The effect of language proficiency on patterns of epenthesis by Persian learners of English

Noah Khaloo - University of California, San Diego
Connor Mayer - University of California, Irvine

Research Question(s)

What are the underlying mechanisms behind the observable patterns of L1 and L2 epenthesis. Specifically, how to explain:

- frequency of epenthesis in different contexts
- location of epenthetic vowel within an utterance

Specific question: What does the interaction between language proficiency and epenthesis patterns tell us about these mechanisms?

Vowel Epenthesis

The insertion of a vowel that is not present in the underlying representation of an utterance (Hall 2011)

- Commonly used in L2 acquisition to repair complex onsets that are not present in L1

Asymmetric patterning of L2 epenthesis

Anaptyxis: The placement of the epenthetic vowel *within* the consonant cluster

(/pliz/ ‘please’ → [pe.liz])

- Typically occurs within obstruent + sonorant clusters (Fleischhacker, 2001)

Prothesis: The placement of the epenthetic vowel *before* the consonant cluster

(/stɑp/ ‘stop’ → [**e**stɑp])

- Typically occurs before sibilant + C clusters (Fleischhacker, 2001)

This asymmetry can be thought of as a reflection of ‘splittability’. How likely is it that particular onset can be split, and what are the mechanisms behind this?

What drives ‘splittabilty’?

Sonority: roughly loudness, openness, resonance (Clements 1990)

Complex onsets can be defined in terms of *sonority deltas*

- Difference between sonority of second and first sounds
  Δ(/st/) = −1 Δ(sn) = 1 Δ(/θɹ/) = 2 Δ(/pl/) = 3

Sonority-based theoretical accounts

Onsets with larger sonority deltas are less marked and more splittable (Singh 1985)

/sC/ (marked onsets with lower sonority deltas) are represented as single, complex segments, and can't be split (Broselow 1987, 1992, 1993)

'Splittability' follows from an innate preference for a drop in sonority across syllable boundaries (Gouskova 2001)

Phonetically-based accounts

Perceptual distance: Location of the epenthetic vowel occurs due to **minimization of perceptual distance** between input and output representations (Fleischhacker, 2001)

- E.g: [epliz] for ‘please’ would be more perceptually ‘damaging’ than [peliz]

Articulatory: Clusters that aren’t very splittable require more precise coordination between articulators, requiring tighter timing restrictions (Hall, 2003)

- sC clusters show **greater gestural overlap** and less variability than other CC clusters (e.g. Pouplier et al. 2022) thus making them harder to be split

Epenthesis usage amongst native speakers of Persian

Native persians who have learned English as their L2 tend to follow the following pattern of epenthesis usage: əST, əSN, əSL, TəR (e.g., Fleischhacker, 2001)

Examples:

- /skul/ ‘school’ → [eskul] (prothesis)
- /brɪŋ/ ‘bring’ → [berɪŋ] (anaptyxis)

Why research this topic?

- L2 speakers' epenthesis rates decline with increased proficiency (Yazawa et al. 2015). This research does not consider the different types of epenthesis.

- Unmarked complex onsets (SSP abiding) are repaired less frequently by L2 learners (Carlisle 2001)

- It has also been shown that unmarked onsets are more easily acquired than marked clusters by children (Geirut 1999)

- Is the rate of improvement for anaptyxis and prothesis in L2 speakers the same? Do we acquire all complex onsets at the same rate?

Hypothesis

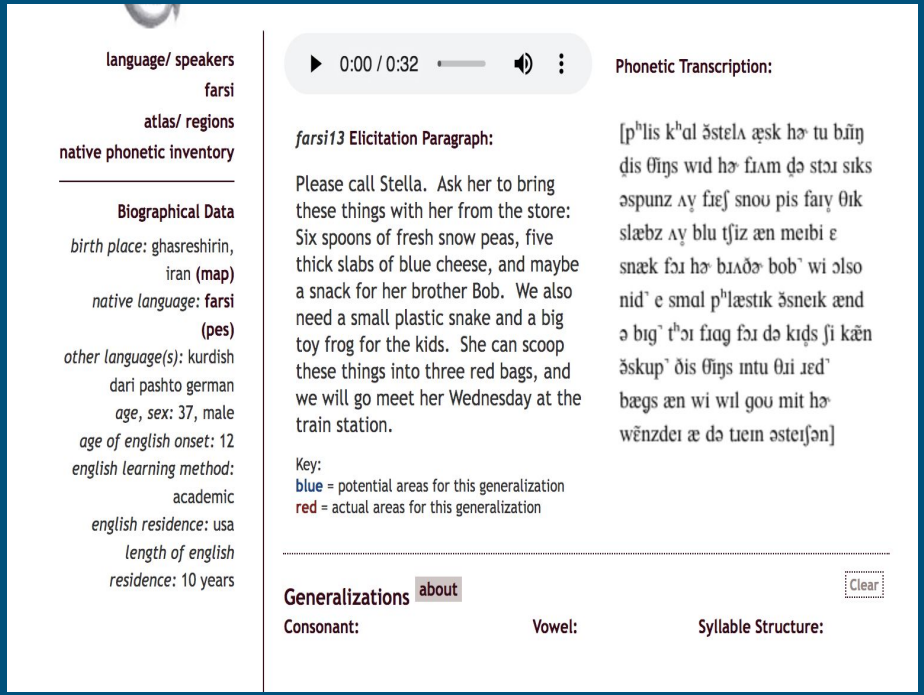
- Considering the patterns of epenthesis amongst Persian English learners, we predict that as L2 (English) proficiency rises, rates of anaptyxis use decline at a faster rate than do prothesis rates

- For example, we predict that a low-proficiency speaker might use both anaptyxis and prothesis in their respective contexts (see slide 5), while a more proficient speaker might only use prothesis and be able to successfully produce obstruent + sonorant onsets without repair

Data Collection

- https://accent.gmu.edu/ (Speech Accent Archive)

- 32 pre-recorded Persian natives who have learned English as a second language reading a passage



Statistical analysis

For this study, we recorded each instance of a disegmental onset produced by each speaker

Statistical analysis using *multinomial mixed effects logistic regression*

Dependent variable: *Epenthesis type* (none, anaptyxis, prothesis)

Independent variables:

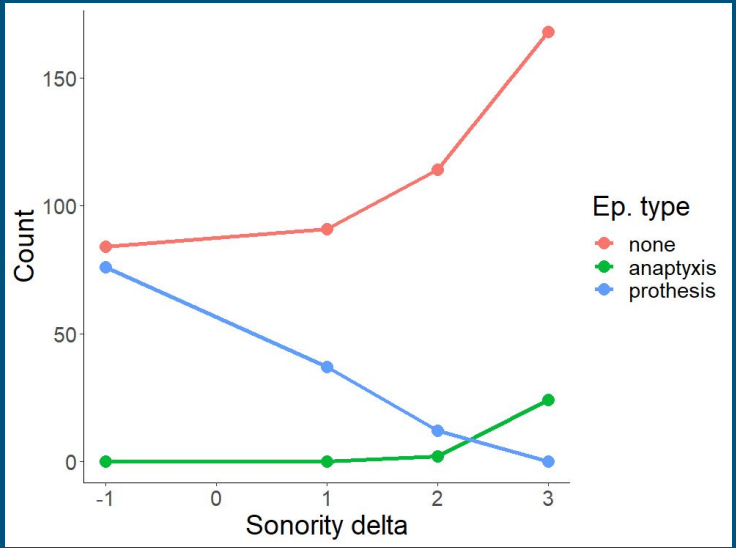
- *Sonority delta*
- *Age of English onset*
- *Presence of preceding vowel*
- *Cluster identity (/sn/, /pl/, etc.)*

Random intercepts for *speaker* and *word*

Results (sonority delta)

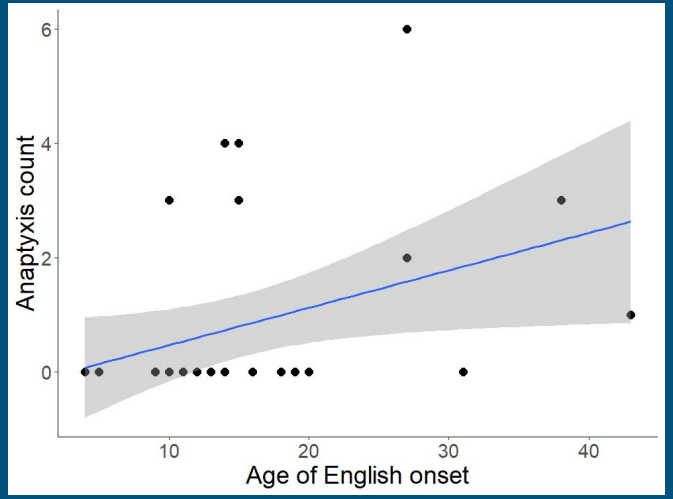
Overall rates of epenthesis decrease as sonority delta increases

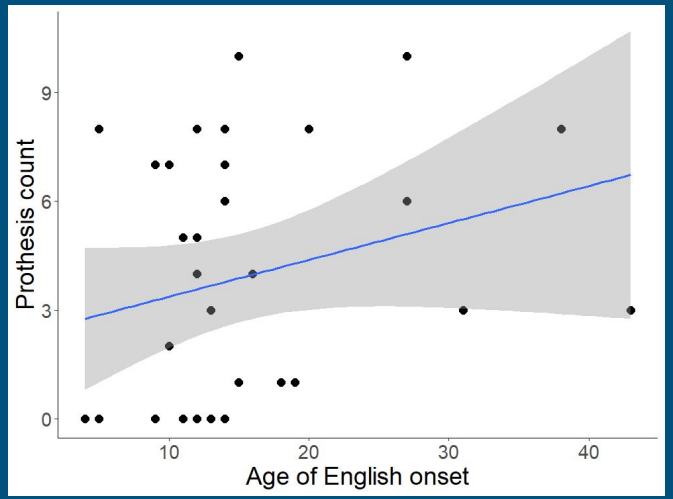
- Relative rate of **anaptyxis** increases
- Relative rates of **prothesis** decreases



Results (onset age)

Higher English onset age corresponds to higher rates of both anaptyxis and prothesis

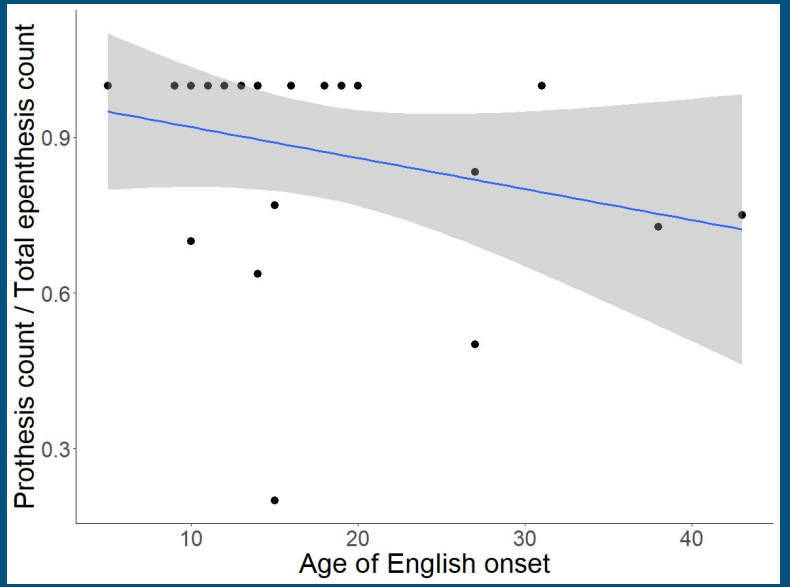




Results (onset age)

As **age of onset** goes up, a greater proportion of total epenthesis use is **anaptyxis**

- Not quite significant, but close!
- Trending in the expected direction



Discussion

Results confirm aspects of previous studies

- Onsets with low sonority deltas produce greater rates of epenthesis
- Onsets with low sonority deltas prefer prothesis
- Epenthesis rates decrease with language ability

New finding

More adept speakers improve at clusters where anaptyxis is used (obstruent + sonorant onsets) faster than clusters where prothesis is used (sibilant + C)

Not straightforwardly captured by perceptual account

- Accounts for position of epenthesis but not difference in learning rates

Consistent with articulatory account

- Contexts where anaptyxis occurs require less precise coordination and timing to produce, potentially making them **easier** to acquire
- Contexts where prothesis is used have greater degrees of gestural overlap and more precise timing, potentially making them **harder** to acquire

Limitations and further study

Speaker proficiency is not well-balanced in the corpus

- Most speakers learned English early
- Onset age is a coarse measure of proficiency

We are collecting new data from Persian English learners

- Sample a wider range of onset ages
- Assess participant language proficiency using LEAP-Q (Blumfield & Kaushankaya 2007)

Goal: collect richer data that we can use to confirm observations from corpus, and gain greater insight into the acquisition of complex onset clusters

Appendix Slides

Minimization of perceptual distance

- Fleischhacker (2001) proposes that the placement of the epenthetic vowel within loanwords is dependent on the minimization of perceptual distance between input and output representations
- She proposes the following hierarchy using the DEP-V/X_Y constraint that penalizes insertion of a vowel that is not present in the input representation:
- DEP-V/S_T » DEP-V/S_N » DEP-V/S_L » DEP-V/T_R
- “T”, “R”, and “S” represent the class of stops, resonants (nasals, liquids, and glides), and sibilant fricatives

Articulatory phonology

- Articulatory phonology is the idea that each segment has multiple articulatory gestures that are regulated by a phonological grammar (Browman & Goldstein 1986)
- In temporal order, the gestural landmarks are onset, target, center, release, and offset
- Hall (2003) proposes a general constraint, applying to all consonants, requiring alignment of C1's release to C2's target (/st/)
- She proposes a more specific constraint for obstruent-sonorant clusters requiring obstruent C1's center to be aligned with sonorant C2's onset, a configuration that results in an excrescent vowel (/pl/)
- least likely to trigger excrescent vowel - most likely to trigger excrescent vowel:
- obstruents < glides, nasals (within which m < n) < r < l < , < gutturals

Statistical analysis

Statistical analysis using *multinomial mixed effects logistic regression*

- *Multinomial logistic regression*: prediction over > 2 categorical outcomes
  - Here three possibilities: No epenthesis, anaptyxis, prothesis
- *Mixed effects* allows idiosyncratic variation across speakers/words to be incorporated into the model

Fit using the *brms* R library (Burkner 2017)

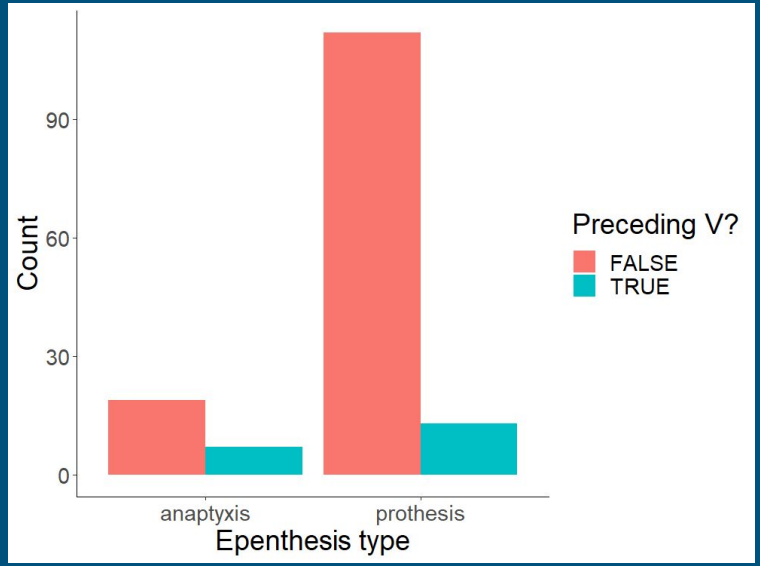
- We report 95% Bayesian confidence intervals rather than *p*-values

Results (preceding vowel)

A **preceding vowel**

- Decreases the likelihood of prothesis
  - none vs. prothesis: β = -3.83, 95% CI = [-5.81, -1.42]

- No effect on likelihood of anaptyxis
  - none vs. anaptyxis: β = -0.75, 95% CI = [-5.05, 3.51]
  - Trending in same direction as prothesis



Results (cluster identity)

Only two of the 12 clusters had significant effects

- /sl/ and /sn/ more likely to undergo prothesis than sonority delta predicts
- Previous studies of L2 learning find similar effects (TODO)