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 learnin
- 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 learnin
- **Hold sound-form and meaning in working memory**
- Store a representation in the mental lexicon
  - Sound-form
  - 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
    - </= 70% likely SLI (i.e., z-score = -2.00)
    - >/= 81% likely NL (i.e., z-score = -0.43)
  - Not culturally biased

Dollaghan & Campbell (1998)

1 syllable	2 syllables	3 syllables	4 syllables
n aɪ b	t eɪ v ɑ k	tʃ i n ɔɪ t aʊ b	v eɪ t ɑ tʃ aɪ d ɔ
v oʊ p	tʃ oʊ v æ g	n aɪ tʃ oʊ v eɪ b	d æ v oʊ n ɔɪ tʃ
t aʊ dʒ	v æ tʃ aɪ p	d ɔɪ t aʊ v æ b	n aɪ tʃ ɔɪ t aʊ v ʊ
d ɔɪ f	n ɔɪ t aʊ f	t eɪ v ɔɪ tʃ aɪ g	t æ v ɑ tʃ i n aɪ
12	20	28 phonemes	36 phonemes

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
    - (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 learnin
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  - 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

Unknown Word	Unknown Object
tɛnət	wood peg
dʒinəs	electrical connector
hokəm	small decorative bird
fɪzək	silk flower

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
    - (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
    - (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)

Assessment Approach 3: Factors Affecting Word Learning

- 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 learnin
- Hold sound-form and meaning in working memory
- Store a representation in the mental lexicon
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  - Meaning
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- Modify new representation upon subsequent exposure

Process of Word Learning

- Recognize that a new word was heard, triggering learnin
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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/~wrdlrng

- 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/%7Emvitevit/PhonoProbHome.html
- To calculate neighborhood density 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 repetitio

Fast mappi

Subscale score

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 stimulabilit for nonstimulable sounds
- Miccio & Elbert, 1996; Miccio, 1999; Powell, Elbert, &

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; Har 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 developmenta 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 limit sound change
- Treatment of more complex sounds tends to result in global sound change

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

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 soun

Least knowledge soun

Late acquired soun

Complex soun

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 & morpholog
  - 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 disorde
- 3 groups
  - No treatment control group
  - Phonology 12-week block – morphology 12-week bloc
  - Morphology 12-week block – phonology 12-week bloc
- 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 bloc
  - Phonology 12-week block – morphology 12-week bloc
  - Weekly alternating morphology and phonology
  - Simultaneous morphology and phonology (same ssn)
- Results
  - Equal gains in phonology across 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

Storkel & Rogers, 2000

High Phonotactic Probability	Low Phonotactic Probability
kisaɪm	tʃeɪθəs
saɪpəm	giʃaɪb
veɪtəl	kaɪðəv
fikeɪd	dʒeɪgaɪb
peɪbaɪn	faɪðig
taɪsiv	zigeɪʒ

**Unusual objects taken from the Macmillan Visual Dictionary

Storkel, 2001; Storkel, 2003

High phonotactic probability/ High neighborhood density	Low phonotactic probability/ Low neighborhood density
wæt	naʊb
hʌp	gim
pin	mɔɪd
koʊf	jeɪp

**Unusual objects taken from children's stories (e.g., Dr. Seuss,

Storkel, Armbruster, & Hogan (in press)

High Probability		Low Probability	
High density	**Low density**	**High density**	**Low density**
pim	hɑn	jeɪm	faʊg
joʊn	nɛp	feɪg	jʌd
mɛk	jɪb	hif	wɑf
wæd	paɪb	naʊt	mug

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

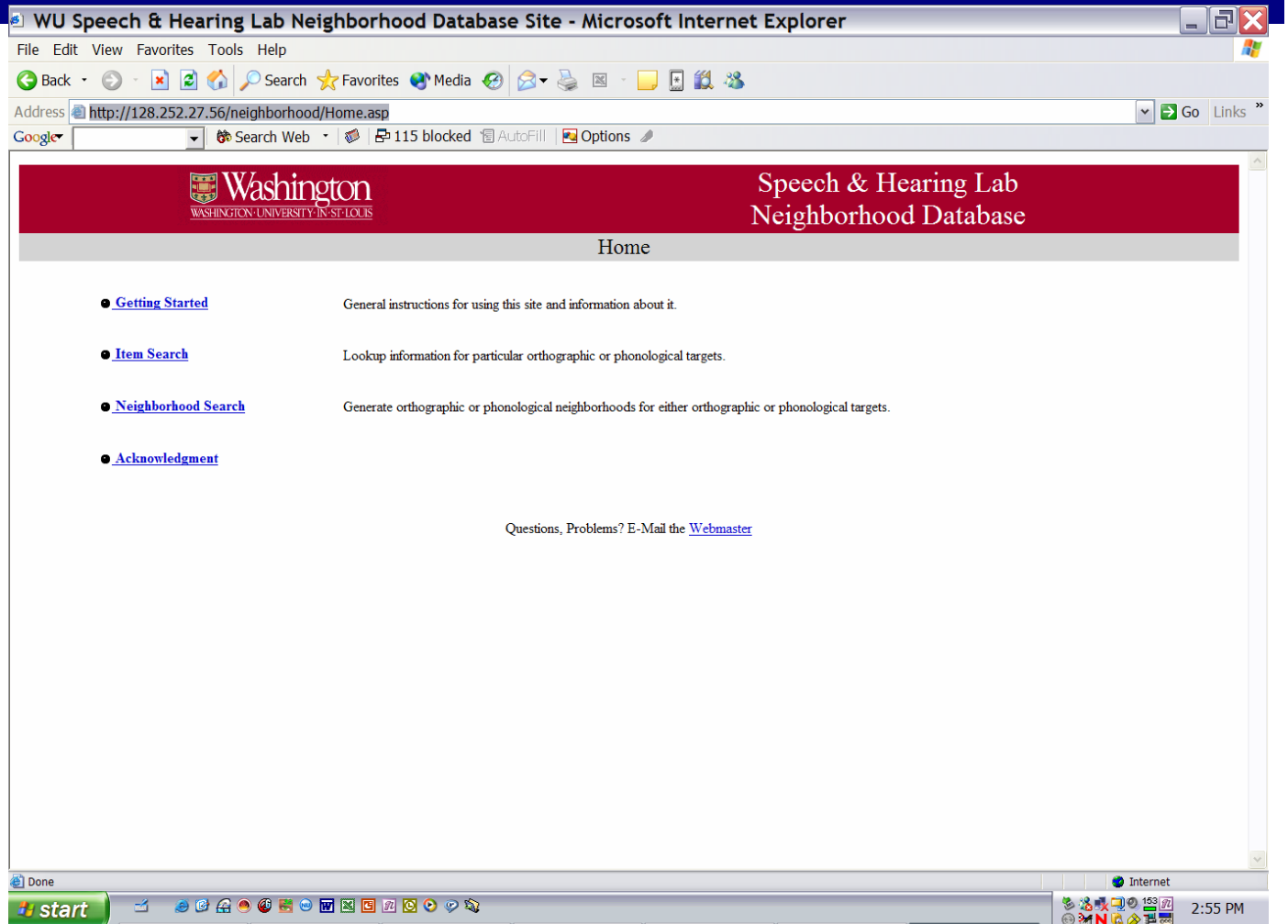
  HIGH FREQUENCY = 100 or greater

  LOW FREQUENCY = 99 or less

  HIGH DENSITY = 10 or more

  LOW DENSITY = 9 or less

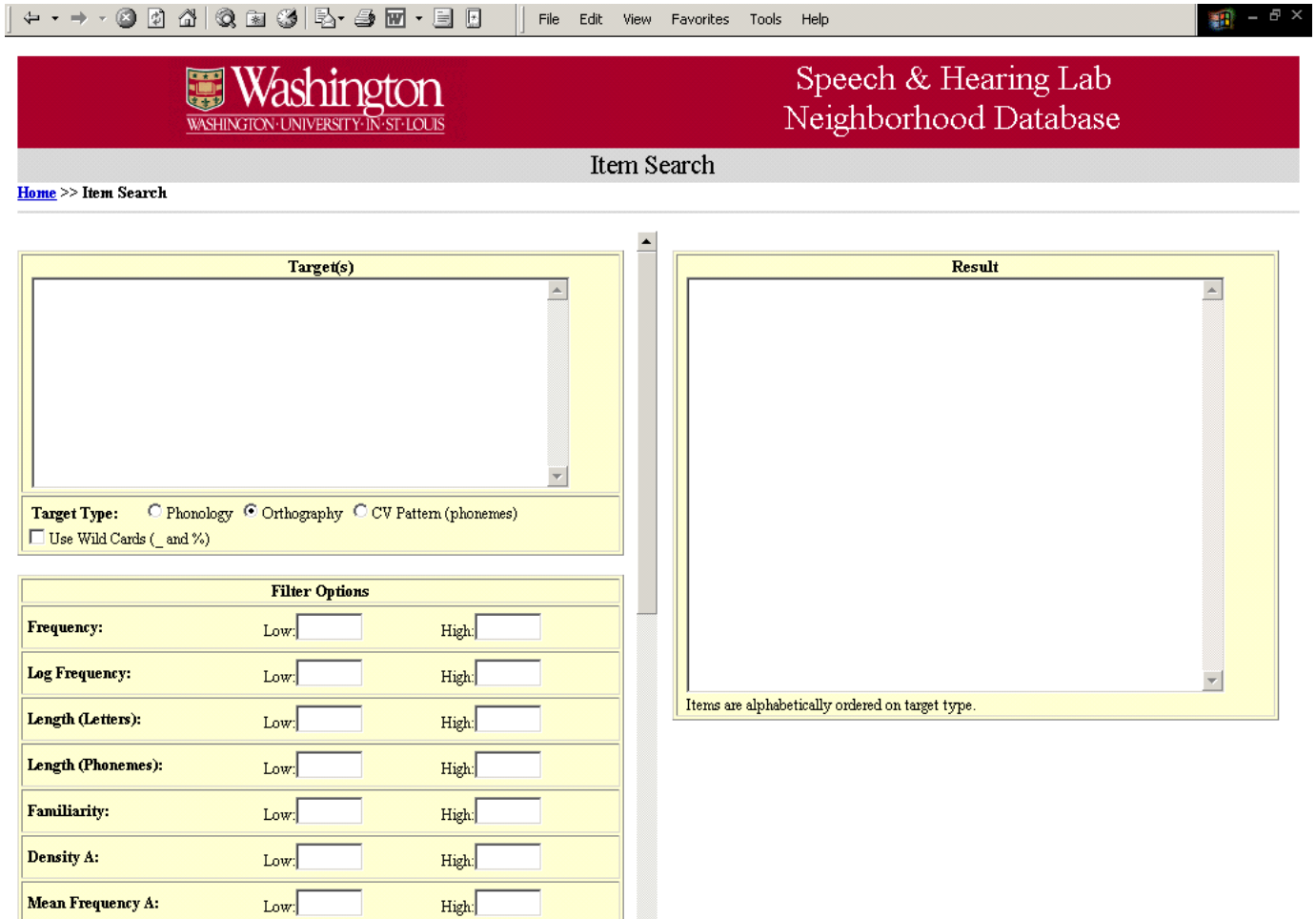
http://128.252.27.56/neighborhood/Home.asp



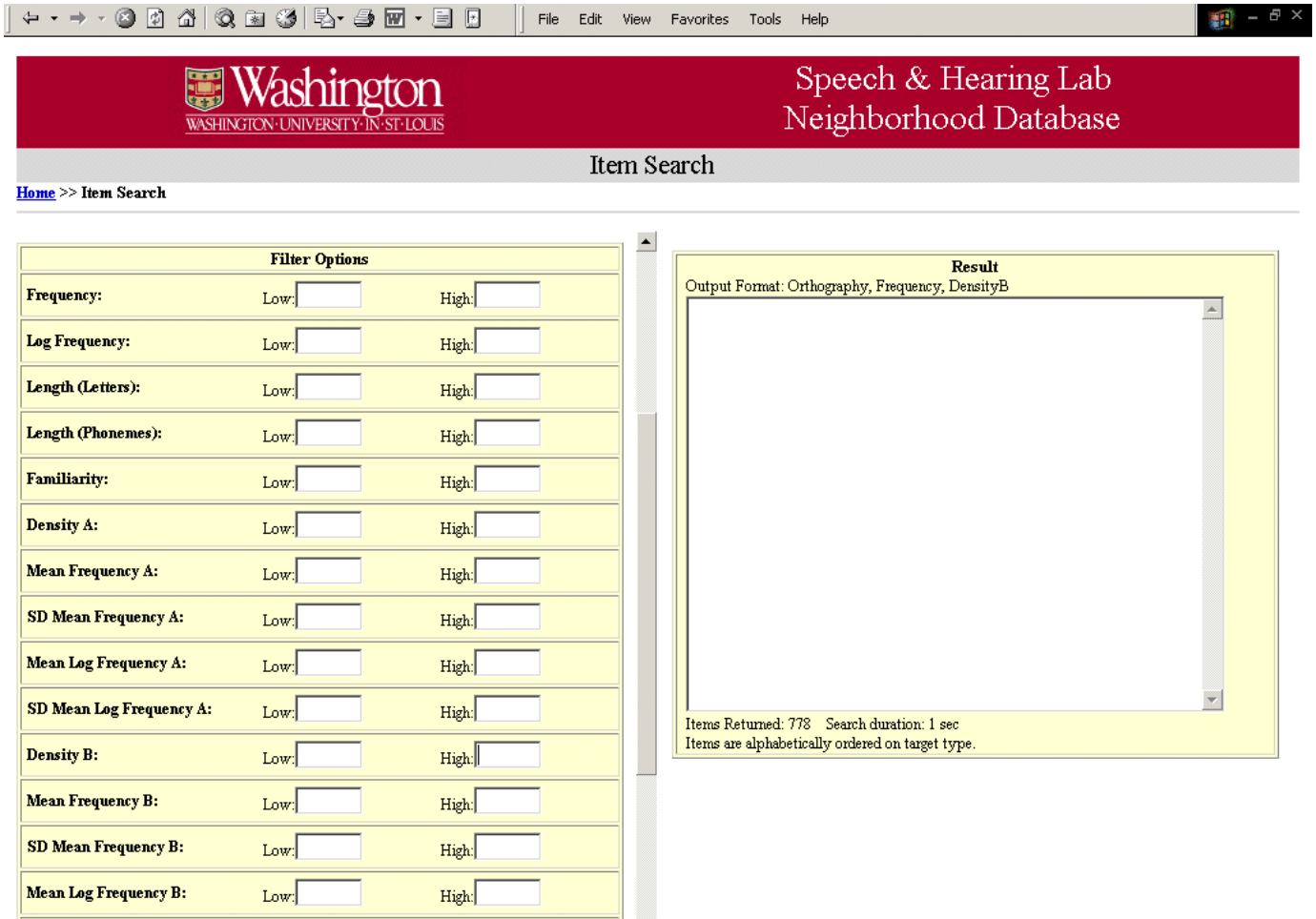
Select *Item Search*

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

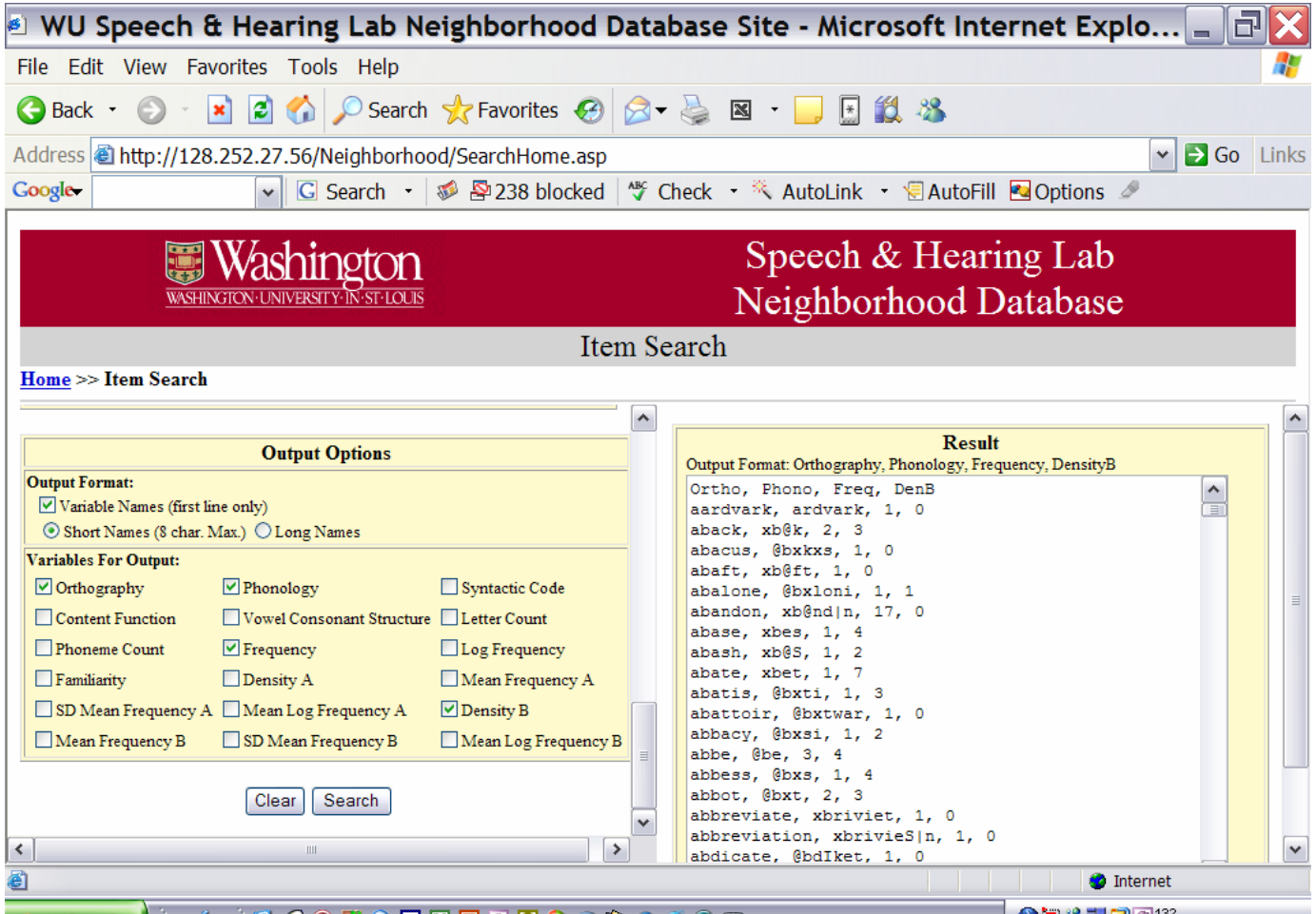
To Find Words for Vocabulary Probe

- 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

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


WU Speech & Hearing Lab Neighborhood Database Site - Microsoft Internet Explo...
File Edit View Favorites Tools Help
Back Search Favorites
Address http://128.252.27.56/Neighborhood/SearchHome.asp
Go Links
Google Search 238 blocked Check AutoLink AutoFill Options
Washington
WASHINGTON UNIVERSITY IN ST LOUIS
Speech & Hearing Lab
Neighborhood Database
Item Search
Home >> Item Search
Output Options
Output Format:
Variable Names (first line only)
Short Names (8 char. Max.) Long Names
Variables For Output:
Orthography
Phonology
Syntactic Code
Content Function
Vowel Consonant Structure
Letter Count
Phoneme Count
Frequency
Log Frequency
Familiarity
Density A
Mean Frequency A
SD Mean Frequency A
Mean Log Frequency A
Density B
Mean Frequency B
SD Mean Frequency B
Mean Log Frequency B
Clear
Search
Result
Output Format: Orthography, Phonology, Frequency, DensityB
Ortho, Phono, Freq, DenB
aardvark, ardvark, 1, 0
aback, xb@k, 2, 3
abacus, @bxkxs, 1, 0
abaft, xb@ft, 1, 0
abalone, @bxloni, 1, 1
abandon, xb@nd|n, 17, 0
abase, xbes, 1, 4
abash, xb@S, 1, 2
abate, xbet, 1, 7
abatis, @bxti, 1, 3
abattoir, @bxtwar, 1, 0
abbacy, @bxsi, 1, 2
abbe, @be, 3, 4
abbess, @bxs, 1, 4
abbot, @bxt, 2, 3
abbreviate, xbriviet, 1, 0
abbreviation, xbrivieS|n, 1, 0
abdicate, @bdIket, 1, 0
Internet

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

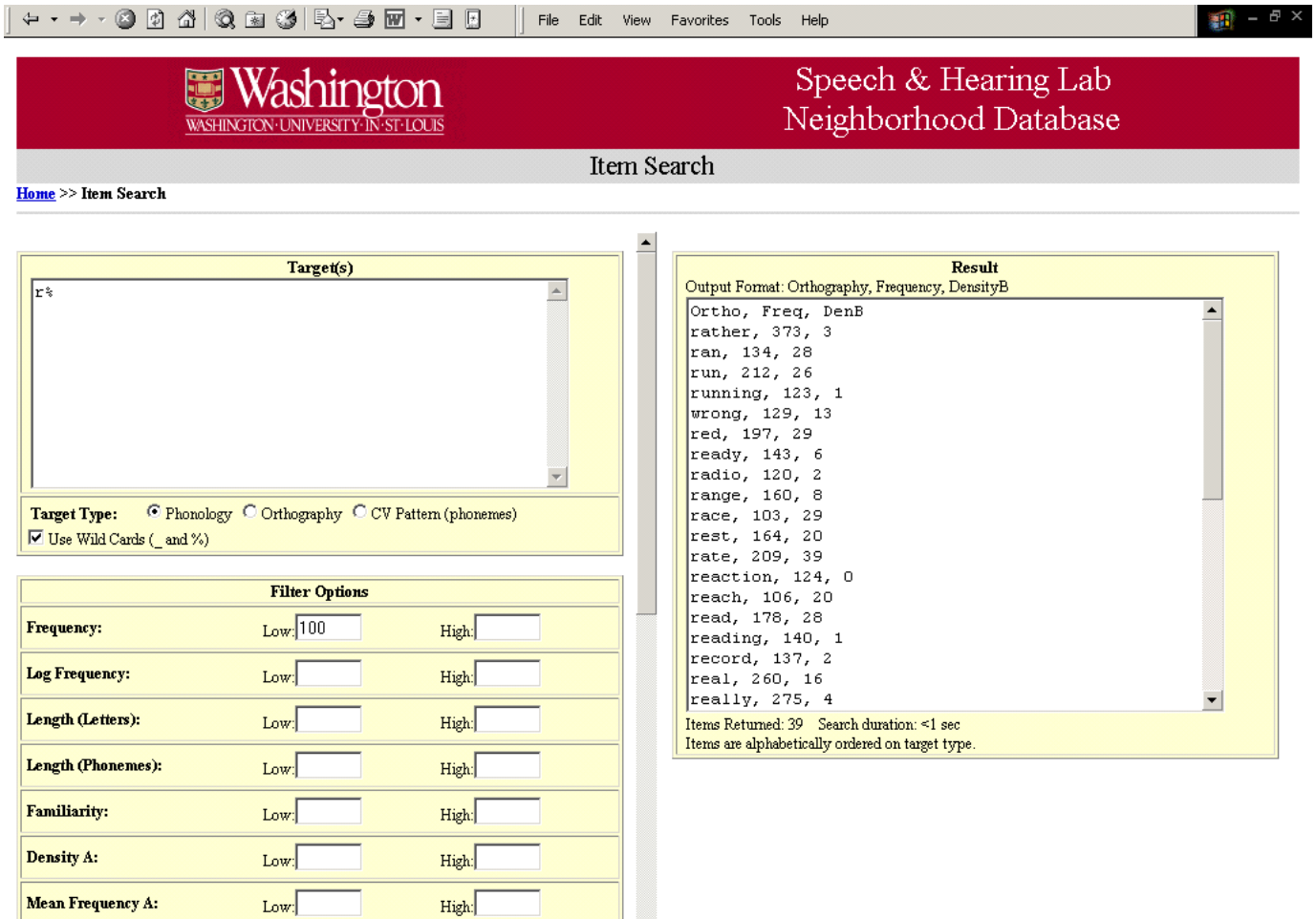
Storkel (2004) Table 2

Length	Median Density		Length	Median Density
1 sound	25		7 sounds	0
2 sounds	23		8 sounds	0
3 sounds	18		9 sounds	0
4 sounds	6		10 sounds	0
5 sounds	1		11 sounds	0
6 sounds	0		12 sounds	0

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 /θ/
    - Use D for /ð/
    - Use S for /ʃ/
    - Use Z for /ʒ/
    - Use C for /tʃ/
    - Use J for /dʒ/

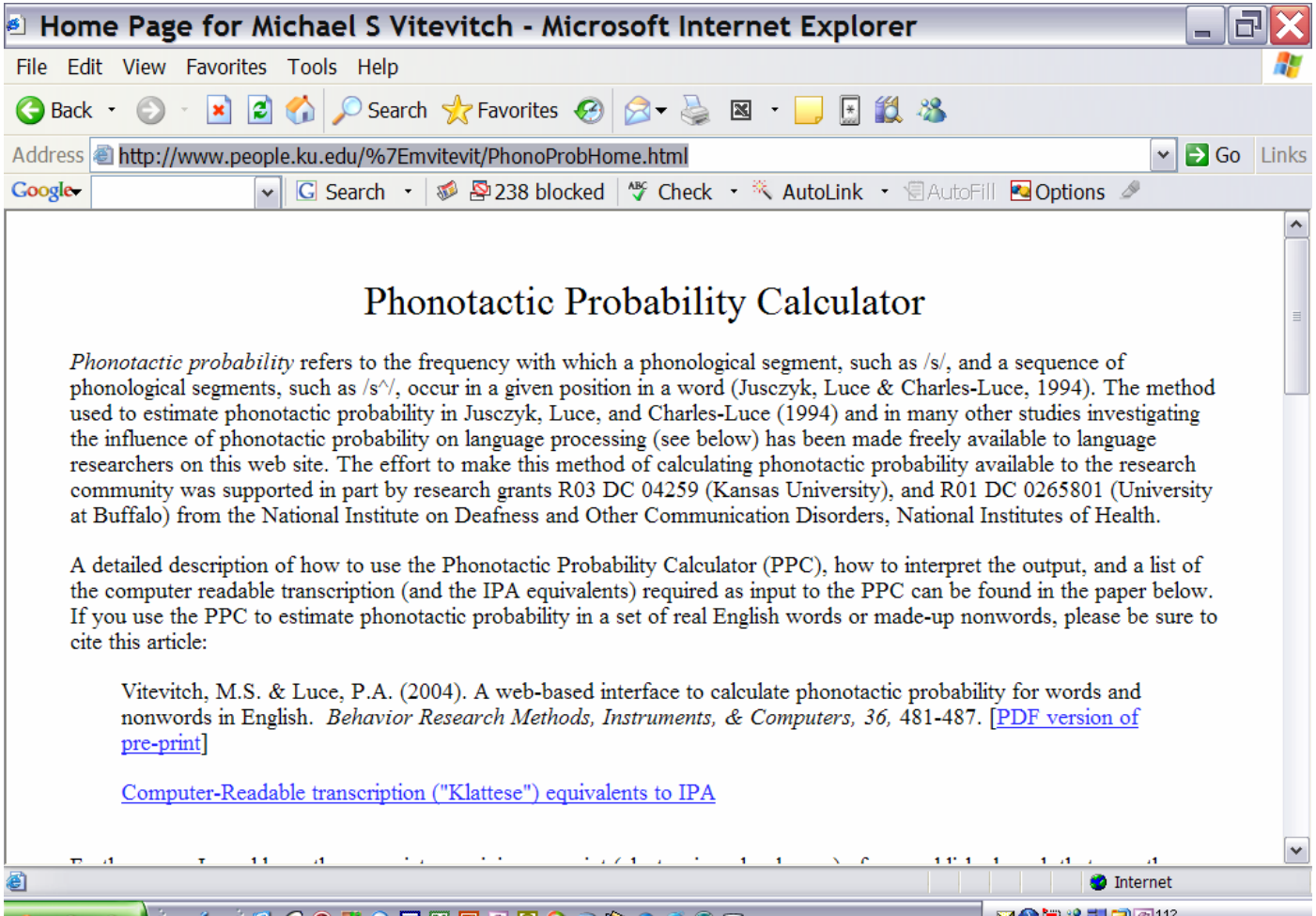
Resources for Computing Phonotactic Probability for Nonsense Words or Real Words

For creating a fast mapping or vocabulary probe

Online Search

- Dr. Michael Vitevitch's Phonotactic Probability Calculator (KU)
  - http://www.people.ku.edu/%7Emvitevit/PhonoProbHome.html
  - Link from Word & Sound Learning Lab website

http://www.people.ku.edu/%7Emvitevit/PhonoProbHome.html

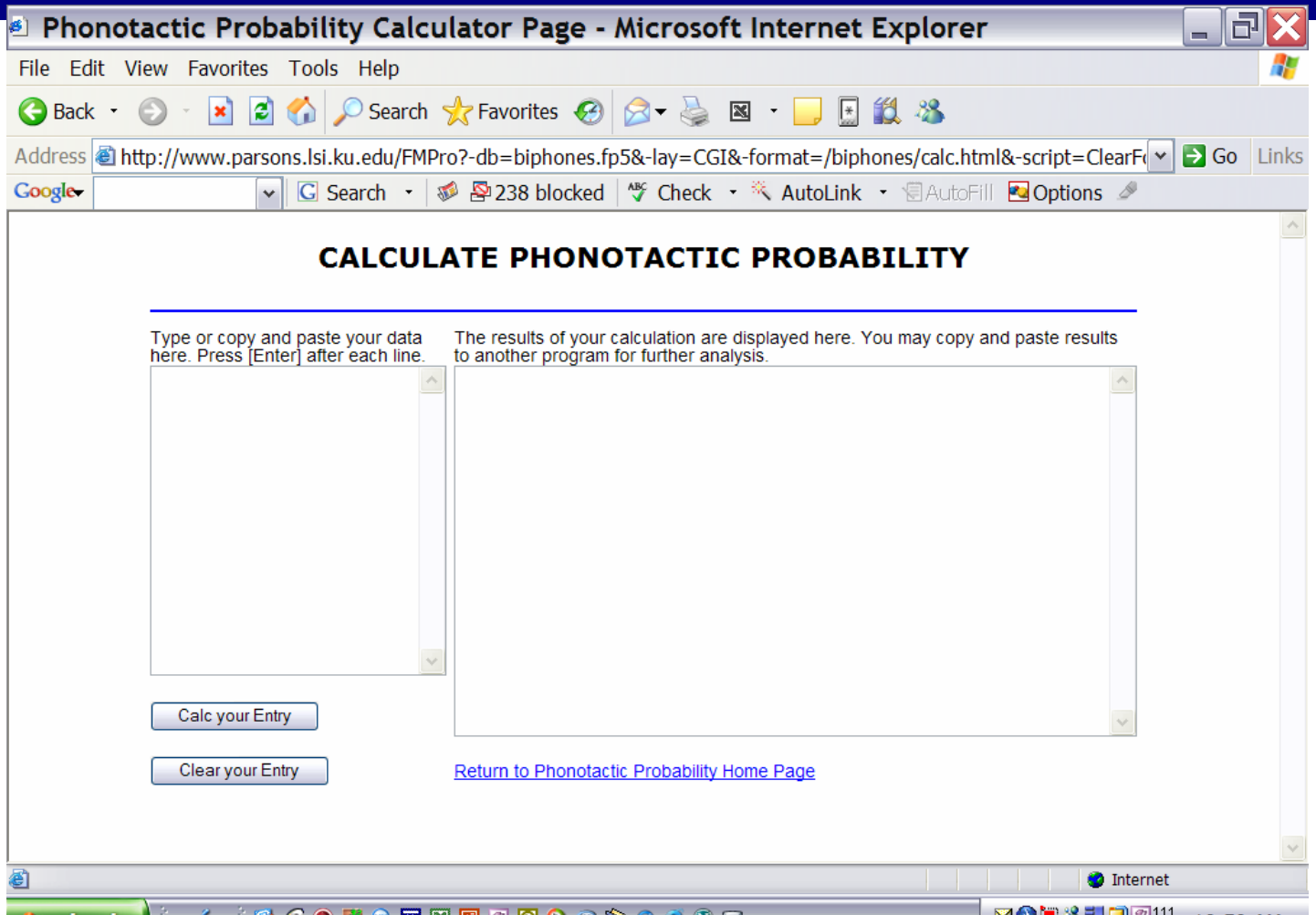


Using the Calculator

- 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

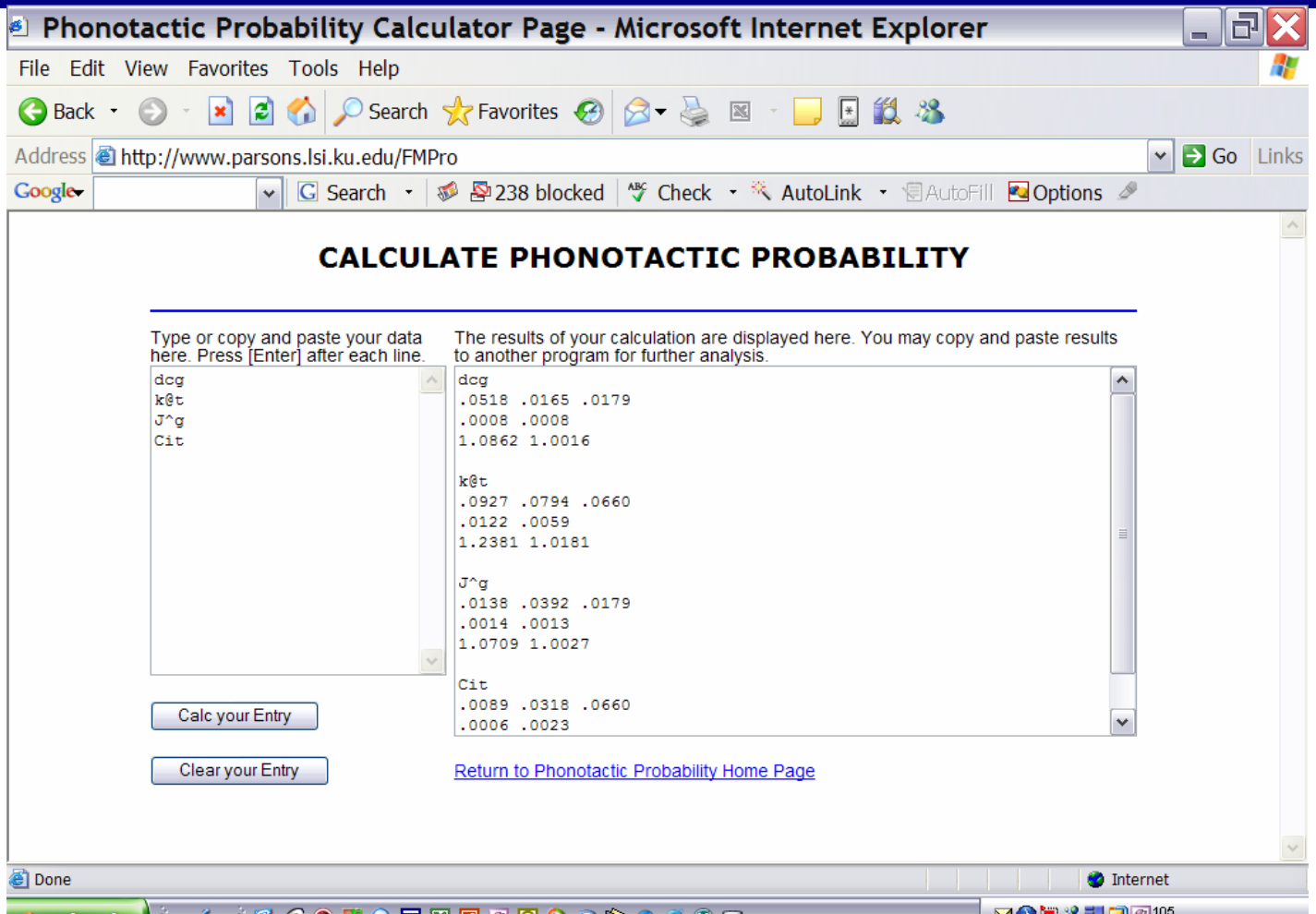
Connect to Calculator



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
File Edit View Favorites Tools Help
Back Search Favorites
Address http://www.parsons.lsi.ku.edu/FMPro
Go Links
Google Search 238 blocked Check AutoLink AutoFill Options
CALCULATE PHONOTACTIC PROBABILITY
Type or copy and paste your data here. Press [Enter] after each line.
dcg
k@t
J^g
Cit
The results of your calculation are displayed here. You may copy and paste results to another program for further analysis.
dcg
.0518 .0165 .0179
.0008 .0008
1.0862 1.0016
k@t
.0927 .0794 .0660
.0122 .0059
1.2381 1.0181
J^g
.0138 .0392 .0179
.0014 .0013
1.0709 1.0027
Cit
.0089 .0318 .0660
.0006 .0023
Calc your Entry
Clear your Entry
Return to Phonotactic Probability Home Page
Done
Internet

Output

- Results appear in the right-hand column
- The third line for each word is the line of interest
  - 1st number = positional segment frequency sum + 1
  - 2nd number = biphone frequency sum + 1
- Subtract "1" from those numbers to get the "true" sum
  - Create an average
    - Divide 1st number by the # of segments in the transcription
    - Divide 2nd 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

Length	Median Segment Average		Length	Median Segme Average
1 sound	0.0075		7 sounds	0.0485
2 sounds	0.0282		8 sounds	0.0507
3 sounds	0.0453		9 sounds	0.0524
4 sounds	0.0463		10 sounds	0.0571
5 sounds	0.0459		11 sounds	0.0564
6 sounds	0.0473		12 sounds	0.0608

Storkel (2004) Table 2

Length	Median Biphone Average		Length	Median Bipho Average
1 sound	N/A		7 sounds	0.0047
2 sounds	0.0010		8 sounds	0.0053
3 sounds	0.0023		9 sounds	0.0061
4 sounds	0.0033		10 sounds	0.0071
5 sounds	0.0037		11 sounds	0.0069
6 sounds	0.0043		12 sounds	0.0070

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 http://www.whatworks.ed.gov
- 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
  http://www.ncbi.nlm.nih.gov/entrez/query.fcgi
- 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 OAIste
  http://oaister.umdl.umich.edu/o/oaister
- Ingenta Connect (for a fee)
  http://www.ingentaconnect.com

Finding Evidence: TOC Alerts

- PubMed's "My NCBI"
  http://www.ncbi.nlm.nih.gov/entrez/query.fcgi
  Click "My NCBI"

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

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

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- NIDCD 04781, 06545

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