Measures of Frequency and the Acquisition of Syllable Structure in Polish

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Introduction

Background

Numerous studies have shown that frequency plays an important role in acquisition of syllable structure (Levelt et al. 2005, Roark & Demuth 2000, Kirk & Demuth 2003, Zamuner et al. 2005).

Different definitions of frequency have been used in different studies. • Frequency (Saladi & Johnson 1997; Kirk & Demuth 2003)
• Token frequency (Roark & Demuth 2000, Zamuner et al. 2005)
• CV level (Roark & Demuth 2000, Levelt et al. 2005)
• Sonority level (Stiles, Kirk & Demuth 2004)

Further, many studies consider the effect of frequency for a limited set of structures such as singleton coda (Zamuner et al. 2004, Stiles, Kirk & Demuth 2004) or clusters (Kirk and Demuth 2003).

Questions

• How much does the exact formulation of frequency matter?
• How can one consistent formulation of frequency work across a wide range of phonological structures?
• How much of acquisition can frequency explain?

Approach

• Analyze 4 children's acquisition of syllable structure in Polish
• We consider six formulations of frequency
• We evaluate their abilities to predict acquisition accuracy across a range of structures and levels:
  • Segment, Sonority, CV levels
  • 6 levels of word margins: #CV, #V, #CCV, V#, VC#, VCC#

We used the fitted models to identify significant differences in accuracy between different word margin types. Specifically, we built confidence intervals around the coefficients corresponding to each word margin type, correcting for multiple comparisons. A difference in accuracy was considered significant for • If three of these supported the CV-level acquisition order
• #PV > #FV
• #PV > #FV
• #PV > #FV

Sonority Level Acquisition Results

At the segment level, we found 23 significant differences in accuracy. • #PV > #FV
• #PV > #FV
• #PV > #FV

CV Level Acquisitions Results

At the CV level, we found 12 significant differences in accuracy. • #PV > #FV
• #PV > #FV
• #PV > #FV

Acquisition Analysis

Methodology

We built Mixed Effects Logistic Regression Models to examine differences in production accuracy. The model predicted production accuracy as a function of word margin types, controlling for a number of possible confounding variables.

Mixed Effects Logistic Regression Models:

• Dependent Variable: Accuracy
  • Factor of interest: Word Margin Type
  • Fixed Effects Controls:
    • Age (two groups: 1;7-2;6)
    • Length of target word in syllables
  • Word Frequency
  • Random Effects Controls:
    • Subject
    • Word

The Models R in notation:

Accuracy ~ Margin Type * Age + Word Length + log(Word Frequency) + 1 + (1 | Subject) + (1 | Word)

Three Models – One for each Level of Representation:

• CV
• Sonority
• Segment

We used the fitted models to identify significant differences in accuracy between different word margin types. Specifically, we build confidence intervals around the coefficients corresponding to each word margin type, correcting for multiple comparisons. A difference in accuracy was considered significant if two of these confidence intervals were non-overlapping.

CV Level Acquisition Results

At the CV level, we found 12 significant differences in accuracy. • #PV > #FV
• #PV > #FV
• #PV > #FV
• #PV > #FV
• #PV > #FV

Sonority Level Acquisition Results

At the sonority level, we found 73 significant differences in accuracy. • #PV > #FV
• #PV > #FV
• #PV > #FV
• #PV > #FV

Acquisition Results

Regression Results

Most Covariables improved the models:
• Word Margin Type Factor: Highly Significant
• Age: Highly Significant (Higher Accuracy for Higher Age Group)
• Word Length: Significant (Lower Accuracy for Longer Words)
• Word Frequency: Not Significant given other covariables

In order to evaluate the abilities of the various frequency measures to predict accuracy across levels of representation, we built a mixed effects logistic regression model for each frequency measure. We then evaluated the predictions of each of these models against the acquisition results in two ways.

Method

• Frequency Models: Accuracy ~ log(Freq) + 1 + (1 | Subject)
• Evaluation 1: Ability to predict robust accuracy differences
• Proportion of robust accuracy distinctions (12, 73, 252) predicted

Evaluation 2: Numerical match between frequency and accuracy
• Proposition correlation between accuracy and predicted frequency for word margin types occurring at least 10 times

Frequency Measures

At the level, we calculated six different measures of frequency from the combined corpus of child-directed speech to these four children. We calculated both type and token frequencies at CV, Sonority, and Segment levels.

Frequency Analysis

EVALUATION 1 - Robust Accuracy Differences

EVALUATION 2 - Fine Accuracy Differences

References