

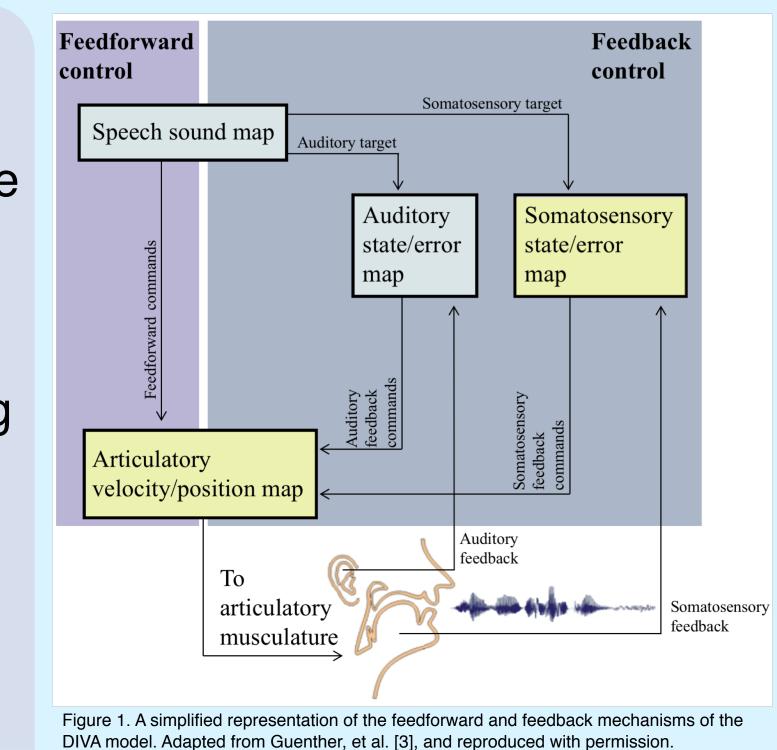
IDENTIFYING INDIVIDUALIZED SENSORIMOTOR PREDICTORS OF RESPONSE TO ULTRASOUND TREATMENT

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INTRODUCTION

- Technology-enhanced treatment options such as acoustic biofeedback [1] and ultrasound biofeedback [2;3] may be efficacious for children with residual speech errors (RSE), but these single-case studies report heterogeneous responses.
- Individuals differ in ability to adjust articulators in response to placement cues, even with biofeedback.
- Speech is produced by executing a stored motor plan and updating the plan using auditory and somatosensory feedback to achieve both auditory and somatosensory targets [4;5] (see figure 1).
 - Locus of breakdown may differ between individuals.
 - o Therefore, it is crucial to understand what sensorimotor factors predict treatment success.

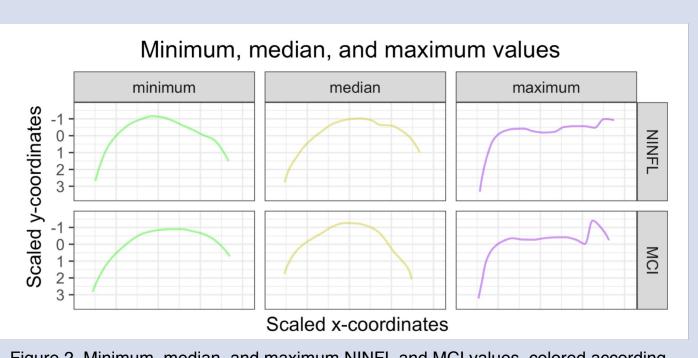


METHODS

- Participants: 21 school-aged children ages 9;1-14;7 (mean = 11;0) received 10 weeks of ultrasound treatment (2-3 sessions/week) at NYU or Haskins Labs.
- Stimulability probe: administered at pre- and post-treatment with targets: ୍ Consonantal /ɹo/,/ɹu/,/ɹα/,/ɹi/,/ɹe/,/ɹaɪ/; Syllabic /ଙ/,/અ/; Vocalic /၁અ/,/αઅ/,/αʊઅ/,/ɪઅ/,/ɛઅ/,/aɪઅ/
- Lingual complexity: To convert the shapes of each contour into coordinates:
- Label acoustic interval of each /r/ production in TextGrid in Praat [18].
- Place anchor points along best contour in Matlab [19] tool GetContours [20].
- Extract 100 X-Y coordinates from each tagged frame; calculate MCI/ NINFL.
- Somatosensory acuity: collected at NYU only (n = 13); auditory acuity for all.
- Perceptual accuracy ratings: difference between second and third formant frequencies normalized against TD children from [16], as described in [17].
- Effect sizes: Cohen's d based on pre- to post-treatment ratings (n = 16).

MOTOR EXECUTION SKILL SENSORY ACUITY

- Non adult-like speech in typically developing (TD) children may be secondary to reduced control of anterior versus posterior lingual regions [6].
- Children with RSE may have delayed ability to differentially move tongue body and tip/blade [7].
- Our lab's analysis of lingual contours from adults in [8] revealed two metrics of lingual complexity:



MCI and NINFL correspond

index (MCI) integrates curvature with length of the arc [8;9], minimizing difference between two adjacent points. Number of INFLection points (NINFL) [10] is the number of sign with intuition: high values are changes of a given lingual contour. more complex (see figure 2).

Somatosensory acuity: ability to access and respond to oral somatosensory input [11].

 Lower in children with RSE than in TD children [12,13].

Measured with an oral stereognosis task: Subjects identify the form of

an object, as in [14]. (Fig 3) Quantified as average size of

correctly identified object.

Small size = better somatosensory acuity

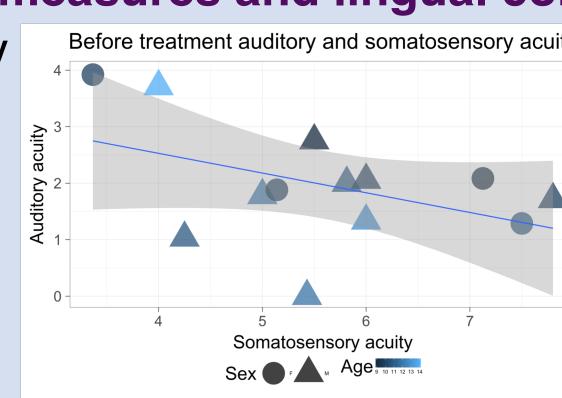
Auditory acuity: ability to access auditory input; control measure in present analyses.

- Measure boundary width in "rake"-"wake" identification task, as in [15].
- Small boundary width = better auditory acuity

RESULTS

Visualize acuity measures and lingual complexity

 Somatosensory acuity & auditory acuity possibly related, t(11) = -1.63, p = 0.13.



MCI & NINFL correlated, t(1323) = 27.62,p < 0.0001.

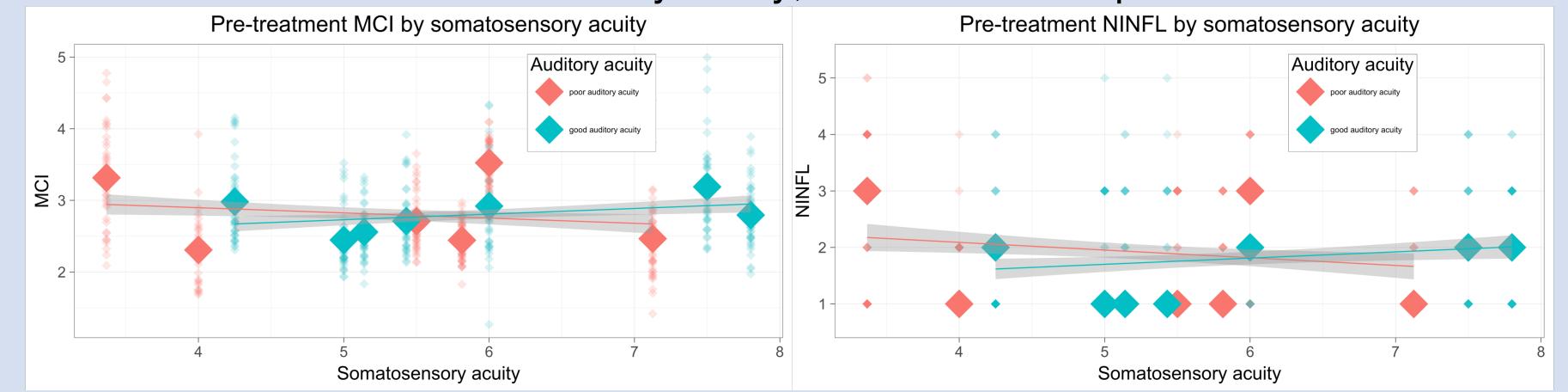


1) Are somatosensory acuity and lingual complexity related?

• Not for MCI, t(11) = 0.12, p = 0.90.

• Not for NINFL, t(11) = -0.16, p = 0.88.

Possible interaction with auditory acuity; need more data points to assess.



This study aims to identify the differential contribution of multiple sensorimotor factors in predicting response to treatment.

Modified curvature

QUESTIONS

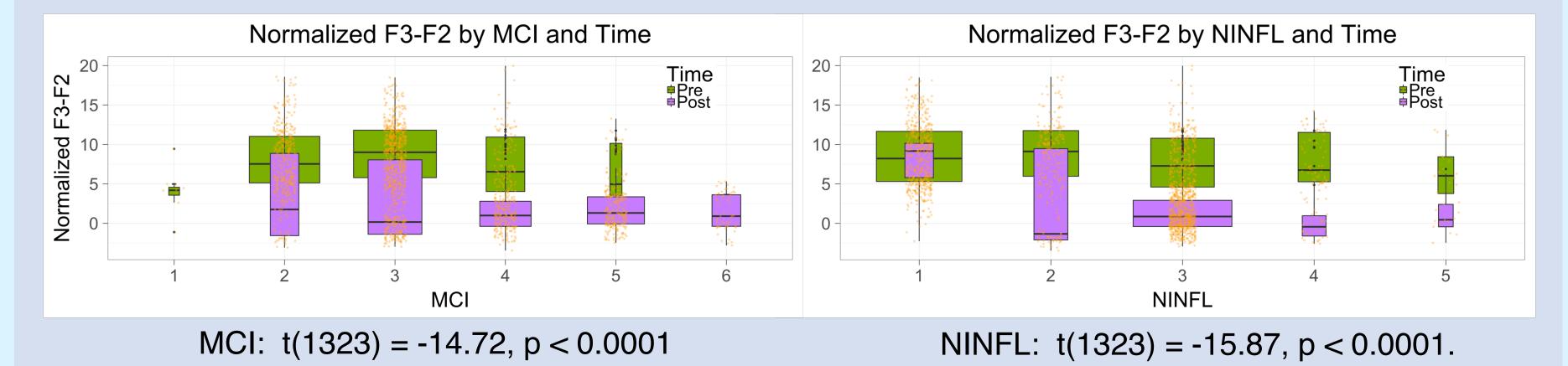
- 1. Are somatosensory acuity and lingual complexity related within individuals. Hypothesis: ↑somatosensory acuity associated with ↑lingual complexity
- 2. Does lingual complexity predict magnitude of response to ultrasound treatment?

Hypothesis: \lingual complexity associated with \response to ultrasound.

Understanding connection between motoric ability (as indexed by lingual complexity) and sensory capacity may offer theoretical insight into how these skills cooperate during speech.

2) Does lingual complexity predict magnitude of response to treatment?

- Based on data from 16 children, lingual complexity does not predict effect size.
- However, both MCI and NINFL showed a significant correlation with acoustics.



CONCLUSIONS

Preliminary findings

- Somatosensory acuity and auditory acuity may be negatively correlated in children with RSE.
- Somatosensory acuity and lingual complexity not correlated, though auditory acuity may play role. Need more data to interpret 3-way relationship.
- Based on small data set, lingual complexity does not predict response to ultrasound treatment.
- However, at token level, lingual complexity does predict acoustic measure of accuracy.
- Need more data to interpret relationship.

Next steps

- Stereognosis task may be valid index of tactile acuity, but may not represent speech-related skill.
- Explore somatosensory measure more aligned with ability to match somatosensory target
 - → proprioceptive awareness of tongue?

Impact

- Theoretical: a child's somatosensory capacity may limit motor speech development.
- *Translational:* the most effective remediation strategy may differ based on deficit profile.
 - Recommendations for motoric vs. phonologically-oriented treatment approach.
 - Recommend acoustic biofeedback to those with reduced auditory acuity and ultrasound biofeedback to those with reduced somatosensory acuity.

Clinical relevance

- Clinicians may consider lingual complexity and sensory acuity when evaluating speech.
- Clinicians could track lingual complexity as index of progress over course of treatment.

This research was supported by an NIH grant NIDCD R01DC013668