Acquisition of articulatory dynamics in second language speech: Japanese speakers' production of English and Japanese liquids

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What articulatory mechanisms make it difficult for L1 Japanese speakers to produce L2 English liquids?

Background

- L1 categories influence L2 speech production [1].
  - Japanese: 1 liquid /r/ [ɾ]
  - English: 2 liquids /l ɹ/
- Lots of acoustic studies, but little articulatory research:
  - Previous articulatory descriptions suggest different degrees of **coarticulatory susceptibility** between English and Japanese liquids [2, 3].
  - Coarticulation needs to be acquired in L2 speech learning, suggesting **a need to look beyond the liquid segment itself** [4].
- L1 Japanese speakers might struggle to produce English /l ɹ/ **due to differences in liquid-vowel coarticulation.**

Methods

Participants:

- **29 L1 Japanese speakers**
  - Intermediate (*n* = 9)
  - Advanced (*n* = 20)
  - Grouping based on perception
- **14 L1 English speakers**
  - US English (*n* = 9)
  - Canadian English (*n* = 5)

Data collection/analysis:

- Simultaneous ultrasound + audio recording using AAA [5]
- Tongue movement tracked via DLC/AAA between **350 ms prior to acoustic liquid onset to vowel offset**

Word list and the number of tokens

Vowel	English /l/ (*n* = 1,309) / English /ɹ/ (*n* = 1,321)			Japanese /ɾ/ (*n* = 445)	
/i/	leaf / reef	leap / reap	leave / reeve	リーフ /ɾi:ɸu/	
/a/	lamb / ram	lamp / ramp	lap / rap	ラム /ɾamu/	ラフ /ɾaɸu/
/u/	loom / room	lube / rube		ルーム /ɾu:mu/	ループ /ɾu:pu/

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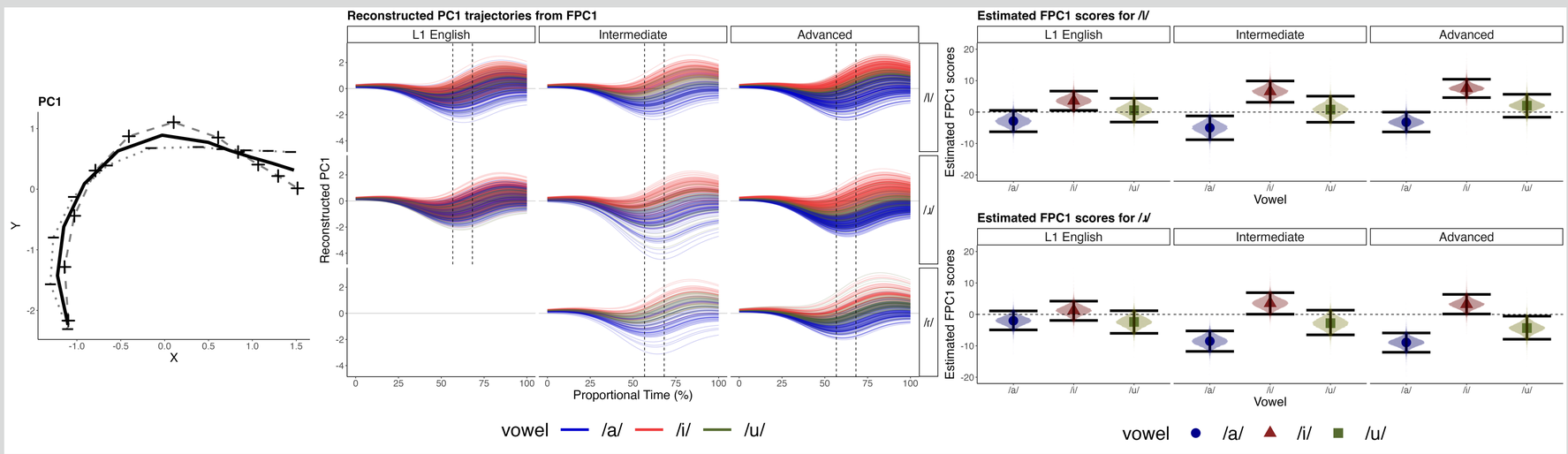
Results



1. Left: The Principal Component Analysis (PCA) identifies **tongue dorsum raising** (PC1) as the primary lingual dimension **explaining 39.28% of the variance in the data**.
   a. Followed by PC2 (30.59%) corresponding to the overall tongue fronting/raising.
2. Middle: Time-varying changes in PC1 scores suggest that **L1 Japanese speakers have distinct tongue dorsum movement patterns** across vowel contexts compared to L1 English speakers.
   a. **Higher FPC1 values = higher PC1 scores = more tongue dorsum raising.**
   b. FPC1 explains 57.93% of the variance, followed by FPC2 (24.56%).
3. Right: Bayesian mixed-effect modelling (right) indicates:
   a. **Little differences are found between the Intermediate and Advanced groups**.
   b. L1 English speakers exhibit **more FPC1 variability for /ɹ/** than for /l/, reflecting possible differences in the degree of **coarticulatory resistance**
   c. **L1 Japanese speakers exhibit more FPC1 variability** than L1 English speakers: smaller differences for English /l/ but greater differences for English /ɹ/ between L1 English and Japanese.

Discussion/Conclusion

1. L1 Japanese speakers show **greater variability in dorsal liquid-vowel coarticulation** than L1 English speakers for English /ɹ/.
2. Previous L2 research argues that **L1 Japanese speakers acquire English /ɹ/ more easily than English /l/** due to different degrees of perceptual dissimilarity [6]
   a. This suggests that **learning should be observed for English /ɹ/ before English /l/**.
3. Given this, this study suggests that **active control over tongue dorsum movement can be a difficulty for L1 Japanese speakers when producing liquid-vowel sequences.**

References

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