Child-Level Factors & Acquisition of the /t/-/k/ Contrast: Perception

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learning to TALK

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Introduction

Background and motivation

- Children acquire the ability to produce speech sound contrasts gradually [1,2,3]
- Phonetic transcription is the traditional perceptual rating system
- Continuous rating scales such as those utilizing Visual Analog Scaling (VAS) have been applied to the acquisition of fricative contrasts[4,5]
- VAS ratings correlate well with acoustic measures and are more gradient and hence potentially more informative than phonetic transcriptions[4,5]

Aims of this study

1. Apply a continuous rating scale to characterize adults' perception of children's production for the /t/-/k/ contrast and derive measures of how robustly children's productions differed based on listeners' ratings
2. Examine predictors of child-by-child differences in the VAS-derived measures of robustness of /t/-/k/ contrast

Methods

Child Talkers

Talker Participants

- 63 children, aged 28-39 months (part of larger study: www.learningtotalk.org)
- Monolingual (Mainstream American English & African American English)
- Range of maternal education levels
- Passed hearing screening, some late talkers, no other diagnoses

Hypothesized Predictor Variables

- Executive Function: Fruit Stroop, Behavioral Rating Inventory of Executive Functions (BRIEF) - Preschool
- Vocabulary: Expressive Vocabulary Test (EVT-2), Peabody Picture Vocabulary Test (PPVT-4), MacArthur Bates Communication Development Inventory (CDI)
- Speech Perception: Minimal pair discrimination task
- Home Language Input: Language Environment Analysis (LENA) measures
- Maternal Education Level: Caretaker questionnaire

Stimulus Preparation

Speech Recording

- Picture prompted auditory word repetition task
- 8 /t/-initial words, 9 /k/-initial words as part of a longer word repetition task
- Recorded in a sound treated booth

Acoustic Event Tagging

- Initial consonant transcribed as:
  [t], [k], [t:k]=intermediate more "t-like", [k:t]=intermediate more "k-like"
- Release of stop burst and onset of vocal fold vibration tagged in Praat
- Consonant-vowel sequence extracted for 1564 total tokens

Adult Listeners

Listener Participants

- 47 native English speakers, aged 19-39 years
- No history of speech, language or hearing disorders

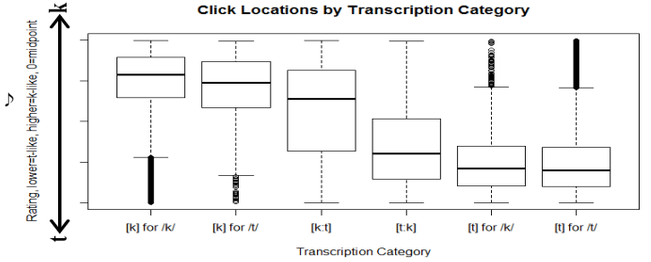
Perception Testing

- Experiment split into 3 versions (about 20 talkers, 500 tokens each)
- 5 training items, 20 repeated items in each version
- One talker presented across all versions
- Click along VAS to rate consonant-vowel sequence; click location logged automatically

Results: Listener Ratings

Category Differentiation

- Linear mixed-effects regressions showed that listeners rated all transcription categories differently (a<0.05) except [t] for target /t/ vs. [t] for target /k/
- Ratings for intermediates were most widely dispersed along the VAS



Intra-rater Reliability

- Reliability was measured by the distance between clicks for repeated tokens
- Reliability varied by experiment version, listener age, and listener sex
- Overall reliability was poor to good depending on listener: need for training?

Set Effects

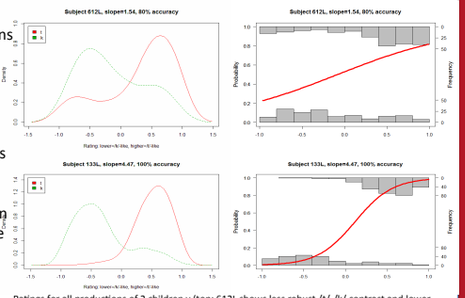
- One talker's productions were presented in all three experiment versions, to determine whether ratings were stable across different sets of stimuli
- Some transcription categories were rated differently by experiment version

Robustness of Contrast

LEFT: Density plots of click locations for /t/ attempts (red) and /k/

RIGHT: Histograms of ratings of attempts at target /k/ (bottom) and /t/ (top).

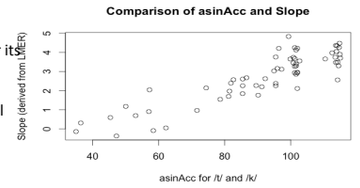
A logit mixed-effect model predicted target (dummy-coded as {1,0}) from VAS rating, with listeners as random effects. The slope of each talker's logit function was estimated. The slope of these functions indicates robustness of contrast. Higher absolute slope = more robust /t/-/k/ contrast



Ratings for all productions of 2 children y (top: 612L shows less robust /t/-/k/ contrast and lower accuracy , bottom: 133L shows more robust contrast and higher accuracy)

Accuracy vs. Slope

Accuracy = Percent of child's attempts at a sound that were transcribed as that sound or its intermediate counterpart (i.e., [t] or [t:k] for target /t/). Rationalized Arcsine transform applied to Accuracy. Slope provides additional separation in data for talkers with high Accuracy



Results: Talkers

Child-level Factors

Linear regression models were analyzed to determine predicting factors of speech production (arcsine transformed Accuracy and Slope).

All vocabulary measures (EVT, PPVT, CDI) were significant (p<0.05) in determining both Accuracy and Slope. Growth Scale Value (GSV) scores were used for the EVT and the PPVT. No other factors were significant in determining speech production

Predictor	Slope p-value	Slope partial r^2 (controlling for age)	Accuracy p-value	Accuracy Partial r^2 (controlling for age)
EVT-2 GSV	0.02*	8%	0.02*	9%
PPVT-4 GSV	0.02*	9%	<0.01**	12%
CDI	<0.01**	15%	<0.01**	13%
Maternal Ed.	>0.05		>0.05	
LENA	>0.05		>0.05	
Executive Fn	>0.05		>0.05	
Minimal Pair	>0.05		>0.05	

Conclusions

- Listeners were able to use a VAS to differentiate all transcription categories except [t] for /t/ vs. [t] for /k/
- Reliability varied by experiment version and listener characteristics. Can reliable listeners be selected based on characteristics, or trained to be more reliable?
- Set effects were present in the experiment versions: context of surrounding tokens influences listeners' ratings
- The robustness of contrast measure "slope" characterizes the difference in VAS ratings for a talker's /t/ and /k/ attempts. Slope provides more information for talkers who have high production accuracy
- Vocabulary size is significant in models predicting speech accuracy. Slope and Accuracy behave similarly in these models

Acknowledgements

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