Longitudinal Emergence of Perception, Production, and Motor Skills in Preschoolers

(((Haskins Laboratories)))

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Introduction

- Speech sound disorder (SSD) affects approximately 16% of all preschool-aged children [1]
- Unresolved SSD can negatively impact academic performance [2], literacy [3], and social participation [4]
- Deficits in speech production can be associated with:
  - motor-based constraints on achieving adult-like articulatory gestures [5];
  - perceptual deficits [6]
- *Measuring motor development:* A low-level index of motor skill is "lingual differentiation," i.e. the ability to control anterior versus posterior regions of the tongue semi-independently
  - Children with SSD produce more undifferentiated gestures than typically-developing children [5] and show increased lingual complexity from pre to post treatment [7]
- *Measuring perceptual development:* SAILS [8] measures ability to distinguish correct vs. incorrect productions of target phonemes across multiple talkers
  - Children with SSD may show reduced acuity for sounds they produce in error
- Research questions:
  - As production accuracy increases over maturation, do we see corresponding increases in motor and perceptual precursors?
  - Does the order of emergence of production accuracy and precursor skills vary across children?

Methods

- Children were treated for errors identified on the HAPP-3 [9] in 18 treatment sessions over 6 weeks
- Cycles treatment [10], which includes:
  - Auditory bombardment to strengthen perceptual targets
  - Motor-based drill-play
- Also 6-week period of no treatment; order counterbalanced across participants

ID	age	sex	targets
302	4;2	M	/l,ɹ/
303	5;0	F	/k/
305	5;4	M	/l,ɹ,k/
2005	4;0	F	/l,ɹ/

- In each week, 3 probes:
  1) Audio recordings } picture-naming
  2) Ultrasound videos } tasks
  3) SAILS perceptual accuracy
- Used GetContours [11] to track frames in target intervals of ultrasound videos (Fig. 1)
- Computed modified curvature index (MCI) [12] of each tongue shape as an index of lingual complexity
- Trained listeners narrowly transcribed each production using Phon speech analysis software [13]
  - Converted to three-way ratings: *correct*; *distortion*; *incorrect*

Fig. 2

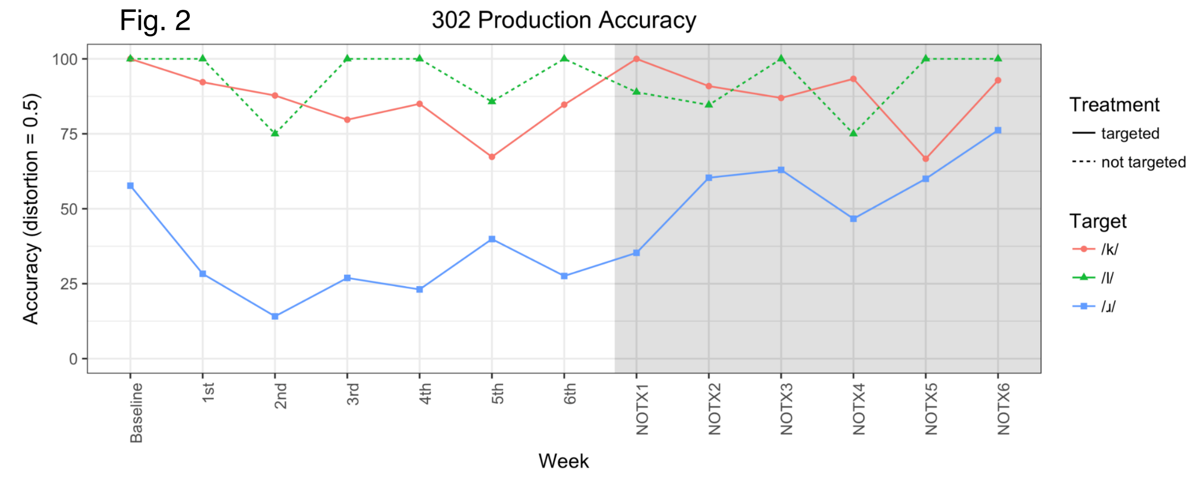


Fig. 3

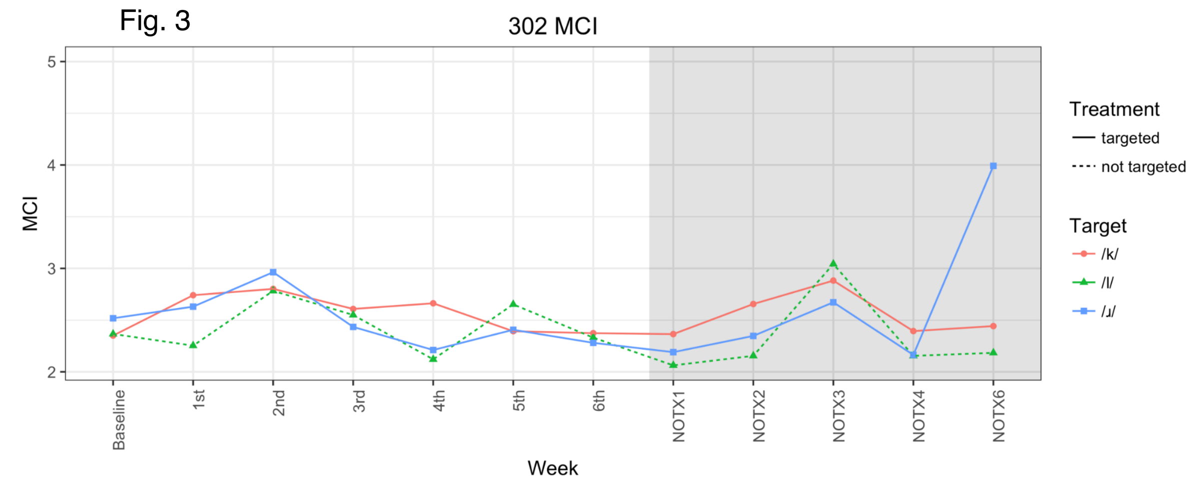


Fig. 4

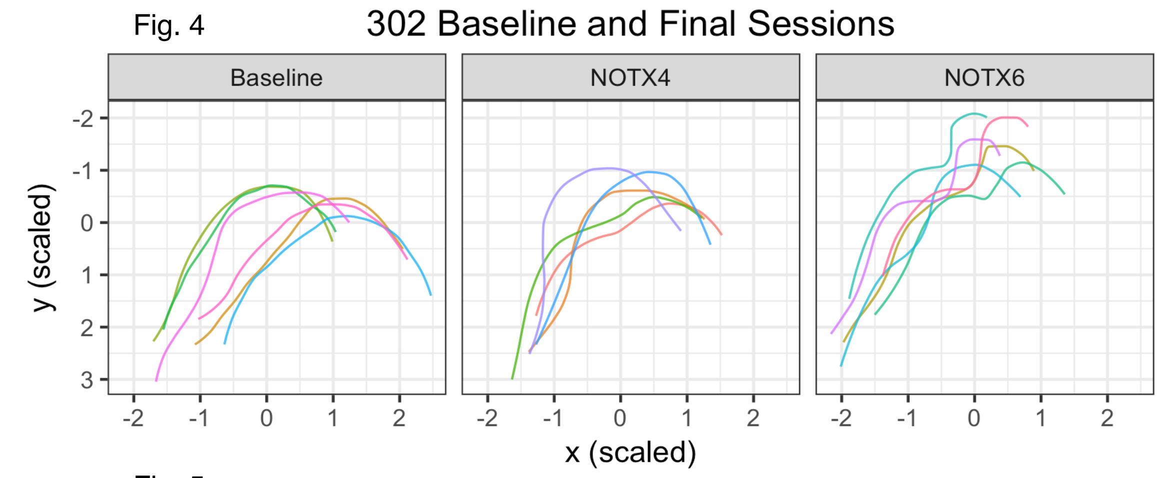


Fig. 5

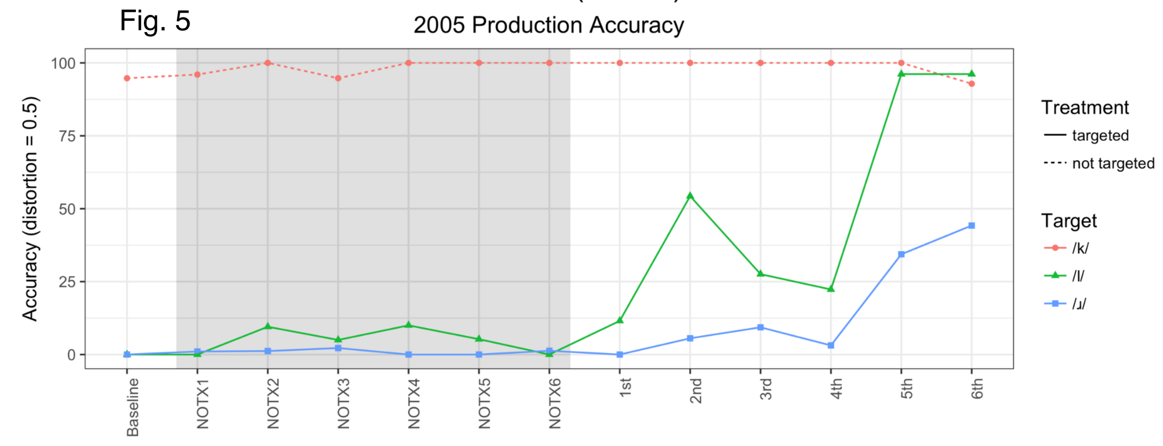
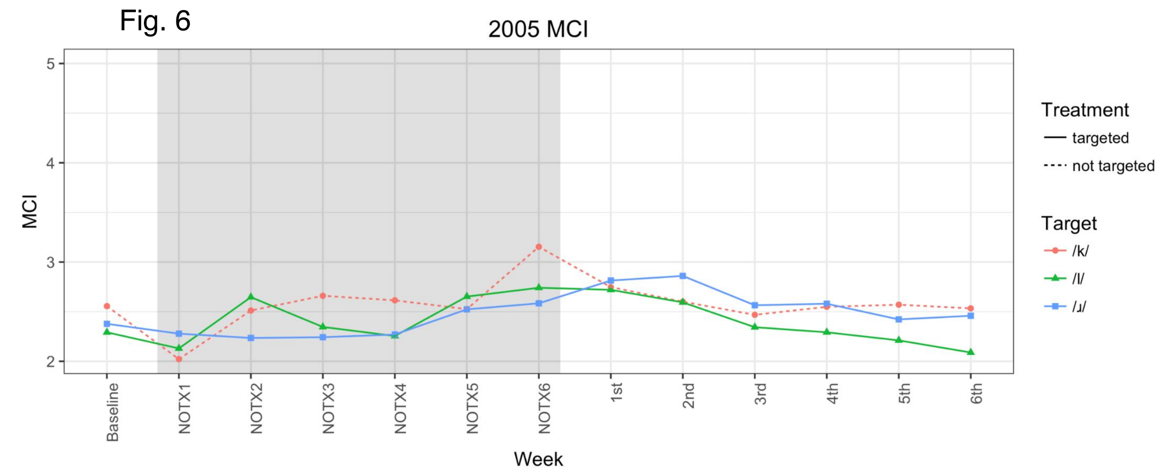


Fig. 6



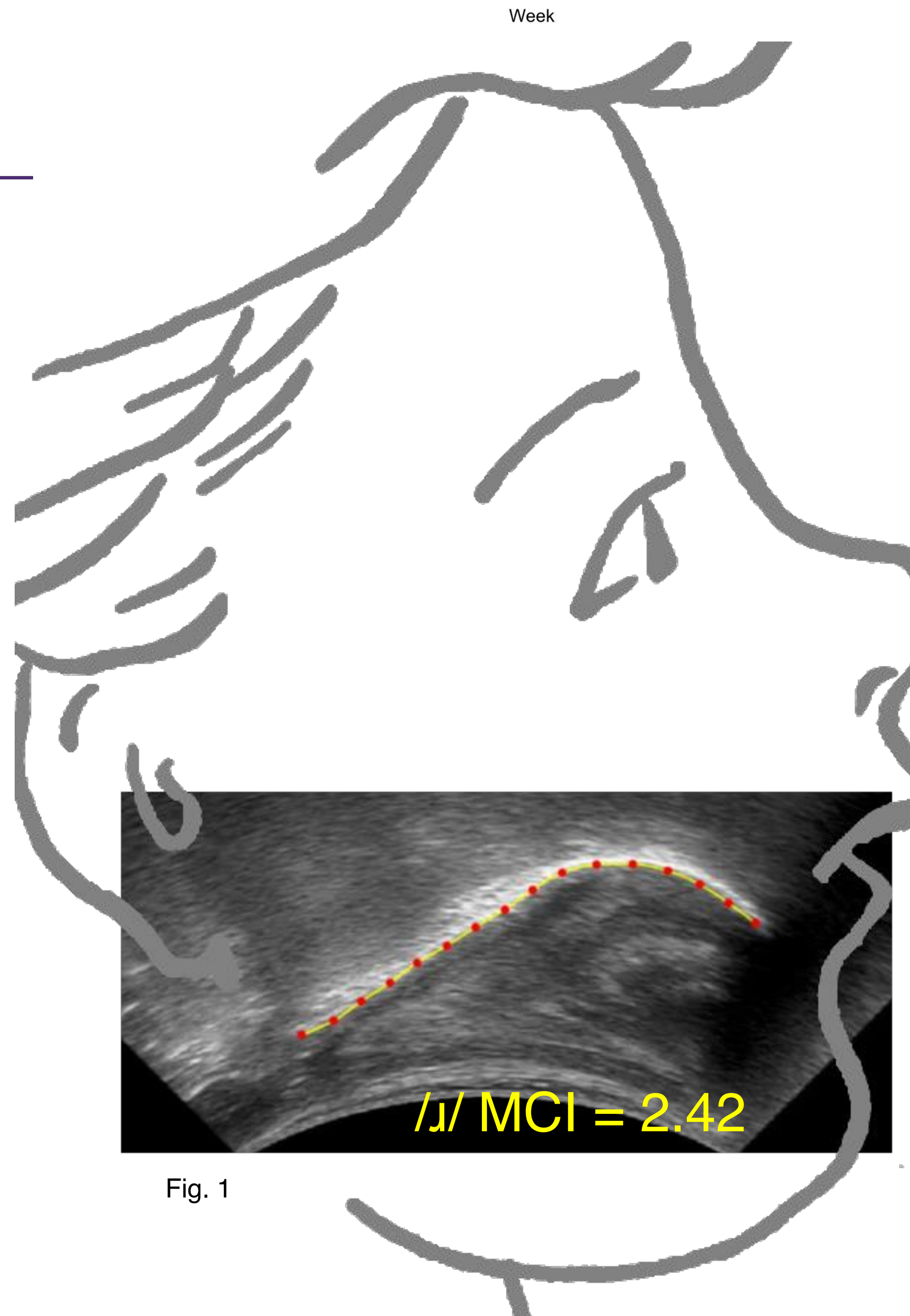


Fig. 1

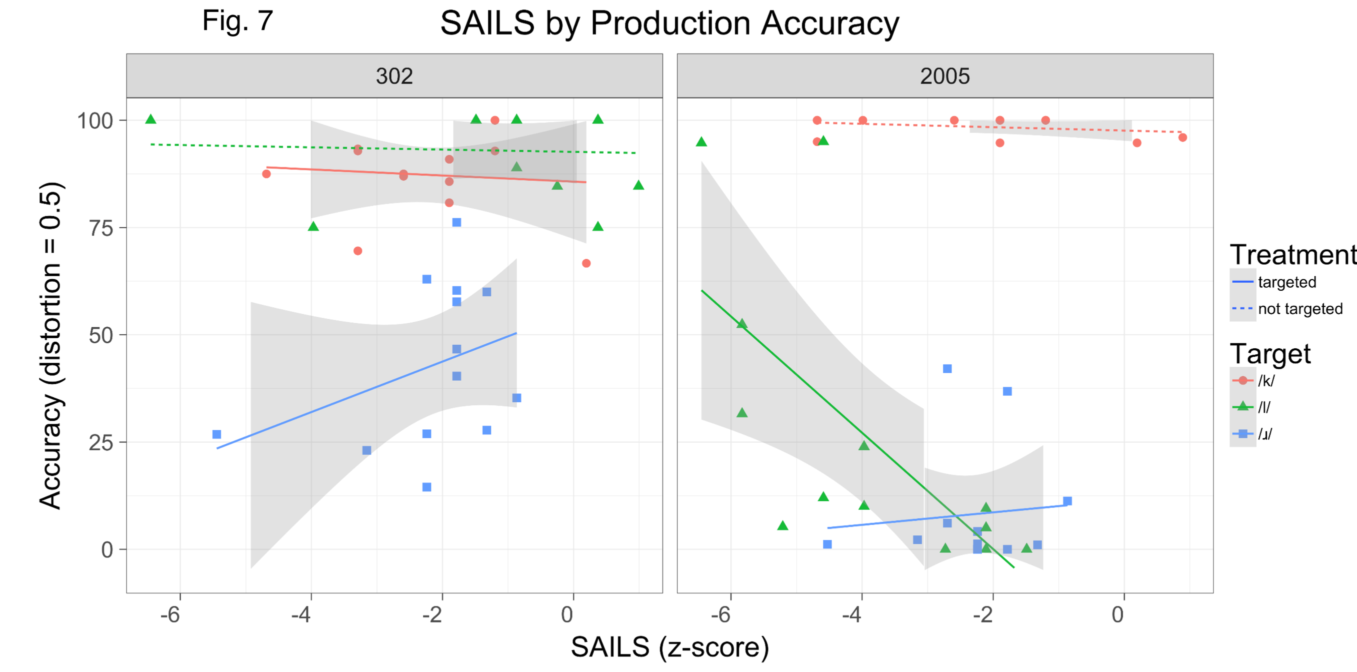
Results

- **305** (not pictured): non-responder
- **303** (not pictured): no treatment response, but targeted error /k/ appeared to emerge spontaneously between baseline evaluation and commencement of study
- **302**: exhibited increases in production accuracy for /ɹ/ in final week of no-treatment period (Fig. 2), which was associated with an **increase** in MCI (Fig. 3) and SAILS scores (Fig. 7); representative tongue shapes for 302's final session show emergence of bunched /ɹ/ shape not seen at baseline (Fig. 4)
- **2005**: exhibited increases in production accuracy for /l/ during treatment condition (Fig. 5), which was associated with a **decrease** in MCI (Fig. 6) and SAILS scores (Fig. 7)

Discussion

- Participants differed in the direction of the relationship between changes in production accuracy and changes in perceptual and articulatory precursor skills
- **Speech acquisition does not adhere to a neat and orderly developmental progression across domains**
  - Various articulatory-perceptual paths to adult-like production
- The curious case of 2005:
  - MCI findings suggest that different articulatory strategies can yield a perceptually correct /l/
  - SAILS findings could reflect idiosyncratic weighting of perceptual cues that enable achievement of perceptually acceptable /l/ despite not having robust perceptual representation

Fig. 7



Limitations & Future Directions

- Children's attention/compliance was variable, particularly given the demanding nature of these tasks administered repeatedly
- Longer duration needed to observe larger magnitude of change
- Next steps:
  1. Compare current data with typically-developing peers to look for group differences in perception and articulation
  2. With a larger dataset, look for profiles of ability that may help to inform dosage, timing, and combinations of treatment strategies for SSD

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