Phonological knowledge and the role of accuracy and error consistency in speech sound acquisition following intervention

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BACKGROUND

EVIDENCE OF PHONOLOGICAL KNOWLEDGE

- **Speech sound accuracy**, stimulability, or whether or not the sound is present in the child's phonetic or phonemic inventory (Gierut, 1992; Miccio, Elbert, & Forrest, 1999; Munson, Edwards, & Beckman, 2005; Powell, Elbert, & Dinnsen, 1991; Tyler & Macrae, 2010)
  - unknown sounds have lower accuracy, are nonstimulable, and are excluded from the phonetic and/or phonemic inventory
- Perceptual knowledge, acoustic and palatographic evidence of covert contrasts (Barlow & Keare, 2008; Gibbon & Lee, 2017; Gierut & Dinnsen, 1986; Jamieson & Rvachew 1992; McGregor & Schwartz 1992; Munson, Edwards, Schellinger, Beckman, & Meyer, 2010; Scobbie, Gibbon, Hardcaste, & Fletcher, 2000; Tyler, Edwards, & Saxman, 1990; Tyler, Figurski, & Langsdale, 1993)
  - children's ability to produce/perceive consistent contrasts between sounds of the adult language that are otherwise undetected via perceptual judgments is suggestive of greater knowledge
- **Error consistency** (Barlow 1996; Dodd & Bradford, 2000; Rice & Avery 1995; Tyler, Williams, & Lewis, 2006)
  - sounds that are assigned greater knowledge on the part of the child tend to have fewer substitutes

ROLE OF PHONOLOGICAL KNOWLEDGE IN PREDICTING TREATMENT OUTCOMES FOR CHILDREN WITH SPEECH SOUND DISORDER (SSD)

- Children show higher accuracy on treated sounds following intervention if they have some degree of knowledge of those sounds prior to treatment (Dinnsen & Elbert 1984; Powell, Elbert & Dinnsen 1991; Rvachew & Nowak 2001)
- In contrast, generalization to untreated sounds may show the reverse pattern, with treatment on unknown sounds leading to greater gains system-wide as compared to treatment on known sounds (e.g. Gierut 1992; Gierut et al. 1987; Williams, 1991; cf. Rvachew & Nowak 2001)
- Children who exhibit consistent errors on treatment targets show greater improvement in accuracy to treated sounds post-treatment, generalizing across word positions, whereas those with inconsistent substitution patterns do not show such gains (Forrest et al. 1997, 2000).
- Gains following treatment are also reflected in increased consistency in errors on the treated target (Cummings & Barlow 2011; Tyler et al. 2002)
- **It is unclear whether treatment on targets that are produced consistently prior to treatment leads to lesser or greater gains on untreated sounds posttreatment**

RESEARCH QUESTIONS

Do pre-treatment target accuracy and error consistency impact treatment outcomes for:

- **the treated target sound?**
- **system-wide phonology?**

METHODS: ARCHIVAL DATA

Evaluation of pre- and post-treatment data from the archives of the Learnability Project (Gierut 2017)*

SUBJECTS

- 98 monolingual English-speaking children with SSD (mean age 52 mos.; range: 36-72)
- Reduced phonemic inventories
- Scores >1 SD below the normative mean on a standardized articulation test (Goldman & Fristoe 1986)
- Within normal limits on hearing, cognition, oral-motor structure/function, and motor-speech measures

TREATMENT

- All children trained on one singleton target from the following set: /k g f θ s ʃ ʧ l ɹ/
- Targets varied by pretreatment accuracy and error consistency
- 1-hour sessions, three times per week, for a mean of 13 sessions (range 5-19)

DATA

- Pre-treatment and immediate post-treatment single-word speech samples from the Phonological Knowledge Protocol (PKP), with an average of 294 words (range: 287-303)
- Mean 735 consonants per child per sample (range: 719-756)
- Treatment targets sampled on average 47 times, dependent on the frequency of the occurrence of the sound in the language and thus the PKP (range: 19-93)

METHODS: ANALYSES

Pre- and post-treatment data analyzed using Phon software v2.2.21 (Hedlund & Rose 2016), for the following:

- accuracy of treatment target in untreated words
- number of unique substitutes for the treatment target (collapsed across word positions)
- Percent Consonants Correct-Revised (PCC-R, a global measure of consonant accuracy; Shriberg et al. 1997)
- mean accuracy of the subset of consonants that had 0% accuracy prior to treatment (known hereafter as "monitored sounds")

Regression analyses evaluated target accuracy and number of substitutions pre-treatment on post-treatment change on the treated target, PCC-R, and monitored sounds.

RESULTS: TREATED SOUND CHANGE

- Results showed an interaction between pre-treatment accuracy and number of substitutes (R^2=. 0.16, F(3,94)= 6.01, p<.01):
- For targets with a greater number pre-treatment substitutes, higher pre-treatment accuracy led to greater posttreatment change
- For those targets with fewer substitutes, pre-treatment accuracy was not as predictive of change

Figure 1. Heat map of Treatment Target Accuracy change over time as a factor of pre-treatment accuracy and number of pre-treatment substitutes.

RESULTS: UNTREATED SOUND CHANGE

PERCENT CONSONANTS CORRECT – REVISED

- Results showed an interaction between pre-treatment accuracy and number of substitutes (R^2=. 0.12, F(3,94)= 4.14, p<.01):
- Greater pre-treatment accuracy and more pre-treatment substitutes led to greater post-treatment change in PCC-R, but fewer substitutes led to less post-treatment change

MONITORED SOUNDS

- Results showed that neither pre-treatment accuracy nor pre-treatment number of substitutes (nor their interaction) were predictive of post-treatment change on monitored sound (p > .05)

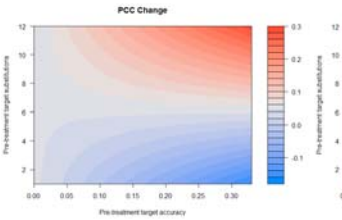


Figure 2. Heat map of PCC-R change over time as a factor of pre-treatment accuracy and number of pre-treatment substitutes.

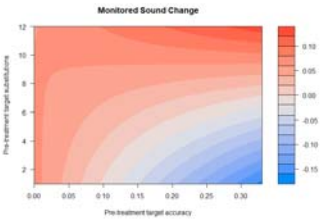
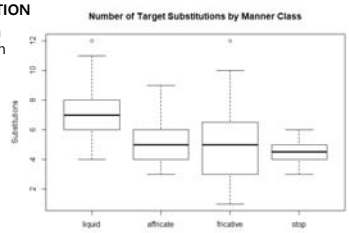


Figure 3. Heat map of Monitored Sound change over time as a factor of pre-treatment accuracy and number of pre-treatment substitutes.

IMPACT OF MANNER OF ARTICULATION

- Liquids were more likely to have a greater number of substitutes than other manners of articulation



IMPLICATIONS

HIGHER ACCURACY AND VARIABILITY = READINESS TO CHANGE?

- Greater pre-treatment accuracy and greater variability in substitutions led to greater post-treatment change in treated target and PCC-R; though unknown aspects of the system were not impacted by these factors
- Targeting known sounds might improve known aspects of the sound system only

HOW DO WE DEFINE PHONOLOGICAL KNOWLEDGE IN ACQUISITION?

- Pre-treatment accuracy is relevant, but may be mediated by error consistency

LIMITATIONS / CAVEATS

- Differences in learning profiles were not robust
- Treatment target differences impacted number of error consistency
- Re-interpretation of data prepared for independent analyses for relational analyses
- Phon target transcription and PCC-R calculation validation is still in progress

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