# Articulatory Analyses of American English /ɹ/ in Typically Developing Children and Children Receiving Ultrasound Biofeedback

Amanda Eads[1], Heather Kabakoff[1], Hannah King[2], Jonathan L. Preston[3] & Tara McAllister[1]
New York University[1], Université Sorbonne Nouvelle [2], Syracuse University[3]

American English /ɹ/

- /ɹ/ receives a lot of attention in the clinical literature because it is later developing and considered one of the most difficult sounds to master.
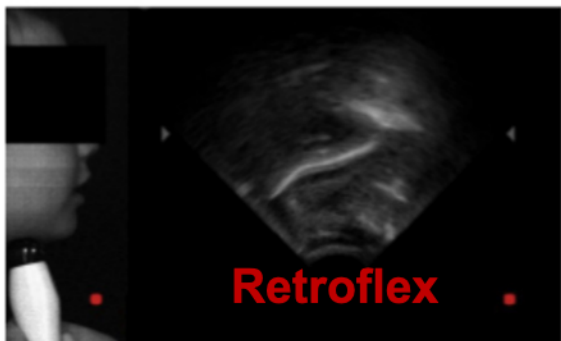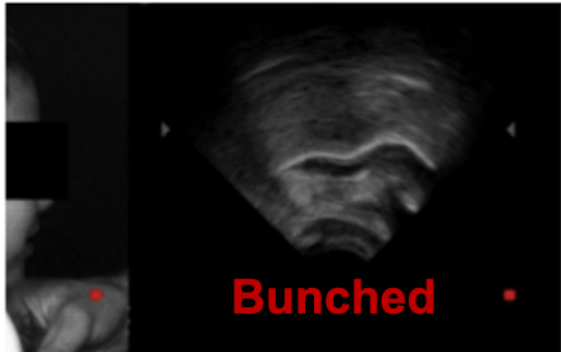
Bunched

Retroflex

- Tongue shapes for /ɹ/ vary within as well as across speakers, with a majority of American English speakers using only bunched shapes (Mielke et al., 2016).
- Retroflex shape is sometimes described as easier to cue/more commonly cued in treatment (Ball et al., 2013).

- Flipsen (2021) describes a "Speech Buddies" device commonly used to aid /ɹ/ development. It only cues retroflex tongue shapes.
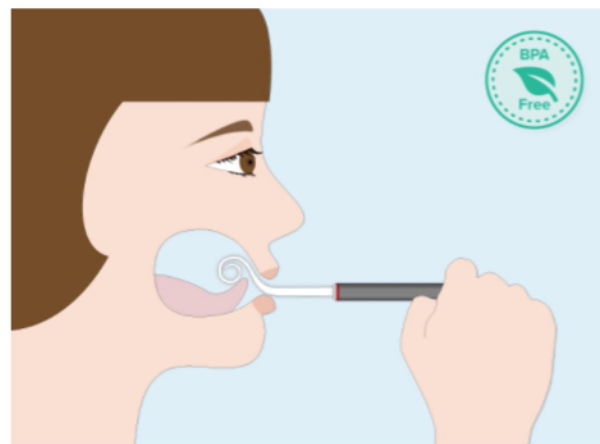
Ultrasound Biofeedback
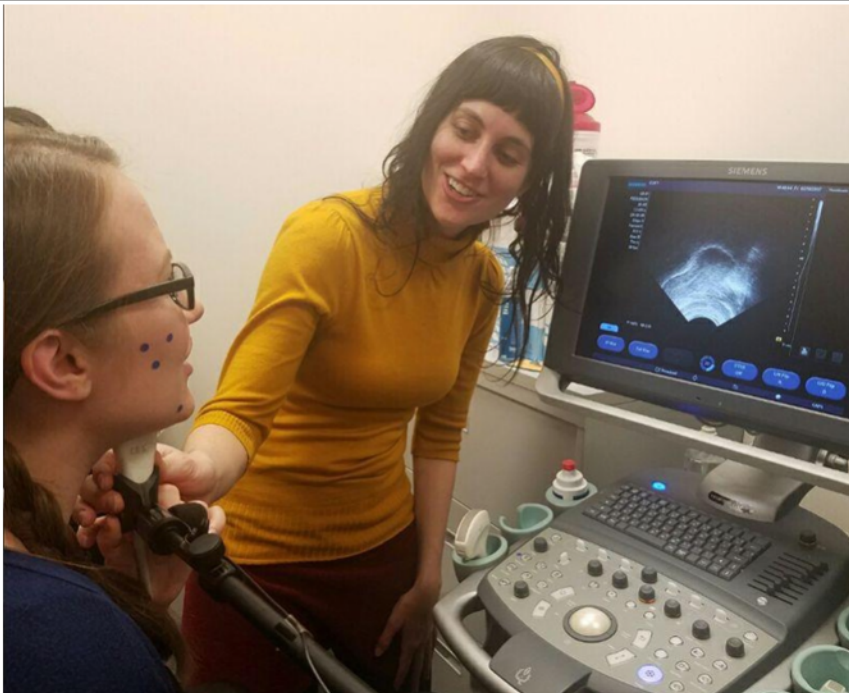
- Ultrasound biofeedback uses ultrasound imaging to provide learners with a real-time visualization of their tongue during speech production.

- A systematic review reported positive effects from ultrasound biofeedback in treatment of **r**esidual **s**peech **s**ound **d**isorder for /ɹ/ (**RSSD**; Sugden et al., 2019).

Methods

- Participants: 66 American English speakers aged 9–15
  - 30 with a history of RSSD who learned to produce perceptually accurate /ɹ/ over the course of an ultrasound biofeedback treatment study (McAllister et al., 2022)
  - 36 without history of RSSD
- Audio and ultrasound data from a stimulability probe (adapted from Miccio 2002):
  - Visual and auditory models provided; participants asked to produce their "best /ɹ/ sound."
  - Only tokens scored as perceptually accurate were analyzed.
- Ultrasound images near /ɹ/ midpoint were coded for tongue shape type in a blinded fashion using PsychoPy.
  - Flowchart from King & Ferragne (2020) was used to classify all tongue shapes as retroflex (tip up) or bunched (tip down)

References

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Research Questions

1. Do child speakers show within- and between-speaker variation in tongue shape patterns for /ɹ/ consistent with expectations from adult studies?

2. Do patterns differ across groups of children with and without history of RSSD affecting /ɹ/?

Main Findings

1. **Yes; patterns appear consistent!**
Similar trends in bunched, mixed, and retroflex usage between the adults in Mielke et al. (2016) and the children in this study underline when pooled across groups.
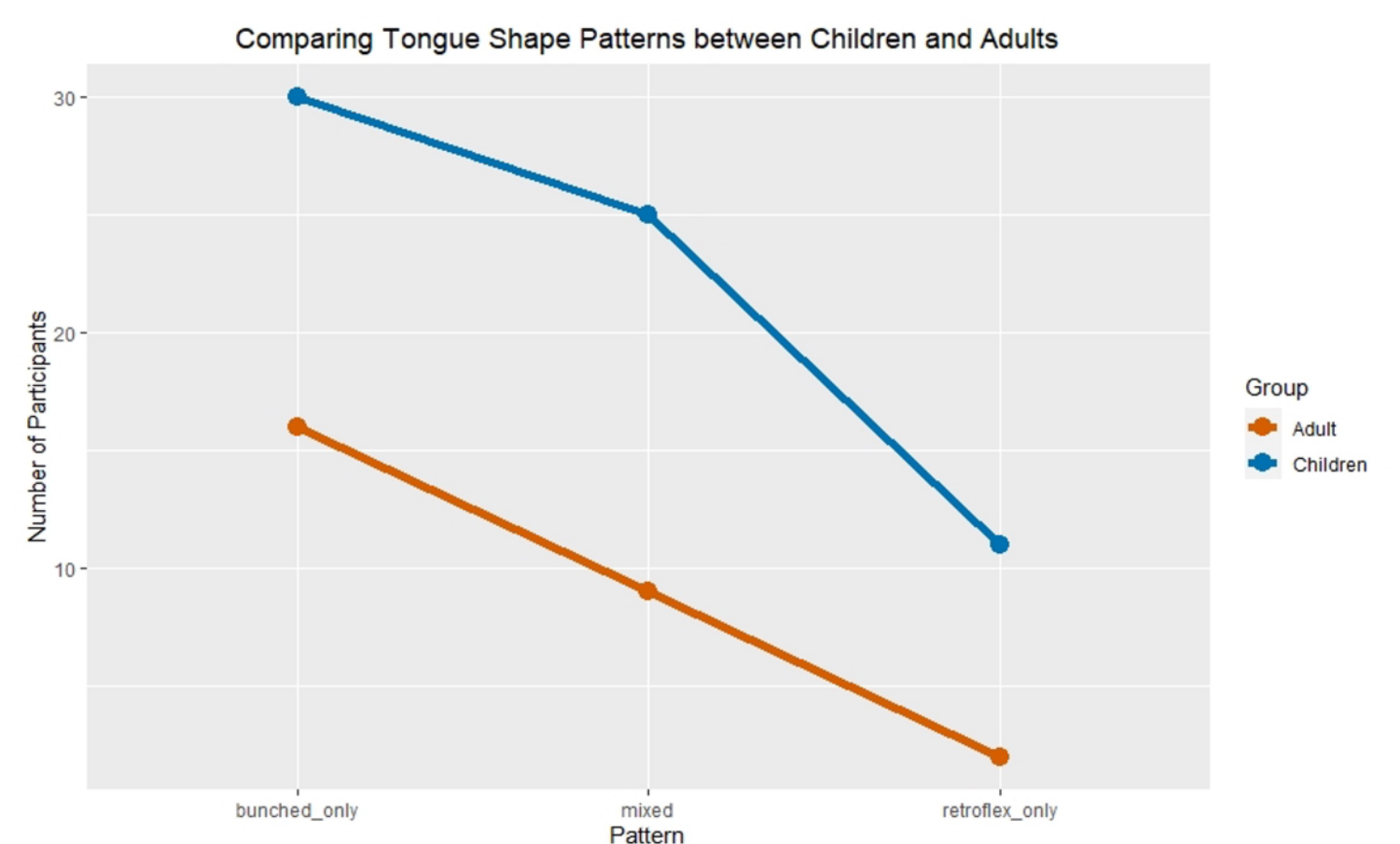
2. **However, patterns differ across child groups!**
Statistically significant ($\beta = -10.99$, SE = 1.91, $p < .001$) differences between the children with and without a history of RSSD.
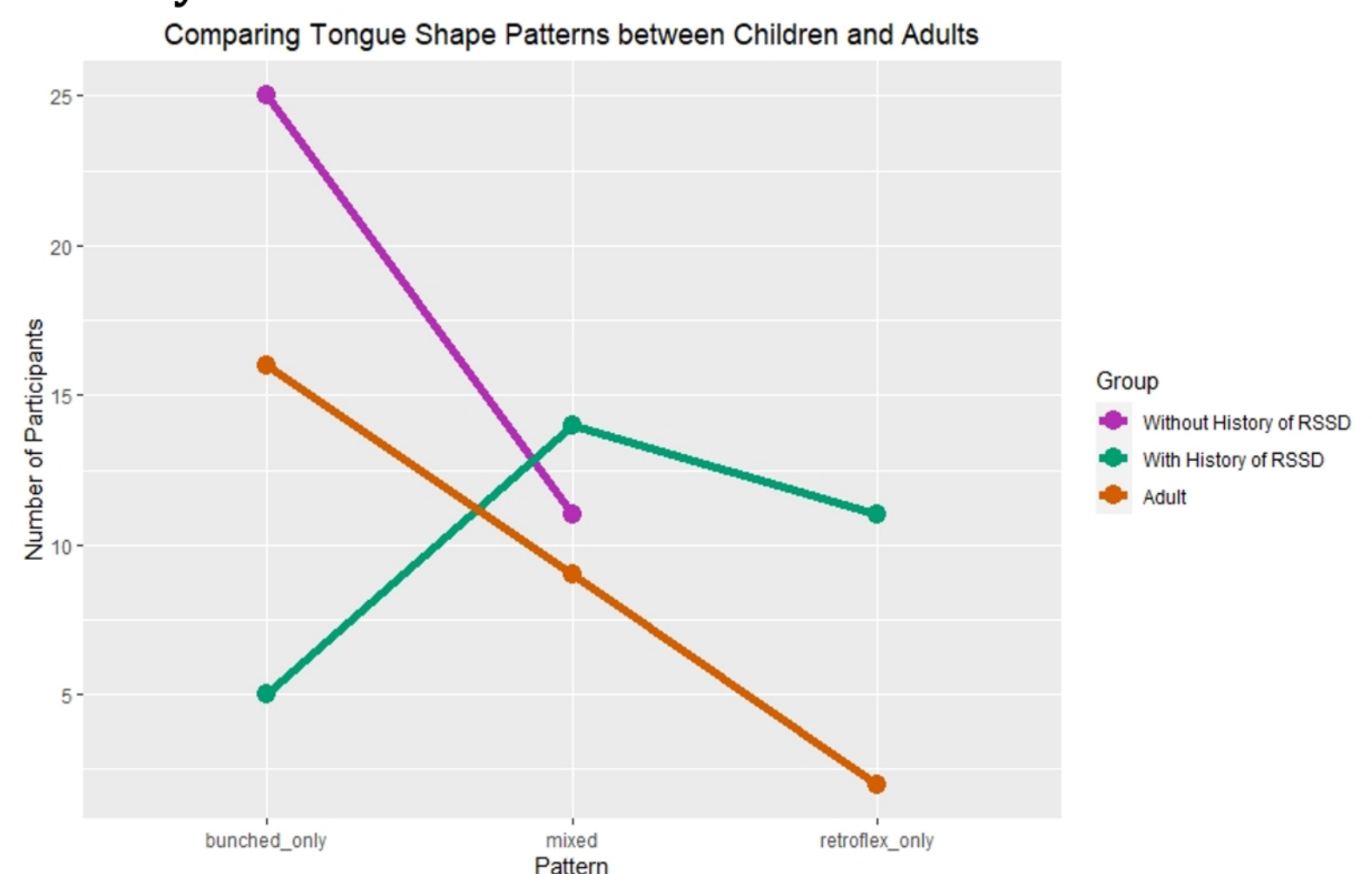
- For the group of children without RSSD, 93.9% of tokens were coded as bunched.
- For the group of children with RSSD, 69.8% of tokens were coded as retroflex.

Why the significant difference in tongue shapes?
- Could this be an effect of clinician cueing?
  - Biofeedback clinicians were required to cue at least one tongue shape of each type at the start of therapy, but could shift toward the tongue shape they found most effective as treatment went on.
- Are retroflex tongue shapes easier to acquire in the context of treatment for RSSD?
  - Note that this study only analyzed accurate productions – this means we do not know if retroflex tongue shapes were successful across all contexts.
- Could this be related to articulatory patterning for /ɹ/ in non-rhotic dialects?
  - Dialects such as British English have a higher retroflexion rate than rhotic dialects.