jTRACE modeling of L2 Mandarin learners' spoken word recognition at two time points in learning

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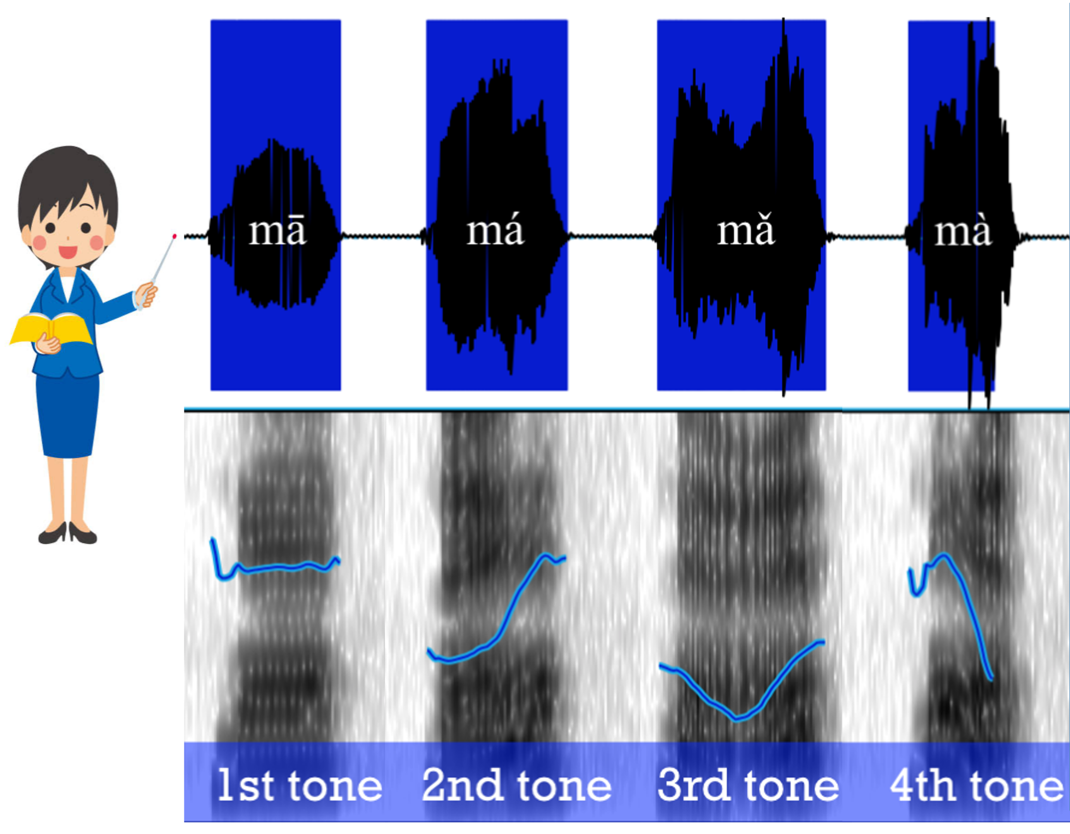
Mandarin Tones



Word recognition in Mandarin requires knowledge of both:

- segmentals
- suprasegmentals

Tones are in order from 1-4 with the estimated F0 track highlighted by the blue line.

Eye-Tracking

Participants:

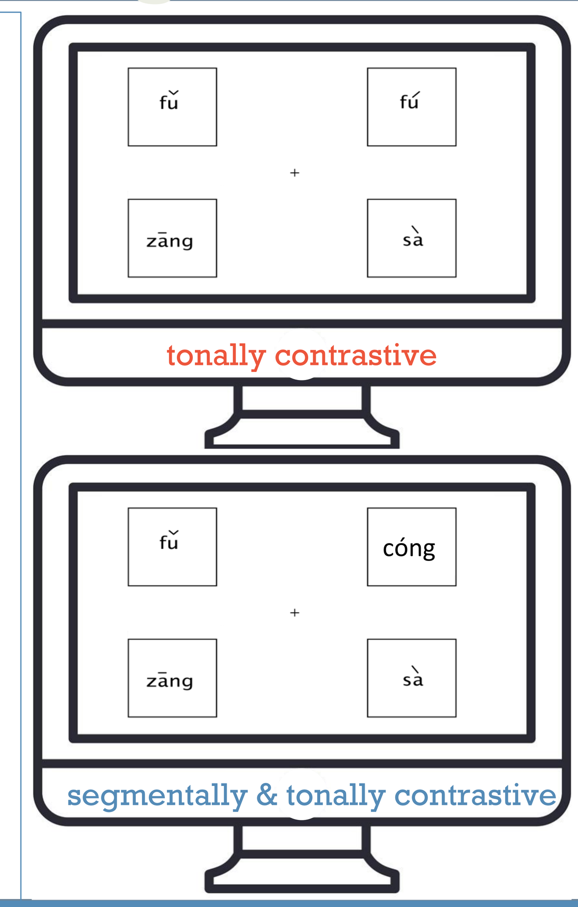
- 15 L1 English L2 Mandarin adults
- First semester in-person class
- No heritage speakers
- All participants passed pitch perception test (20Hz)

Materials:

- 48 segmentally identical and tonally contrastive items
- 72 segmentally and tonally contrastive items
- Counterbalanced design

Procedure:

- Tested at two time points:
  - week 1
  - week 15



Modeling Word Recognition in a Tonal Language: adding a layer

TRACE model

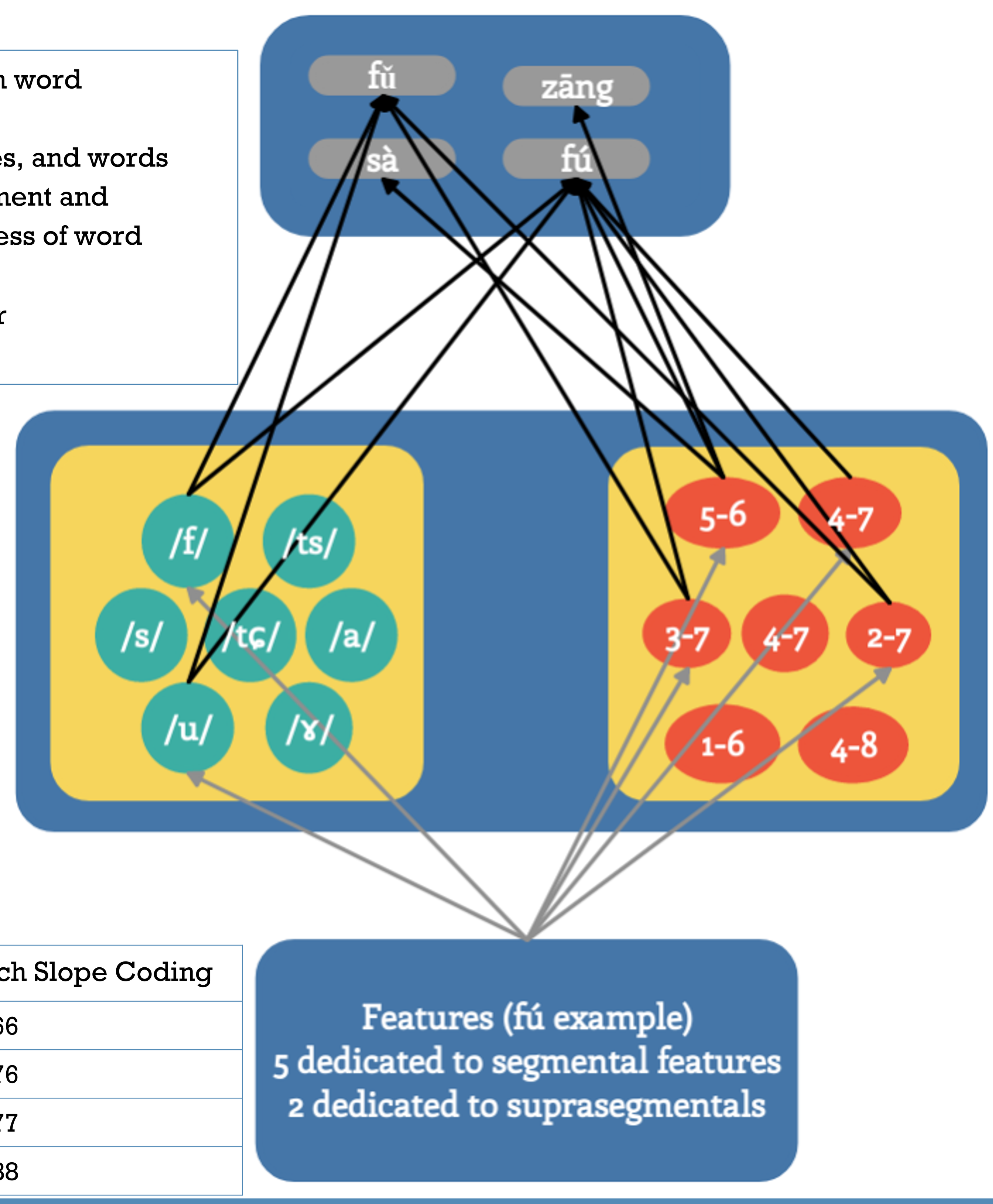
- Connectionist model of spoken word recognition
- Three tiers: features, phonemes, and words
- Dynamic: tiers activate excitement and inhibition throughout the process of word recognition [4, 5]
- Did **NOT** originally account for **suprasegmental** information.

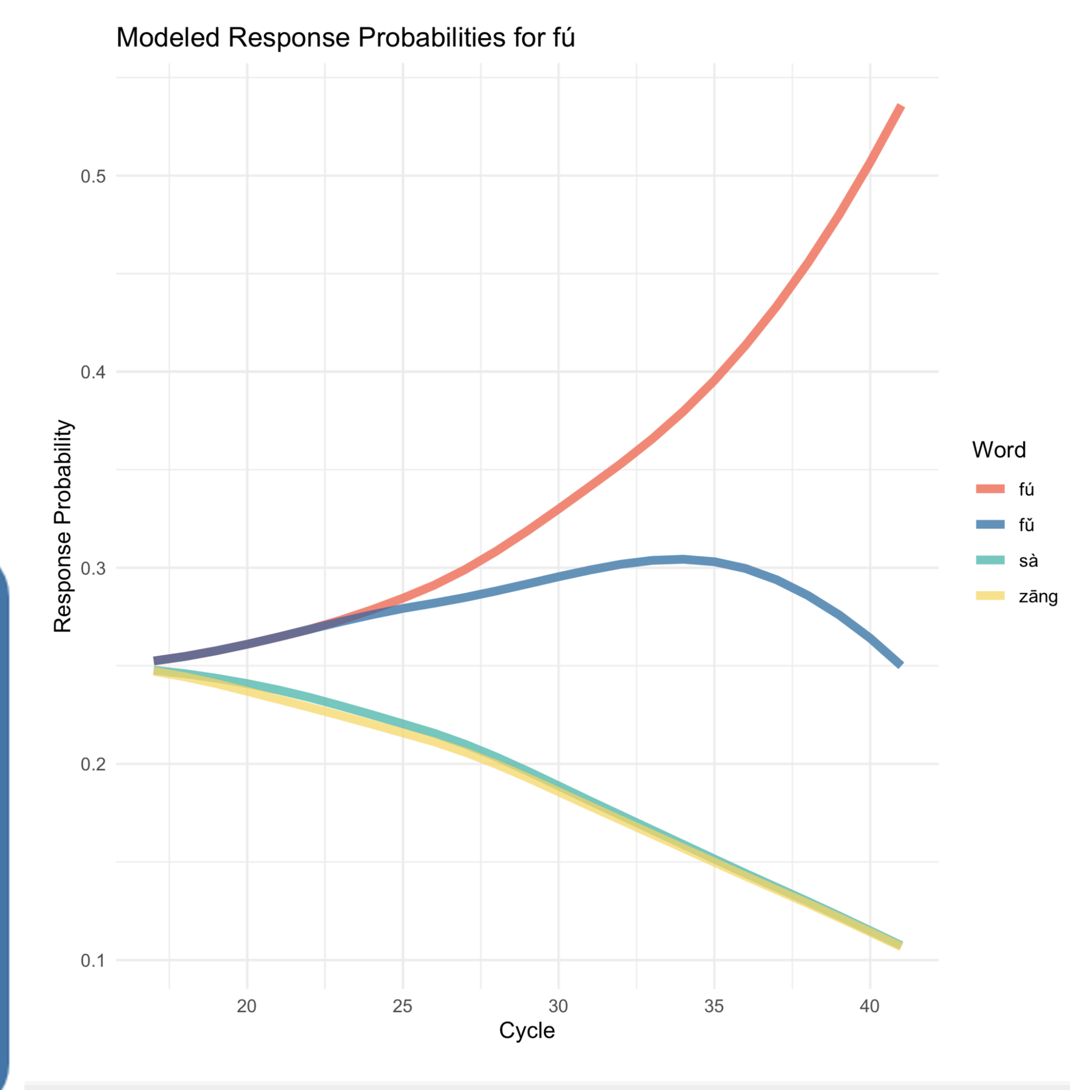
TRACE model (with Toneme Layer)

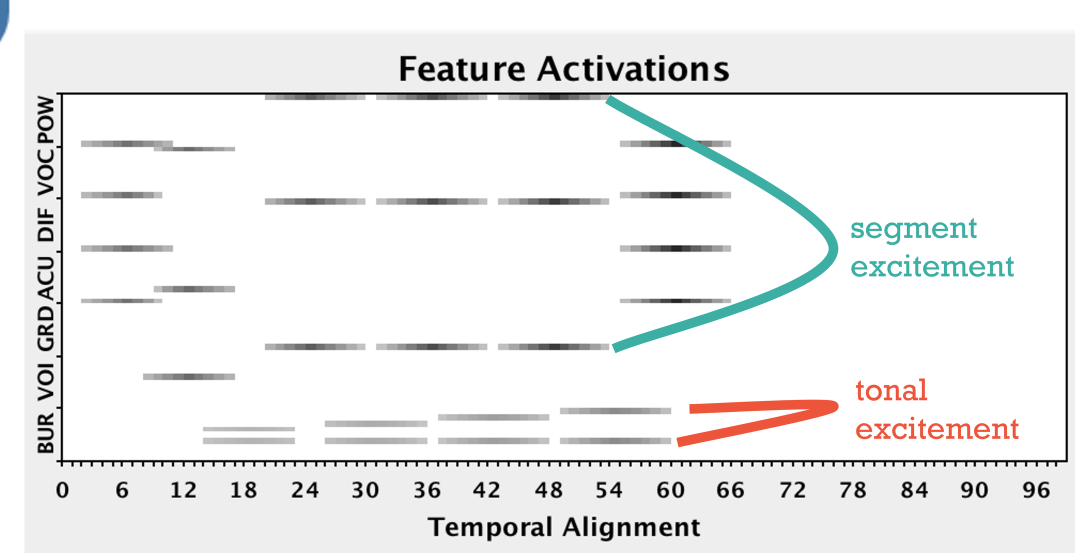
- Splitting the second tier: tonemes [6]
- TRACE-T [8]
  - segment features
  - tonal features
  - Mandarin & other tonal languages

- Pitch height: 1 (lowest) ~ 5 (highest)
- Pitch slope: Level (L = 6), Rising (R = 7), Falling (F = 8)

Tones	Pitch Height Coding	Pitch Slope Coding
1st	5555	6666
2nd	2345	7776
3rd	2123	8677
4th	5432	6888



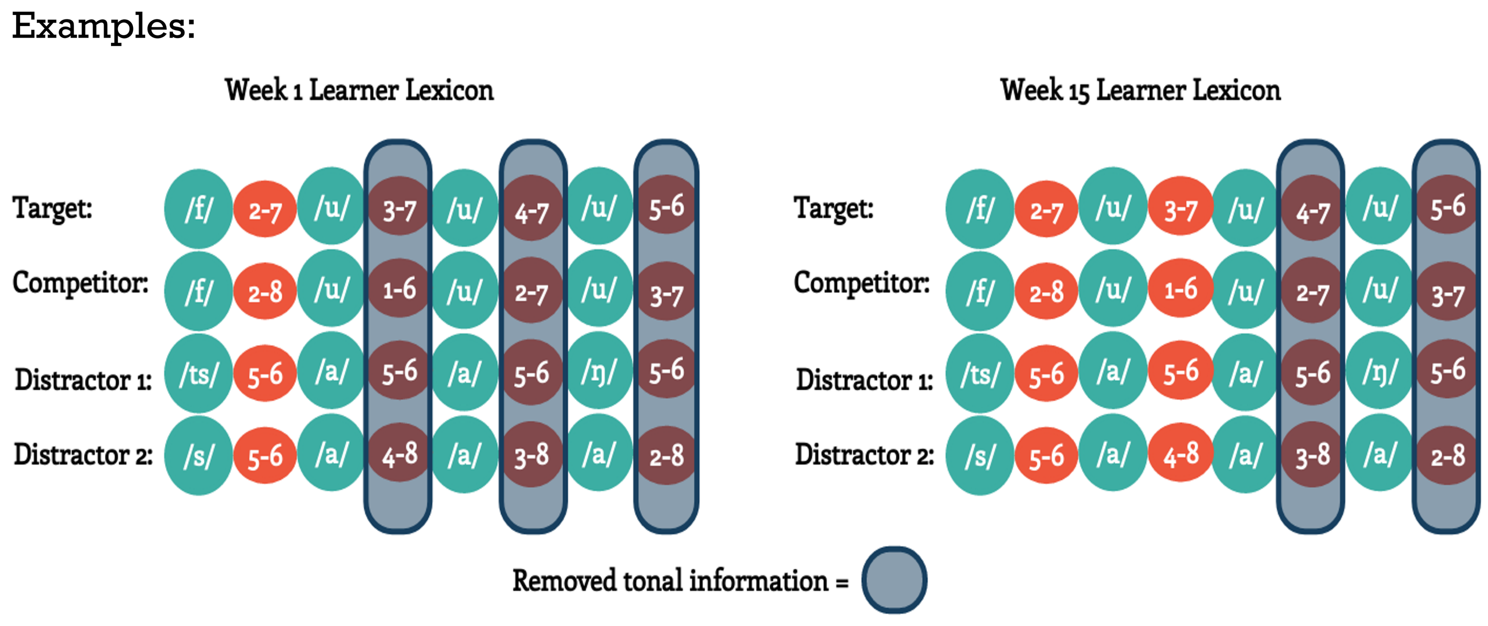




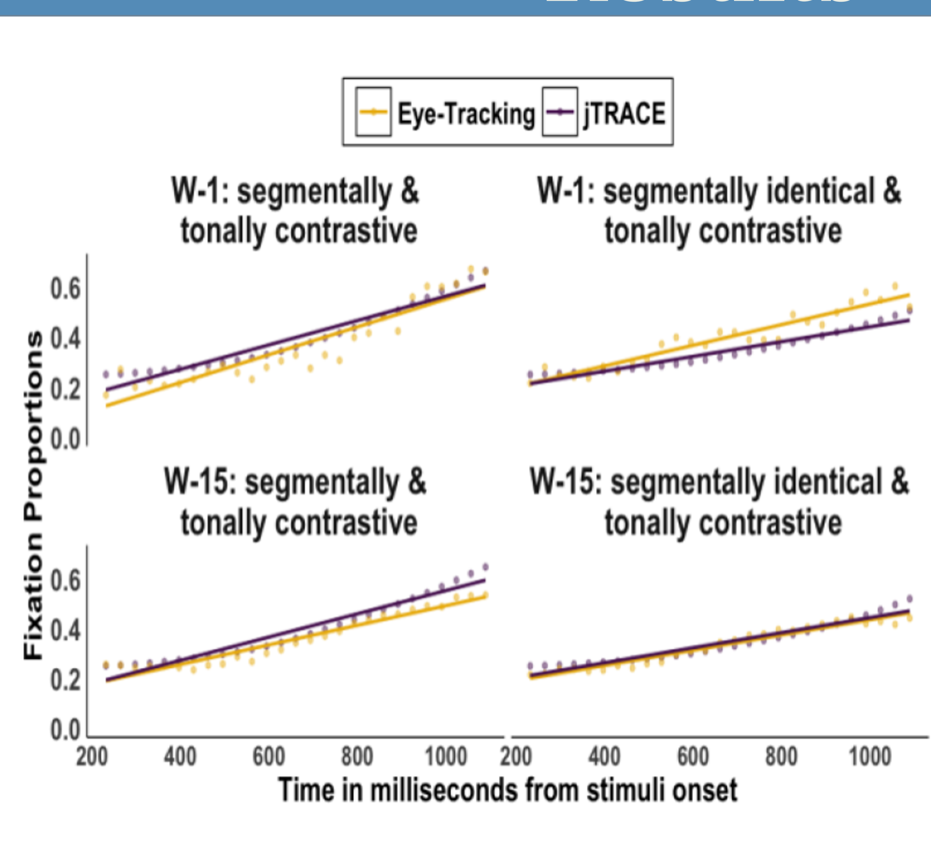
Reduced Tones as Learning

- Naive listeners rely on F0 height and slope less than L1 listeners for tonal word recognition [10].
- Two lexicons were created following TRACE-T [8]: week 1 (25% tonal information) and week 15 (50% tonal information).

Examples:



Results



*lm(fixation-proportion ~ data type*time*condition)*

Null effect of data type: $\beta = 0.03$, $SE = .03$, $t = 1.14$, $p = .25$

Null effect of time: $\beta = -0.01$, $SE = .03$, $t = -0.16$, $p = .87$

Discussion

- We successfully extended jTRACE modeling to a novel L2 learner population.
- We adapted the TRACE-T phonology to capture L2 word recognition of both segmentally identical and tonally contrastive items, and segmentally contrastive and tonally contrastive items.
- The null effect of learning could be due to large variability at week 1, small sample size, a limited number of data points, and/or our linear regression modeling approach.

Future Directions

- **Increasing stochastic noise** in the jTRACE model may produce similar results for early learners in line with [4] and [7] that are more generalizable to non-tone languages.
- Comparing jTRACE modeling and eye-fixation data of **L1 Mandarin listeners**.
- Modeling the tone competitor fixations in the segmentally identical but tonally contrastive condition with **growth curve analysis** and/or **generalized additive mixed models**.

Acknowledgements

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