Enhancing lip contrasts between /u/ and /y/ in Taiwan Mandarin

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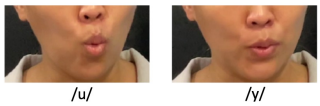
Introduction

- [round] of the lips provides more visual cues than [back] of the tongue [1].
- Feature [round] is associated with two postures:
  - ❖ *endolabial*: pull of corners of the lips together; more protrusion. E.g., /u/ [2].
  - ❖ *exolabial:* upper and lower lip approximation; less protrusion. E.g., /y/ [2].

	[back]	[round]
/u/	+	+
/y/	–	+


/u/ /y/

- Lip rounding is more of phonetic classification than phonemic identification [1].
  - ❖ Lip rounding can be individually variable [3].
  - ❖ Some speakers do not have rounded feature for English /ʃ/.

→ Lip postures appear a secondary articulation compared to tongue position.

Research Questions

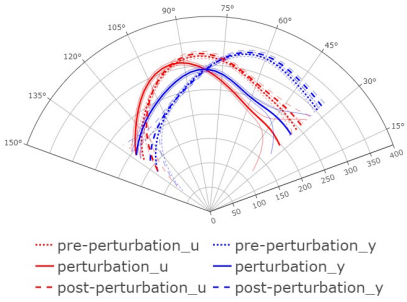
- What are the role of such secondary articulation and their indispensability?
- Specifically, can we reinforce/amplify the role of the lips during the production of high round vowels?

Methods

- Perturbation (an egg bolus) on tongue (cf. [4, 5]).
  → Enhanced lip contrasts are expected.
- Participants: 9 (6 females) native Taiwan Mandarin speakers, aged 20-27 (mean = 22.8; SD = 2.2).
- Conditions: Pre-perturbation (baseline), perturbation, post-perturbation
- Targets: 20 tokens of /u, y/ (self-paced).
- Measurements:
  - ➢ Tongue contours (ultrasound)
  - ➢ Lip aperture and protrusion (MediaPipe)
  - ➢ Acoustics: F1 ~ F3 (Praat)
- Analyses:
  - ➢ Generalized Additive Mixed Models (GAMMs) for tongue contours, lip aperture, lip protrusions, and acoustics.

Results

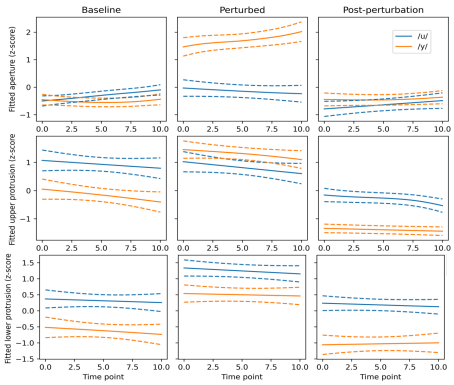
Tongue contours



- **GAMMs model:**
  bam(Y ~ Condition + s(X, by = Condition) + s(Participant, bs = 're'), data, discrete = TRUE, family = scat(), rho, AR.start)
- Contrastive tongue shapes for /u/ and /y/.
- When perturbed, tongue tip and blade were much depressed.

→ More comparable tongue shapes between /u/ and /y/.

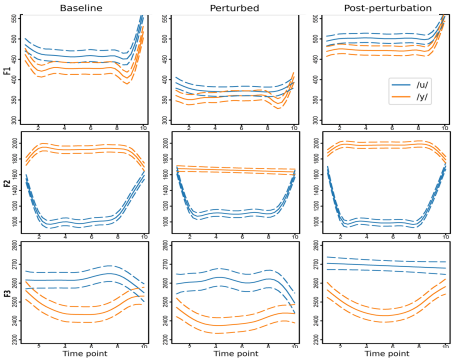
Lip measurements



- **GAMMs model:**
  bam(measurement ~ vowel + s(time_point, by=vowel) + s(participant, bs=c('re'), by=vowel) + te(time_point, token, bs=c('cr', 're'), by=vowel, rho, AR.start)
- Considering lip aperture, the contrast between /u/ and /y/ was enhanced when perturbed.
- Both lips were more protruded when perturbed.
- Overall, the lips were more protruded for /u/ than for /y/, except for the upper lip during production.

→ Contrastive lip postures in response to perturbation.

Acoustics



- **GAMMs model:**
  bam(formant ~ vowel+ s(timepoint, by = vowel) + s(Participant, bs = 're'), data, discrete = TRUE, family = scat(), rho, AR.start)
- Lower F1 was induced during perturbation → Tongue lowering.
- Perturbed /y/ was associated with lowered F2 → Bolus pushes the tongue back.
- Contrastive F2 and F3 between /u/ and /y/ were observed with and without perturbation.

Discussion

- During perturbation, the tongue was constrained. The acoustic contrasts between /u/ and /y/ can only be achieved by other articulatory gesture(s).
- Lip postures between /u/ and /y/ can be amplified when the primary articulatory contrasts of these vowels (i.e., tongue) are perturbed.
  - ❖ Lip contrasts are enhanced in lip aperture; much less so in protrusion.
  - ❖ More upper protrusion in perturbed /y/ may be resulted from lip approximation.

→Indispensability of the secondary articulation (i.e., lips) for these rounded vowels.

- Bolus perturbation may affect the degrees of lip aperture and protrusion. Future examination is required.
- Enhanced lip contrasts may be further validated through articulatory modelling.

References

[1] Lisker, L., & Rossi, M. (1992). Auditory and visual cueing of the [± rounded] feature of vowels. *Language and speech, 35*(4), 391-417.
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Lab website
Poster in .pdf