

# Influence of Phonotactic Probability on Production Accuracy of Children with Cochlear Implants

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## INTRODUCTION

- Because the auditory input that children with cochlear implants (CIs) receive is degraded, children with CIs may have poorer phonological representations of words than children with normal hearing (NH).
- In nonword repetition tasks, children with NH produce sound sequences with high phonotactic probability more accurately than sound sequences with low phonotactic probability (Edwards, Beckman, Munson, 2004).
  - This suggests that children's vocabularies influence their production of novel words.
  - Phonotactic probability: the frequency of occurrence of sounds and sound sequences in words in a language.
- Do children with CI show the same relationship as children with NH between phonotactic probability and nonword repetition accuracy?

## PARTICIPANTS

- 4- to 5-year-olds with cochlear implants (N = 20)
  - bilateral implants
  - all implanted before 2;11 (years;months)
  - mean age of implantation was 1;5
- 3- to 5-year-olds with normal hearing (N = 31)
  - passed a hearing screening.
- All children:
  - monolingual English speakers
  - participants in larger studies
- Children with cochlear implants (CI) were compared to two groups of children with normal hearing.
  - children matched on age (NH-age)
  - children matched on vocabulary age (NH-voc)

Group	N	Male	Mean age	Mean vocabulary age equivalence
CI	20	11	5;1 (0;7)	4;10 (1;9)
NH-age	20	11	5;0 (0;7)	6;0 (1;3)
NH-voc	20	11	4;5 (0;9)	4;11 (1;2)

## STIMULI

- 2 and 3 syllable nonwords e.g., /disem/, /kjonədrok/
- Initial CV/CCVs varied in phonotactic probability.
  - 11 CVs  
/da, di, du, ga, gi, ta, ti, tu, ka, ki, ku/
  - 6 CCVs  
/kju, kjo, twa, twi, kwi, kwe/
  - Each CV/CCV occurred in 3 nonwords.
- Calculation of phonotactic probability:
  - Natural log of the proportion of words in the Hoosier Mental Lexicon (19,321 words) which began with that CV/CCV
  - e.g., /di/ as in /dibikruz/,  $\ln(376/19321) = -3.94$
- 3 lists of nonwords
  - Across lists, nonword endings (sounds which followed the initial CV/CCV) were appended to different CV/CCVs.
  - Across lists, the order of nonwords differed.
  - 51 nonwords per list
- Audio recordings were made of an adult female native English speaker saying the nonwords using child-directed speech.

## PROCEDURE

- The nonwords were presented to the children over speakers.
- A color photograph of a novel object, animal, or plant was presented on a computer screen as the child heard the auditory presentation of the nonword.
- The children's productions of the nonwords were recorded.

/gidʒɪmæb/



- Standardized tests:
  - *Peabody Picture Vocabulary Test, 4<sup>th</sup> edition* (children with cochlear implants)
  - *Receptive One Word Picture Vocabulary Test, 2<sup>nd</sup> edition* (children with normal hearing)

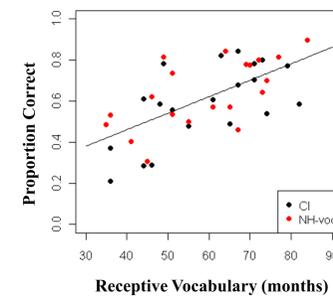
## ANALYSIS

- Accuracy of initial consonants and consonant clusters was scored by a trained adult native English speaker.
- Interrater reliability for the children with cochlear implants and the children with normal hearing was 84% and 87%, respectively.
- Likelihood ratio tests were used to assess the statistical significance of fixed effects in predicting accuracy within mixed-effects logistic regression models with random intercepts for participants. Tests statistics were compared to a chi-squared distribution with  $df = 1$ .

## RESULTS

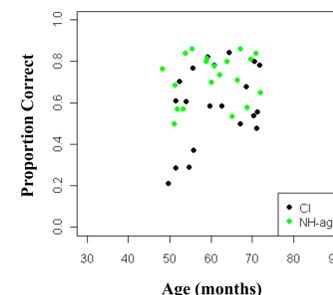
Group	Mean Accuracy
CI	59% (SD=19%)
NH-voc	64% (SD=16%)
NH-age	72% (SD=12%)

What is the relationship between nonword repetition accuracy and receptive vocabulary size for the children with cochlear implants and the NH-voc group?



- Vocabulary size,  $p < .001$
- Group, N.S.
- Interaction, N.S.

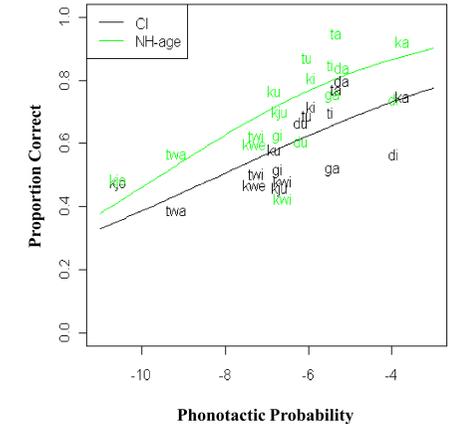
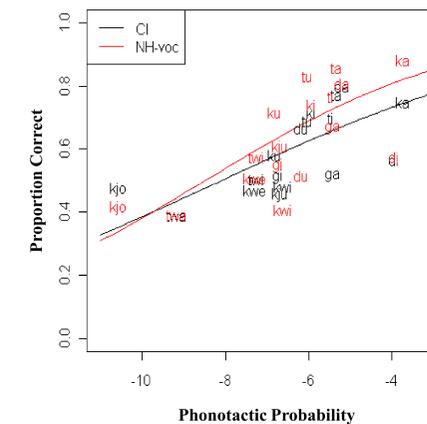
What is the relationship between nonword repetition accuracy and age for the children with cochlear implants and the NH-age group?



- Age, N.S.
- Group,  $p = .01$
- Interaction, N.S.

What is the relationship between phonotactic probability and nonword repetition accuracy for the children with cochlear implants and the children with normal hearing?

- Phonotactic probability,  $p < .001$
- Interaction, N.S.
- Phonotactic probability,  $p < .001$
- Interaction, N.S.



What is the relationship between nonword repetition accuracy and phonotactic probability for individual children in each group?

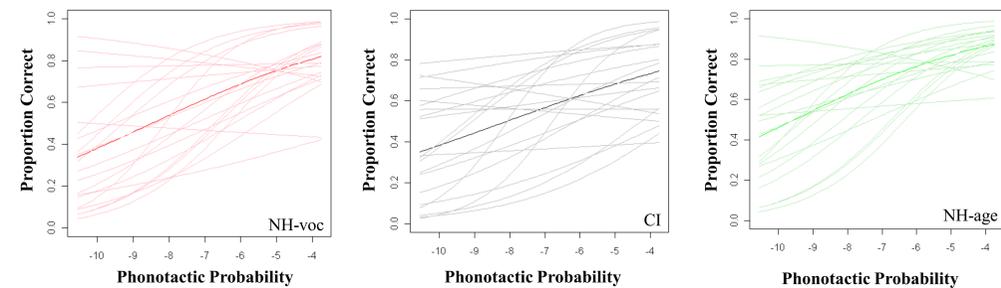


Figure. Faded lines show the logistic regression lines for individual children. Bold lines show the logistic regression lines for the groups.

## CONCLUSIONS

- Similar relationships between vocabulary size and nonword repetition accuracy were found for the children with CIs and the children with NH.
- Similar relationships between phonotactic probability and nonword repetition accuracy were found for the children with CIs and the children with NH.
- All three groups showed wide between-participant variability in accuracy when phonotactic probability was low. When phonotactic probability was high, the children with CIs showed more between-participant variability than the children with NH.

## ACKNOWLEDGEMENTS

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