TARGETING RETROFLEX VS BUNCHED /r/:
EVIDENCE FROM ULTRASOUND BIOFEEDBACK INTERVENTION

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No disclosures to report.
Residual speech errors: Clinical issues

• Most developmental speech errors resolve, spontaneously or through therapy, by the early school-age years.

• When errors remain past 9 years of age, they are considered ‘residual speech errors,’ or RE (Shriberg et al., 1994).
  • Often persist despite months or years of intervention.

• A challenge for the clinician:
  • Undesirable to terminate therapy because spontaneous resolution is unlikely in older children.
  • But limited resources make it difficult to keep children on the caseload when progress seems to have plateaued.
Residual errors affecting /r/

- Most common type: RE affecting /r/ (e.g. Ruscello, 1995)
- English /r/ has a complex articulatory configuration consisting of an anterior lingual constriction, a posterior tongue root constriction, and (in most speakers) lip rounding.

/u/ (simple shape)  /r/ (complex shape)

Image credit: S. Boyce and colleagues, supported by NIH R01-DC05250
Variation in tongue shapes for /r/

- Typical adults differ in how they form the anterior constriction for /r/. Two major categories (plus many intermediate options):
  - *Retroflex*: Tongue tip is raised and may be curled back
  - *Bunched*: Tip is down; tongue forms a bunch near the palate.

- Clinicians vary in which shape they choose to target in treatment. Not known which shape is best to target.

Source:
http://www.csha.org/documents/events/SecordHandout2.pdf
Evidence from ultrasound biofeedback

• In visual biofeedback, instrumentation is used to provide real-time information about aspects of speech that are difficult to perceive under ordinary circumstances.

• Ultrasound biofeedback:
  • Transducer emitting ultrasound waves (no radiation) is placed below chin to view tongue.
  • Use real-time video of tongue shape/movements to encourage more appropriate tongue configuration for /r/.

Display from SeeMore ultrasound imaging software

Anterior tongue
Posterior tongue
Ultrasound biofeedback

- Barriers to clinical use are lowering as cost of ultrasound technology drops.
- This study used a USB-powered ultrasound probe (Interson SeeMore PI 7.5); relatively inexpensive.
- Evidence for efficacy of ultrasound biofeedback:
  - For residual /r/ errors, several non-experimental studies (e.g. Adler-Bock et al., 2007; Bernhardt et al., 2008; Modha et al., 2008)
  - For CAS, single-subject experimental evidence (Preston, Brick, & Landi, 2013).
- This study: Systematically document efficacy of ultrasound biofeedback for residual /r/ errors using a controlled single-subject design.
A tale of two (or more) tongue shapes

- However, our study evolved in an unexpected direction.
- In the first cohort of participants (Study 1), all participants were cued to match the same bunched tongue shape target.
- Very little response to treatment, with one exception:
  - Participant who happened to produce a retroflex tongue shape which yielded a perceptually accurate /r/.
- Speculation: Outcomes could be improved by using individualized tongue shape targets.
  - For Study II, study protocol was modified so participants could explore different tongue shape alternatives.
  - Caution: Studies I-II do not constitute a controlled comparison.
Outline

I. Biofeedback for treatment-resistant speech errors

II. Study I and Study II
   • Methods
   • Results

III. Comparing Study I and Study II

IV. Conclusions
Participants

• All monolingual English-speakers
• Passed pure tone hearing screening, auditory comprehension assessment and oral mechanism examination
• <30% correct production of /r/ in words. Articulation otherwise intact.

Study I
• 2 males, 2 females
• Age range: 6;1 – 10;3 years (mean = 8;0).
• Duration of previous treatment: 0-3.5 years

Study II
• 2 males, 2 females
• Age range: 7;8 – 15;8 years (mean =10;10)
• Duration of previous treatment: 1-8 years
Structure of study: Shared Aspects

- Multiple-baseline across-subjects design.
- Participants received 16 thirty-minute sessions of biofeedback treatment over eight weeks.
- 64-word /r/ probe (measure of generalization) was administered in baseline sessions and re-administered in two maintenance sessions after the conclusion of therapy.
- Within treatment, a 20-item subset of the /r/ word probe was administered at the start of every third session.
Structure of study: Shared Aspects

- Biofeedback was provided in all sessions with the Interson SeeMore USB ultrasound probe.
- Clinician held probe beneath child’s chin.
- After child formed a correct tongue shape for /r/, we traced the shape on a sheet protector as a target for subsequent trials.
- Each session elicited 60 trials (30 /ɔ/, 30 /ra, ri, ru/).
Comparing Study I and Study II: Differences

- Study I: Participants cued to match a single tongue shape target representing bunched /r/ (most common in typical adults).
- Study II: Added extra instructional session in which participants were encouraged to try out different tongue shapes.
  - Recorded ultrasound video of participant’s tongue movements during a contextual /r/ probe administration.
  - Selected three tongue shape targets (Tiede et al., 2004).
  - Two were chosen to be as similar as possible to the participant’s best perceptual /r/ approximation. One target was selected as an “exploratory” alternative option.
  - Targets were adjusted/altered as needed over the course of treatment depending on perceptual accuracy.
Measurement

• /r/ word trials were pooled across all participants and pre-, mid-, and post-test measures.

• Presented in randomized, de-identified fashion with computerized response recording.

• Three certified speech pathologists rated every /r/ sound as correct or incorrect.
  • Instructed to use a strict standard, i.e. distorted sounds with some rhotic quality should be rated incorrect.
  • Pairwise inter-rater agreement > 80%.
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Results: Study 1

- Two participants made no sustained gains on generalization probes.
- Variable performance within the treatment setting.
Results: Study 1

- Two participants showed slight rise in accuracy of consonantal /r/ in generalization probes.

- For participant “Gabby,” accuracy within treatment showed a sustained increase starting in Tx 10.
Results: Study II

- Two participants showed lasting gains in the production of both consonantal and vocalic /r/.
- Dip in “Autumn’s” accuracy reflects sustained absence (Hurricane Sandy!)
Results: Study II

- Two participants showed lasting gains in the production of both consonantal and vocalic /r/, but with asymmetry between the types.
Tongue shapes: “Autumn”

- **Pretest:** Reasonable approximation with either bunched or retroflex shape.
  - Baseline 1, “fur”

- Tried both targets in treatment and settled on retroflex.

- **Posttest:** Perceptually accurate with retroflex shape.
  - Maintenance 3, “her”
Tongue shapes: “Philip”

- **Pretest**: Approximation of retroflex shape, but with poor perceptual quality.
  - Baseline 1, “water”
- **Posttest**: Perceptually accurate with retroflex shape.
  - Maintenance 3, “gear”
Tongue shapes: “Lilianne”

• **Pretest**: More bunched than retroflex; poor perceptual quality.
  • Baseline 3, “fur”

• **Posttest**: Perceptually accurate with bunched shape.
  • Maintenance 2, “sir”
Tongue shapes: “Jordan”

- **Pretest:** No rhotic quality; no anterior tongue elevation.
  - Baseline 1, “run”

- **Posttest:** Perceptually more accurate; approximation of bunched shape.
  - Maintenance 3, “rock”
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• Our strategy in Study II was to identify any tongue shape that was facilitative of perceptually accurate /r/ and reinforce it.
  • Not necessary to match a canonical retroflex or bunched shape.
• These two studies do not constitute a controlled comparison of ultrasound treatment with and without the option to select individualized tongue shapes.
  • Need for systematic follow-up research.
• However, our results suggest that /r/ treatment should include opportunities to explore different tongue shapes in order to find the most facilitative variant for the individual child.
Conclusions

- Participants in Study II had a minimum of 1 year and a maximum of 8 years of previous treatment.
- All participants in Study II achieved perceptually accurate /r/ within a month of treatment.
- Thus, this study offers systematic evidence that ultrasound biofeedback, with proper parameters of treatment, can be an effective intervention for children who do not respond to other forms of treatment.
Acknowledgments

• Consultants:
  • Suzanne Boyce
  • Sue Schmidlin
  • Penelope Bacsfalvi

• Research team members
  • Clinical assistant: Sarah Granquist
  • Research assistants: Diana Barral, Olivia Bell, Jackie Ostrander
  • Clinician data raters: Meghan Hemmer, Sarah Carmody, Risa Battino, Robbie Lazarus, Lacy MacDonald, Lauren Winner, Laura Ksyniak
  • Special thanks to participants and their families, without whom this research would not have been possible.
References


