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# Dynamic tongue movements in L1 Japanese and L2 English liquids

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# The Japanese /r/ - /l/ problem

(Flege, J. E., Aoyama, K., & Bohn, O.-S., 2021, p. 84)

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- L1 categories influence L2 speech production:
  - Japanese (1 liquid: taps/flaps) vs English (2 liquids: /l ɹ/)
- "[N]ative Japanese speakers have little or no experience with the precise articulatory configurations required for English /ɹ/ and /l/ production" (Bradlow, 2008, p. 293)
- However, there isn't much articulatory research!

(cf. Masaki et al., 1996; Moore et al., 2018; Morimoto, 2021; Zimmermann et al., 1984)

- **Then, what exactly are we struggling with?**

(e.g., Flege, 1995; Gick, Bernhardt, Bascfalvi, Wilson & Oh, 2007; Harper, Goldstein & Narayanan, 2016)

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# English and Japanese liquids:
## Midsagittal ultrasound

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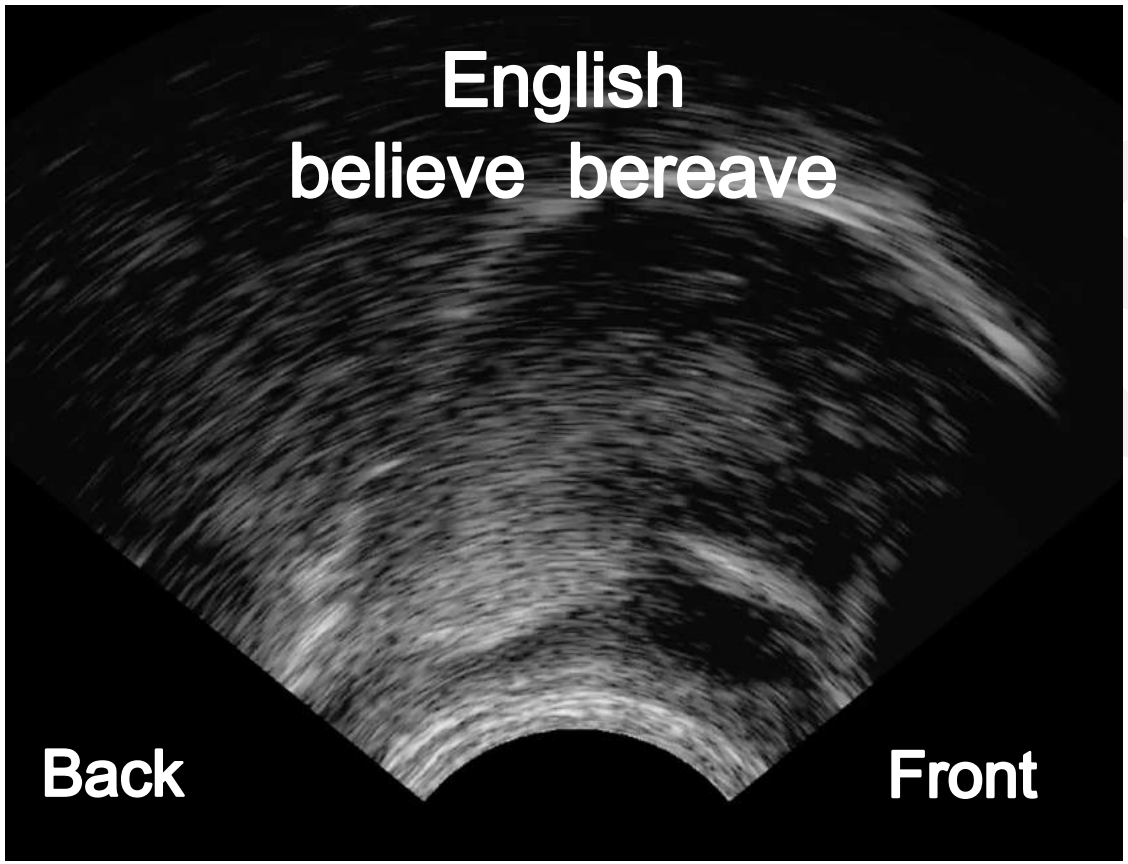


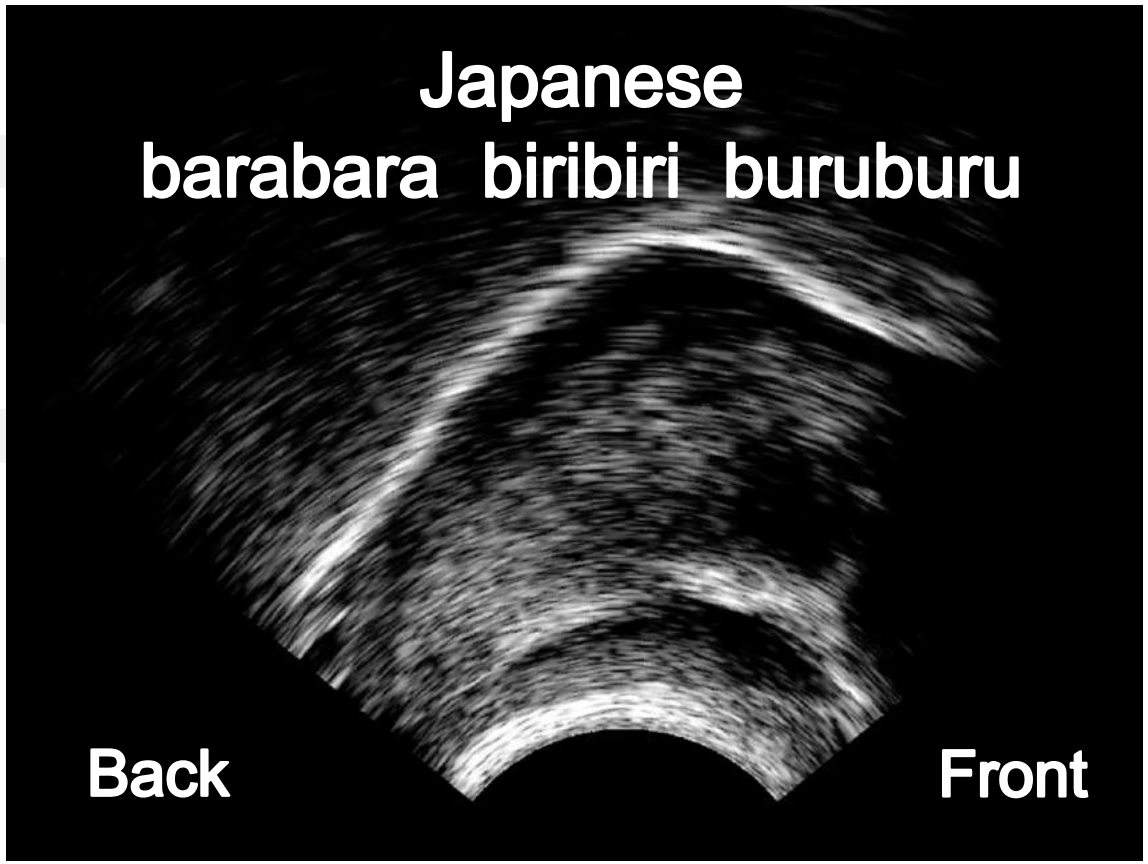

# Dynamics in English liquids

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- Japanese and English liquids may differ in gestural coordination:
  - English: Dynamic coordination of coronal and dorsal gestures.
  - Japanese: Coronal (and/or dorsal), strong vocalic coarticulation
    (e.g., Yamane, Howson & Po-Chun, 2015; Proctor, Walker, Smith, Szlay, Goldstein & Narayaan, 2019; Morimoto, 2020)
  - **Lack of tongue retraction** and **strong vocalic coarticulation** of Japanese [ɾ] may characterise L2 English liquids produced by L1 Japanese speakers (Zimmermann et al., 1984)
- However, existing studies are based on 'static' pictures at one point in time, when English liquids show dynamic characteristics in articulation.
- **Liquid-vowel dynamics may offer finer-grained accounts on the Japanese /r/-/l/ problem?**

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# Research question

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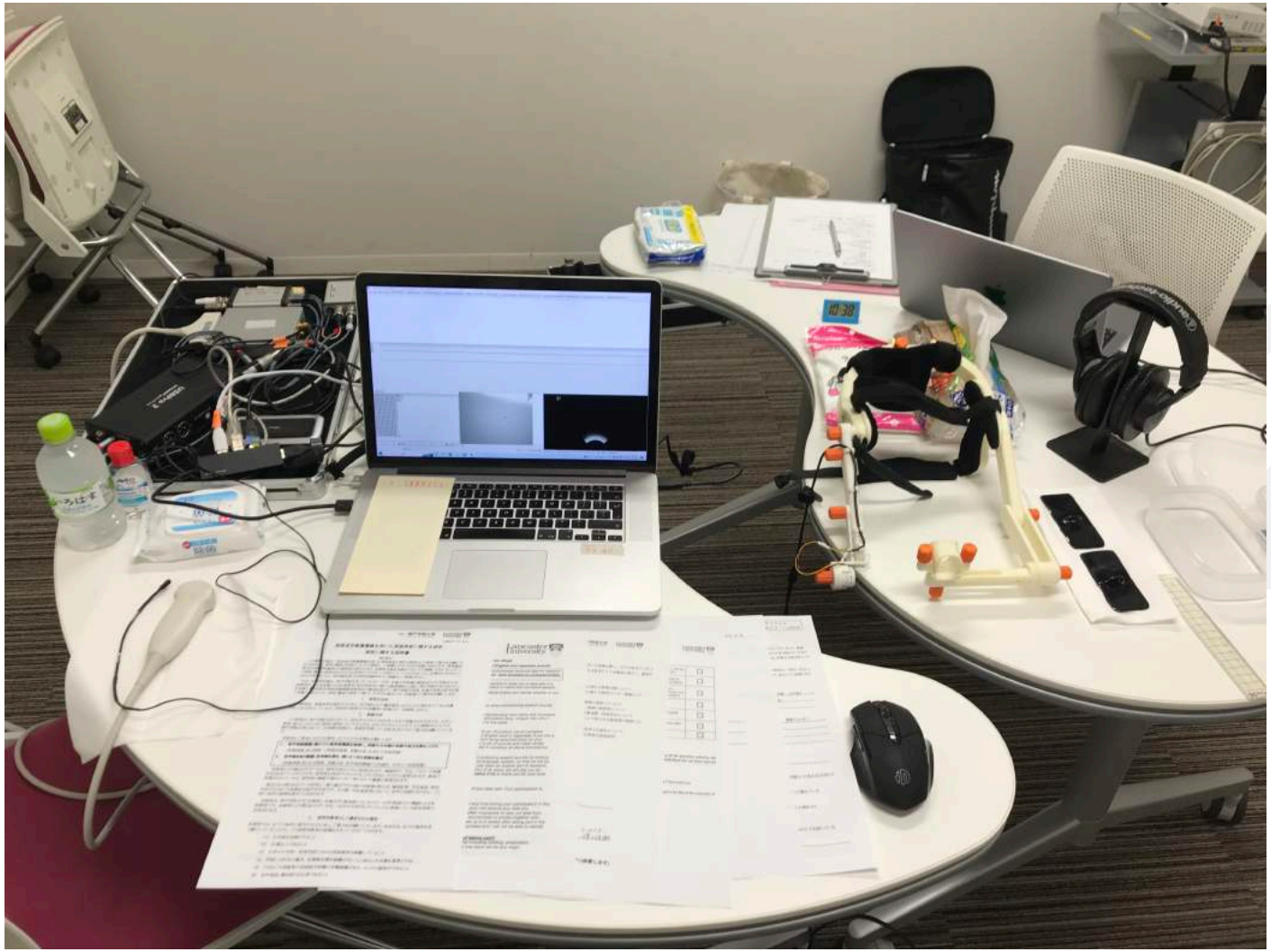
**What articulatory dimensions characterise L2 English liquids produced by L1 Japanese speakers?**

keywords: ultrasound / dynamic analysis



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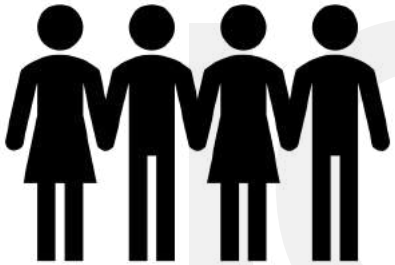
# Methods

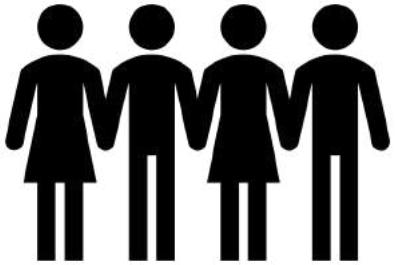
- Participants
- Recording
- Materials
- Analysis

# Participants



**L1 Japanese speakers (*N* = 17)**

- 8 female, 9 male ($M_{age}$ = 19.76, *SD* = 0.97)
- Studying English as a foreign language in Japan
- Overseas experience: ~ 4 months



**L1 North American English speakers (*N* = 12)**

- 10 female, 2 male ($M_{age}$ = 29.08, *SD* = 6.30)
- From US (*n* = 8) or Canada (*n* = 4)

# Materials

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## believe bereave biribiri（びりびり）

- Intervocalic syllable-initial liquids
- Read in isolation one by one
- Articulate Assistant Advanced (AAA)
  - 80mm depth
  - 100% FOV
  - ca. 80 frames per second
- 271 tokens in total

| | Speaker's L1 | | |
|---|---|---|---|
| | English | Japanese | **Total** |
| **Prompt** | | | |
| believe | 52 | 59 | 111 |
| bereave | 57 | 56 | 113 |
| biribiri | 0 | 47 | 47 |
| **Total** | 109 | 162 | 271 |

# Dynamic ultrasound analysis

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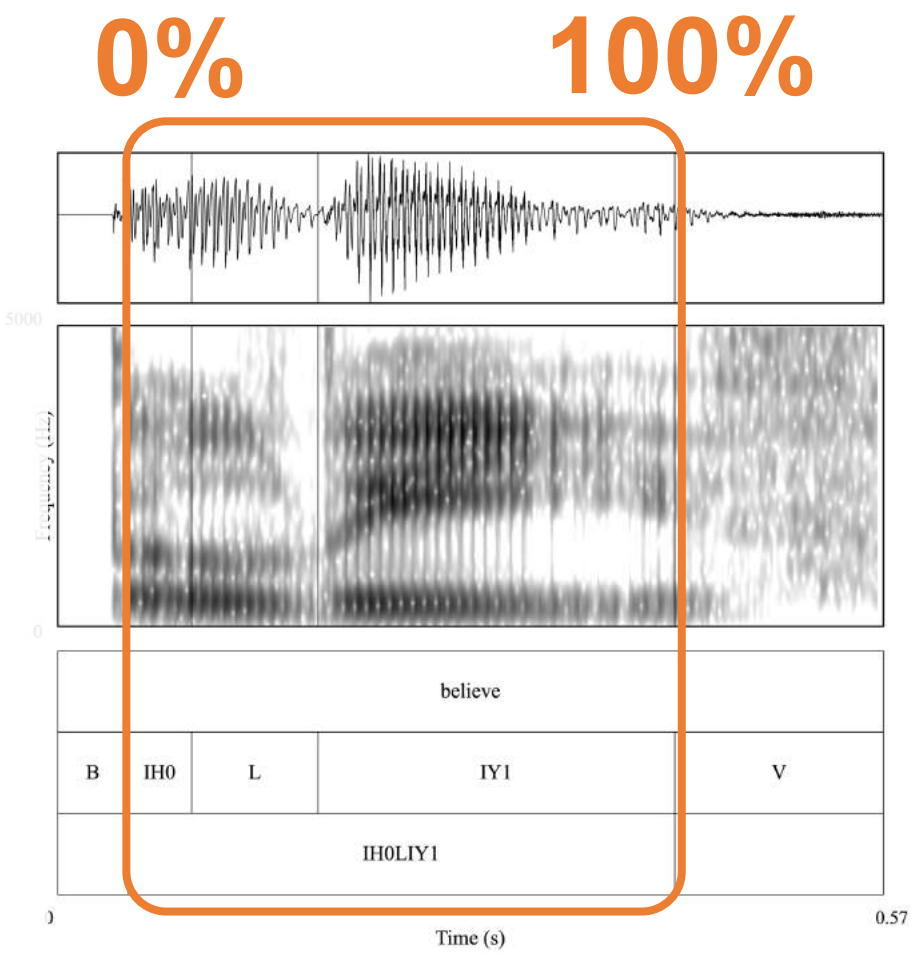
## Dynamic analysis

- Vowel – liquid – vowel intervals are delimited acoustically.

  b**elie**ve b**erea**ve b**iri**biri

- Tongue shapes are extracted at 11 equidistant timepoints **during the interval.**
  - Normalised time: 0% = V1 onset, 100% = V2 offset



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# Results

# Dynamic changes of PC1
(tongue retraction)

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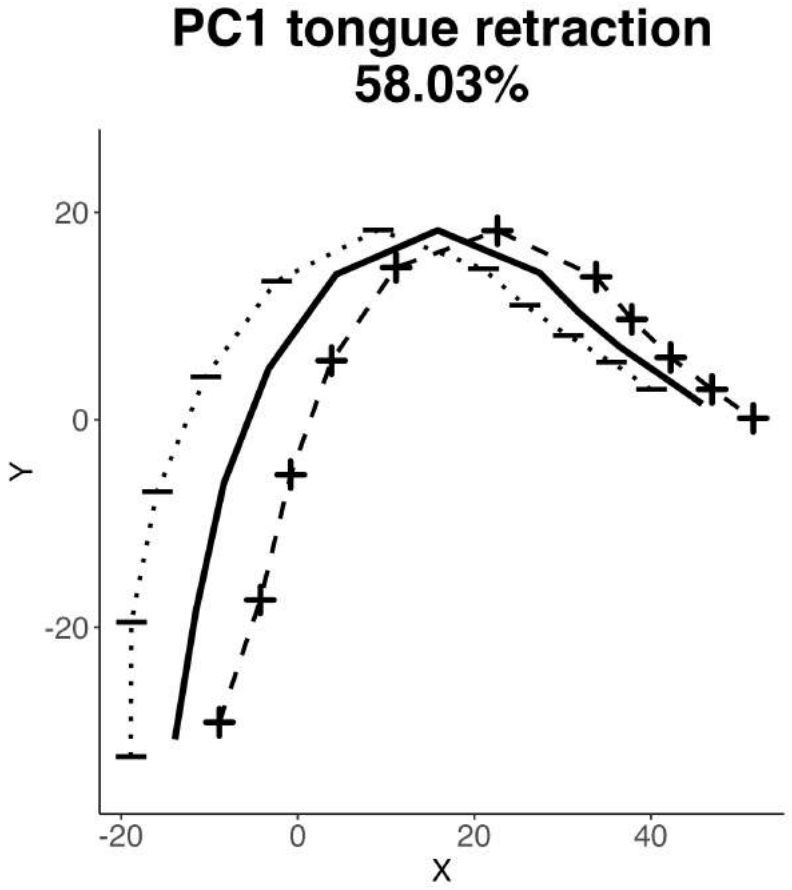


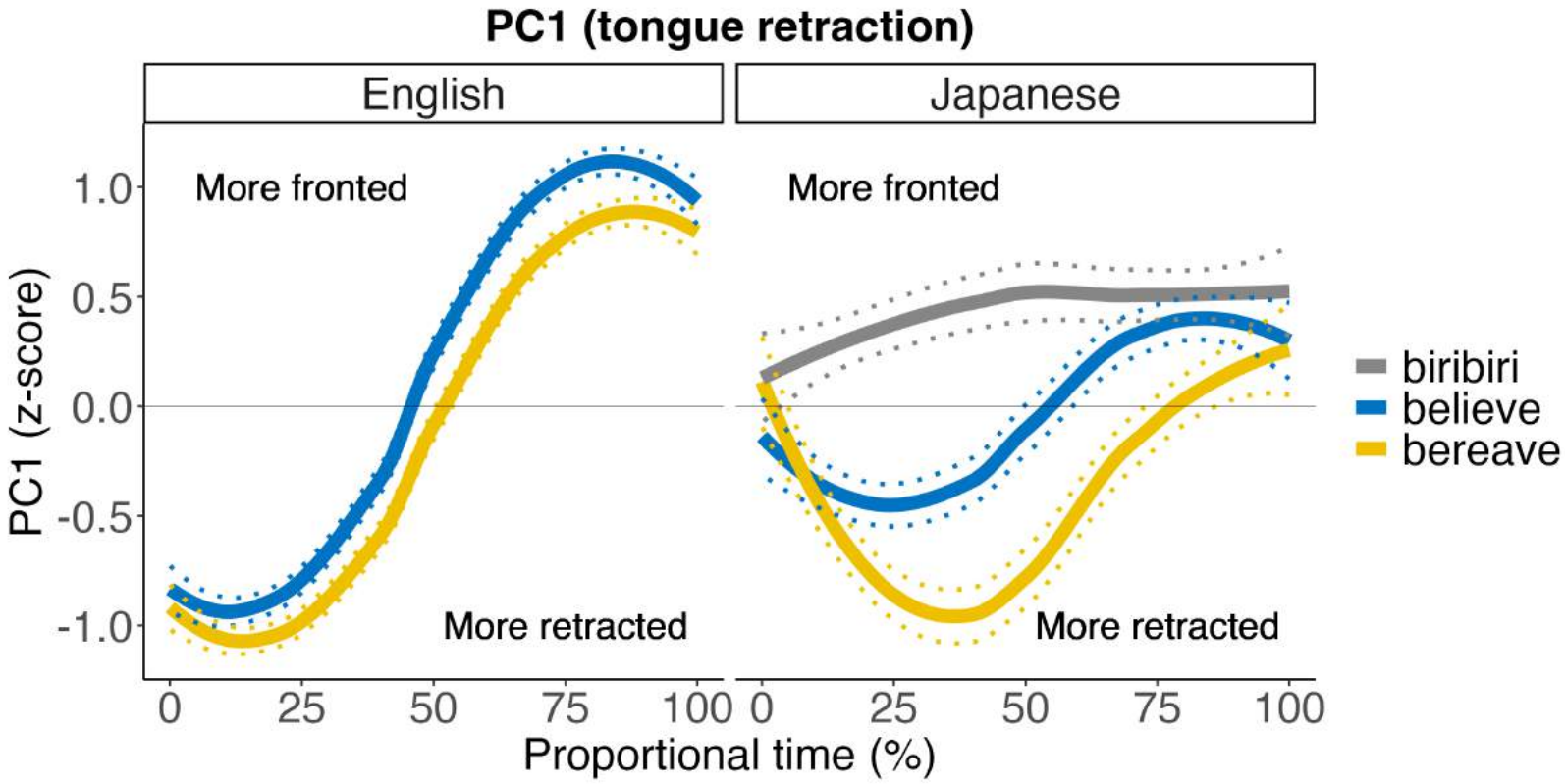

# Magnitude / Timing

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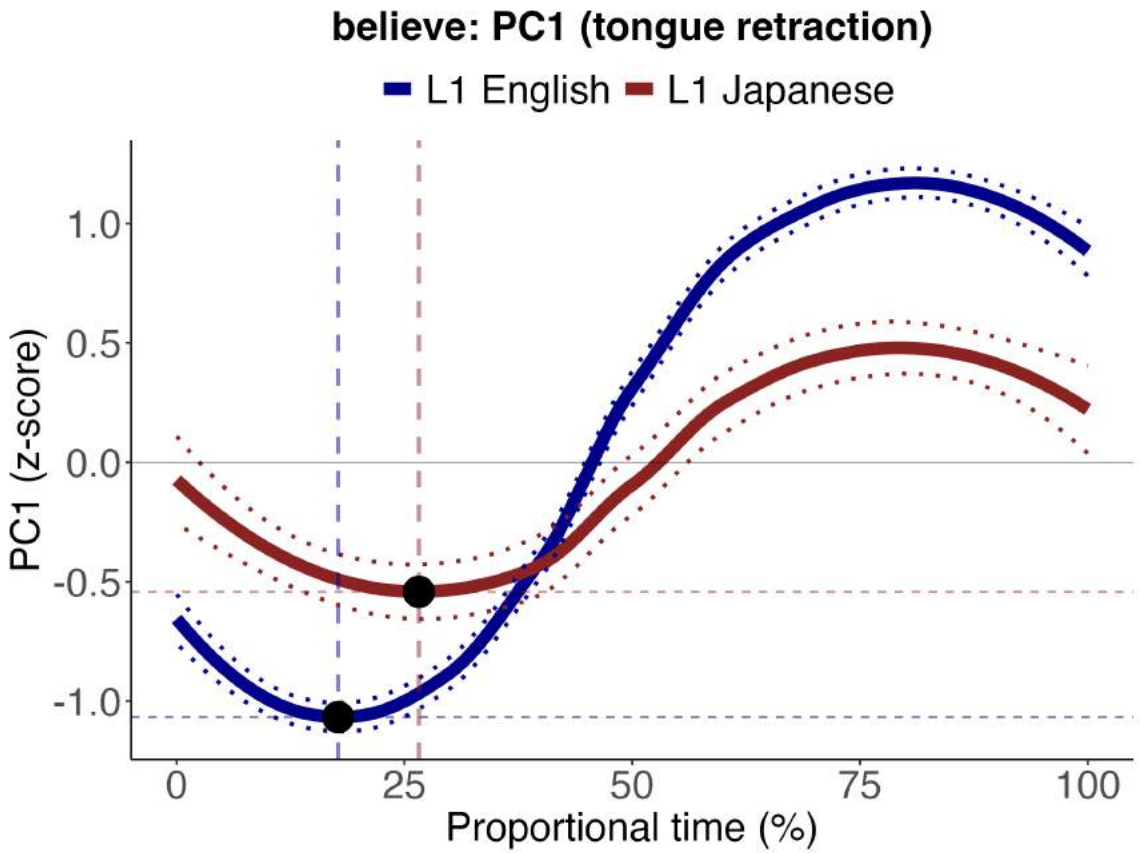
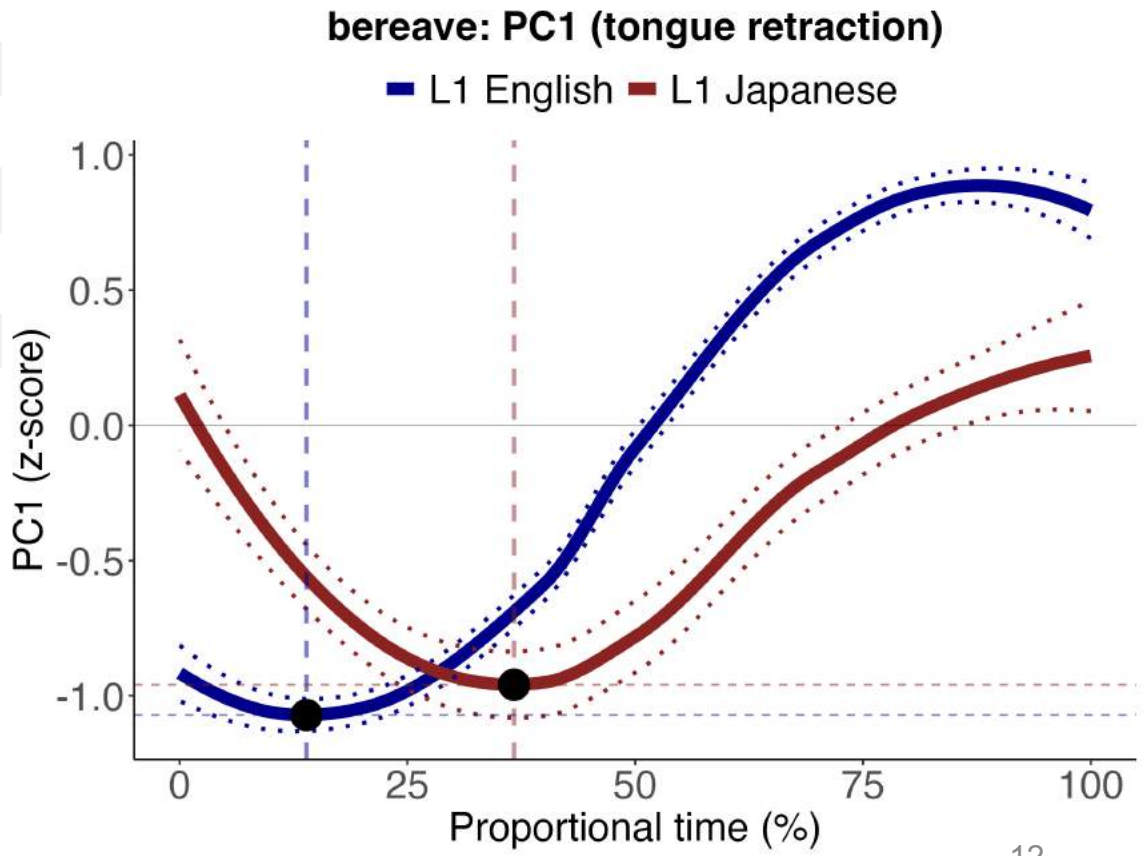
## believe




## bereave



# Discussion

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- **TD movement as 'L1 articulatory habit'**
  - Smaller degree of tongue retraction for /l/
  - Later achievement of tongue retraction for /ɹ/
  - cf. lack of tongue retraction, stronger vocalic coarticulation

    (Zimmermann et al., 1984)
- The liquid-vowel dynamics offers finer-grained accounts of the Japanese /r/-/l/ problem:
  - Dynamic information might be part of L2 phonological representation, similarly to vowels. (e.g., Schwartz and Kaźmierski, 2020)
  - How about acoustics? How about other vowel contexts?
  - Pronunciation teaching textbook?

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# Conclusion

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**What articulatory dimensions characterise L2 English liquids produced by L1 Japanese speakers?**

- **Overall smaller degree of tongue retraction**
- **Timing (/ɹ/) and magnitude (/l/) difference**

**What exactly are we struggling with?**

- **Tongue retraction (TD gesture)**

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# References (1/3)


- Flege, J. E., Aoyama, K., & Bohn, O.-S. (2021). The Revised Speech Learning Model (SLM-r) Applied. In R. Wayland (Ed.), *Second Language Speech Learning* (1st ed., pp. 84–118). Cambridge University Press. https://doi.org/10.1017/9781108886901.003
- Gick, B., Bacsfalvi, P., Bernhardt, B. M., Oh, S., Stolar, S., & Wilson, I. (2008). A motor differentiation model for liquid substitutions in children's speech. *Proceedings of the Meeting Acoustics*, *1*, 060003. https://doi.org/10.1121/1.2951481
- Harper, S., Goldstein, L., & Narayanan, S. S. (2016). L2 Acquisition and Production of the English Rhotic Pharyngeal Gesture. *Interspeech 2016*, 208–212. https://doi.org/10.21437/Interspeech.2016-658
- Moore, J., Shaw, J., Kawahara, S., & Arai, T. (2018). Articulation strategies for English liquids used by Japanese speakers. *Acoustical Science and Technology*, *39*(2), 75–83. https://doi.org/10.1250/ast.39.75

# References (2/3)


- Masaki, S., Akahane-Yamada, R., Tiede, M. K., Yasuhiro, S., & Fujimoto, I. (1996). An MRI-based analysis of the English /r/ and /l/ articulations. *Proceeding of Fourth International Conference on Spoken Language Processing.*, 1581–1584. https://doi.org/10.1109/ICSLP.1996.607922
- Morimoto, M. (2021). Articulatory Preference in Japanese Liquids and F3 in English: A Preliminary Report. *ICU Working Papers in Linguistics: Selected Papers from the 5th Asian Junior Linguists Conference (AJL5)*, *15*, 1–6.
- Morimoto, M. (2020). *Geminated Liquids in Japanese: A Production Study* [PhD Thesis, University of California Santa Cruz]. https://escholarship.org/uc/item/9sz2j7gd
- Proctor, M., Walker, R., Smith, C., Szalay, T., Goldstein, L., & Narayanan, S. (2019). Articulatory characterization of English liquid-final rimes. *Journal of Phonetics*, *77*, 100921. https://doi.org/10.1016/j.wocn.2019.100921

# References (3/3)


- Sheldon, A., & Strange, W. (1982). The acquisition of /r/ and /l/ by Japanese learners of English: Evidence that speech production can precede speech perception. *Applied Psycholinguistics*, *3*(3), 243–261. https://doi.org/10.1017/S0142716400001417
- Yamane, N., Howson, P., & Po-Chun (Grace), W. (2015, August). An ultrasound examination of taps in Japanese. *Proceedings of the 18th International Congress of Phonetic Sciences*. https://www.internationalphoneticassociation.org/icphs-proceedings/ICPhS2015/Papers/ICPHS0815.pdf
- Zimmermann, G. N., Price, P. J., & Ayusawa, T. (1984). The production of English /r/ and /l/ by two Japanese speakers differing in experience with English. *Journal of Phonetics*, *12*(3), 187–193. https://doi.org/10.1016/S0095-4470(19)30873-3

# Thank you!

**Any thoughts on tongue retraction?**
**(or any jobs?)**

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