Using Developmental Data to Explore Frequency and Neighborhood Density Effects in Production
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Previous research has suggested that various lexical properties of words can influence their production. For example, low frequency words are hyperarticulated compared to high frequency words (Bell et al., 2003; Gahl, 2008). Neighborhood density also influences the phonetic realization of words; however the results have been conflicting as to whether high density words result in more hyperarticulation (Munson, 2004) or more hypoarticulation (Gahl, Yao, & Johnson, 2012).

Various hypotheses have been put forth for these lexical effects. Baese-Berk and Goldrick (2008) contrast an exemplar explanation for the data with a production-internal account. Under an exemplar account (Pierrehumbert, 2002), speakers store episodic memories from perception and use these episodes, or exemplars, to update their production targets. Low frequency words are produced with more extreme articulation because listeners hear these words produced with more extreme articulations. However, under the production internal account (Dell, 1986), both frequency and density effects are driven by the dynamics of the production system and competition induced by activation of related forms during production.

In the present study, we contrast these two accounts using developmental data. In Experiment 1, we contrasted words that were high and low frequency for both children and adults with words that are high frequency for one group but low frequency for the other. In Experiment 2, we compared words with high or low neighborhood density for both age groups with words that were high density for one group and low density for the other. We compare children’s productions to adults’ for each of these conditions. If lexical influences on the phonetic realization of words can be accounted for by the storage of exemplars, we would expect children’s productions to follow the characteristics of the adult lexicon, not the frequency and density characteristics of a child lexicon. However, if these effects are driven more by production-internal mechanisms, we would expect the opposite to be true. Children should produce words that have a high lexical frequency or high neighborhood density in a child lexicon differently than words that are low frequency or density in a child lexicon, regardless of their density or frequency in an adult lexicon.

**Methods** In Experiment 1, children ($n=16$; age: 50.5-67.1 months) named a set of 48 pictures. The pictures were divided into four conditions (12 pictures/group) depending on their relative frequency for adults and children (see Table 1 for examples). In Experiment 2, a separate set of participants ($n=16$; age: 48.8-67.3) named 48 pictures that contrasted in neighborhood density rather than frequency. Stimuli were matched for several other features, including phonotactic probability, voicing of final stops, vowel identity, overall length, and concreteness/imageability. Density and frequency for children was calculated using an online calculator (Storkel & Hoover, 2010). Most participants repeated each word three times over the course of the experiment, though the number for many child participants was highly variable. We measured overall word duration, vowel space, and vowel duration. Data collection for adult participants and data analysis for adults and children is ongoing. Below, we report results for word duration for children’s productions.

**Results** Preliminary results suggest that children produce words that are high frequency for both adults and children with longer durations than words with low frequency for both groups. Critically, collapsed across adult frequency, children’s productions are hyperarticulated for words that are low frequency in a child lexicon as compared to words that are high frequency in their lexicon. Examining words that differ in adult frequency alone (collapsed across child frequency) show no such frequency effects (see Figure 1). A similar result is found when examining neighborhood density. Children’s productions appear to follow the lexical characteristics of a child lexicon, rather than an adult lexicon (see Figure 2).

**Conclusions** Taken together, the results of the two experiments suggest that neighborhood density and lexical frequency influence children’s phonetic productions of words: children demonstrate increased hyperarticulation for words that are low frequency and high density. Importantly, these effects appear to be driven by characteristics of the child lexicon, and not the adult lexicon that serves as input. These preliminary results provide evidence in support of production-internal accounts of
lexical influences on phonetic properties of words. However, it is possible that productions of words in parental input to children do not reflect the lexical characteristics of the words in the adult lexicon. If so, children’s productions may indeed be reflecting properties of their input. We are currently examining the content of adult productions of these same words in child-directed speech to evaluate this possibility.

References
http://doi.org/10.1121/1.1534836
http://doi.org/10.1016/j.jml.2011.11.006
http://doi.org/10.3758/BRM.42.2.497

<table>
<thead>
<tr>
<th>Child lexical frequency</th>
<th>High Frequency</th>
<th>Low Frequency</th>
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<tbody>
<tr>
<td>Adult Lexical Frequency</td>
<td>Beach</td>
<td>Peak</td>
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<tr>
<td>High Frequency</td>
<td></td>
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<tr>
<td>Low Frequency</td>
<td>Peach</td>
<td>Beak</td>
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</tbody>
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Table 1: Example words for each frequency condition

![Figure 1: Word duration as a function of frequency category](image1.png)

Figure 1: Word duration as a function of frequency category (Error bars = standard error)

![Figure 2: Word duration as a function of neighborhood density](image2.png)

Figure 2: Word duration as a function of neighborhood density (Error bars = standard error)