# Skilled deaf readers exhibit efficient reading behavior:

## Does that mean they are speed reading?

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in collaboration with Karen Emmorey,
Casey Stringer, Frances Cooley, Grace Sinclair, & Emily Saunders

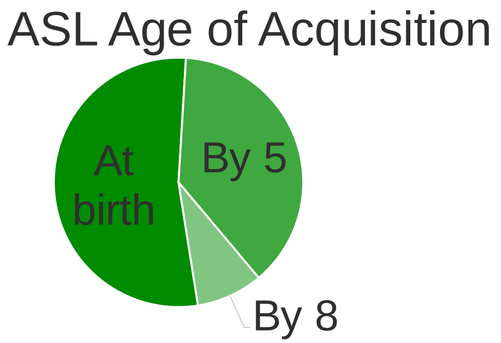
# A unique group of highly efficient readers: deaf early signers

## Faster Reading Rates

300-350 words/minute (Bélanger et al., 2012; Schotter et al., 2024; Stringer et al., 2024)
vs. ~238 words/minute for their hearing peers (Brysbaert, 2019)

## Equivalent Comprehension Level

Early ASL signers = no language deprivation before learning to read
(Hall et al., 2019; Humphries et al., 2012, 2022)



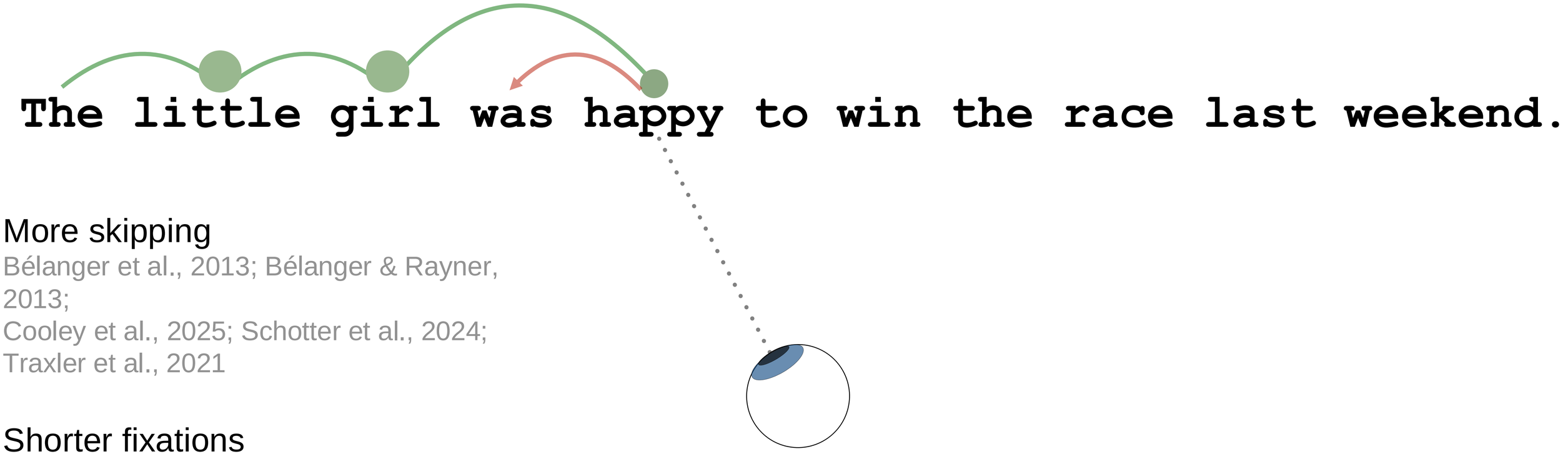

## Despite Reading in a Second Language

Although English is their primary language for text processing
(Cooley et al., 2025)

## No Spoken Access to the Language They are Reading

Profoundly deaf (loss of 70 dB or greater; few had cochlear implants)
Prelingually deaf (before learning language)

# Characterizing reading behavior: a unique profile for deaf readers




## More skipping

Bélanger et al., 2013; Bélanger & Rayner, 2013;
Cooley et al., 2025; Schotter et al., 2024;
Traxler et al., 2021

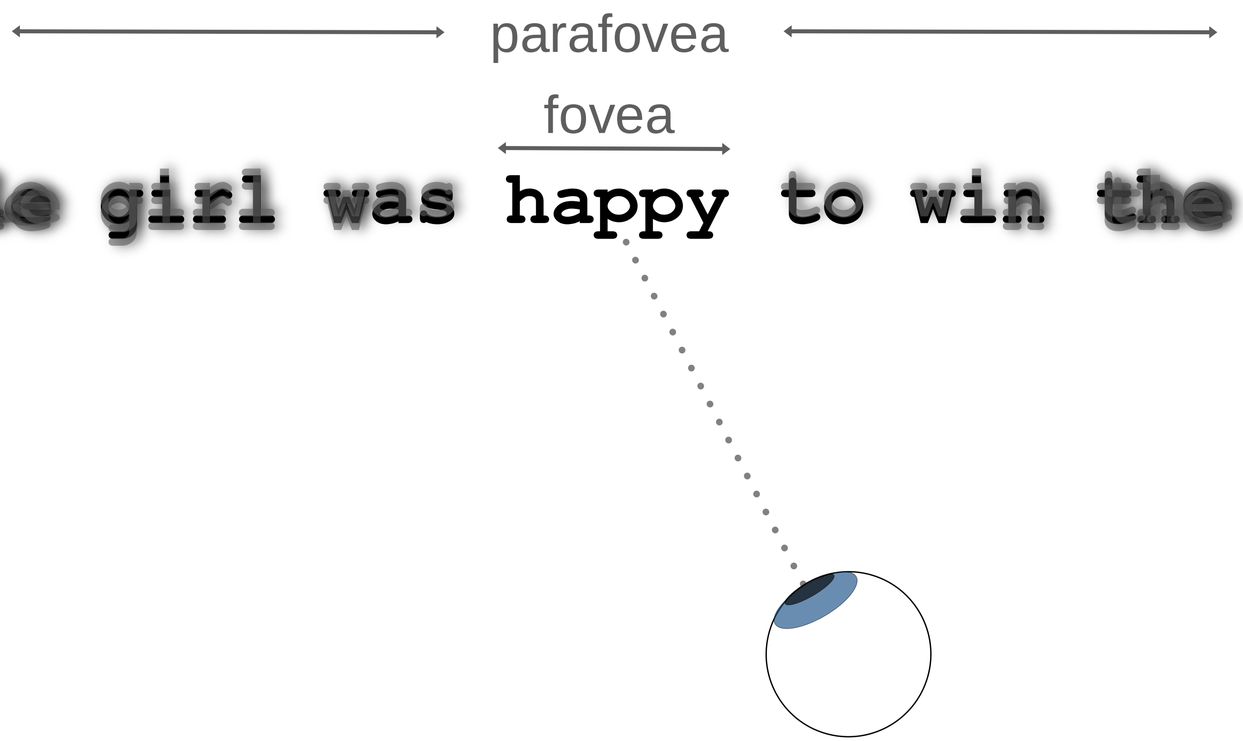
## Shorter fixations

Traxler et al., 2021; Cooley et al., 2025

## Fewer regressions

Bélanger et al., 2012. 2013, 2018;
Schotter et al., 2024; Stringer et al., 2023

# Reading efficiency: Parafoveal processing

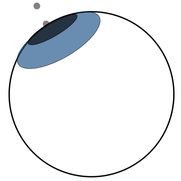



Schotter, Angele, & Rayner (2012)

# Assessing the extent of parafoveal perception: the reading span

**xxxxxxxxxxxxxxxxxxxxhappyxxxxxxxxxxxxxxxxxxxxxxxxxxxxx.**

5-character window



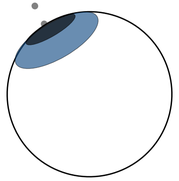
McConkie & Rayner (1975)

# Assessing the extent of parafoveal perception: the reading span

parafovea

**xxxxxxxxtle girl was happy to win thexxxxxxxxxxxxxxxxxxxx.**

29-character window

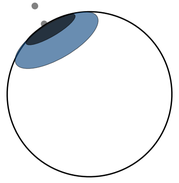


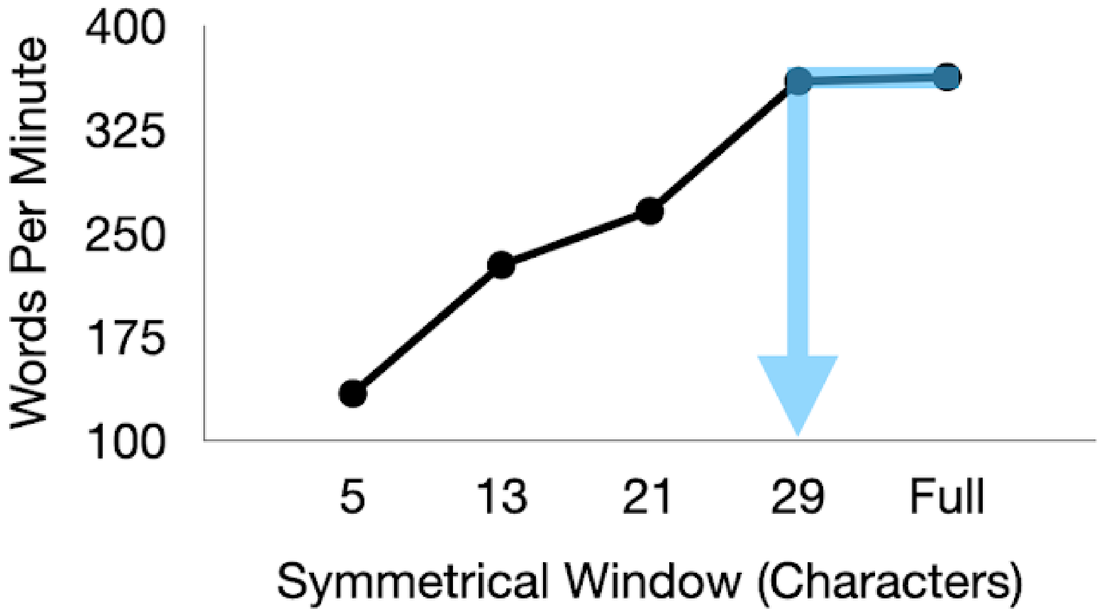
McConkie & Rayner (1975)

# Assessing the extent of parafoveal perception: the reading span

parafovea

**xxxxxxxxtle girl was happy to win thexxxxxxxxxxxxxxxxxxxx.**





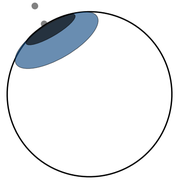

Rayner & Bertera (1979)

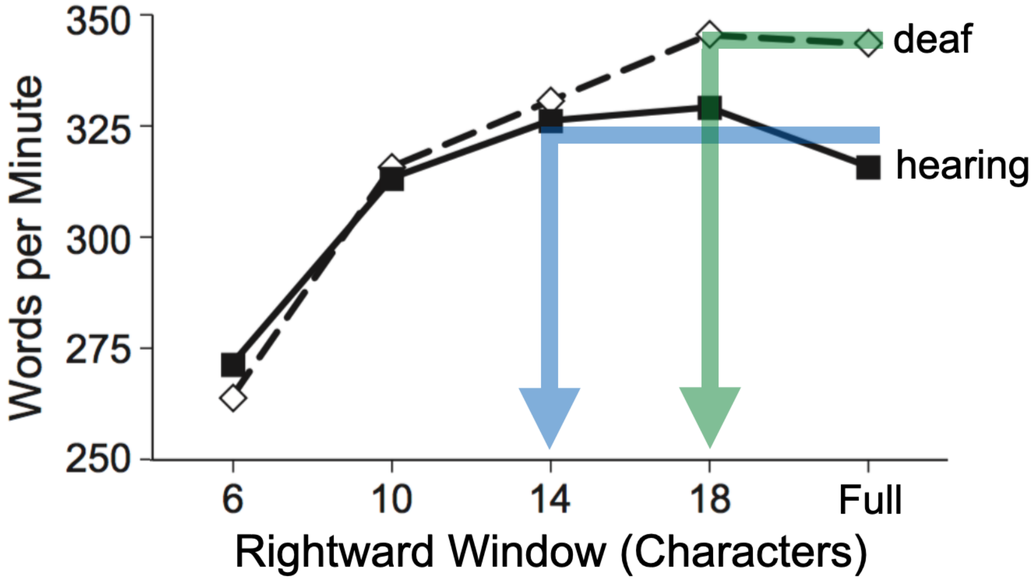
McConkie & Rayner (1975)

# An enhanced rightward span for skilled deaf readers

parafovea

**xxxxxxxxxxxxxxxxxxxxs happy to win the racexxxxxxxxxxxxxxx.**






Larger rightward spans: Bélanger et al. (2012; 2018)

# Dissociating perceptual & word identification spans

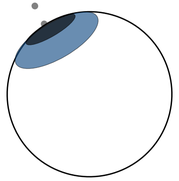
Schotter, Stringer, Saunders, Cooley, Sinclair, & Emmorey (2024)

**xxxxxxxxxxxxxxxxxxxx happy xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx.**

Full mask

1) Plan saccades:
visuo-spatial layout (spaces between words)

2) Initiate word recognition:
orthographic content (letters within words)



Morris, Rayner, & Pollatsek (1990)

# Dissociating perceptual & word identification spans





Schotter, Stringer, Saunders, Cooley, Sinclair, & Emmorey (2024)

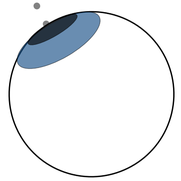
4 14

**Thexlittlexgirlxwas happy to win the racexlastxweekend.**

Assessing the perceptual span

Experiment 1

1) Plan saccades:
visuo-spatial layout (spaces between words)

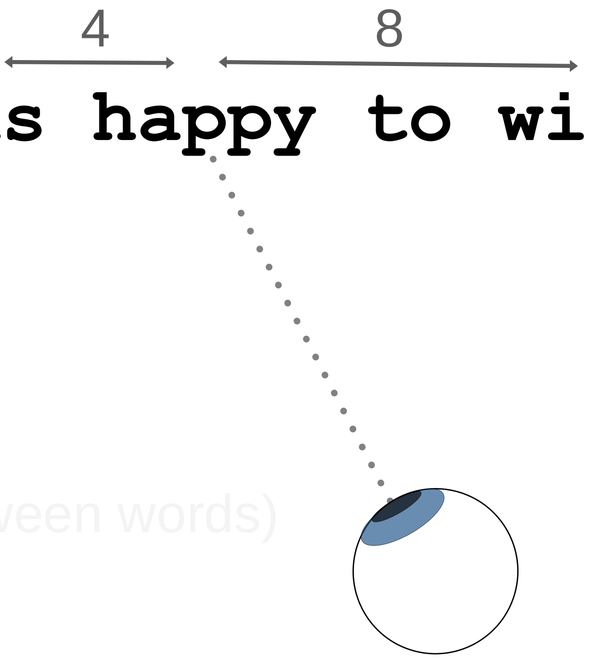


2) Initiate word recognition:
orthographic content (letters within words)

Morris, Rayner, & Pollatsek (1990)

# Dissociating perceptual & word identification spans

Schotter, Stringer, Saunders, Cooley, Sinclair, & Emmorey (2024)




Assessing the word identification span

Experiment 2

1) Plan saccades:
visuo-spatial layout (spaces between words)

2) Initiate word recognition:
orthographic content (letters within words)

Morris, Rayner, & Pollatsek (1990)

# Details on Participants

Schotter, Stringer, Saunders, Cooley, Sinclair, & Emmorey (2024)

| | **Hearing** (N = 60) | **Deaf** (N = 42) | t-test p value |
|---|---|---|---|
| English Reading Comprehension Ability (PIAT-R score; 60-100) | 85.2 (9.90) | 83.9 (10.59) | 0.53 |
| Non-verbal Intelligence (KBIT score; 15-46) | 38.7 (3.62) | 37.5 (5.50) | 0.27 |
| English Spelling Ability (Spelling Recognition score; 0-87) | 73.5 (7.3) | 73.2 (9.93) | 0.84 |
| Comprehension Accuracy (from the experiments; 0-100) | 92.78 (5.40) | 90.33 (6.83) | 0.06 |
| Age (years; 18-55) | 29.7 (10.02) | 33.3 (8.03) | 0.05 |
| Education (years in college) | 4.3 (2.96) | 6.3 (3.21) | < 0.01 |
| Sign Language Comprehension Ability (ASL-CT score; 0-30) | – | 25.12 (2.89) | – |

# Deaf readers are more efficient

Schotter, Stringer, Saunders, Cooley, Sinclair, & Emmorey (2024)

| **Normal Reading Behavior** (all visible condition) | **Hearing** (N = 60) | **Deaf** (N = 42) | p value |
|---|---|---|---|
| Reading Rate (words per minute; wpm) | 254 | 321 | < .001 |
| Skipping Rate (% words skipped) | 38% | 44% | < .005 |
| Regression Rate (% backward saccades) | 12% | 9% | < .01 |

# Overview of Experiments: Method





Schotter, Stringer, Saunders, Cooley, Sinclair, & Emmorey (2024)

## Experiment 1: Perceptual Span

**Thexlittlexgirlxwas happy toxwinxthexracexlastxweekend.**

| Left | 4 | | | | | All Visible |
|---|---|---|---|---|---|---|
| Right | 6 | 10 | 14 | 18 | 22 | All Visible |

Rightward span

## Experiment 2: Word Identification Span

**xxx xxxxxx xxxx xxx happy xx xxx xxx xxxx xxxx xxxxxxx.**

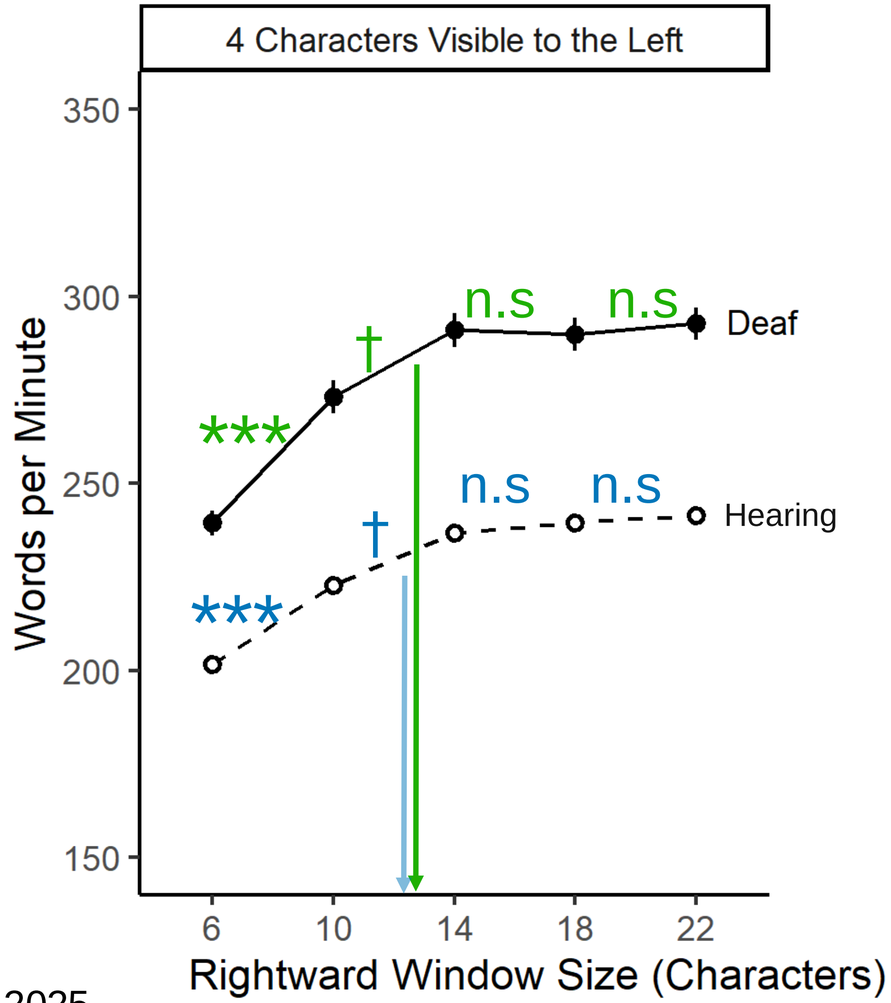
| Left | 4 | | | | All Visible |
|---|---|---|---|---|---|
| Right | 4 | 6 | 8 | 10 | All Visible |

Rightward span

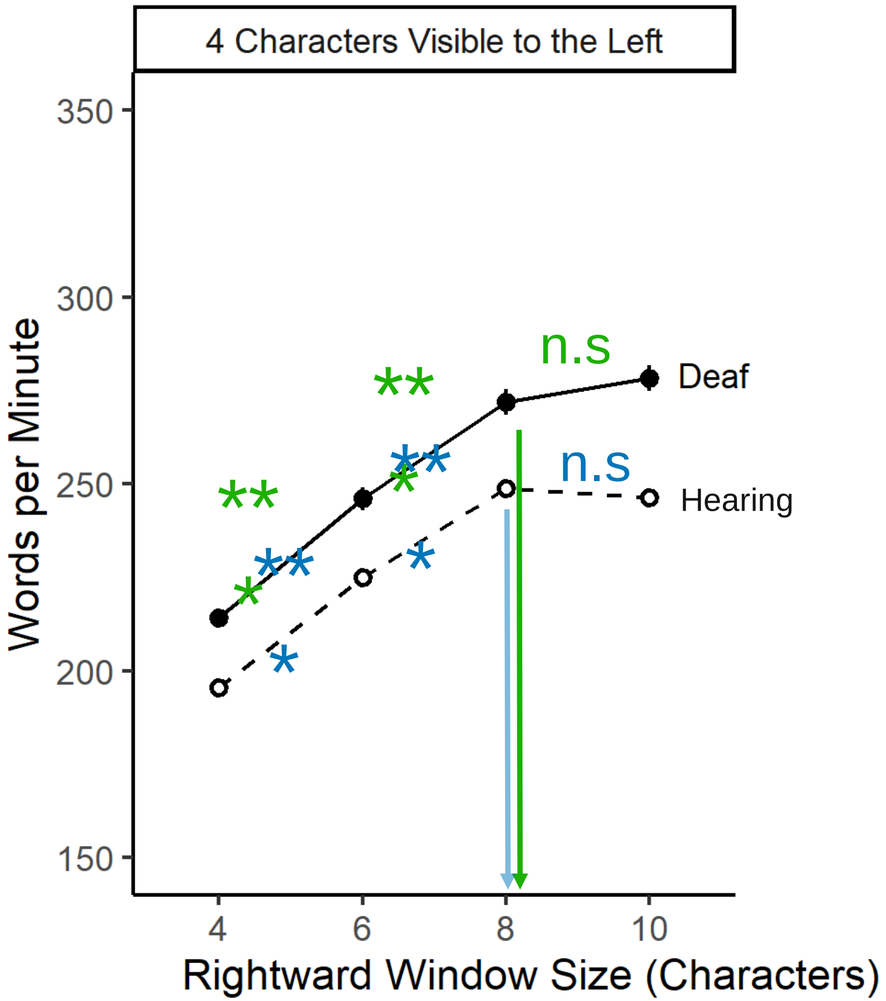
# Deaf readers' spans are similar (when dissociated)

Schotter, Stringer, Saunders, Cooley, Sinclair, & Emmorey (2024)

## Experiment 1: Perceptual Span



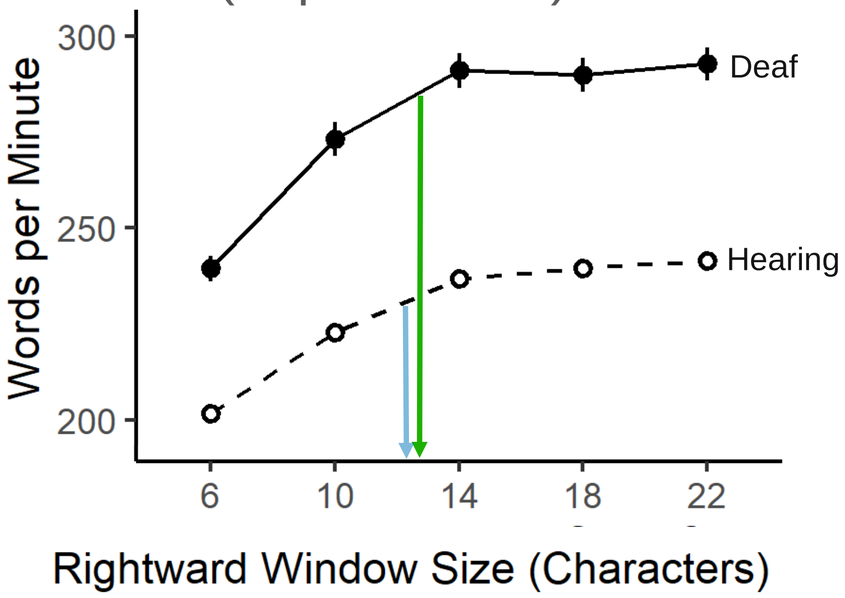

## Experiment 2: Word Identification Span



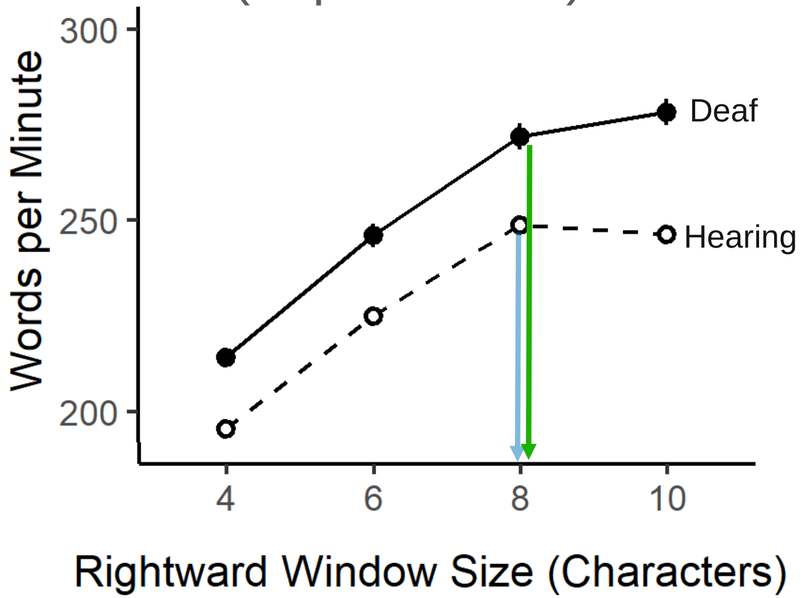
# Deaf readers integrate perceptual and linguistic information for larger rightward spans

Schotter, Stringer, Saunders, Cooley, Sinclair, & Emmorey (2024)

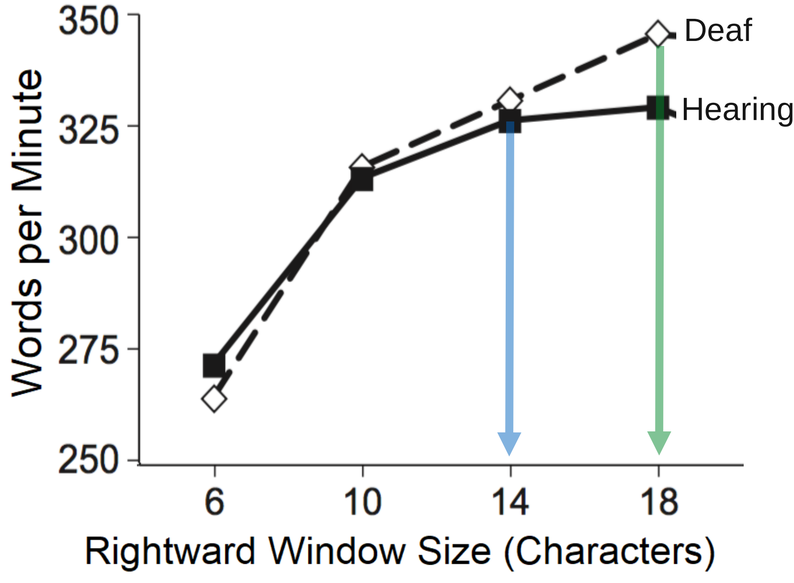
Perceptual Span
(Experiment 1)




Word Identification Span
(Experiment 2)




Full Mask
(Bélanger et al., 2012; 2018)

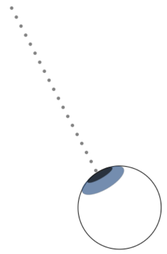


# What about deaf readers' leftward spans?

Schotter, Stringer, Saunders, Cooley, Sinclair, & Emmorey (2024)

## Experiment 1: Perceptual Span

**Thexlittlexgirlxwas happy toxwinxthexracexlastxweekend.**



| Left | 4 | | | | | All Visible |
|---|---|---|---|---|---|---|
| Right | 6 | 10 | 14 | 18 | 22 | All Visible |

Rightward span

Leftward span

## Experiment 2: Word Identification Span

**xxx xxxxxx xxxx xxx happy xx xxx xxx xxxx xxxx xxxxxxx.**

| Left | 4 | | | | All Visible |
|---|---|---|---|---|---|
| Right | 4 | 6 | 8 | 10 | All Visible |

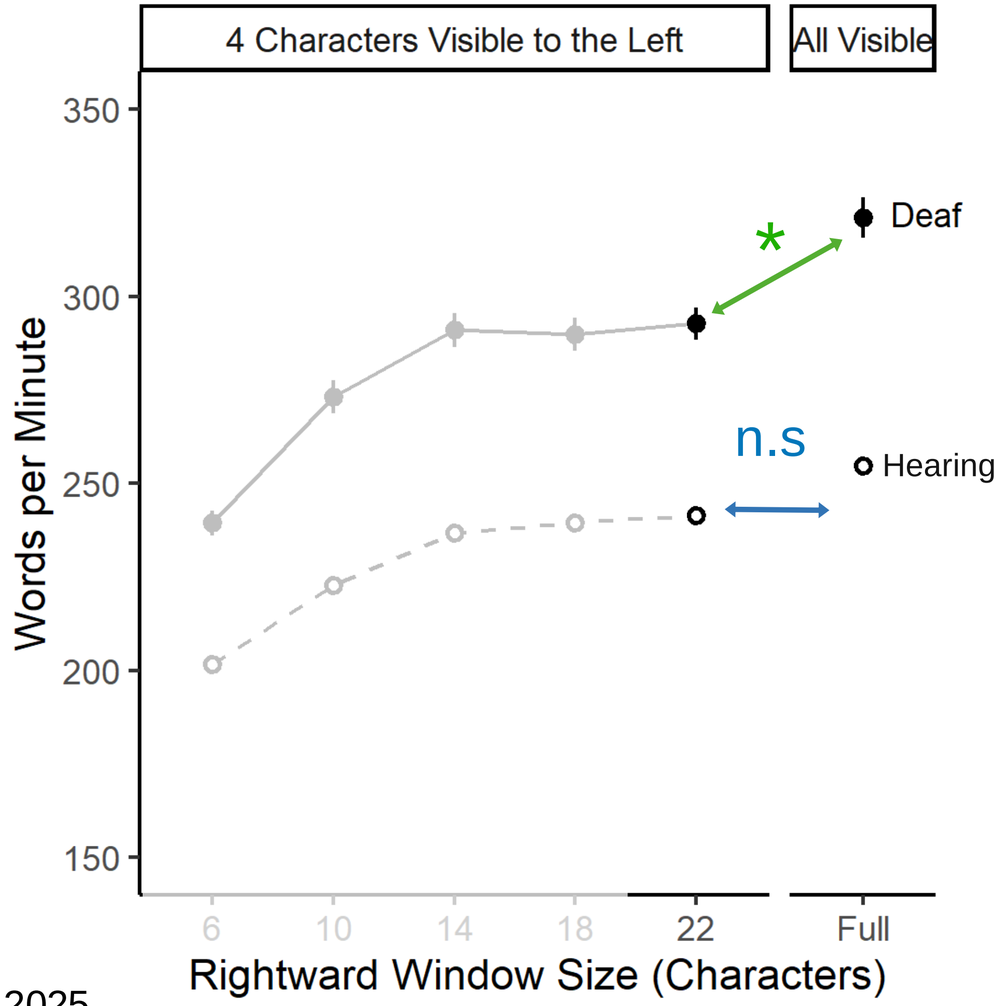
Rightward span

Leftward span

# Deaf readers' leftward spans ARE larger

Schotter, Stringer, Saunders, Cooley, Sinclair, & Emmorey (2024)

## Experiment 1: Perceptual Span

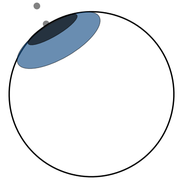



## Experiment 2: Word Identification Span

# Deaf readers' leftward spans: 10 vs. 4 for hearing readers

Stringer, Cooley, Saunders, Emmorey, & Schotter (2024)

**xxx xxxxxx xirl was happy to wix xxx xxxx xxxx xxxxxxxx.**



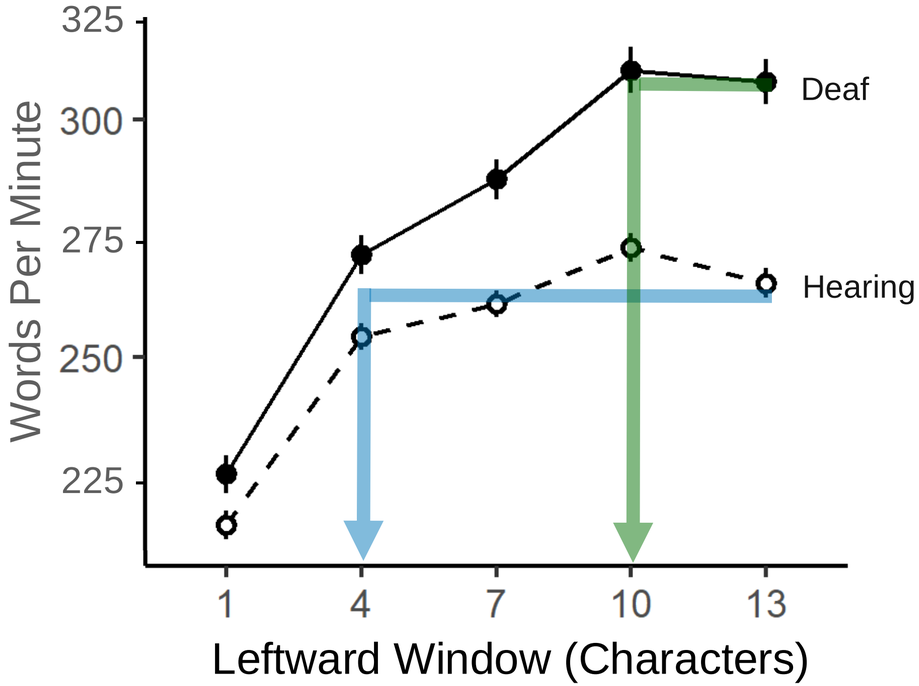
## More skipping

Bélanger et al., 2013; Bélanger & Rayner, 2013;
Cooley et al., 2025; Schotter et al., 2024;
Traxler et al., 2021

Traxler et al., 2021; Cooley et al., 2025

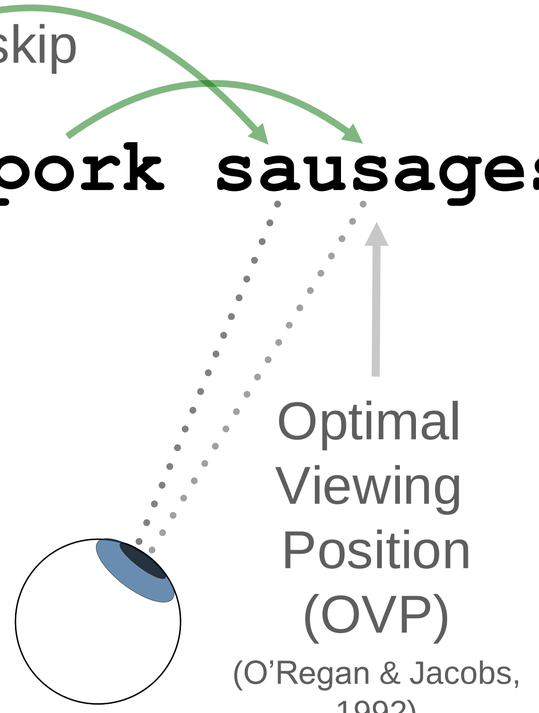
## Fewer regressions

Bélanger et al., 2012. 2013, 2018;
Schotter et al., 2024; Stringer et al., 2023



# Readers do not land optimally

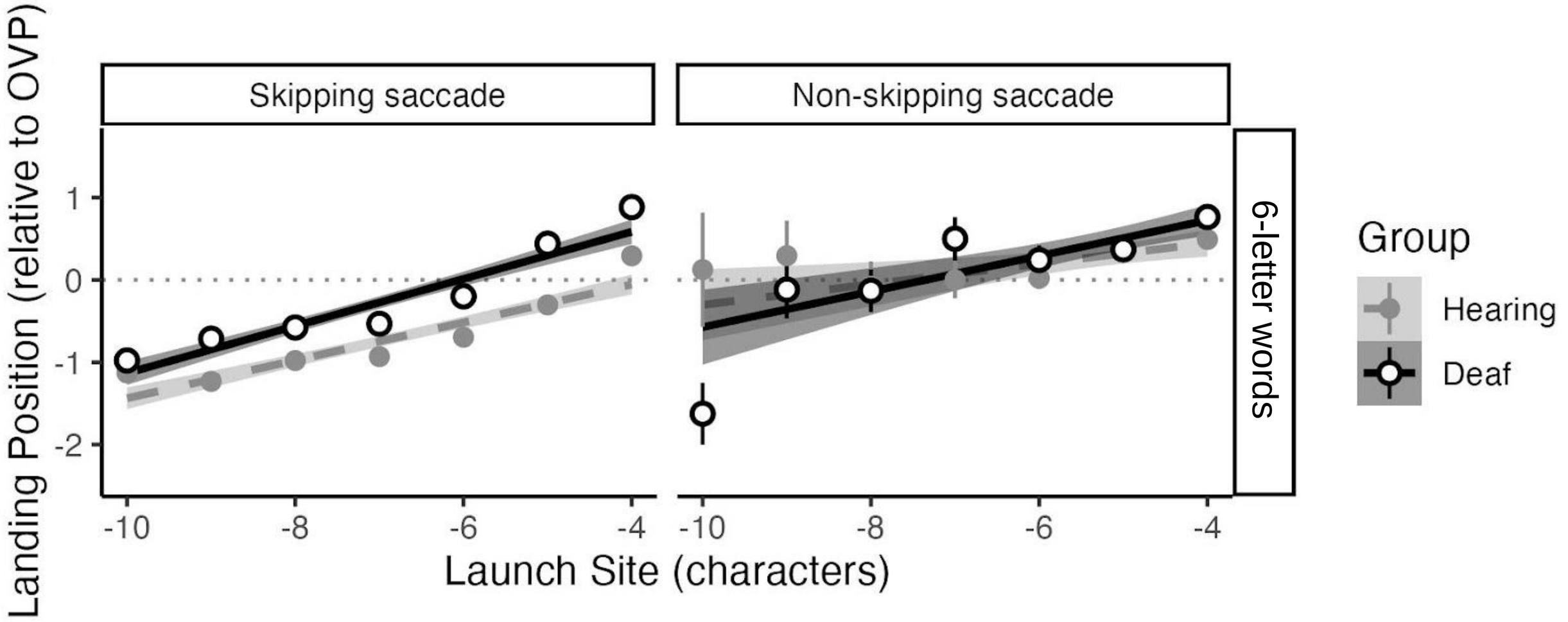
Sinclair, Cooley, Stringer, Saunders, Emmorey, & Schotter (under review)




(see Rayner, 1979; Kuperman, 2022; Gnetov & Kuperman, 2024)

# Landing Positions (relative to OVP)

Sinclair, Cooley, Stringer, Saunders, Emmorey, & Schotter (under review)



# Deaf readers are more efficient

Wider rightward span…

(Bélanger et al., 2012; 2018)

… when able to integrate perceptual and linguistic information

(Schotter et al., 2024)

Wider leftward span

(Schotter et al., 2024; Stringer et al., 2024)

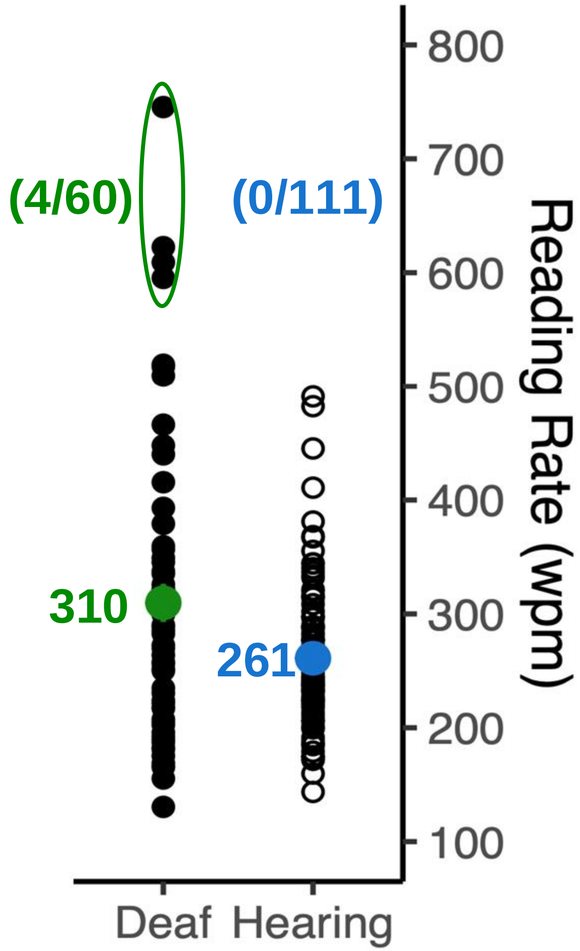
Better saccade targeting toward optimal position (even after skipping)

(Sinclair et al., under review)

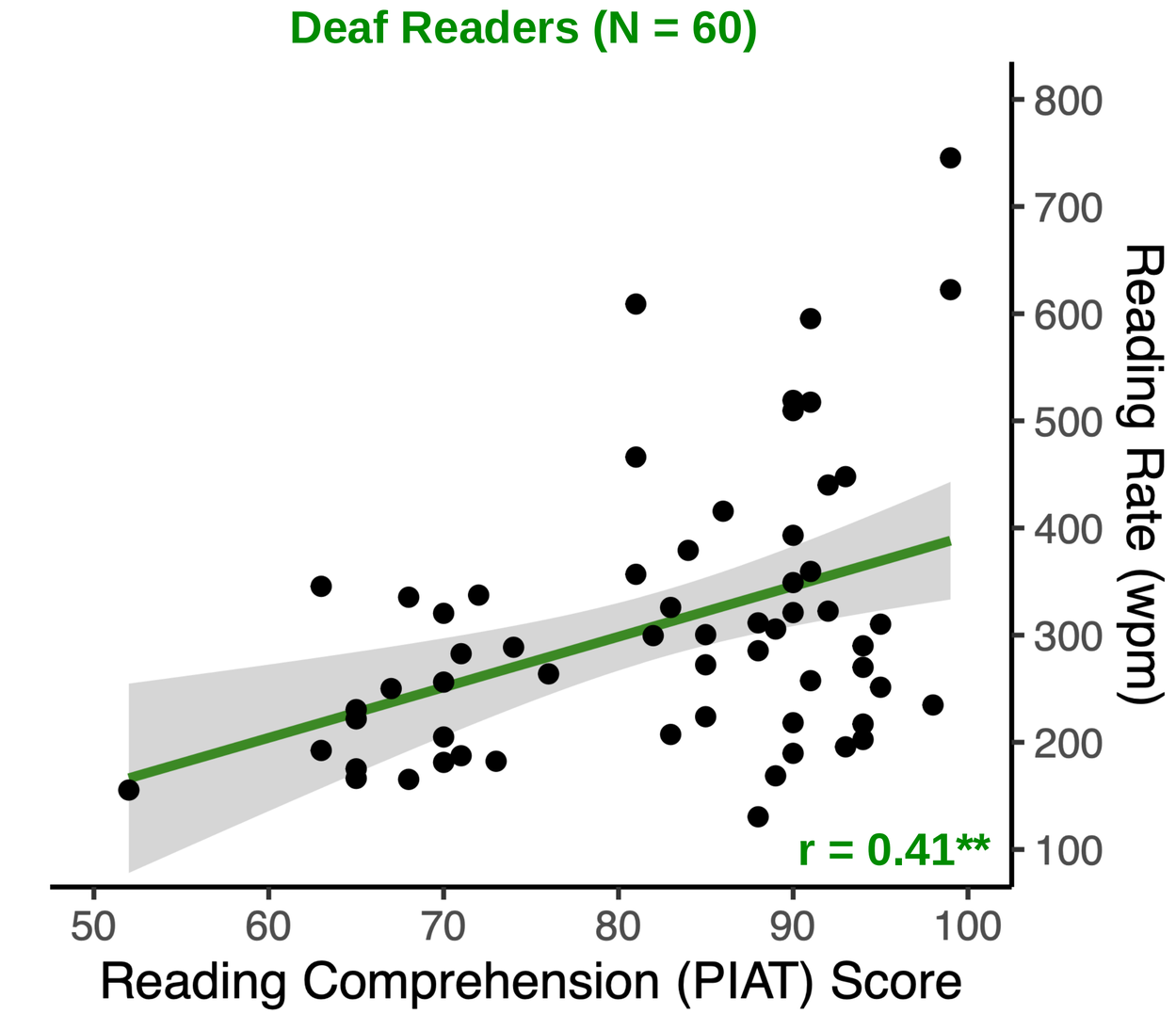
Contribute to deaf readers' faster reading rates with equivalent comprehension (i.e., **efficiency**)

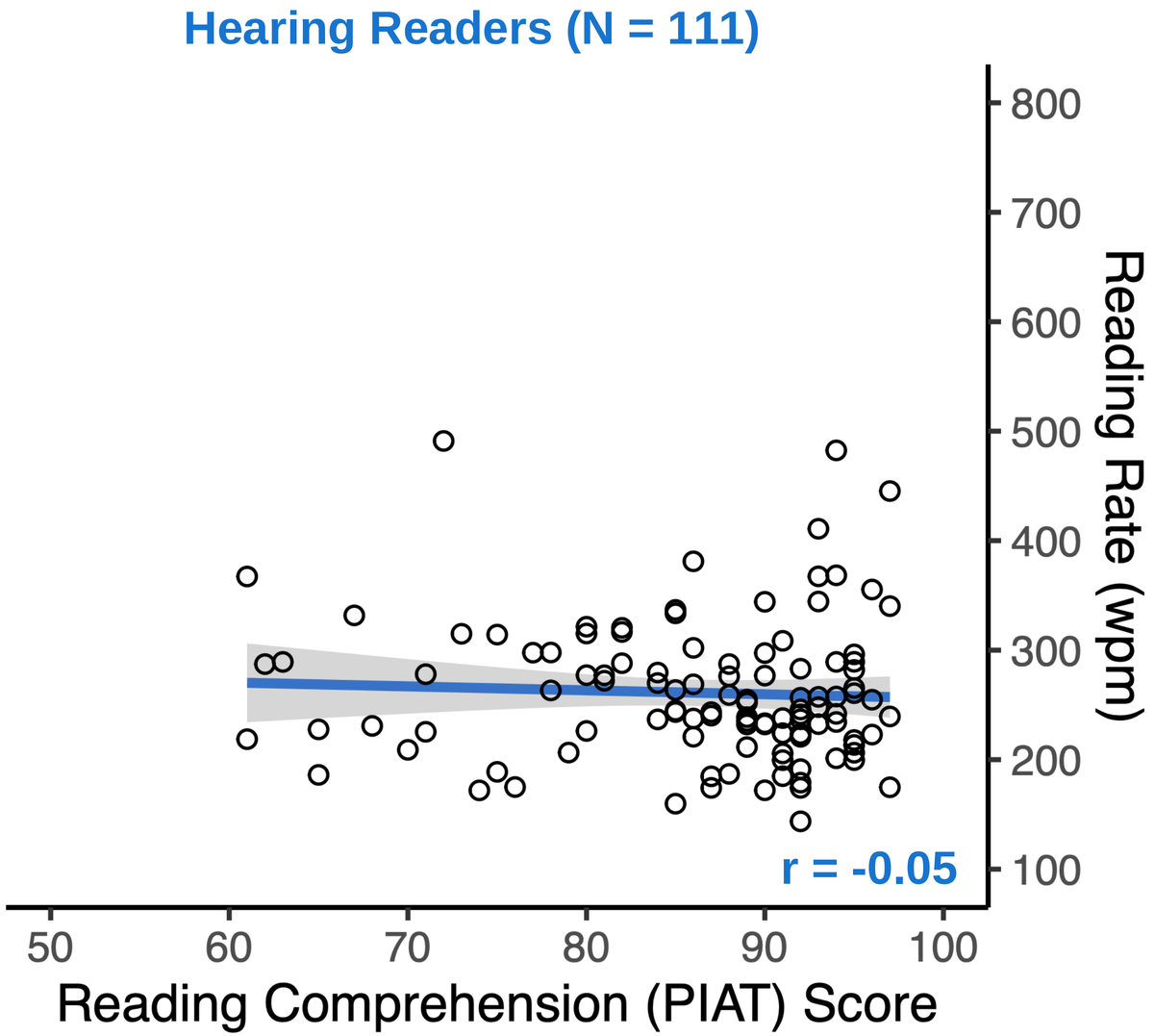
- More skipping
- Shorter fixations
- Fewer regressions

# Deaf readers are more efficient… to a limit



# Deaf readers have a different relationship between speed and comprehension ability



# What does the deaf reader's profile imply about speed reading for hearing people?

| No. | Learning goal | Description |
|---|---|---|
| A | omit subvocalization | The inner speech ("subvocalization") has to be omitted when reading. |
| B | grasp meaning purely visually | The brain must be able to comprehend the seen words and sentences without any help of sub-vocalizing. |
| C | see with two-dimensional vision | During normal reading, the reader has colloquially formulated a "tunnel vision" and only recognizes the word that has just been fixated on, and possibly the following word. The rest of the viewing circle that the visual acuity would normally allow is masked out. The reader must learn to see "two-dimensionally" again. |
| D | set fixations precisely | The page must be filled with viewing circles so that the type area is completely covered. If the fixations are not set exactly, there are "blind spots" on the page and the text cannot be completely captured. |

T3.2
Critical learning goals for visual speed reading

## Deaf readers

- ✓ Do not (primarily) represent or access English phonology while reading
- ✓ Represent and process language (primarily) through the visual modality
- ✓ Have wider spans (take in information from a wider area of the text) to both the left and right of fixation
- ✓ Target eye movements more accurately toward word centers, despite skipping more

From Principles of Speed Reading
Roesler (2021)

# What does the deaf reader's profile imply about speed reading for hearing people? - Maybe not much

Deaf early signers have fundamentally different visual, auditory, and language experiences from birth

Early deafness results in a change in the spatial distribution of visual attention

(Bavelier et al., 2001, 2006; Bosworth & Dobkins, 2002; Chen et al., 2006; Fine et al. 2005; Hong Lore & Song, 1991; Li et al., 2022; Neville & Lawson, 1987; Sladen et al., 2005)

Early sign language experience can also impact attention in the visual periphery

(Bosworth et al., 2020, 2022; Bosworth & Stone, 2021; Dye et al. 2015; Emmorey et al., 2008; Mastrantuono et al., 2017; Stoll et al., 2018, 2019; Stoll & Dye, 2020)

Deaf readers rely less on English phonology than hearing readers

(Bélanger et al., 2012, 2013; Costello et al., 2020; Mayberry et al., 2011; Sehyr & Emmorey, 2022)

Deaf signers activate sign language representations when reading (in a different language)

(Saunders et al., 2024)

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LLCN Laboratory for Language and Cognitive Neuroscience

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# Word skipping during reading

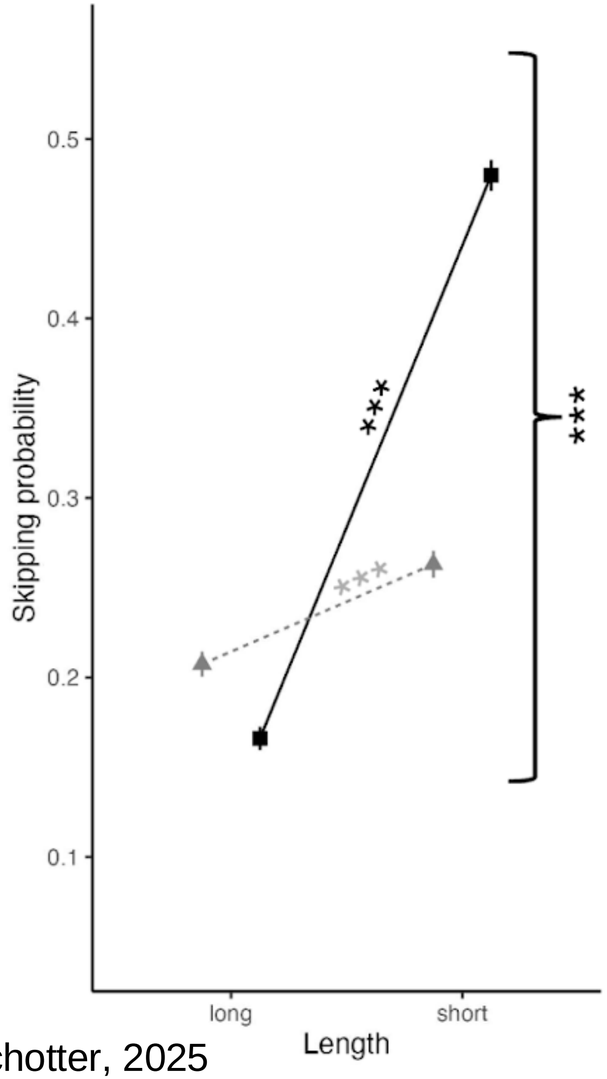
**THE BIG 3:**
Length
Frequency
Predictability

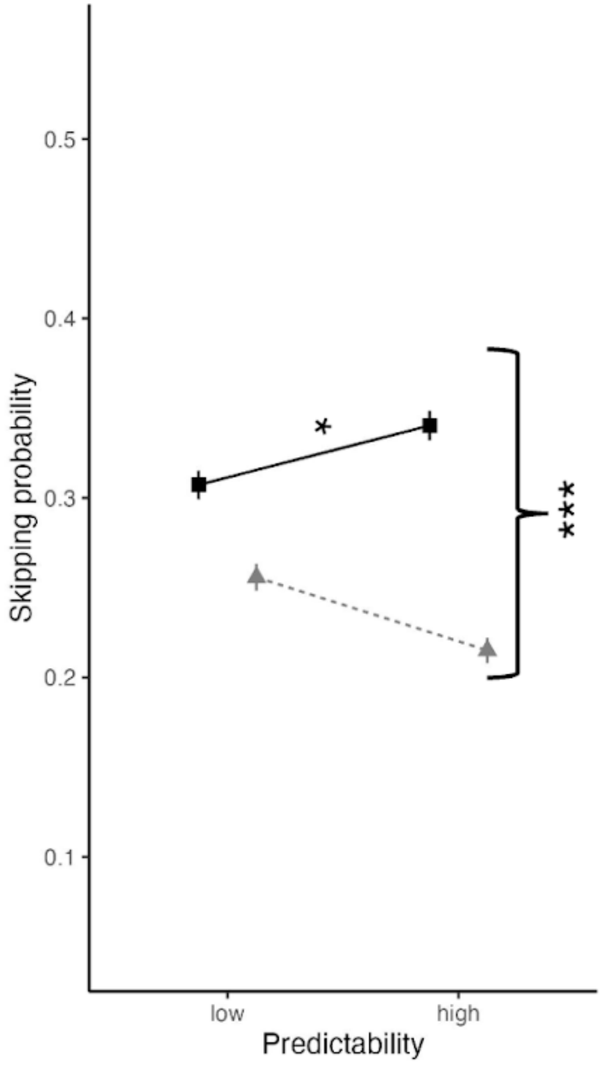


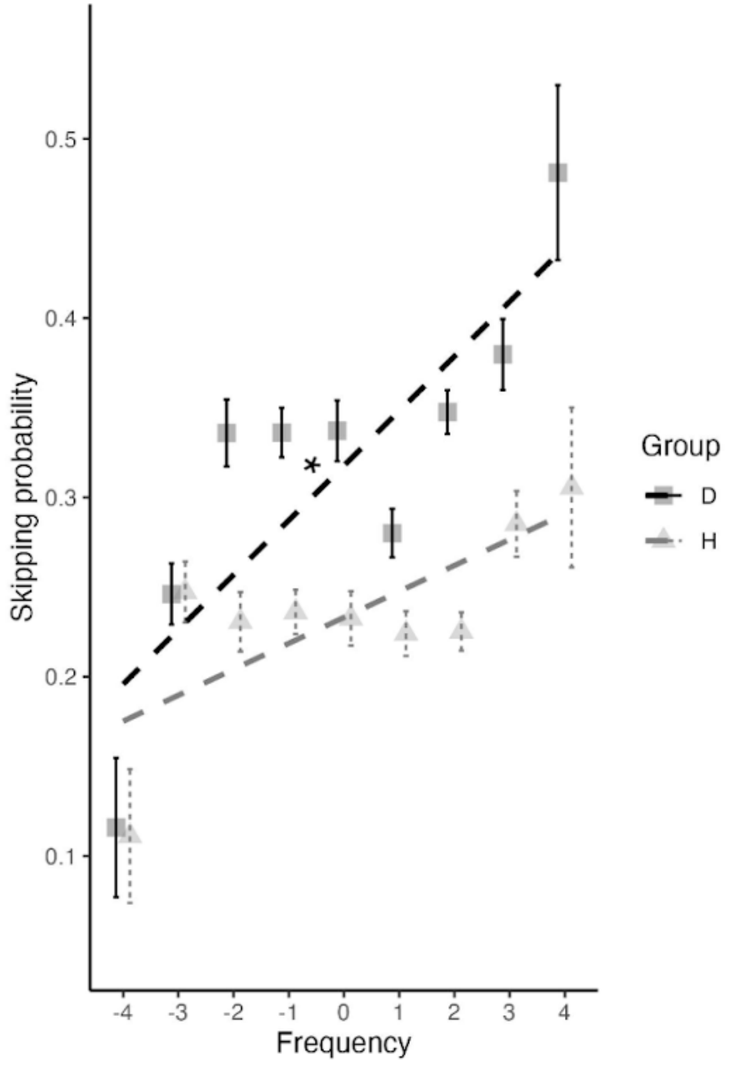


(see Brysbaert & Vitu, 1998; Kliegl et al., 2004)

Cooley, Emmorey, Saunders, Sinclair, Stringer, & Schotter (2025)



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