

## How do deaf individuals learn to read?



Zed Sevcikova Schyr  
San Diego State University

zsevcikova@sdsu.edu



## Low levels of academic readiness of deaf students leaving school

- ♦ 40% of deaf students read at/above 4.0 grade
- ♦ Only 8% read at/above grade 8.0

(Allen, 1994)

## Low levels of academic readiness of deaf students leaving school

Prop. of students qualified if standards set to:	All students	Black non-Hispanic	Hispanic
4 <sup>th</sup> grade	.40	.22	.19
5 <sup>th</sup> grade	.27	.13	.10
6 <sup>th</sup> grade	.15	.05	.06
7 <sup>th</sup> grade	.12	.03	.05
8 <sup>th</sup> grade	.08	.01	.04

1992-93 Annual Survey on ~ 2,730 high-school leavers, aged 17-21, with severe-profound hearing loss, avg. hearing threshold 71dB or greater

Allen, 1994

- However, some profoundly deaf individuals do learn to read proficiently!

## Deaf adults reading levels:

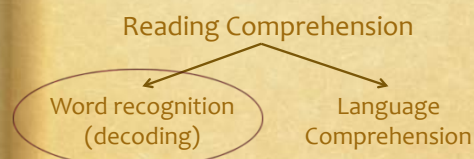
### PIAT reading comprehension subtest

- ♦ Deaf (n = 136): mean PIAT score = 85, SD=11 (GE 8.0)
- ♦ Hearing (n = 165): mean PIAT score = 88, SD = 10 (GE 10.0)

## To learn to read children must:

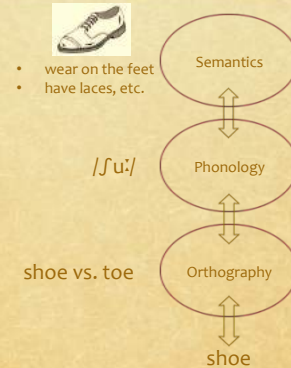
- ♦ Master the writing system that encodes a (spoken) language
- ♦ Learn the language that is encoded by the writing system
- ♦ Deaf children are at disadvantage for both!

## The Simple View of Reading



## Word recognition

- ♦ Rapid, highly automatic process (~250ms)
- ♦ Ability to quickly and accurately transform perceived visual units into meaningful units in lists or texts
- ♦ Words are stored in the mental lexicon; different levels of representations



## Word recognition

- ♦ **Phonological awareness** = ability to notice, think about and manipulate speech sounds:

Which words begin with the same sound?



## Word recognition

- ♦ **Phonological decoding** = ability to map letters (graphemes) to speech sounds (phonemes)

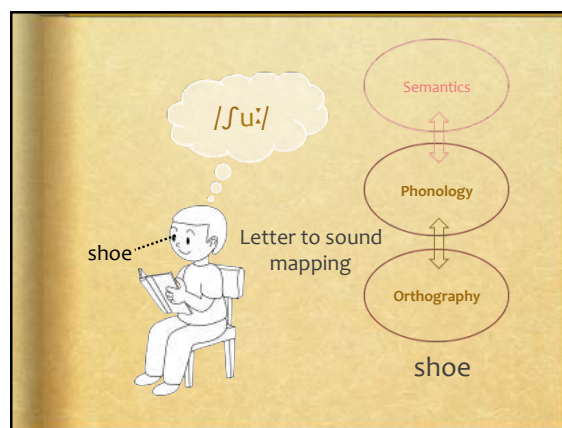
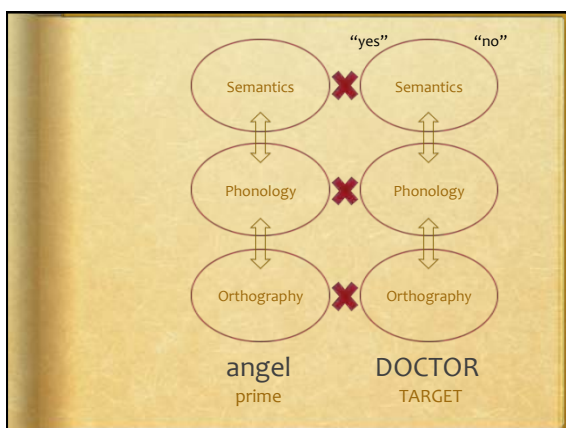
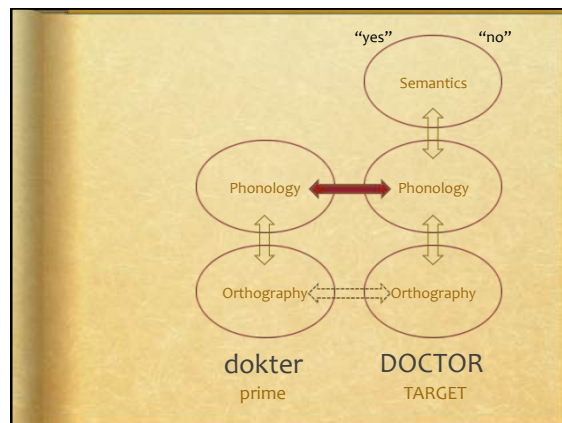
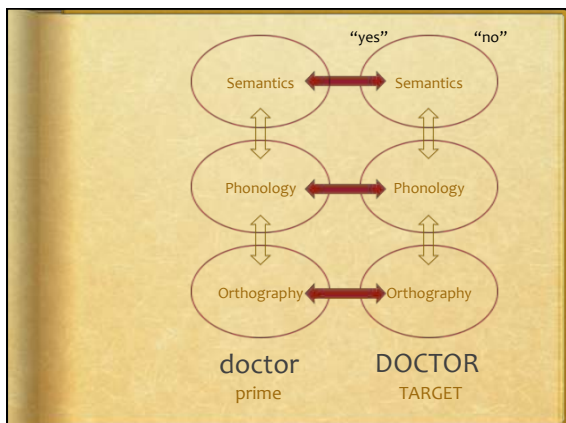
Which two words rhyme?

late – eight  
pint – hint

## How to examine word recognition?

- ♦ Lexical decision (auditory or visual)
  - ♦ is WEERD a real word? “yes” or “no”
- ♦ Measure decision latencies and accuracy
- ♦ **Priming** paradigm: how does a presentation of one stimulus (prime) influence a decision about the next stimulus (TARGET)?
  - ♦ Prime-target pairs can be orthographically, phonologically or semantically related or unrelated





### Deaf children have impoverished access to phonology

- ♦ A lack of auditory input means acquisition of speech is difficult and delayed
- ♦ Hearing amplification and cochlear implants can distort speech sounds

  
20 CHANNEL

### The role of phonology in deaf readers

- ♦ Can deaf readers access phonology to decode print?
- ♦ If so, do they actually use phonology when reading?
- ♦ Are there alternatives to phonological decoding?
- ♦ How crucial is phonological decoding or awareness to achieve skilled reading in deaf readers?



### The Phonological Loop

- ♦ The phonological loop is used to temporarily store and rehearse information in WM
- ♦ Words are stored in form (speech) based representation

Baddeley (1986)

### Let's take a short-term memory test

- ♦ You will see a '+' and then 4 words will appear in the middle of the screen one by one for 1 sec
- ♦ Wait until you have seen all 4 words then write them down in the same order they appeared
- ♦ Leave blank / guess if you don't remember
- ♦ Then the next list of 4 words will appear
- ♦ There will be 4 lists



### Phonological similarity effect

Answers:

- ♦ List 1: two you who shoe
- ♦ List 2: king tax some farm
- ♦ List 3: chew jew due blue
- ♦ List 4: cry bug farm king

**Hard?**

### The phonological similarity effect for ASL signs

- ♦ Poorer recall of phonologically related signs

Similar handshapes		Dissimilar handshapes	
BOOK	BROOM	BATH	EGG
SOAP	BREAD	KEY	BOOKS

Poizner et al. (1981), Wilson & Emmorey (1997)



### Sign-based Phonological Loop

- ASL signs are stored in a form based representation, just like words

Speech-based phonological short-term store

Subvocal rehearsal

Baddeley (1986)

Sign-based phonological short-term store

Submanual rehearsal

Wilson & Emmorey (1997)

### Evidence for phonological decoding in deaf readers is mixed

- Phonological coding facilitated immediate serial recall of print for some, not all, congenitally deaf individuals (older, orally-trained skilled readers)
- Some (older) deaf readers show sensitivity to spelling-to-sound regularities: rhyme judgments, e.g. save vs. wave / eight vs. late
- Deaf score 64% vs. hearing (99%) on phonological awareness test

Chincotta & Chincotta (1996); Conrad (1979); Hansen & Fowler (1987); Hanson (1982)

### Experiment 1: Immediate serial recall of printed words

Hypothesis:

- If deaf ASL signers recode printed words into a phonological code, phonological similarity should reduce accuracy in serial recall of print.

Sehyr & Emmorey (2016)

### Immediate short-term recall: Phonological similarity effect

- Words repeated from a small set to reduce reliance on long-term memory
- Poorer recall of sound-related words:

<u>Similar words</u>	<u>Dissimilar words</u>
blue	king
hard? chew	farm easy?
due	tax
jew	bug

Sehyr & Emmorey (2016)

### Experiment 1: Immediate serial recall of printed words

- Participants :
  - 21 deaf signers (M age = 31, SD = 11; 11F)
  - 21 hearing non-signers (M age = 23, SD = 5; 18F)

dissimilar	similar
king, some, farm, with, tax, that, bug, cry	blue, shoe, chew, who, due, two, jew, you

- Phonological similarity led to worse recall in both deaf & hearing groups (groups matched on reading skill).

Group	dissimilar	similar
hearing	~47	~41
deaf	~44	~39

Sehyr & Emmorey (2016)

- ♦ No relationship between phonological recoding and phonological awareness scores in deaf and hearing!
- ♦ For deaf signers, recall accuracy positively correlated with reading skill and ASL skill

Sehyr & Emmorey (2016)

### Experiment 2: Immediate serial recall of ASL fingerspelling

- ♦ Alternative orthography to represent English letters in ASL
- ♦ “Chaining” – common teaching technique in which an association is created between signs, FS & print



### Experiment 2: Immediate serial recall of ASL fingerspelling

Research hypothesis:

- ♦ If deaf ASL signers recode fingerspelled words into a phonological code, phonological similarity should reduce accuracy in serial recall of fingerspelling.

Sehyr & Emmorey (2016)

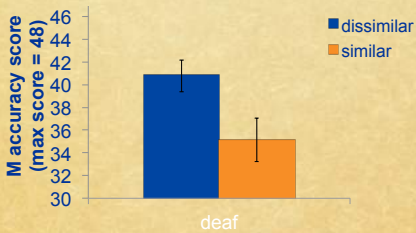
### Study 2: Immediate serial recall of ASL fingerspelling

- ♦ Participants
- ♦ 22 deaf signers ( $M_{age} = 32, SD = 10, 10F$ )

dissimilar	similar
king, some,	blue, shoe,
farm, with,	chew, who,
tax, that,	due, two,
bug, cry	jew, you

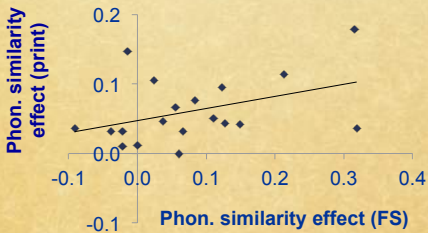


- ♦ Deaf signers recoded fingerspelling into a phonological code



Sehyr & Emmorey (2016)

- ♦ Deaf signers who phonologically recoded print also phonologically coded FS in memory



Sehyr & Emmorey (2016)

### Serial recall of print and fingerspelling: summary

- Phonological similarity decreased recall accuracy in deaf & hearing groups
- Deaf readers recoded print & fingerspelling using a phonological (speech-based) code in short-term memory
- A tight relationship between English mouthings and fingerspelling may promote phonological recoding of fingerspelling

### What is the nature of phonology in profoundly deaf individuals?

- Visible speech information



The McGurk Effect

### What is the nature of phonology in profoundly deaf individuals?

- Visible speech information (speech reading)
- The articulatory feel of words from speech training/speaking
- **Fingerspelling**, learning to write, and exposure to print may help develop an awareness of phonological structure

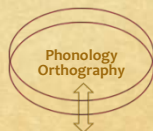
### What is the ROLE of phonology for deaf readers?

- Do deaf readers access phonology during fast reading?
- How crucial is phonological decoding or awareness to achieve skilled reading in deaf readers?  
**... perhaps not so..**
- Are there alternative routes to word access? Do deaf readers read 'differently'?

### Orthographic processing

male vs. mail

= phonological effect or orthographic effect?



- Can the effect of orthographic and phonological activation be dissociated?

### Quebec Sign Language (LSQ) signers and readers of French

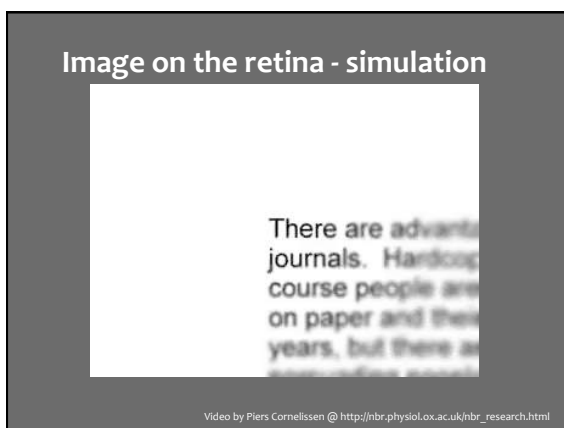
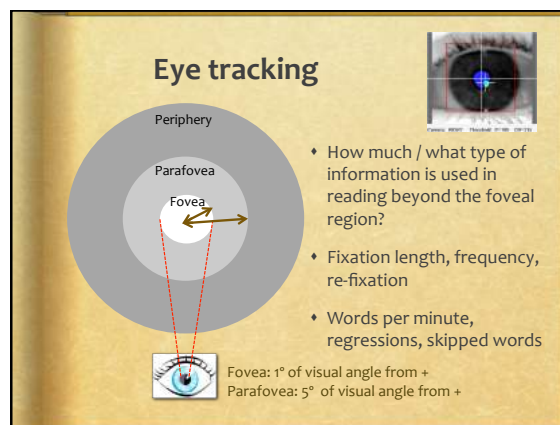
	PRIMING	
	O	P
Skilled Hearing Readers (11-12th grade)	✓	✓
Skilled Deaf Readers (11 <sup>th</sup> -12 <sup>th</sup> grade)	✓	✗
Less-skilled Deaf Readers (5 <sup>th</sup> grade)	✓	✗

LSQ (primus)

French (target)

	PRIMING		RECALL	
	O	P	O	P
Skilled Hearing Readers (11-12th grade)	✓	✓	✓	✓
Skilled Deaf Readers (11 <sup>th</sup> -12 <sup>th</sup> grade)	✓	✗	✓	✗
Less-skilled Deaf Readers (5 <sup>th</sup> grade)	✓	✗	✓	✗

• A study with deaf signers of LSQ and readers of French (Quebec): reading difficulties in the deaf population are not just due to the lack of use of phonological codes



### Alternating saccades and fixations on a text

There are advantages and disadvantages of both electronic and hardcopy journals. Hardcopy journals are more easily browsed, more portable and, of course people are very much used to their format. Electronic journals save on paper and their format has improved considerably over the past few years, but there are still problems over managing copyright restrictions and persuading people to use electronic instead of hardcopy journals. There is also the problem of portability. More and more journals are now being published in electronic format, although some publishers will only let you subscribe to an electronic journal provided you also subscribe to the hardcopy (more money for the same thing). Some electronic journals cost over 100% more than their equivalent hardcopy. With all these factors in mind I have been discussing individual and shared-subscriptions with the Biochemistry Department, the RSL and Blackwell's. Whilst I feel that a move from hardcopy to electronic journals will be a very slow process in the ULP Library, electronic publishing is being carefully monitored and I would hope to introduce a few electronic texts into the Library alongside the journals which are already available for free over the Internet.

Video by Piers Cornelissen @ [http://nibr.physiol.ox.ac.uk/nibr\\_research.html](http://nibr.physiol.ox.ac.uk/nibr_research.html)

### Word identification span

- A region of ~6-8 letters to the right of fixation.
- Hearing readers process both O and P information in this region before the word is looked at; short words can be skipped.
- "Preview benefit" – information to the right is used to recognize words in sentences.

The perceptual span extends 14-15 letters to the right of fixation point.

(Rayner, 1998)





## Perceptual span

- Wider than Word identification span, includes processing of low level visual information that is used to guide eye movements (spaces between words, word length, ascenders/descenders, etc.)
- 3-4 letters to the left of fixation
- 14-15 letters to the right of fixation

The perceptual span extends 14-15 letters to the right of the fixation point.

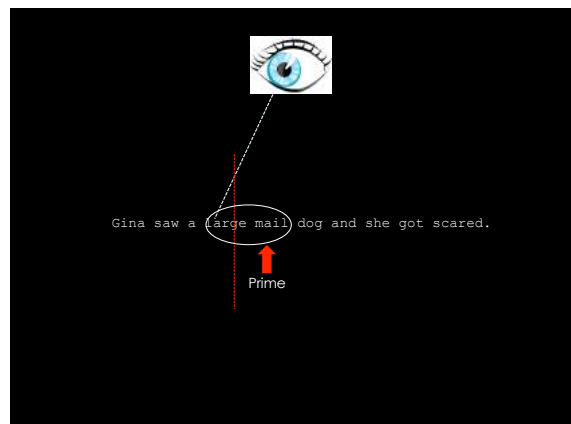
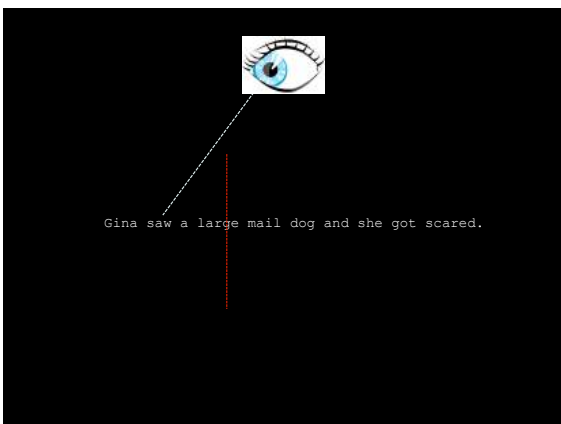
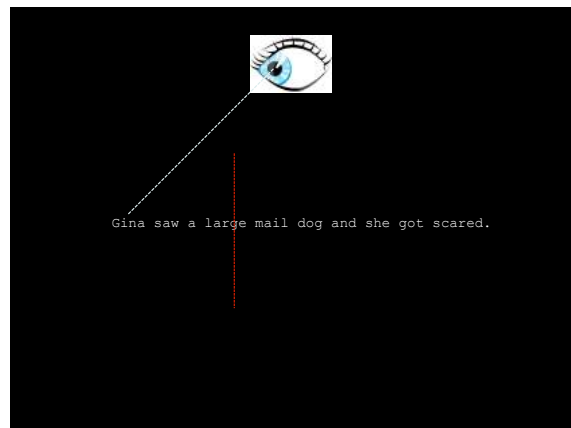
## Perceptual span

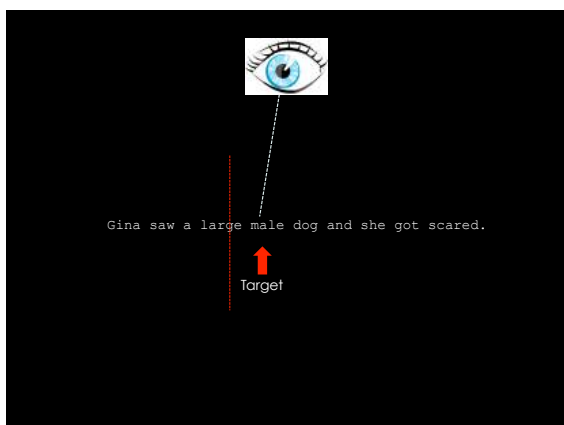
- Young novice readers have a smaller span than older readers
- Less-skilled readers have a smaller span than skilled readers
- Processing difficulty of the fixated word influences the size of span

(Rayner, 1986; 1998; Henderson & Ferreira, 1990; Haikio et al., 2010)

## Deaf reading: evidence from eye tracking & the word identification span

- Do deaf readers (skilled / less skilled) engage phonological codes during reading?
- Can effects of orthographic and phonological information be independently measured in the word identification span?
- Invisible boundary paradigm – a word in the parafovea is replaced by another word (similar to priming)





## Deaf readers do not activate phonological codes

	Preview benefit (priming effect)	
	Ortho	Phono
Skilled hearing	✓	✓
Skilled deaf	✓	✗
Less-skilled deaf	✓	✗

- ♦ The lack of use of phonological codes is NOT the main cause of reading difficulties in the Deaf population
- ♦ Phonological codes are 'skipped'; this implies more direct links between orthography and semantics

Bélanger, Mayberry & Rayner (2013)

## The Simple View of Reading



## Language comprehension

- ♦ Word recognition can occur without a firm grounding in English phonology
- ♦ Language comprehension requires a firm understanding of morphology, semantics and syntax!
- ♦ Learning the language encoded by the print system is critical to reading success.

## What determines reading comprehension in deaf readers?

- ♦ phonology?
- ♦ spelling?
- ♦ vocabulary?
- ♦ ASL skill?
- ♦ speech-reading?
- ♦ syntax?
- ♦ others?

## Predicting reading success in deaf vs. hearing adult readers

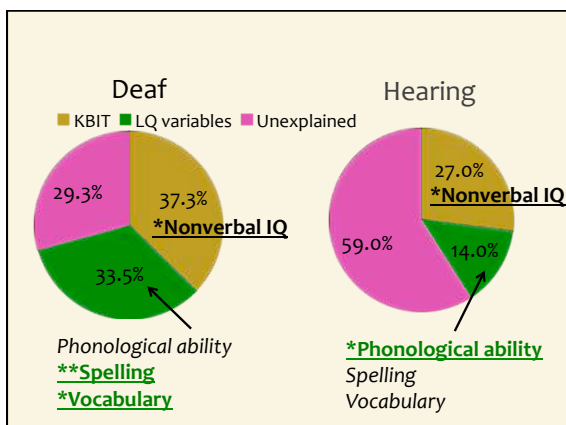
### Participants:

- ♦ 46 deaf readers (read. comp. score = 85)
- ♦ 39 matched hearing readers

### Assessment tests:

- ♦ spelling recognition test
- ♦ vocabulary test
- ♦ phonological awareness test
- ♦ reading comprehension test
- ♦ nonverbal IQ test

We have preliminary data based on statistical modeling..



### The role of **spelling** in reading ability

- ♦ Better readers tend to be better spellers
- ♦ The amount of exposure to print matters
- ♦ Skilled readers (hearing and deaf) might bypass phonological coding when reading texts
- ♦ e.g. the BOSS effect

### The BOSS effect: Basic Orthographic Structure

= Maximizes amount of information in the first sublexical unit by drawing a structural boundary after all consonants that follow the first vowel of the stem morpheme

	BOSS:	PS:
cadet	cad et	ca det
movie	mov ie	mo vie
doctor	doct or	doc tor

- Skilled hearing readers prefer reading words with a BOSS division than PS segmentation
- Both deaf and hearing better at reading text with BOSS

(Emmorey & Petrich 2012)

### The role of **vocabulary** in reading comprehension

- ♦ Rich lexical knowledge needed to derive meaning from text
- ♦ Not just isolated word meanings (vocabulary tests & definitions) but a broader understanding of words in context is needed
- ♦ Integration of specific lexical knowledge with text understanding is required
- ♦ In deaf readers: *vocabulary size* and reading comprehension are strongly correlated!

### The role of ASL in reading comprehension

- ♦ Better deaf readers are also more skilled ASL signers and fingerspellers!
- ♦ Language experience is vital for language growth and reading achievement, yet many deaf children live in relative “language” poverty

Thank you!

### Clicker question 1

Which statement is incorrect?

- A. For hearing readers, phonological skill and reading achievement are closely related.
- B. It is possible to access word meaning without activating the phonological representations.
- C. Skilled deaf readers access phonological codes during reading but less-skilled deaf readers do not.

### Clicker question 2

The phonological similarity effect occurs when:

- A. visual speech information during lip reading is misperceived
- B. recall of items from short-term memory is decreased due to overlap in form
- C. orthography and phonology of a word greatly overlap
- D. phonological similarity effect cannot be observed in deaf readers because they do not hear speech sounds.

### Clicker question 3

Word identification span refers to a region to the left and right of the fixation point that is used to extract low-level visual information from the surrounding words.

- A. True
- B. False