Whole-word versus part-word phonotactic probability/neighborhood density in word learning by children

Holly L. Storkel and Jill R. Hoover
University of Kansas
NIDCD 04781, 00052

What do children have to learn to “know” a word?

Phonological Characteristic
- Phonotactic probability (Vitevitch & Luce, 1999)
  - Frequency of occurrence of individual sounds (i.e., positional segment frequency)
  - Frequency of co-occurrence of pairs of sounds (i.e., biphone frequency)
  - High probability advantage in recognition and production

Lexical Characteristic
- Lexical neighborhood density (Luce & Pisoni, 1998)
  - Number of similar sounding words
    - Words that differ by only one phoneme in any word position
  - High density disadvantage in recognition
  - High density advantage in production and serial recall
Relationship between Phonology and Lexicon

- Phonotactic probability correlated with lexical density (Vitevitch, et al., 1999; Storkel, 2004)
  - High probability ~ high density
  - Low probability ~ low density

Past Studies of Word Learning

- Examined probability/density of the whole word

Parts of Words Matter

- Onset density affects recognition and production by adults (Vitevitch, 2002; Vitevitch, Armbruster, & Chu, 2004)
  - e.g.: mass = map, mad, man, pass
    - self = odd, odd, hot, sock
    - mass has many onset neighbors (few rhyme)
    - sad has many rhyme neighbors (few onset)
- Words with many onset neighbors recognized more slowly than words with many rhyme neighbors (few onset)
- Words with many onset neighbors produced more quickly than words with many rhyme neighbors (few onset)

Does part-word probability/density affect word learning?

Does the effect of part-word probability/density vary by age?

Shift from Whole to Part?

- Lexical re-structuring model (Metsala & Walley, 1998)
  - Posits holistic representation that changes to fine-grain
- Evidence from classification tasks that:
  - Young children classify words by overall similarity
  - Older children classify words by parts
    - First, rhyme
    - Then, onsets
Purpose

- Pit whole-word probability/density against part-word probability/density
- Examine effect across age because sensitivity to parts of words may increase with age

Method

- 43 monolingual English-speaking children
  - 20 3-year-olds
  - 23 4- and 5-year-olds
- 16 CVC nonwords varying in whole-word and part-word phonotactic probability/neighborhood density
  - Low CV/Low VC Wholeness = low
  - Low CV/High VC Wholeness = medium
  - High CV/Low VC Wholeness = medium
  - High CV/High VC Wholeness = high

<table>
<thead>
<tr>
<th></th>
<th>Low CV/ Low VC</th>
<th>Low CV/ High VC</th>
<th>High CV/ Low VC</th>
<th>High CV/ High VC</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CV probability</strong></td>
<td>0.0004</td>
<td>0.0004</td>
<td>0.0046</td>
<td>0.0061</td>
</tr>
<tr>
<td><strong>CV density</strong></td>
<td>2</td>
<td>1</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td><strong>VC probability</strong></td>
<td>0.0004</td>
<td>0.0030</td>
<td>0.0005</td>
<td>0.0057</td>
</tr>
<tr>
<td><strong>VC density</strong></td>
<td>1</td>
<td>8</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td><strong>Whole probability</strong></td>
<td>0.001</td>
<td>0.003</td>
<td>0.005</td>
<td>0.012</td>
</tr>
<tr>
<td><strong>Whole density</strong></td>
<td>4</td>
<td>11</td>
<td>11</td>
<td>21</td>
</tr>
</tbody>
</table>
### Results

- 2 CV x 2 VC x 2 Age mixed ANOVA

- Significant 3-way interaction of CV x VC x Age
  - $F(1, 41) = 6.14, p = 0.02$

- Analyze each age separately
Summary

- 3-year-olds
  - Effect of whole-word probability/density
  - Low & High advantage over Mid

- 4- & 5-year-olds
  - Effect of part-word probability/density
  - Low VC advantage over High VC

Interpretation: Development

- Effect of whole vs. part changes with development
- Supports shift from holistic to fine-grain processing
  - Coincides or precedes emergence of phonological awareness of the rhyme?

Interpretation: “U” for Whole-Word

- Low = High > Mid
- Low advantage = unique
  - Sequence is novel and must be learned
- High advantage = cohesive, predictable
  - Easier to hold in memory
  - Easier to create a lexical representation
- Mid = not unique and not predictable

Interpretation: Part-Word

- Low > High rhyme
  - Again, advantage for uniqueness
- Rhyme characteristics more influential than onset

Taken together, parts of words seem to influence word learning for older, but not younger, children

Emergence of the influence of part-words may be an important milestone

Thank you!

- Participants
- NIDCD 04781, 00052
- Contributors: Teresa Brown, Jennie Fox, Andrea Giles, Stephanie Gonzales, Junko Maekawa, Mariza Rosales, Maki Sueto, Courtney Winn, Allison Wade
- Contact information: Holly L. Storkel
  - bstorkel@ku.edu
  - www.ku.edu/~wrdlrng