Children with SLI: Associated Deficits in Phonology and Word Learning

Holly L. Storkel, Ph.D.
KU Speech-Language-Hearing

www.ku.edu/~wrdlrng
Associated Deficits in SLI: Word Learning

- Children with SLI tend to
  - Score lower than children with NL on vocabulary tests
  - Learn fewer words than children with NL

- Vocabulary tests (Gray et al, 1999)
  - 15% of SLI score 1.5 SD below mean
  - 7% of SLI score 2.0 SD below mean

- Word learning (Gray, 2004)
  - 35% of SLI fail to meet criterion

- Overall, 7-35% of kids with SLI have significant word learning deficits (based on small samples)
Importance of Word Learning

- Vocabulary is a good predictor of later reading ability
  - Decoding/word reading
    (Metsala, 1999; Metsala & Walley, 1998; Walley et al., 2003)
  - Reading comprehension
    (Chall et al., 1990; Cunningham & Stanovich, 1997; Scarborough, 1998)

- Vocabulary is related to academic success
  (Baker et al., 1998; Becker, 1977; Cunningham & Stanovich, 1998)

- Children who enter school with vocabulary deficits have difficulty "closing the gap" with their peers
  (Baker et al., 1998; Biemiller, 2001; Hart & Risley, 1995)
Vocabulary Differences in NL

- **By 2nd grade** (Biemiller & Slonim, 2001)
  - Lowest vocabulary quartile = 4,000 root words
  - Highest vocabulary quartile = 8,000 root words

- **After 2nd grade** (Biemiller & Slonim, 2001)
  - Rate of acquisition is similar across quartiles
Associated Deficits in SLI: Phonology

- Prevalence in general population = 3.8% (Shriberg et al., 1999)

- Co-occurrence of SLI and phonological disorders (Shriberg et al., 1999)
  - 5-8% of 6-year-old children diagnosed with SLI have phonological disorders
  - 11-15% of 6-year-old children diagnosed with phonological disorders have SLI

- Overall, 5-15% co-occurrence (conservative estimate)
Importance of Phonology

- Phonological disorders may impact:
  - Reading and writing
    (Bird et al., 1995; Catts, 1993; Catts & Kamhi, 1986)
  - Academic success
    (Aram, Ekelman, & Nation, 1984; Felsenfeld, Broen, & McGue, 1994; Shriberg & Kwiatkowski, 1988)
  - Social well-being
    (Crowe Hall, 1991; Silverman & Paulus, 1989)
Word Learning

Focus on Assessment
Mental Lexicon

- Store of words in long-term memory
  - Sound-form of the word, e.g., /kæt/
  - Meaning of the word, e.g., small 4-legged furry animal that purrs
  - Connection between sound-form and meaning
  - Connection between words

- Must add words to the mental lexicon
  - Word learning

- Must access words in the mental lexicon
  - Word retrieval (production) or word recognition (comprehension)
How do we know that a child with SLI also has word learning difficulties?
Standardized Vocabulary Tests

- Reportedly insensitive to word learning differences
  (e.g., Gray, 2004)

- May be culturally biased
  (e.g., Campbell, Bell, & Keith, 2001; Washington & Craig, 1992)

- Examine the *products*, not the *process* of word learning
  (e.g., Dollaghan & Campbell, 1998)
    - Represents exposure & ability
Process of Word Learning

- Recognize that a new word was heard, triggering learning

- Hold sound-form and meaning in working memory

- Store a representation in the mental lexicon
  - Sound-form
  - Meaning
  - Link between sound-form and meaning

- Integrate new representation with other known words in mental lexicon

- Modify new representation upon subsequent exposure
Assessment Approach 1: Nonword Repetition

- Success in nonword repetition associated with success in word learning (e.g., Gathercole & Baddeley, 1990)

- Children with SLI typically perform poorly on nonword repetition tasks (e.g., Gathercole & Baddeley, 1990; Dollaghan & Campbell, 1998; Weismer et al., 2000)
Process of Word Learning

- Recognize that a new word was heard, triggering learning
- Hold sound-form and meaning in working memory
- Store a representation in the mental lexicon
  - Sound-form
  - Meaning
  - Link between sound-form and meaning
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Nonword Repetition Tasks

- Dollaghan & Campbell (1998) *JSLHR*, 41
  - 16 nonwords (see next slide)
  - Score = percent phonemes correct
  - Data from children age 5;8 to 12;2
  - Compute z-score based on NL mean & SD
    - (Obtained score – 84)/7
    - Use traditional cut-points (e.g., -1.25, -1.50, etc)
  - Report recommended cut-points
    - $\leq 70\%$ likely SLI (i.e., z-score = -2.00)
    - $\geq 81\%$ likely NL (i.e., z-score = -0.43)
  - Not culturally biased
<table>
<thead>
<tr>
<th>1 syllable</th>
<th>2 syllables</th>
<th>3 syllables</th>
<th>4 syllables</th>
</tr>
</thead>
<tbody>
<tr>
<td>n ai b</td>
<td>t ei v a k</td>
<td>tʃ i n ə t au b</td>
<td>v ei t a tʃ ai d ə p</td>
</tr>
<tr>
<td>v ou p</td>
<td>tʃ ou v æ g</td>
<td>n ai tʃ ou v ei b</td>
<td>d æ v ou n ə tʃ i g</td>
</tr>
<tr>
<td>t au dʒ</td>
<td>v æ tʃ ai p</td>
<td>d ə t au v æ b</td>
<td>n ai tʃ ə t au v u b</td>
</tr>
<tr>
<td>d ə f</td>
<td>n ə t au f</td>
<td>t ei v ə tʃ ai g</td>
<td>t æ v a tʃ i n ai g</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>12 phonemes</th>
<th>20 phonemes</th>
<th>28 phonemes</th>
<th>36 phonemes</th>
</tr>
</thead>
</table>

Dollaghan & Campbell (1998)
Nonword Repetition Tasks

- Ellis Weismer et al. (2000) *JSLHR*, 43
  - Used same nonwords as D&C
  - Provide means & SD from a larger number of children (age 7;1 to 8;11)
  - Compute z-score based on NL mean & SD
    - \((\text{Obtained score} - 83.3)/9.1\)
    - Use traditional cut-points (e.g., -1.25, -1.50, etc)
  - Recommended cut-points
    - \(<= 60\) likely SLI (i.e., z-score = -2.56)
    - \(>= 90\) likely NL (i.e., z-score = +0.74)
  - Not culturally biased
Nonword Repetition Tests

- Standardized tests
  - Comprehensive Test of Phonological Processing (CTOPP)
    - Ages 5 to 24 years
  - Preschool Comprehensive Test of Phonological and Print Processing (PreCTOPP)
    - Preschool
    - Forthcoming
  - Children’s Test of Nonword Repetition
    - Ages 4 to 8 years
    - UK sample
Assessment Approach 2: Fast Mapping

- Comprehension performance in fast mapping predicts comprehension performance in word learning (Gray, 2004)

- Production performance in fast mapping predicts production performance in word learning (Gray, 2004)
Process of Word Learning

- Recognize that a new word was heard, triggering learning

- Hold sound-form and meaning in working memory

- Store a representation in the mental lexicon
  - Sound-form
  - Meaning
  - Link between sound-form and meaning

- Integrate new representation with other known words in mental lexicon

- Modify new representation upon subsequent exposure
Fast Mapping Tasks

- Gray (2004), *JSLHR*, 47
  - Preschool children (4;0-5;11)
  - 4 unknown objects and 4 common objects
  - 4 unknown objects were named with unknown words
  - All 8 objects on a table
  - Phase 1: Modeling (“This is a ____”)
  - Phase 2: Comprehension (“Point to the ___”)
  - Phase 3: Production (“What’s this?”)
  - Completion of phases 1-3 = 1 cycle
  - Complete 3 cycles
Gray (2004) Stimuli

<table>
<thead>
<tr>
<th>Unknown Word</th>
<th>Unknown Object</th>
</tr>
</thead>
<tbody>
<tr>
<td>tεnət</td>
<td>wood peg</td>
</tr>
<tr>
<td>dʑines</td>
<td>electrical connector</td>
</tr>
<tr>
<td>hokəm</td>
<td>small decorative bird</td>
</tr>
<tr>
<td>fizək</td>
<td>silk flower</td>
</tr>
</tbody>
</table>
**Gray (2004) Scoring**

- Focus on the 4 unknown objects
- Count the number of correct comprehension responses across all 3 cycles (max = 12)
  - Compute z-score based on NL mean & SD
    - \((\text{Obtained score} - 8.65)/2.50\)
- Count the number of correct production responses across all 3 cycles (max = 12)
  - Compute z-score based on NL mean & SD
    - \((\text{Obtained score} - 1.10)/0.91\)
    - Score of 0 = -1.21 SD (lowest possible z-score)
Extensions

- Fast mapping in a naturalistic context
  - Work with teacher to determine new vocabulary in a lesson
  - Pre-test students
  - Teacher teaches lesson
  - Post-test students
    - Compare target children to rest of class

- Dynamic assessment
  - Perform a similar fast mapping task but probe for supportive cues/contexts
Assessment Approach 3: Factors that Affect Word Learning

- **Phonotactic probability**
  - Likelihood of occurrence of a sound sequence
  - Common sequences – e.g., “coat”
  - Rare sequences – e.g., “watch”

- **Neighborhood density**
  - Number of similar sounding words (i.e., share all but one sound)
  - Dense – e.g., “coat” has 31 neighbors
  - Sparse – e.g., “watch” has 5 neighbors
Assessment Approach 3: Factors Affecting Word Learning

- NL children learn common/dense sound sequences more rapidly than rare/sparse (e.g., Storkel & Rogers, 2000; Storkel, 2001)

- Phonotactic probability/neighborhood density appear to facilitate learning of
  - Sound-form and meaning association (Storkel, 2001)
  - Sound-form (Storkel, 2004)
Recent work with adults disentangling phonotactic probability and neighborhood density suggests:

- Phonotactic probability may aid in triggering learning (Storkel, Armbruster & Hogan, in press))
  - Adults learn rare faster than common
- Neighborhood density may aid in creating and integrating representations (Storkel et al., in press)
  - Adults learn dense faster than sparse
- Similar results observed in children (Storkel, in progress)
Process of Word Learning

- Recognize that a new word was heard, triggering learning
- Hold sound-form and meaning in working memory
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Assess Factors Affecting Word Learning

- Storkel (in preparation)
  - Examined items on standardized vocabulary tests
    - Phonotactic probability
    - Neighborhood density
  - Correlated on most tests
  - Possible to create subscale scores on
    - PPVT-3
    - EVT
    - ROWPVT-2
Assess Factors Affecting Word Learning

- Storkel (in preparation)
  - PPVT-3 and EVT
  - Compared overall test score to PP/ND subscale scores
  - PP/ND subscale scores generally were better predictors of word learning
Assess Factors Affecting Word Learning

- Once published, our subscale worksheets will be posted at www.ku.edu/~wrddlrg

- In near future,
  - Compute PP/ND subscale scores on standardized vocabulary tests
Assess Factors Affecting Word Learning

- For now, you could:
  - Construct your own vocabulary probe sensitive to PP/ND
  - Examine PP/ND of words child has difficulty learning
  - Manipulate PP/ND on a fast mapping probe

- To calculate phonotactic probability
  [http://www.people.ku.edu/~Emvitevit/PhonoProbHome.html](http://www.people.ku.edu/~Emvitevit/PhonoProbHome.html)

- To calculate neighborhood density
  [http://128.252.27.56/neighborhood/Home.asp](http://128.252.27.56/neighborhood/Home.asp)

- For help understanding/interpreting calculations
  Storkel (2004), *JSLHR*, 47 (6)
Word Learning Take-Home Message: Supplement standardized vocabulary tests to accurately identify word learning deficits in SLI.

Suggested supplements:
- Nonword repetition
- Fast mapping
- Subscale scores
Questions?
Phonology

Focus on treatment
Phonological Disorder

- Breakdown in the production and/or knowledge of the sound system of the surrounding speech community

- Focus: Children with functional phonological disorders
  - No obvious cause of their deficit
  - Normal oral-motor function/structure, hearing, intelligence
Components of Phonological Treatment

- Sound selection: Which sounds to treat?
- Word selection: What words to treat the sound in?
- Treatment activities: How to teach the selected sound(s)?
Sound Selection: Child Variables

- Stimulability: ability to produce a sound correctly with instruction (model, feedback, articulatory cues)
- Stimulable sounds tend to improve without treatment
- Nonstimulable sounds require treatment
- Teach nonstimulable sounds and/or establish stimulability for nonstimulable sounds

Miccio & Elbert, 1996; Miccio, 1999; Powell, Elbert, & Dinnsen, 1991; Rvachew, 1999; Dinnsen & Elbert, 1984
Sound Selection: Child Variables

- Consistency of substitutes: stability of the production of a substitute across word positions and across words

- Treatment of sounds with consistent substitutes leads to generalization across untrained word positions

- Treatment of sounds with inconsistent substitutes shows limited generalization across untrained word positions
  - A special approach may be required to produce learning
  - See Forrest & Elbert (2001)

- Forrest, Dinnsen, & Elbert, 1997; Forrest & Elbert, 2001; Forrest, Elbert, & Dinnsen, 2000
Sound Selection: Child Factors

- Knowledge: accuracy of child’s sound production
  - Least knowledge: low accuracy
  - More knowledge: mid accuracy
  - Most knowledge: high accuracy (not a likely tx target)

- Treatment of least knowledge sounds leads to change in least & more knowledge sounds

- Treatment of more knowledge sounds leads to change in more knowledge sounds only

- Gierut, Elbert, & Dinnsen, 1987; Briere, 1966; Hammerly, 1982; Hardy, 1993; Williams, 1991; but see Rvachew & Nowak (2001)
Sound Selection: Phonological Variables

- Developmental norms: Age when sounds are typically acquired

- Treatment of early acquired sounds (i.e., 1 year or more below CA) leads to limited sound change

- Treatment of late acquired sounds (i.e., 1 year or more above CA) leads to global sound change

- Gierut, Morrisette, Hughes, & Rowland, 1996; Powell, 1991; Powell et al, 1998; but see Rvachew & Nowak, 2001; Debate – M&G, 2003; R&N, 2003
Sound Selection: Phonological Variables

- Complexity: based on cross-linguistic and developmental patterns
  - Less complex = common x languages & early acquired (e.g., nasals, stops, glides)
  - More complex = rare x languages & late acquired (e.g., liquids, fricatives, affricates, clusters)

- Treatment of less complex sounds tends to result in limited sound change

- Treatment of more complex sounds tends to result in global sound change

See Gierut, 1999 for comprehensive review of 30+ studies
Word Selection

- Word frequency: number of times a word occurs in a language

- Neighborhood density: number of phonologically similar words

- Treatment of high frequency words leads to greatest sound change

- Treatment of high density words leads to minimal sound change

- Morrisette & Gierut, 2002; Gierut, Morrisette, & Champion, 1999
Treatment Activities

- Different treatment packages
  - Cycles
  - Whole language
  - Metaphon
  - Traditional/motoric
  - Minimal pair + variants (maximal opposition; multiple opposition)

- Comparisons of packages generally fail to show a clear advantage for one package over another
  - Exception, variants of minimal pair better than traditional minimal pair (Williams, 2005; Gierut, 1991)
Phonology Take-Home Message: 
_Sound and word selection are critical to treatment success_

Recommended targets: 
- Nonstimulable sounds 
- Least knowledge sounds 
- Late acquired sounds 
- Complex sounds 
- High frequency words
Questions?
Goal Sequencing

Treatment of Phonology & Morphology
If children with SLI have multiple deficits, how do we sequence treatment goals?

Focus on phonology and morphosyntax
Tyler & Sandoval (1994)

- Preschool children with SLI and phonological disorders
- 3 Groups
  - Treat phonology only
  - Treat morphology only
  - Treat phonology & morphology
- Results
  - Phonology only – improvements in both phonology & morphology
  - Morphology only – minimal improvements
  - Phonology & morphology – improvements in both
- Conclusion
  - Treat phonology only but select targets relevant to morphology
  - Treat both phonology & morphology
Tyler, Lewis, Haskill, & Tolbert (2002)

- 20 preschoolers with SLI & phonological disorders
- 3 groups
  - No treatment control group
  - Phonology 12-week block – morphology 12-week block
  - Morphology 12-week block – phonology 12-week block
- Results
  - Both treatments better than no treatment
  - Similar results at the end of both treatments
- Conclusion:
  - No clear sequence effect
Tyler, Lewis, Haskill, & Tolbert (2003)

- 47 preschoolers with SLI and phonological disorders
- 5 groups (24 weeks of treatment)
  - No treatment control group
  - Morphology 12-week block – phonology 12-week block
  - Phonology 12-week block – morphology 12-week block
  - Weekly alternating morphology and phonology
  - Simultaneous morphology and phonology (same ssn)

Results
  - Equal gains in phonology across treatments
  - Best gains in morphology in alternating treatments
Goal Sequencing Take-Home Message: Alternate morphology and phonology goals on a weekly basis
Questions?
Additional Resources
Nonsense Words Varying in Phonotactic Probability/Neighborhood Density

For creating a fast mapping probe
<table>
<thead>
<tr>
<th>High Phonotactic Probability</th>
<th>Low Phonotactic Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>kisaim</td>
<td>tseirθes</td>
</tr>
<tr>
<td>saipem</td>
<td>gisairb</td>
</tr>
<tr>
<td>veitəl</td>
<td>kaiðəv</td>
</tr>
<tr>
<td>fikeid</td>
<td>dzeiɡaib</td>
</tr>
<tr>
<td>peibain</td>
<td>faïdíg</td>
</tr>
<tr>
<td>taïsiv</td>
<td>zigeiʒ</td>
</tr>
</tbody>
</table>

**Unusual objects taken from children’s stories (e.g., Dr. Seuss, Mercer Mayer)**

<table>
<thead>
<tr>
<th>High phonotactic probability/ High neighborhood density</th>
<th>Low phonotactic probability/ Low neighborhood density</th>
</tr>
</thead>
<tbody>
<tr>
<td>wæt</td>
<td>naub</td>
</tr>
<tr>
<td>hap</td>
<td>gim</td>
</tr>
<tr>
<td>pin</td>
<td>mɔɪd</td>
</tr>
<tr>
<td>kouf</td>
<td>jeɪp</td>
</tr>
<tr>
<td>High Probability</td>
<td>Low Probability</td>
</tr>
<tr>
<td>------------------</td>
<td>----------------</td>
</tr>
<tr>
<td><strong>High density</strong></td>
<td><strong>Low density</strong></td>
</tr>
<tr>
<td>pim</td>
<td>han</td>
</tr>
<tr>
<td>joun</td>
<td>nęp</td>
</tr>
<tr>
<td>męk</td>
<td>jib</td>
</tr>
<tr>
<td>wæd</td>
<td>paib</td>
</tr>
</tbody>
</table>
Resources for Computing Word Frequency and Neighborhood Density for Real Words

For creating a vocabulary probe or selecting words for phonological treatment
Online search

- Dr. Mitchell Sommer’s website (Washington U)
  http://128.252.27.56/neighborhood/Home.asp
  link from Word & Sound Learning webpage

- Operational definitions
  
  HIGH FREQUENCY = 100 or greater
  LOW FREQUENCY = 99 or less
  HIGH DENSITY = 10 or more
  LOW DENSITY = 9 or less
http://128.252.27.56/neighborhood/Home.asp
Select *Item Search*

*2nd tab on right*
Item Search (top)
Item Search (middle)
Item Search (bottom)
To Find Words for Vocabulary Probe

- Enter search criteria on the left side of the page

- In the middle section, select frequency and density values
  - Low frequency, low density
    - Frequency: High = 99
    - Density B: High = 9
  - High frequency, high density
    - Frequency: Low = 100
    - Density B: Low = 10
To Find Words for Vocabulary Probe

- In the middle section, select frequency and density values (cont)
  - High frequency, low density
    - Frequency: Low = 100
    - Density B: High = 9
  - Low frequency, high density
    - Frequency: High = 99
    - Density B: Low = 10

- Can specify additional criteria related to:
  - Word length
  - Familiarity (on a 7-point scale with 7 being highly familiar to college students)
To Find Words for Vocabulary Probe

- In the bottom section, select output
  - Orthography
  - Phonology (pronunciation)
  - Frequency
  - Density B
  - Any other criteria you would like listed in the output

- Click Search

- Results appear on the right side of the screen
Output
To Find Words for Vocabulary Probe

- Highlight output
- Copy output
- Paste output into text file (e.g., Notepad)
- Save text file
- Import into Excel
  - Open excel
  - File – open – select your text file
  - Select delimited (next)
  - Select comma (finish)
- Select words
Note

- Density varies depending on word length
  - Short words tend to be high density
  - Long words tend to be low density

- Other cut-offs for high versus low density can be selected
  - Storkel (2004) JSLHR -- see next slide
  - > median = high density for that word length
  - </= median = low density for that word length
<table>
<thead>
<tr>
<th>Length</th>
<th>Median Density</th>
<th>Length</th>
<th>Median Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 sound</td>
<td>25</td>
<td>7 sounds</td>
<td>0</td>
</tr>
<tr>
<td>2 sounds</td>
<td>23</td>
<td>8 sounds</td>
<td>0</td>
</tr>
<tr>
<td>3 sounds</td>
<td>18</td>
<td>9 sounds</td>
<td>0</td>
</tr>
<tr>
<td>4 sounds</td>
<td>6</td>
<td>10 sounds</td>
<td>0</td>
</tr>
<tr>
<td>5 sounds</td>
<td>1</td>
<td>11 sounds</td>
<td>0</td>
</tr>
<tr>
<td>6 sounds</td>
<td>0</td>
<td>12 sounds</td>
<td>0</td>
</tr>
</tbody>
</table>
Selecting Words for Phonological Treatment

- **Target box**
  - Specify the sound pattern for treatment
    - e.g., r% = /r/ with 0 or more sounds following (/r/ in initial position)
  - Check phonology
  - Check use wildcards

- **Filter options**
  - Set low frequency filter to 100 (high frequency)

- **Variables for output**
  - Check orthography
  - Check frequency
  - Check density B
Output: High Frequency /r/-initial Words
Selecting Words for Phonological Treatment

- Like vocabulary probe words, you can copy and paste the output to a text file and then import to Excel

- Notes on specifying word position
  - Sound% = word-initial
    - r%
  - %sound% = any word position (initial, medial, final)
    - %r%
  - %sound = word-final
    - %r
Selecting Words for Phonological Treatment

- Specifying sounds
  - For most sounds, use the IPA symbol
  - Exceptions (IPA symbols that don’t use standard letters):
    - Use G for /ŋ/
    - Use y for /j/
    - Use T for /ð/
    - Use D for /ð̊/
    - Use S for /ʃ/
    - Use Z for /ʒ/
    - Use C for /tʃ/
    - Use J for /dʒ/
Resources for Computing Phonotactic Probability for Nonsense Words or Real Words

For creating a fast mapping or vocabulary probe
Online Search

- Dr. Michael Vitevitch’s Phonotactic Probability Calculator (KU)
  - http://www.people.ku.edu/~mvitevit/PhonoProbHome.html
  - Link from Word & Sound Learning Lab website
Phonotactic Probability Calculator

Phonotactic probability refers to the frequency with which a phonological segment, such as /s/, and a sequence of phonological segments, such as /s/ç/, occur in a given position in a word (Jusczyk, Luce & Charles-Luce, 1994). The method used to estimate phonotactic probability in Jusczyk, Luce, and Charles-Luce (1994) and in many other studies investigating the influence of phonotactic probability on language processing (see below) has been made freely available to language researchers on this web site. The effort to make this method of calculating phonotactic probability available to the research community was supported in part by research grants R03 DC 04259 (Kansas University), and R01 DC 0265801 (University at Buffalo) from the National Institute on Deafness and Other Communication Disorders, National Institutes of Health.

A detailed description of how to use the Phonotactic Probability Calculator (PPC), how to interpret the output, and a list of the computer readable transcription (and the IPA equivalents) required as input to the PPC can be found in the paper below. If you use the PPC to estimate phonotactic probability in a set of real English words or made-up nonwords, please be sure to cite this article:


Computer-Readable transcription (“Klattese”) equivalents to IPA
Using the Calculator

- Click on the link Computer-Readable transcription ("Klattese") equivalents to IPA

- All real words or nonsense words entered must be entered by their pronunciation
  - Link above will take you to a table showing you the symbols you need to use to show pronunciation
Connect to Calculator
Using Calculator

- Enter the pronunciation of your words in the left-hand box
  - Enter only one word per line

- Click *Calculate your entry*
Output

Phonotactic Probability Calculator Page - Microsoft Internet Explorer

CALCULATE PHONOTACTIC PROBABILITY

Type or copy and paste your data here. Press [Enter] after each line.

The results of your calculation are displayed here. You may copy and paste results to another program for further analysis.

gdg
k8t
7'g
Cit

Calcul your Entry

Clear your Entry

Return to Phonotactic Probability Home Page
Output

- Results appear in the right-hand column

- The third line for each word is the line of interest
  - 1\textsuperscript{st} number = positional segment frequency sum + 1
  - 2\textsuperscript{nd} number = biphone frequency sum + 1

- Subtract “1” from those numbers to get the “true” sum
  - Create an average
    - Divide 1\textsuperscript{st} number by the \# of segments in the transcription
    - Divide 2\textsuperscript{nd} number by (\# of segments – 1)
Interpretation

- Storkel (2004) *JSLHR* provides medians by word length
  - See next slide
  - > median = high probability for that word length
  - <= median = low probability for that word length
Storkel (2004) Table 2

<table>
<thead>
<tr>
<th>Length</th>
<th>Median Segment Average</th>
<th>Length</th>
<th>Median Segment Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 sound</td>
<td>0.0075</td>
<td>7 sounds</td>
<td>0.0485</td>
</tr>
<tr>
<td>2 sounds</td>
<td>0.0282</td>
<td>8 sounds</td>
<td>0.0507</td>
</tr>
<tr>
<td>3 sounds</td>
<td>0.0453</td>
<td>9 sounds</td>
<td>0.0524</td>
</tr>
<tr>
<td>4 sounds</td>
<td>0.0463</td>
<td>10 sounds</td>
<td>0.0571</td>
</tr>
<tr>
<td>5 sounds</td>
<td>0.0459</td>
<td>11 sounds</td>
<td>0.0564</td>
</tr>
<tr>
<td>6 sounds</td>
<td>0.0473</td>
<td>12 sounds</td>
<td>0.0608</td>
</tr>
<tr>
<td>Length</td>
<td>Median Biphone Average</td>
<td>Length</td>
<td>Median Biphone Average</td>
</tr>
<tr>
<td>---------</td>
<td>------------------------</td>
<td>---------</td>
<td>------------------------</td>
</tr>
<tr>
<td>1 sound</td>
<td>N/A</td>
<td>7 sounds</td>
<td>0.0047</td>
</tr>
<tr>
<td>2 sounds</td>
<td>0.0010</td>
<td>8 sounds</td>
<td>0.0053</td>
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<tr>
<td>3 sounds</td>
<td>0.0023</td>
<td>9 sounds</td>
<td>0.0061</td>
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<tr>
<td>4 sounds</td>
<td>0.0033</td>
<td>10 sounds</td>
<td>0.0071</td>
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<tr>
<td>5 sounds</td>
<td>0.0037</td>
<td>11 sounds</td>
<td>0.0069</td>
</tr>
<tr>
<td>6 sounds</td>
<td>0.0043</td>
<td>12 sounds</td>
<td>0.0070</td>
</tr>
</tbody>
</table>
Resources for Finding Evidence
Finding Evidence: Evidence Reviews

- ASHA’s National Center for Evidence-Based Practice
  http://www.asha.org/members/ebp/guidelines/N-CEP-Registry
- Cochrane Collaboration
  http://www.cochrane.org/index0.htm
- Campbell Collaboration
  http://www.campbellcollaboration.org
- What Works Clearinghouse
- Agency for Healthcare Research and Quality
  http://ww.ahcpr.gov
- National Guideline Clearinghouse
  http://www.guideline.gov
Finding Evidence: Special Reports/Lists

- ASHA
  http://www.asha.org

- National Institute on Deafness and Other Communication Disorders
  http://www.nidcd.nih.gov

- Bamford-Lahey Children’s Foundation
  http://www.bamford-lahey.org/ebp.html

- National Reading Panel
  http://www.nationalreadingpanel.org/Publications/publications.htm
Finding Evidence: Databases for Searches

- PubMed

- ASHA full text journals (1990 ff)
  http://www.asha.org/members/deskref-journals/journals/journals-default

- Google Scholar
  http://scholar.google.com

- Ingenta Connect
  http://www.ingentaconnect.com

- http://www.science.gov
Finding Evidence: Full-Text Articles

- PubMed Central
  http://www.pubmedcentral.nih.gov

- ASHA full text journals (1990 ff)
  http://www.asha.org/members/deskref-journals/journals/journals-default

- Author’s website
  use Google Scholar, University digital archive, or OAiSter
  http://oaister.umdl.umich.edu/o/oaister

- Ingenta Connect (for a fee)
  http://www.ingentaconnect.com
Finding Evidence: TOC Alerts

- PubMed’s “My NCBI”
  Click “My NCBI”

- ASHA Journals TOC Alerting
  http://www.asha.org/about/publications/journal-abstracts/journal-list.htm

- Ingenta Connect
  http://www.ingentaconnect.com

- http://www.science.gov
Acknowledgements

- NIDCD 04781, 06545

- Contact information:
  Word & Sound Learning Lab
  wrdlrng@mail.ku.edu
  www.ku.edu/~wrdlrng