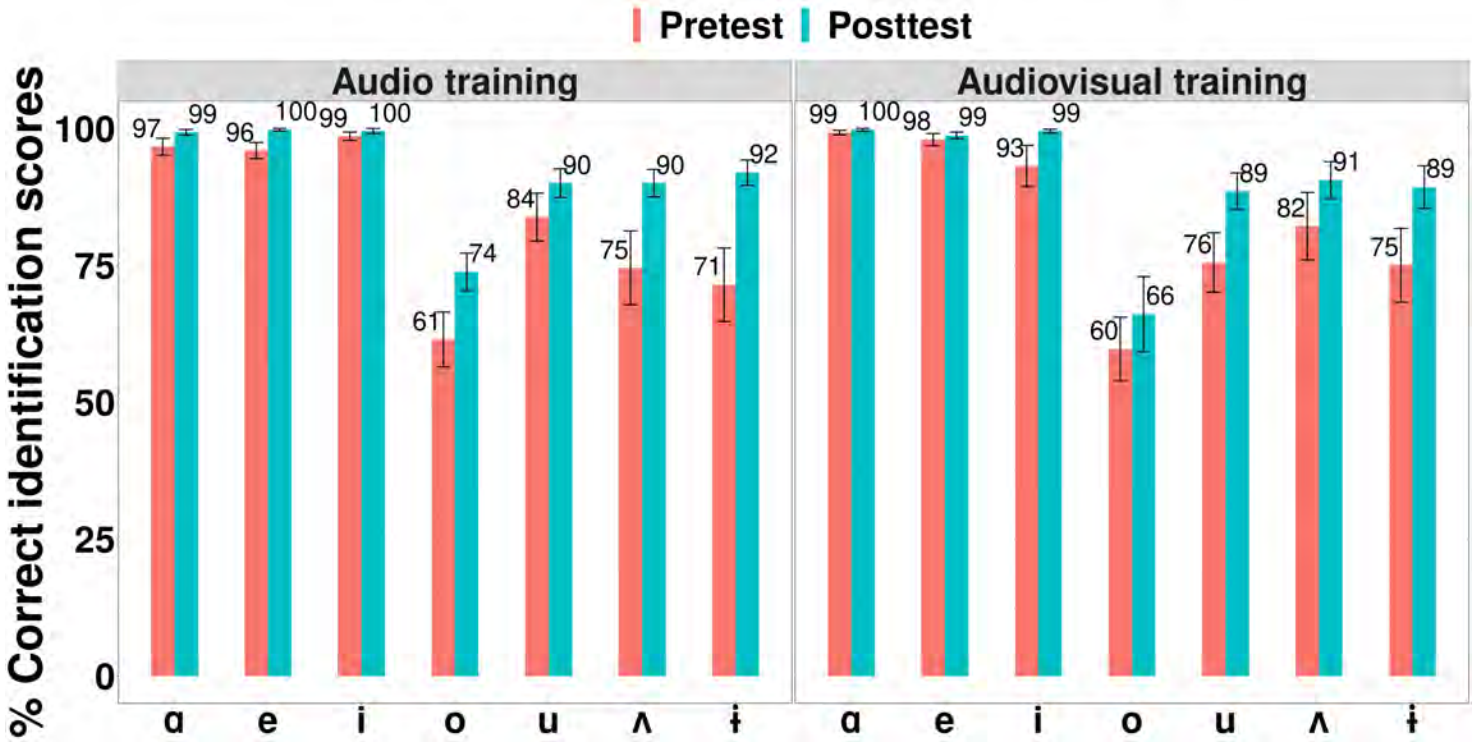
- **Audio-only training group & Audiovisual training groups**: There is significant difference in the identification accuracy of the vowels between pre-test and post-test
  - Both training is effective for L2 learners to improve their perceptual ability of difficult L2 sounds



Comparison of identification accuracy of the Korean vowels by audio-only and audiovisual training at pre- and post-test

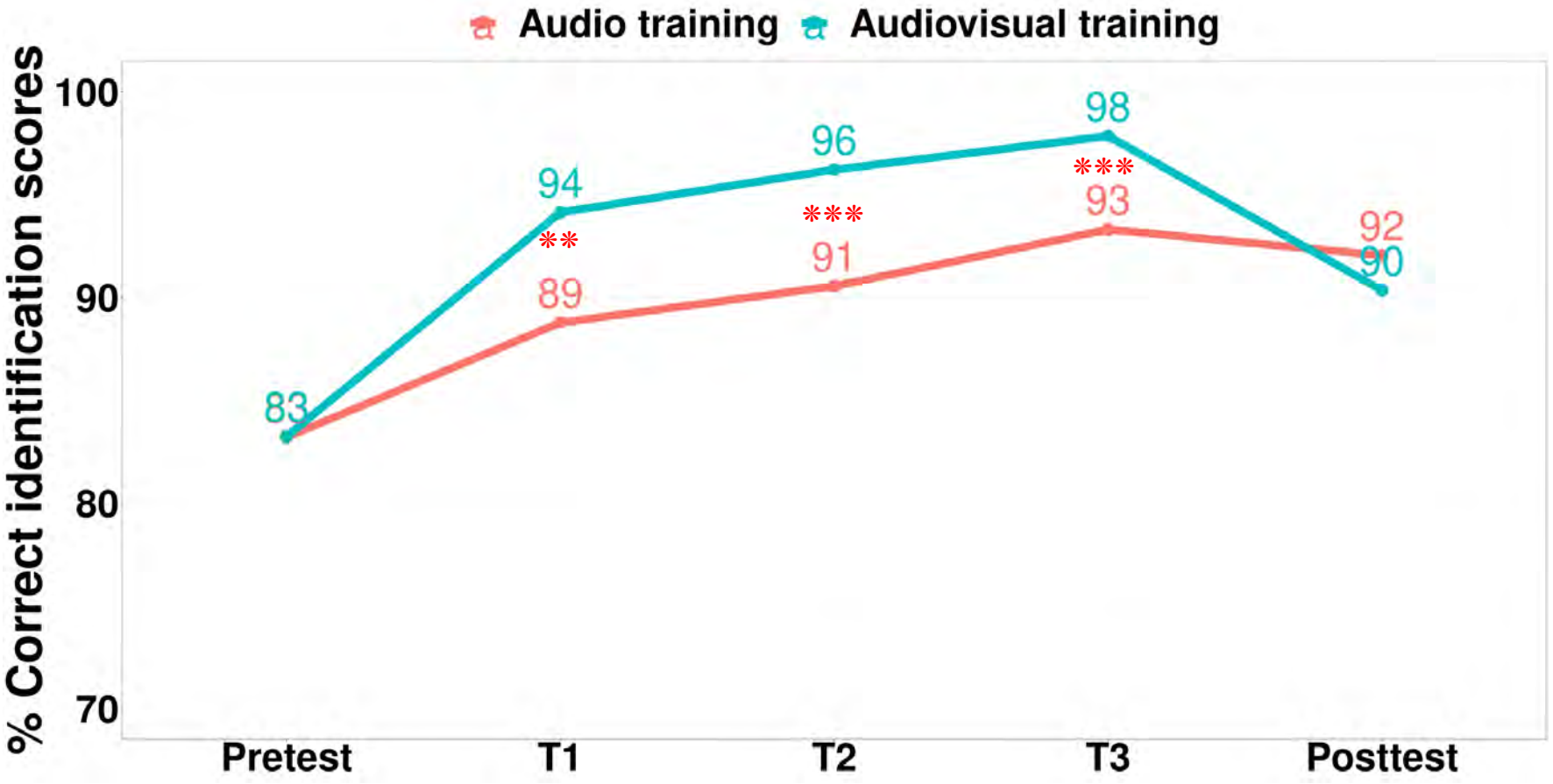
Perceptual accuracy of Korean vowels

- The hierarchy of difficulty of Korean vowel perception: **/o, ɨ, ʌ , u/ > /e, a, i/**
- Perception of all Korean vowels including difficult vowels to perceive **/o, ɨ, ʌ , u/** significantly improved.



Identification accuracy of individual Korean vowels at pre-test and post-test

Development of L2 perception during training



Development of perceptual accuracy of Korean vowels during online training sessions

Conclusions

- This study examined the effects of auditory and audiovisual perception training on the perception of Korean vowels by L2 English-speaking learners of Korean.
- Result 1: Both training groups significantly improved their perceptual accuracy of Korean vowels, suggesting that perceptual learning of L2 vowels can be enhanced by both methods of online training.
- **Results 2**: There was no significant difference between the two training groups at post-test, indicating that perceptual training with audiovisual tokens does not lead to a greater improvement in the perception of L2 vowels than training with only auditory tokens.
- Pedagogical implications: Innovative pedagogical tools such as web-based audiovisual and audio-only training programs can significantly improve learners' perception of L2 sounds in the context of online and distance learning.

Comments or Questions

Na-Young Ryu: nmr5569@psu.edu