# What we know about what we've never heard: evidence from production

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## Introduction

***How do learners arrive at a complete grammar from inconclusive evidence?*** Two positions:

1) When the data support only a partial constraint ranking, learners pick a complete ranking at random knowing that any ranking they choose will be consistent with the data (Tesar & Smolensky 2000)
2) Ranking reflects the initial state, e.g, M >> F (Smolensky 1996)
   - ❖ Support for initial state markedness rankings comes from studies showing listener preference for unmarked structures despite having no direct experience (e.g., Berent et al. 2007).
   - ❖ However, some researchers have also pointed out problems with Berent et al's methodology and raised alternative interpretations of the results (e.g., Peperkamp 2007; Davidson 2011).

*Japanese high vowel deletion offers a novel test of these positions*

## Background

Our past work has shown that the lingual target of the high vowel /u/ in Japanese optionally deletes between voiceless consonants, giving rise to heterosyllabic consonant clusters, e.g.:

/ʃutaisei/ → [ʃ.tai.sei]~[ʃu̥.tai.sei]
/ɸusoku/ → [ɸ.so.ku]~[ɸu̥.so.ku]

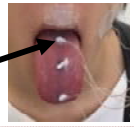
(Shaw & Kawahara, 2018a, 2018b, 2018c)

- ❖ Vowel deletion probability varies across items, possibly due to constraints on syllable contact (but the data were thin: one item each)
- ❖ Due to the absence of voicing, vowel presence/absence can be difficult for language learners to detect in the acoustic signal.
- ❖ When parsing weak signals, listeners rely more on prior expectations, making for insightful probes into latent phonological knowledge.

## This study

**Main question**: Is vowel deletion more likely when it leads to consonant clusters with less marked syllable contact? Here, we test: **sonority plateau (fricative-fricative)** vs. **sonority fall (fricative-stop)**

Since the acoustic signal is ambiguous with respect to presence/absence of the vowel, we used Electromagnetic Articululography to track the movement of the **tongue dorsum**



**Participants**: seven (four male) Tokyo natives aged 19-22
**Materials**: near minimal pairs with voiced/voiceless /u/ read in carrier phrase: *o:ke: ___ to it:e* 'okay, say ___'; 10-15 repetitions per word.

**SONORITY PLATEAU**

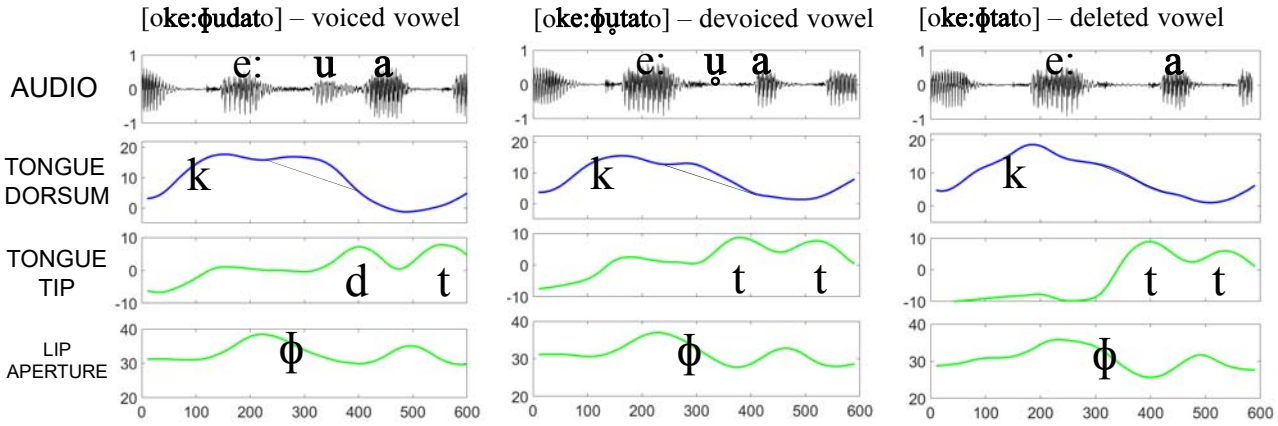
| Fricative Fricative (FF) | |
|---|---|
| Voiced (control) | Devoiced (test) |
| ɸuzoku 'attached' | ɸusoku 'shortage' |
| ɸuzai 'absence' | ɸusai 'couple' |
| ɸuzakeru 'to frolic' | ɸusagaru 'to be closed' |

**SONORITY FALL**

| Fricative Stop (FS) | |
|---|---|
| Voiced (control) | Devoiced (test) |
| ɸudo: 'immobility' | ɸuton 'mattress' |
| ɸudan 'ordinary' | ɸutan 'responsibility' |
| ɸuda 'brevity' | ɸuta 'lid' |

**Analysis:** analysis of tongue dorsum trajectories followed Shaw & Kawahara (2018a); the posterior probability of vowel deletion in devoiced contexts was computed using a Bayesian classifier trained on Discrete Cosine Transform coefficients fit to voiced vowel and vowel-absent (linear interpolation) trajectories. Effect of syllable contact on posterior probabilities was assessed using mixed effects models.

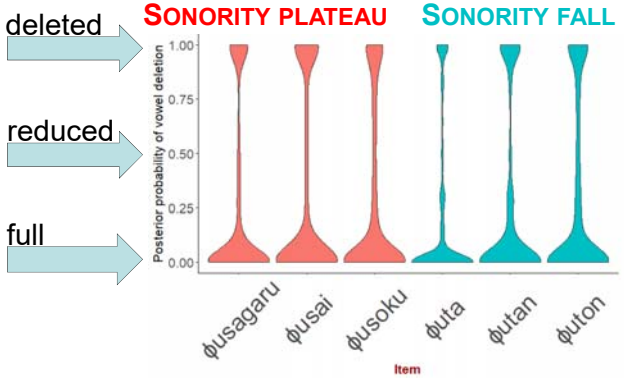
## Example movement trajectories




## Posterior probability of deletion in devoicing environments

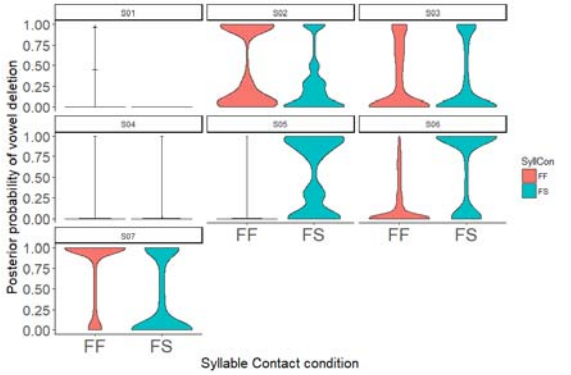
### Items analysis

no difference between sonority sequencing conditions




| Comparison of nested Linear Mixed Effects models | Df | AIC | Chisq |
|---|---|---|---|
| deletion_prob ~ (1\|Subject)+(1\|Item) | 4 | 29734 | |
| deletion_prob ~ (1+Sonority\|Subject)+(1\|Item) | 6 | 25721 | 4017*** |
| deletion_prob ~ Sonority+ (1+Sonority\|Subject)+(1\|Item) | 7 | 25723 | 0.16 (n.s.) |

### Subjects analysis




**FOUR DIFFERENT PATTERNS**

1) No vowel deletion (S01, S04)
2) Equal vowel deletion for FS & FF (S02, S03)
3) TETU – more deletion in FS than FF (S05, S06)
4) Reverse TETU – more deletion in FF than FS (S07)

## Discussion and Conclusion

Japanese high vowel deletion provides the right kind of case study for assessing latent phonological knowledge; because of weak perceptual cues to vowel deletion, it is difficult for learners to track the conditioning environments for deletion.

- ❖ Lacking clear evidence in the input for deletion environments, learners appear to **rank syllable contact constraints randomly**; of five possible patterns, four of them are attested in our sample of seven speakers.

Syllable contact constraints **are active** in conditioning deletion patterns but only on a speaker-specific basis.

- ❖ Supports the view that in the absence of direct evidence, listeners will randomly choose a full grammar, leading to speaker-specific variation in production
- ❖ Also accords with Tesar and Smolensky claim that learnability via constraint demotion requires a fully-ranked hierarchy.

**References: Berent, I., Steriade, D., Lennertz, T., & Vaknin, V.** (2007). What we know about what we have never heard: Evidence from perceptual illusions. *Cognition, 104*, 591-630. **Davidson, L.** (2011). Phonetic, phonemic, and phonological factors in cross-language discrimination of phonotactic contrasts. *Journal of Experimental Psychology: Human Perception and Performance, 37*(1), 270. **Peperkamp, S.** (2007). Do we have innate knowledge about phonological markedness? Comments on Berent, Steriade, Lennertz, and Vaknin. *Cognition, 104*, 631-637. **Shaw, J. A., & Kawahara, S.** (2018a). Assessing surface phonological specification through simulation and classification of phonetic trajectories. *Phonology, 35*(3), 481-522. **Shaw, J. A., & Kawahara, S.** (2018b). *Consequences of High Vowel Deletion for Syllabification in Japanese*. Paper presented at the Annual Meetings on Phonology (AMP 2017), New York University. **Shaw, J. A., & Kawahara, S.** (2018c). The lingual articulation of devoiced /u/ in Tokyo Japanese. *Journal of Phonetics, 66*, 100-119. **Smolensky, P.** (1996). *The initial state and 'Richness of the Base' in Optimality Theory* (JHU-CogSci-96-4). **Tesar, B., & Smolensky, P.** (2000). *Learnability in Optimality Theory*. Cambridge, Mass.: MIT Press.