The Lexical Restructuring Hypothesis: Two Claims of PA Evaluated

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Introduction

- Phonological awareness (PA) is an important skill for learning to read (McBride-Chang, 1990; Cunningham & Stanovich, 1997).
- A variety of factors including phonological working memory (PWM), speech perception, and vocabulary skills have been shown to be related to phonological awareness.
  - However, the relationships among these factors are not well understood.
- The *lexical restructuring hypothesis* proposes that the association among PWM, speech perception and PA are secondary to vocabulary development in children.
  - Thus, PA primarily emerges as a result of the gradual reorganization of the lexicon and, to a lesser degree, the encoding (e.g., speech perception) and storage (e.g., memory capacity) of sub-lexical units.

Purpose

This study uses mediation analysis to evaluate:

- Is the relationship between speech perception and PA explained by children's vocabulary development?
- Is the relationship between phonological working memory and PA explained by children's vocabulary development?

Participant Summary & Descriptive Statistics

- Ages: 3;0 (+/- 2 months) at time 1 and 4;0 (+/- 1 month) at time 2.
- Monolingual English speakers with typical speech and language development.

Analysis 1: *Accuracy & Frequency Effect*
N = 73
Mediation Model 1: *PWM → Vocabulary → PA*
N = 66
Mediation Model 2: *Speech Perception → Vocabulary → PA*
N = 66

Number of males/ females	Mean EVT-2 standard score at age 3 (SD)	Mean Elision scaled score at age 4 (SD)	Mean Blending scaled score at age 4 (SD)
35/38	116 (14)	11 (3)	10 (3)

Methods: Tasks

Minimal Pairs

Stimuli
- 15 minimal pairs of familiar words.
- Children were presented with the stimuli in their native dialect

"peas" vs. "keys"

Procedure
- Each pair of images presented and named by the computer before both images were presented at once while the target word was played

Primary measure
- Percent correct for each child was computed automatically

Methods & Analysis

Nonword Repetition

Stimuli
- 22 pairs of nonsense words adapted from Edwards et al., 2004
- Pairs included a 2-phoneme sequence that contrasted in phonotactic probability
- Presented stimuli matched child's native dialect

Procedure
- Nonwords were paired with a picture of an unfamiliar object in a picture-prompted auditory-word-repetition task

High PP

"tweket" vs. "pwagub"

Low PP

Analysis of the Nonword Repetition Task

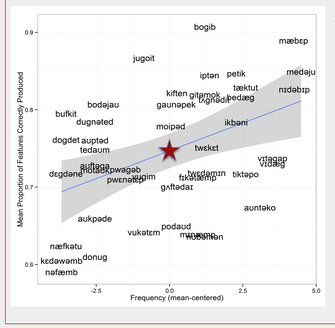
- The 2-phoneme target sequences were transcribed and scored as in Edwards et al., 2004 by counting the number of target features produced correctly
- We fit a generalized linear mixed-effects model to predict accuracy from phonotactic probability:
  - *Fixed effects*: Overall accuracy (*intercept*) and the sequence frequency effect (*slope*)
  - *Random effects*: By-subject random intercept and random slope, and the by-item random intercept
  - *Outcome measure for mediation analysis*: Estimated accuracy score for each participant controlling for frequency (*a measure of PWM*)

Mediation Analyses

- Mediated Logistic Regression Model used for Elision scores
  - 1/3 of participants scored a raw score of 0
- Mediated Linear Regression Model used for Blending scores
  - *Independent variables*: NWR child-level intercept, EVT-2 GSV score, and % correct on Minimal Pairs
  - *Dependent variables*: CTOPP-2 Elision Scaled Score and CTOPP-2 Blending Scaled Score

Analysis 1: Accuracy & the Frequency Effect

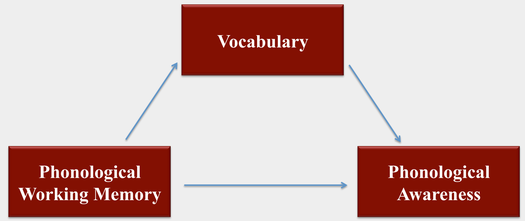
- As in previous research, phonotactic probability is a significant predictor of NWR accuracy



- A one-unit increase in phonotactic probability above the average corresponded to an increase in accuracy of 1.6% ($b = 0.1$, SE = 0.03, $z = 3.09$, $p = 0.002$).

Results

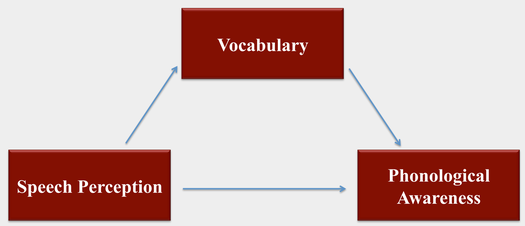
Mediation Model 1



Elision Results:
- There is no evidence for mediation.
- Using a boot-strapping method to evaluate mediation, there is a significant indirect effect of PWM on PA, $p < .001$, but the direct effect of PWM on PA remains significant at $p = .04$.
- 54% of the effect of PWM on PA is mediated by expressive vocabulary size.
  - PWM and vocabulary size independently predict phonological awareness.

Blending Results:
- Consistent with partial mediation.
- Using a boot-strapping method to evaluate mediation, there is a significant indirect effect of PWM on PA, $p < .001$, and the direct effect of PWM on PA is no longer significant.
- 60% of the effect of PWM on PA is mediated by expressive vocabulary size.
  - The direct effect of PWM on PA is no longer significant when the model accounts for effects of vocabulary size.

Mediation Model 2



Elision Results:
- Consistent with partial mediation
- A boot-strapping method to evaluate mediation yields a significant indirect effect of speech perception on PA, $p < .001$, and a marginally significant direct effect of speech perception on PA, $p = .06$.
- 60% of the effect of speech perception on PA is mediated by vocabulary size.
  - The direct effect of speech perception on PA is marginally significant when the model accounts for effects of vocabulary size.

Results

Mediation Model 2

Blending Results:
- Consistent with complete mediation.
- A boot-strapping method to evaluate mediation yields a significant indirect effect of speech perception on PA, $p < .001$, and the direct effect of speech perception on PA is no longer significant.
- 94% of the effect of speech perception on PA is mediated by expressive vocabulary size.
  - The direct effect of speech perception on PA is no longer significant when the model accounts for effects of vocabulary size.

Summary & Discussion

Summary

- Not surprisingly, words that were higher in phonotactic probability were produced more accurately than words that were lower in phonotactic probability.
- The results partially support the lexical restructuring hypothesis.
- For Blending, a substantial proportion of the effects of both speech perception and PWM on PA was explained by a child's lexical knowledge.
- For Elision, the results were similar for the effect of speech perception on PA. However, Mediation Model 1 did not support the claim that the effect of PWM on PA was mediated by vocabulary knowledge. This finding suggests that both vocabulary size and PWM independently influence PA.

Discussion

- A primary goal of speech and language services is to provide a platform and foundation for academic success. The results of this study suggest that a comprehensive approach to treatment that emphasizes vocabulary may lead to natural improvements in the child's phonological awareness skills.
- It is necessary to consider the differences among tasks used to measure PA
  - Elision is particularly challenging and requires children to make use of both their lexical knowledge and phonological working memory.
  - By contrast, children can succeed on blending simply by relying on their lexical knowledge.

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