Representation and Access in Phonological Impairment

Benjamin Munson
Adriane L. Baylis
Miriam O. Krause
Dong-Sun Yim
Dept. of Speech-Language-Hearing Sciences
University of Minnesota, Twin Cities

The Goal

- To understand the cognitive-linguistic and perceptual-motor process that give rise to variation in speech production
- How? By comparing children who have atypical speech and language *in the absence of an obvious predisposing condition* to children with typical speech and language

Phonological Impairment

- Our abbreviation: PhI
  - Our use of *impairment* rather than *disorder* is intended to make clear the parallel between PhI and 'Specific' Language Impairment (SLI)
- Habitual age-inappropriate misarticulations in the absence of a condition that would otherwise lead to inaccurate speech-sound production
- Not the same as
  - Acquired neuromotor speech disorders
  - 'Specific' language impairment (SLI)
  - Dyslexia

Phonological Impairment

- Highly unintelligible
- Untreated PhI is associated with poor academic outcomes in subjects related to sounds (i.e., reading and spelling)

Phonological Impairment

- Our research on PhI is motivated by some basic assumptions about phonological knowledge
- 1. Phonological representations encompass both *specific* information about the sensory characteristics of sounds, and *abstract* information of how continuous articulatory and acoustic variation is parsed into the phonological categories of the language (Beckman, Munson, & Edwards, 2004 [Labphon 9], Pierrehumbert, 2003)
- 2. During real-time speech production, listeners must *access* long-term representations for words and sounds

Phonological Impairment

- Our lab's modus operandi:
- 1. Identify experimental measures that tap into different types of linguistic knowledge.
- 2. Examine how children with PhI and TD differ from each other on these measures.
- 3. Make inferences about the factors that cause (or at least contribute to) PhI by examining where the strongest, most consistent group differences are.

Representation and Access

- This project's goal:
- To determine whether children with PhI and children with TD differ more strongly in the ability to learn new perceptual representations for sounds and words, or the ability to access words from the lexicon during real-time language formulation.

Representation and Access

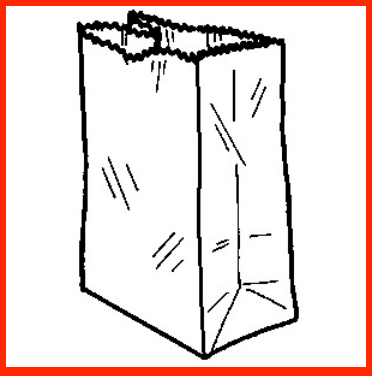
- This project consists of a set of standardized measures of speech and language, and three experimental measures designed to assess three distinct aspects of phonological knowledge
  - 1. A measure of the efficiency with which children **access words from the lexicon**
  - 2. A measure of children's ability to **phonologically encode words** once they have been accessed from long-term memory
  - 2. A measure of children's ability to **implicitly learn phonological representations** for novel words

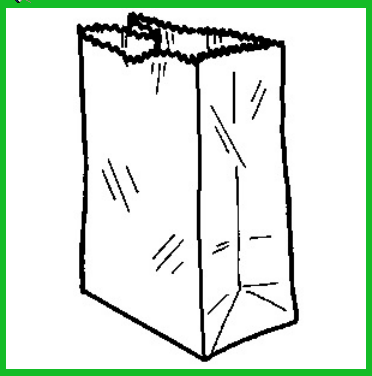
Representation and Access

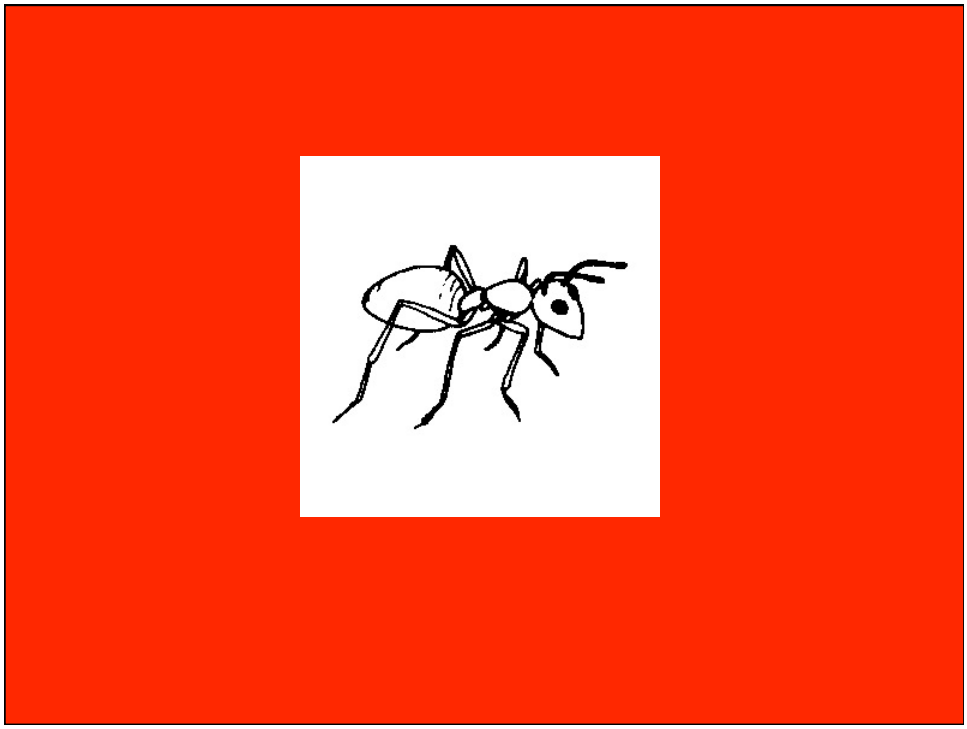
- Two groups: PhI and TD
  - (n=25, 18, and 19, 18 in each group for experiments 1, 2, and 3 respectively)
- The two groups differed in
  - Speech production accuracy (not surprising)
  - Vocabulary size (very small, and all were well above normal)
  - Speech discrimination (p=0.05 for the entire cohort of 50 children, average difference ~ 5%)
- The two groups did not differ in
  - Age, ethnicity, hearing status

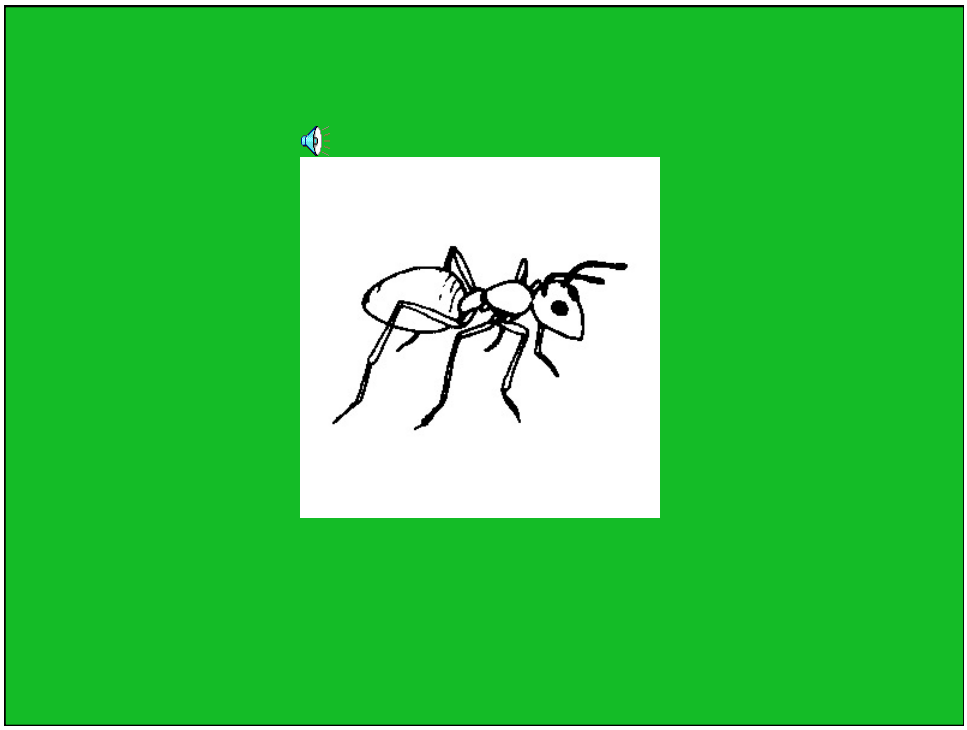
Delayed Naming

- *Munson, Brincks, Yim, & White (in prep)*
- In the delayed naming paradigm, children view a picture and either name it immediately, or wait a specified interval before they must name it.
- Used previously by Lahey and Edwards (1996) to examine lexical access in children with SLI
- A variant of the delayed reading task (Balota & Chumbly, 1985; Munson, 2004)









Delayed Naming

- In the immediate-response condition, response characteristics (particularly latency) reflect the combined influence of lexical access and the cognitive processes that occur after lexical access
- As the delay interval increases, responses reflect progressively *less* of the influence of lexical access, and progressively *more* of the influence of post-access processes.

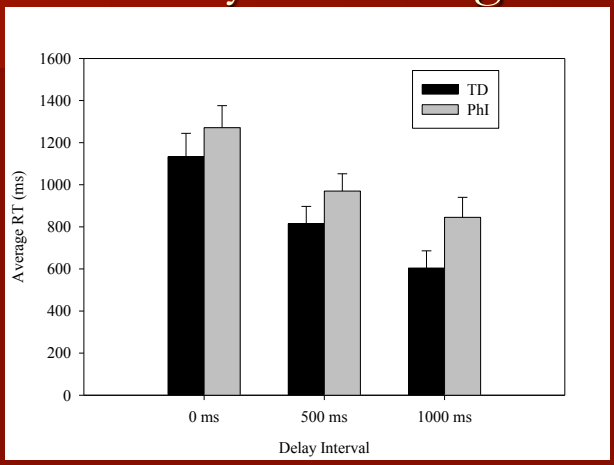
Delayed Naming

- Latency of response should decrease as delay interval increases, and accuracy should increase.
- This reflects the benefit associated with allowing time for lexical access to take place
- If PhI is associated with a deficit in lexical access, then we should see the largest group differences at the shorter delay intervals

Delayed Naming

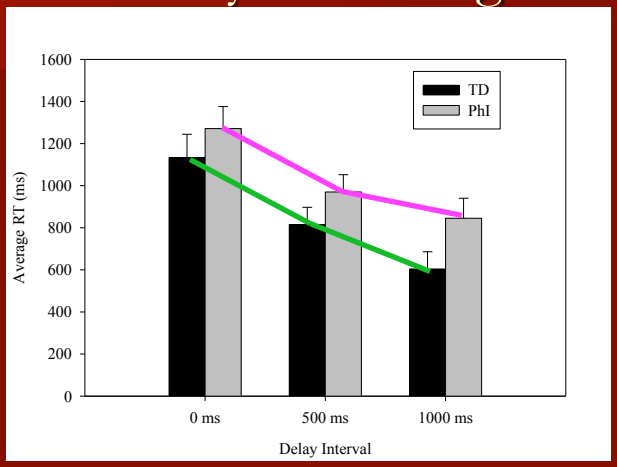
- Children named 15 pictures each at 3 delay intervals: 1000 ms, 500 ms, and 0 ms
- Pictures were chosen because they had a high likelihood of being named uniformly, and because their names did not include last-acquired phonemes.
- Accuracy, as well as latencies for correct responses, were tallied

Delayed Naming



Children with PhI *<u>were not</u>* disproportionately slower than children with TD in the 0 ms delay condition

Delayed Naming



If anything, the children with PhI have slightly *faster* speed of lexical access than children with TD

Delayed Naming

- Regression analyses found that a measure of severity of PhI predicted RTs and accuracy measures at all three delay intervals; however…
- …this measure did not predict an estimate of speed of lexical access, RT_{0s}—RT_{1000ms}
- The preliminary conclusion: PhI is not associated with a deficit in lexical access

Picture-Word Interference

- Why were the RTs of the children with PhI longer at all three delay intervals?
- Perhaps longer RTs are just characteristic of PhI, as they are characteristic of SLI
- Or, perhaps they reflect less-efficient phonological encoding during speech production
- The next experiment examined phonological encoding in greater detail

Picture-Word Interference

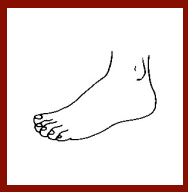
- A technique developed to study the timing of lexical access and phonological encoding ins peech production
  - First presented in Schriefers, Meyer, & Levelt (1990)
  - Used with children in Brooks and MacWhinney (2000) and Jerger et al. (2002)
- Children see a picture and hear a word. The spoken word varies in:
  - Its phonological similarity to the picture
  - Its timing relative to presentation of the picture

Picture-Word Interference

"cat"

Extremely Facilitatory:
***cat* is named quickly**

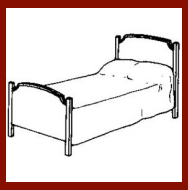
Picture-Word Interference



"make"

Extremely Inhibitory:
***foot* is named slowly**

Picture-Word Interference



"red"
"book"

Naming RT for *bed* is intermediate Between the other conditions

Picture-Word Interference

- Responses are facilitated relative to a neutral condition if the word is identical, and inhibited if the word is not identical.
  - The degree of interference depends on the phonological similarity of the word to the picture name
  - Phonological facilitation is greatest when the interfering word occurs concurrent with or after the picture

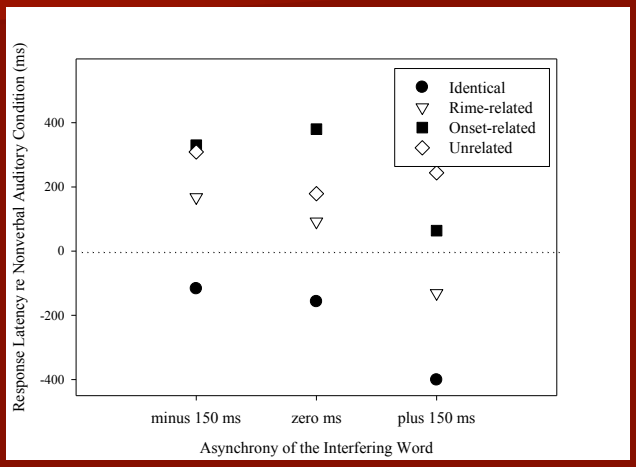
Picture-Word Interference

- The influence of IW similarity on naming latencies can tell us about the efficiency of phonological encoding during speech production
- If the difference between the phonologically unrelated and phonologically related IWs is relatively small, then we can infer that phonological encoding isn't efficient

Picture-Word Interference

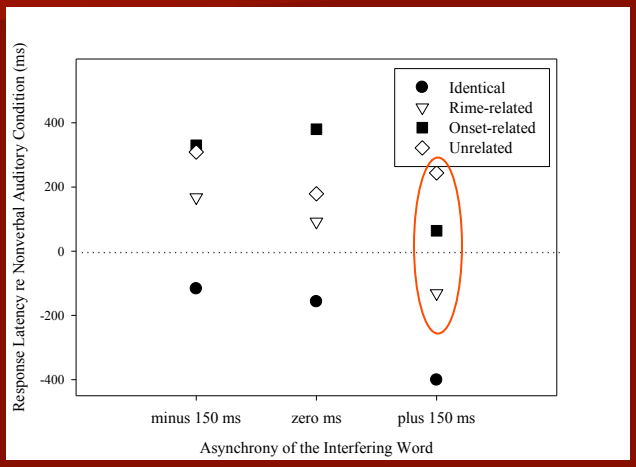
- Nine pictures were named in the presence of five types of IWs. There were three stimulus onset asynchronies: -150 ms, 0 ms, and +150 ms
- Picture names were trained in advance of the experimental task
- Naming latencies were measured for correctly named pictures

Children with TD



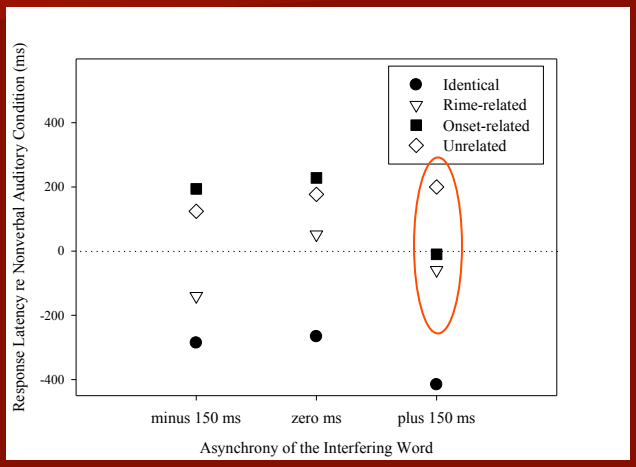
Picture-naming RTs in the presence of onset- and rime-related IWs were faster at the +150 ms SOA than those for unrelated IWs for kids with TD…

Children with TD



Picture-naming RTs in the presence of onset- and rime-related IWs were faster at the +150 ms SOA than those for unrelated IWs for kids with TD…

Children with PhI



…And for kids with PhI. PhI does not appear to be associated with reduced phonological encoding abilities.

Implicit Priming

- If children with PhI do not have a reduced ability to access and encode lexical representations relative to their TD peers, then where is the problem?
- Perhaps the problem is in encoding and retaining the perceptual characteristics of words.
- (This is essentially what Beckman, Munson, and Edwards hypothesized in our Labphon 9 paper, and what Edwards, Beckman, and Munson found in an earlier collaborative project)

Implicit Priming

- *Munson, Baylis, & Simmons (in prep)*
- Fisher et al. (2001): Children listened passively to a string of nonwords presented without a referent
- After a distracter task, they are played a list that includes some of the same nonwords ('primed') and some new nonwords ('unprimed')

Implicit Priming

- In Fisher et al. (2001), children repeated primed nonwords more accurately than unprimed ones
- This was true even when the primed sequences of phonemes were put in a different phonetic frame.
- Children are able to build perceptual representations for words based on minimal exposures.

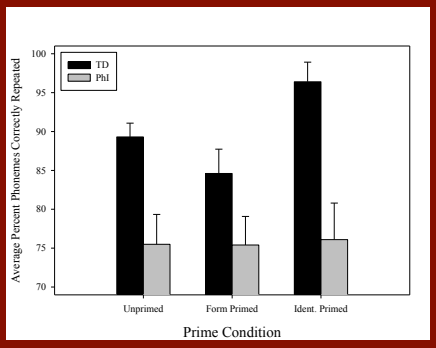
Implicit Priming

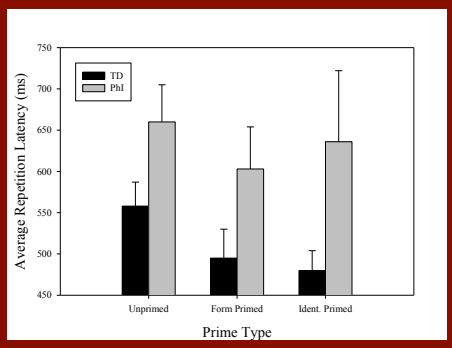
- Our priming task was similar to Fisher et al.'s,
- Three types of nonwords were presented in the test phase
  - 1. Unprimed
  - **2.** Primed, same talker
  - 3. Primed, new talker
- Stimuli included only early-acquired sounds and simple syllable shapes

Implicit Priming

- Typically developing children should produce primed nonwords more accurately and with shorter latencies than unprimed nonwords, reflecting their ability to create phonological representations based on brief exposures
- We predict that children with PhI will show a reduced influence of priming, reflecting their decreased ability to learn new perceptual representations

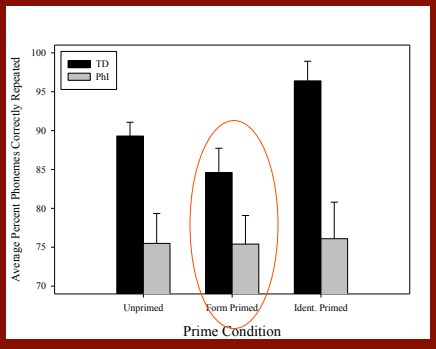
Implicit Priming

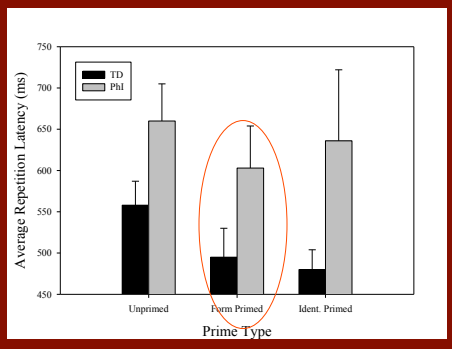




Children with PhI show a *reduced influence* of priming on the accuracy and latency with which they repeat stimuli in the test phase

Implicit Priming





The form-primed condition did not behave as we had hoped it would. The accuracies and latencies in this condition *should* be intermediate between the other two.

Representation and Access

- Children with PhI *do not* have a deficit in lexical access or phonological encoding
- Children with PhI show a *clear* deficit in implicit learning of perceptual representations for novel sequences of phonemes

The Bigger Picture

- These findings are consistent with the notion that variation in speech production is more closely linked to variation in perception than variation in abstract phonological knowledge

Acknowledgments

- The research in this application was funded by NIH grant R03 DC005702 to Benjamin Munson
- Molly Babel, Kenda Blasing, Sarah Brincks, Jessica Sanders, Dawn Simmons, and Aubrey White helped with data collection and measurement.