

## New Frontiers in Clinical Practice: Children with Phonological Disorders



Word & Sound  
Learning Lab  
[www.ku.edu/~wrldrng/](http://www.ku.edu/~wrldrng/)

University of Kansas

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## Phonological Disorder

- Can co-occur with other language disorders
- Past studies measured language skills in broad terms
  - More recent evidence suggests potential weaknesses
- Areas to be considered in this session
  - Word learning
  - Morphosyntax
  - Reading
  - Bilingual context

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## Introduction and Overview



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## Finding Evidence: Evidence Reviews

- Cochrane Collaboration  
<http://www.cochrane.org/index0.htm>
- Campbell Collaboration  
<http://www.campbellcollaboration.org>
- What Works Clearinghouse  
<http://www.whatworks.ed.gov>

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## 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

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## 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>

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## 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>

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## Word Learning



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## 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>

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## Children Rapidly Acquire Words

- Diary/Checklist
  - Add ~2-5 words per day (expressive)
  - Add ~9 words per day (receptive)
- Fast mapping
  - Associate form with referent with 1 exposure
- Extended mapping
  - Initial representations retained and modified with subsequent exposure

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## 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>
- <http://www.science.gov>

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## Why so fast?

- Constraint Account
  - Born with innate principles
- Associationistic Account
  - Learn regularities in the environment
- Emergentist Coalition Account
  - Innate principles help learn first words
  - Extract cues or regularities from learned words
  - New principles emerge

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## Why so fast?

- Constraint Account
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## Does phonotactic probability influence word learning by children with phonological delays?

Storkel (2004), JSLHR, 47 (5)

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## Phonological Regularities: Phonotactic Probability

- Likelihood of occurrence of sound sequence
  - Common = sounds frequently occur in that word position; Adjacent sounds frequently co-occur
  - Rare = sounds infrequently occur in that word position; Adjacent sounds infrequently co-occur
- Common (e.g., "coat") vs. Rare (e.g., "watch")
- See Storkel & Morrisette (2002), LSHSS, 33 (1), 24-37 for review

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## Participants

|                        | Phonological Delay (PD) | Normal Comparison (NC) |
|------------------------|-------------------------|------------------------|
| Number                 | 20                      | 24                     |
| Age                    | 5;0                     | 3;10                   |
| PPVT-3 Standard Score  | 105                     | 106                    |
| EVT Standard Score     | 105                     | 107                    |
| GFTA-2 Percentile Rank | 10                      | 41                     |

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## Phonotactic Probability Influences:

















- Word recognition and memory in adults (e.g., Frisch, Large, & Pisoni, 2000; Vitevitch & Luce, 1998; 1999)
- Nonword repetition in childhood (e.g., Beckman & Edwards, 1999; Gathercole et al., 1999)
- Word learning in typically developing children (e.g., Storkel, 2001, 2003, 2004; Storkel & Rogers, 2000)
- Common > Rare

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## Stimuli

- 16 CVC nonsense words
  - ½ common
  - ½ rare
- Paired with unfamiliar objects
- Incorporated into narrative and pictures

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|         | Form   |      | Referent  |   |   |   |
|---------|--------|------|---|---|---|---|
|         | Common | Rare | Item 1  | Item 2  | Item 3  | Item 4  |
| Known   | mæb    |      |  |  |  |  |
|         |        | gɔɪt |  |  |  |  |
| Unknown | rouf   |      |  |  |  |  |
|         |        | θum  |  |  |  |  |

## Storkel (2004) Summary

- PD & CN groups learned a similar number of words, BUT
  - PD group learned rare sound sequences
  - CN group learned common sound sequences
- PD group may have difficulty differentiating common sound sequences
- PD lexicon may differ from the CN lexicon

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## Procedure

Test 0 Story 1 Test 1 Story 1 Test 2 Story 1 Test 3 Test 4  
 Episode 1 Episode 2 Episode 3  
 1 exposure 3 exposures 3 exposures  
 8 stimuli 8 stimuli 8 stimuli

Test 0 Story 2 Test 1 Story 2 Test 2 Story 2 Test 3 Test 4  
 Episode 1 Episode 2 Episode 3  
 1 exposure 3 exposures 3 exposures  
 8 stimuli 8 stimuli 8 stimuli

### • Picture Naming



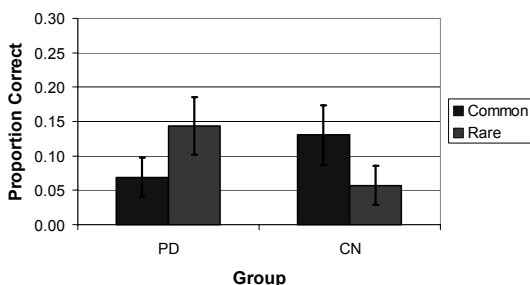
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**Both groups scored within normal limits on vocabulary tests**

Vocabulary tests may not be sensitive to underlying word learning mechanisms

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## Naming Correct at Post-Test



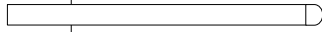
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## Standardized Vocabulary Tests

- Reportedly insensitive to word learning differences (e.g., Gray, Plante, Vance, & Henrichsen, 1999)
- May be culturally biased
- Examine the *products*, not the *process* of learning (e.g., Dollaghan & Campbell, 1998)
  - Represents exposure & ability

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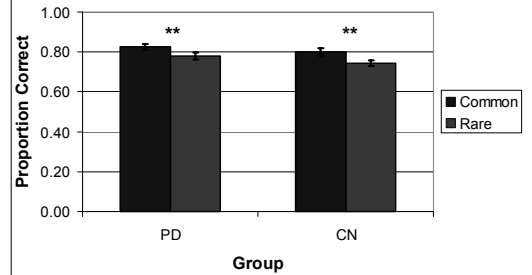
Can the sensitivity of vocabulary tests be improved by examining the types of words that kids know?



Storkel & Giles  
(in progress)

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### Expressive Vocabulary Test



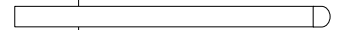
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### Examine Phonotactic Probability Subscale Scores

- Peabody Picture Vocabulary Test – 3A Expressive Vocabulary Test
- Code items as common or rare
- For each child, compute
  - % Common correct
  - % Rare correct

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Are these subscale scores better predictors of word learning than overall scores?

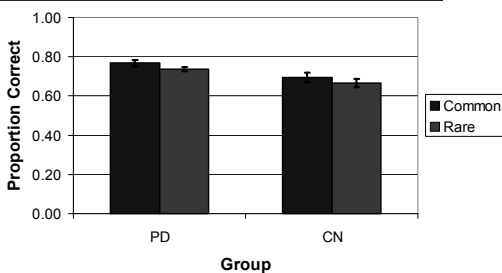


Regression Analysis

Predictors:  
CA, PPVT raw, PPVT common, PPVT rare, EVT raw, EVT common, EVT rare

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### Peabody Picture Vocabulary Test - 3A



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### Significant Predictors of Word Learning

|        | PD        | CN                           |
|--------|-----------|------------------------------|
| Common | PPVT rare | PPVT raw score<br>EVT common |
| Rare   | ∅         | PPVT raw score               |

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## Summary: Utility of Subscale Scores

- Show promise in predicting word learning in typically developing children
- Warrant further exploration
  - Not all outcomes were as expected
  - For PD, PPVT rare predicted learning of common
- Need to consider how correlated variables may affect outcome
  - Tests not designed to investigate phonotactic probability

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## For More Information

- [www.ku.edu/~wrdrng](http://www.ku.edu/~wrdrng)  
Scoresheets for subscale scores (in progress)
- To compute phonotactic probability  
<http://www.people.ku.edu/%7Emvitevit/PhonoProbHome.html> (link available from [www.ku.edu/~wrdrng](http://www.ku.edu/~wrdrng))
- Search strategies & TOC Alerts:  
Search by author Storkel HL ( or HL Storkel)  
Search by author Munson B or Edwards J  
Search for phonotactic probability (and phonological disorders)  
Alternative terms for phonological disorder: speech disorder, speech sound disorder

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## Alternative Processing Measures

- Nonword repetition  
(Storkel & Hoover, in progress)
- Nonword processing task  
(Storkel & Hoover, in progress)
- Still need sensitivity to factors that influence word learning

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## Acknowledgements

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## Conclusion

- Findings from basic science research can be used to build better diagnostic tools
- Increase the sensitivity of diagnostic tools
- Influence treatment planning in a more direct way

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## Grammatical Morphology



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## Grammatical Morphemes

Present progressive {-ing}  
Prepositions 'in' and 'on'  
Plural {-s}  
Past irregular e.g., 'ran', 'went'  
Possessive {-s}  
Uncontractible copula e.g., '\*there it is'  
Articles e.g., 'the', 'a'  
Past regular {-ed}  
3<sup>rd</sup> person singular e.g., 'walks'  
3<sup>rd</sup> person irregular, e.g., 'does', 'has'  
Uncontractible auxiliary {be}, e.g., '\*Are you going?'  
Contractible copula {be}, e.g., 'I'm sick'  
Contractible auxiliary {be}, e.g., 'She's leaving'

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## Assessment

- Problematic in children with co-occurring speech & language impairments
  - Late acquired sounds
    - /s/ & /z/
  - Phonological processes
    - Final consonant deletion

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## Language Impairment

Present progressive {-ing}  
Prepositions 'in' and 'on'  
Plural {-s}  
Past irregular e.g., 'ran', 'went'  
Possessive {-s}  
Uncontractible copula e.g., '\*there it is'  
Articles 'the', 'a'  
Past regular {-ed}  
3<sup>rd</sup> person singular e.g., 'walks'  
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Uncontractible auxiliary {be}, e.g., '\*Are you going?'  
Contractible copula {be}, e.g., 'I'm sick'  
Contractible auxiliary {be}, e.g., 'She's leaving'

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## Assessment cont..

- Production tasks
  - Imitation of a sentence with a target morpheme
    - "The boy **walked** to the store"
- Receptive tasks
  - Grammaticality judgments
    - "He run to the school bus"
- Standardized Assessment
  - Rice Wexler Test of Early Grammatical Impairment (TEGI)

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## Phonological Disorders & Language Impairment

- Shriberg, Tomblin, & McSweeney (1999)
  - At 6 years, 11-15% of children with persisting speech delay had a language impairment (LI)
  - At 6 years, 2-8% of children with persisting LI had a speech delay
- Clinical implications for assessment and treatment of children with co-occurring speech and language impairments

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## TEGI (Rice & Wexler, 2001)

- Phonological probe
  - Assesses /s/, /z/, /t/, /d/ in final position
  - Can the child use the sounds to produce morphemes?

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## TEGI

(Rice & Wexler, 2001)

- Production Tasks
  - Third Person Singular Probe
    - "Here is a painter, tell me what he does"
  - Past Tense Probe
    - "Here the boy is raking. Now he is done. Tell me what he did"
  - Be/Do Probe
    - "Is the kitty resting?"
    - "Does the bug like milk?"
- Receptive Task
  - Grammaticality Judgment Probe (ages 4;0 – 8;11)
    - "Zee found two spoon"

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## Participants

- 3;0- 5;11
- Intervention group and control group
- Impairments in speech & language
  - Greater than 1 standard deviation below the mean on the PLS-3 or CELF or greater than 1.5 standard deviations below the mean on MLU
  - Greater than 1 standard deviation below the mean on the BBTOP
  - Normal cognition, hearing, and oral motor functioning

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## How should we co-treat phonology and morphology?

Tyler, Lewis, Haskill, & Tolbert (2003), JSLHR 46 (5)

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## Goal Selection

- 24-week intervention schedule
- 4 phonology goals
- 4 morphology goals
- Time-based rather than criterion-based

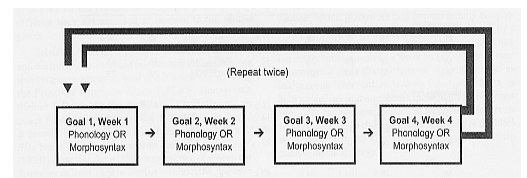
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## Co-targeting Phonology & Morphology in Treatment

- Which goal attack strategy produces the greatest change in phonology & morphology?

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## Phonology 1<sup>st</sup> or Morphology 1<sup>st</sup> Goal Attack Strategies



- Repeated 3 times for phonology and 3 times for morphology

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## Alternating Phonology & Morphology Goal Attack Strategy

- Weekly alternation of a phonology & a morphology goal in three 8-week periods

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## Treatment Efficacy Results

- All interventions resulted in significant change in phonology and morphology when compared to the control group

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## Simultaneous Phonology & Morphology Goal Attack Strategy

- 1 phonology & 1 morphology goal co-targeted in each session a week for six 4-week periods

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## Phonology Change

- After 12 and 24 weeks, there were equal significant gains in phonology across the 4 goal attack strategies

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## Intervention Activities

- Receptive Activities
  - Naturalistic Activities
    - e.g., songs and books loaded with the target morpheme and sound
  - Feedback
    - e.g., expanding child's productions or modeling correct production of target morpheme and sound
- Production Activities
  - e.g., eliciting target morpheme and sound

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## Morphology Change

- After 12 weeks, greatest gains with morphology first *and* alternating goal attack strategies
- After 24 weeks, greatest gains with alternating goal attack strategy
  - No difference in morphology gains between the remaining three goal attack strategies after 24 weeks

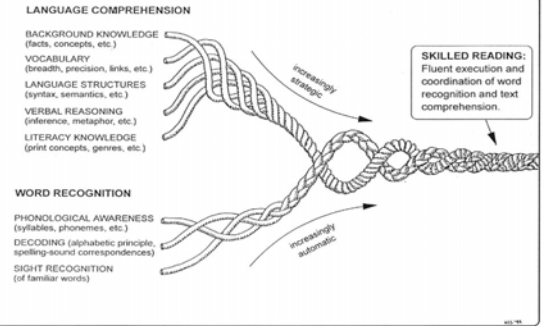
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## Conclusion

- Intervention in morphology can facilitate change in phonology
- Intervention beginning with morphology first results in the greatest immediate gains in morphology
- Weekly alternations of phonology & morphology goals results in the greatest gains in morphology overall

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## THE MANY STRANDS THAT ARE WOVEN INTO SKILLED READING



See Scarborough, H. S. in Neuman, S.B. & Dickinson, D. K. (2001). *Handbook of Early Literacy Research*. New York: Guilford Press.

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## For More Information

- Additional Studies:
  - Tyler (1997), *Topics in Language Disorders*, 17 (4)
  - Tyler, Lewis, Haskill, & Tolbert (2002), *LSHSS*, 33 (1)
  - Tyler, Lewis, & Welch (2003), *AJSLP*, 12 (3)
  - Tyler, Lewis, Haskill, & Paul (2003), *Clinical Linguistics & Phonetics*, 17 (1)
- Search Strategies & TOC Alerts:
  - Author: Tyler A
  - Phonology & morphology
  - Co-occurring speech & language impairment
- Rice Wexler Test of Early Grammatical Impairment:
  - <http://www.clp.ku.edu/mabelrice/Default.htm>

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## Phonological Disorder & Reading

- Are children with phonological disorders in preschool going to have reading difficulties in the later years?
- Maybe
  - Some go on to have reading impairments and some do not

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## Reading



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## Which kids with phonological disorder are at risk for reading impairment?

- Five main factors to consider
  - Types of phonological production errors
  - Persistence of phonological disorder
  - Co-occurrence of language impairment
  - Pre-reading skills
  - Family history of reading impairment

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## Types of errors

- reversal errors vs. substitution errors
  - "aminal" for animal rather than "wabbit" for rabbit
- Consistent use of unusual or nondevelopmental errors
- Multisyllabic words especially difficult

(Catts, 1986; 1989; Dodd, et al., 1995; Magusson & Naucler, 1990, Larrivee & Catts, 1999; Leitao & Fletcher, 2004)

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## Pre-reading Skills

- Top predictors
  - Phonological awareness
  - Letter knowledge
- Do all children with phonological disorders have phonological awareness deficits?
- Not necessarily – two different domains

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## Persistence of the Problem

- Most children with speech sound disorders resolve their problems by 6 years of age (approximately 75%)
- Children with more persistent problems have poorer literacy outcomes
- These children are more likely to have poor phonological representations at the beginning of formal reading instruction.

(Bishop & Adams, 1990; Larrivee & Catts, 1999; Nathan et al, 2004).

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## Phonological Awareness

- Phonological Awareness
  - the explicit awareness of the sounds of speech independent of meaning (Stanovich, 1988; Torgesen, 1996, 1999)
  - usually measured by rhyming, deleting, or segmenting parts of words
    - Example, say "cowboy" without "boy"

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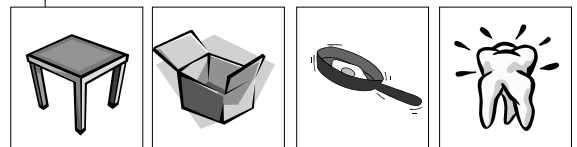
## Co-occurrence of Language Impairments

- A child with a phonological disorder & language impairment is more at-risk for literacy problems than one with only a phonological disorder
- Late talkers are also at risk

(Catts, 1993; Bishop & Adams, 1990; Levi et al., 1982; Nathan et al., 2004; Naucler & Magnusson, 1998).

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## PreCTOPP (in press)



Elision Practice 1

## Family history of reading impairment

- If a child has a family history of reading impairment, he/she is more likely have to a reading deficit

(Catts & Sittner, 2005; Lyytinen, et al., 2004)

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## Literacy intervention for children with phonological impairment

- Preschool children
  - Incorporate phonological awareness activities and letters into phonological therapy
- School age children
  - Definitely at risk
  - Incorporate reading and language activities into phonological therapy
- Phonological therapy alone won't do it! (Gillon, 2000, 2002; Harbers, Paden, & Halle, 1999; Blischark, Shah, & Lombardino, 2004; Segers & Verhoeven, 2004, Smith, Downs, Mogford-Bevan, 1998)
- Illusionary recovery – reading changes over time

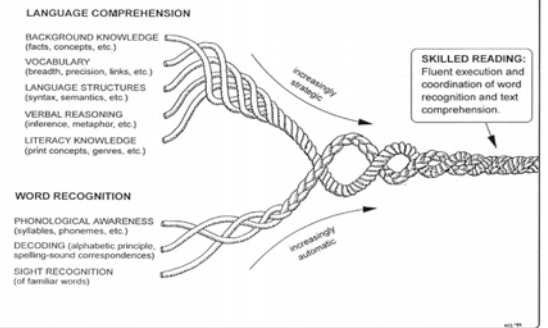
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## Assessment Implications

- Preschool children
  - Assess pre-reading skills
  - Ask about child & family history
  - Assess language skills
- School age children
  - Assess reading skills
  - Assess language skills

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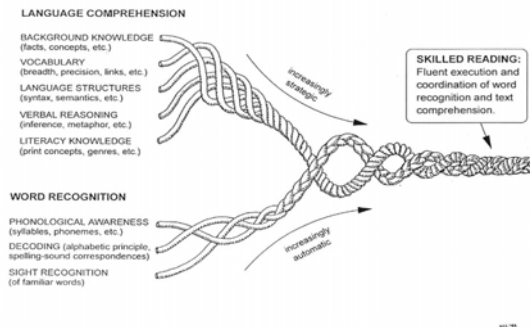
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## For More Information

- Search strategies
  - Phonological disorders and reading, literacy
  - Pre-reading
  - Author: Gillon, Catts
- TOC Alerts
  - Dyslexia (not reading)
  - Phonological awareness
- Catts website: <http://www.ku.edu/~splh/Catts/>
- Gillon website: <http://www.cmds.canterbury.ac.nz/people/gillon.shtml>
- Coming Soon
  - Special issue of LSHSS on new phonological awareness research

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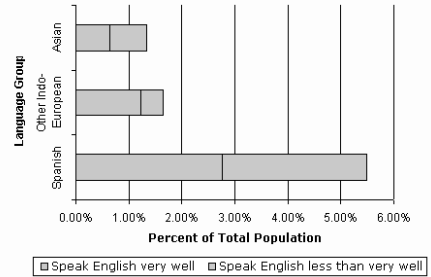
## Bilingual Children



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Ability to speak English among those speaking a language other than English, 2000



(www.censusscope.org)

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## Language Spoken in Kansas

- 8.7% (>5 years) speak language other than English at home.
- 9.5% are linguistically isolated.

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## Difference vs. Disorder

- Difference, not disorder
  - Influence of native languages
    - /r/ and /l/ for Japanese speakers
    - /θ/ and /ð/ for Spanish speakers
- Disorder

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Language Spoken at Home, 1990-2000

(www.censuscope.org)

|                         | 1990      |         | 2000      |         |
|-------------------------|-----------|---------|-----------|---------|
|                         | Number    | Percent | Number    | Percent |
| Only English            | 2,158,011 | 94.25%  | 2,281,705 | 91.26%  |
| Spanish                 | 62,059    | 2.71%   | 137,247   | 5.49%   |
| Other Indo-European*    | 44,110    | 1.93%   | 41,207    | 1.65%   |
| Asian Language**        | 21,406    | 0.93%   | 33,203    | 1.33%   |
| Other                   | 4,029     | 0.18%   | 6,998     | 0.28%   |
| Total Population Age 5+ | 2,289,615 | 100.00% | 2,500,360 | 100.00% |

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## Phonological Development: Bilingual vs. Monolingual Children

- Lower intelligibility rating, more consonant and vowel errors overall, more distortion, more uncommon error patterns (Gildersleeve, Davis, & Stubbe, 1996)
- Differences decrease overtime (Gildersleeve-Neumann & Davis, 1998)

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## How do we assess phonology of bilingual children?

Goldstein & Washington  
(2001), *LSHSS*, 32(3)

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## Goldstein & Washington (2001): Results - Bilingual data

- No significant difference between Spanish and English in accuracy and % phonological processes
- Sounds not mastered:
  - Fricatives, affricates (English)
  - Flaps, trills (Spanish)
- Phonological processes
  - Stopping, final consonant deletion (English)
  - Liquid simplification, cluster reduction (Spanish)

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## Goldstein & Washington (2001): Participants

- n = 12 (10 girls, 2 boys)
- Age = 4;0-4;11 (M = 4;7)
- Spanish-English bilinguals
- Typically developing

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## Goldstein & Washington (2001): Results – Bilingual vs. Monolingual

- Generally similar in phonological systems
  - Some exceptions: e.g., liquid simplification in Spanish (bilingual > monolingual)
- Different types of errors, substitution patterns
  - e.g., Error / substitution patterns for flaps and trills in Spanish
    - Bilingual: deletion, [l], [r] (for /r/), etc.
    - Monolingual: [r] (for /r/)

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## Goldstein & Washington (2001): Method

- Single-word phonological assessment
  - English and Spanish
  - Analyses
    - Phonetic inventory
    - PCC
    - PCC for voicing, place of articulation, manner of articulation
    - % occurrence for phonological processes
    - Comparison to monolingual data

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## Goldstein & Washington (2001): Clinical implication

- Bilingual children may differ from monolingual children
  - Types of errors, substitution patterns
- Assessment
  - Different norms
  - Nature/quantity for substitution types
  - Assess both languages

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## Do we need to treat one language or both?

Holm & Dodd (2001),  
*Folia Phoniatrica et  
Logopaedica*, 53 (3)

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## Holm & Dodd (2001) Articulatory Therapy - Outcome

- /s/ (treatment target) → improved
- Generalization to Cantonese? → YES
  - Jason produced /s/, /t<sup>s</sup>/, and /t<sup>sh</sup>/ correctly in Cantonese in 70% of opportunities.

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## Holm & Dodd (2001)

- Do bilingual children with articulation and phonological disorder generalize treated sounds to another language?
- Jason (5;2)
  - Cantonese (L1) – English (L2)
  - Interdental lisp
  - Cluster reduction, substitutions

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## Holm & Dodd (2001) Phonological Therapy

- Cluster reduction and gliding (Cantonese and English)
- Treatment with phonological contrasts in minimal pairs/triplets in English
- 45 minutes x 8 weeks
- Treatment target:
  - cluster reduction and gliding

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## Holm & Dodd (2001) Articulatory Therapy

- Interdental lisp (Cantonese & English)
- Treatment of English /s/
- (20 minutes x 2/wk) x 7 weeks
- Sound monitored
  - /s/: treatment target

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## Holm & Dodd (2001) Phonological Therapy - Outcome

- Cluster reduction and gliding → improved
- Generalization to Cantonese? → NO

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## Holm & Dodd (2001) Summary

- Cross-language generalization
  - Articulation → Yes (universal)
  - Phonology → No (language specific)
- Articulation may be treated in only one language, but phonology may need to be treated in both languages.

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## Assessment of Children with Phonological Disorders

- Need to consider language skills at both initial assessment as well as later
  - Word learning: may need to augment vocabulary tests
  - Grammatical morphology: need to consider impact of phonological errors on morphemes
  - Reading:
    - Preschool: assess pre-reading skills, family history, language
    - School: assess reading
- Bilingual children
  - Assess in both languages
  - Monolingual norms inadequate

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## For More Information

- Roseberry-McKibbin, C. (2002). *Multicultural students with special language needs.* (Academic Communication Associates, Inc.)
  - Cultural and linguistic differences
  - Assessment and intervention
- US Census Bureau ([www.census.gov](http://www.census.gov))
- Search terms
  - Multicultural
  - Bilingual
  - Spanish & phonology

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## Treatment of Children with Phonological Disorders

- If co-occurring deficits or at-risk for future deficits, need to treat both
  - Alternate grammatical morphology and phonology treatment targets
  - Treat pre-reading or reading skills simultaneously with phonology
- For bilingual children,
  - If motor deficit, treat one language and monitor the other
  - If phonological deficit, treat both languages

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## Conclusion



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## Staying Current

- Find more current evidence on these topics by searching databases such as PubMed, ASHA journals, Ingenta Connect, Science.gov
- Set-up table of contents alerts at the above websites so you'll always know when new information is available

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