

Today's topics:

- **Eye movements in reading**
- **Extracting visual information from text**

Background:

- Rayner, Pollatsek, Ashby, & Clifton (2012), Ch 4, "The work of the eyes"

0. Key points today

- Eye movement patterns
 - fixation, saccade, regression
- Fixation duration
- Some methodologies and their results
 - What/how “preview” information is used

1. Basics of vision and eye movement

Eye movement patterns during reading:

- **Fixation**
- **Saccade** [səkɑd]
- **Regression**
- **Return sweep**

1. Basics of vision and eye movement

Eye movement patterns during reading:

- **Fixation** — 150-500 ms
 - eyes are close to immobile
 - **all** visual information extracted during fixations
- **Saccade** [səkəd] — 20-35 ms
 - rapid movement (ballistic — “launched”)
 - eyes move about **7-9** character spaces (regardless of text size, if non-extreme)
 - 4-5 saccades per second

1. Basics of vision and eye movement

Types of eye movement during reading:

- **Regression** (regressive saccade; moves backward)
 - about 10-15% of saccades
 - about 1 regression every 2 sec
 - reader unaware of most regressions
- **Return sweep** — eyes move to start of new line
 - starts 5-7 characters before end of line
 - lands 3-7 characters after beginning of line
 - may be followed by short regression (correction?)

1. Basics of vision and eye movement

- Real-time [eye-tracking video](#) (YouTube)
- Eye-tracking data: Fig 4.1, p 94
 - Fixations and fixation duration are marked
 - Saccades between fixations
 - Can you find a regression?
 - Most words have one fixation — can you find exceptions?
 - Skipped words
 - Words with multiple fixations

1. Basics of vision and eye movement

- **Oral reading** is a little different
 - Fixations last about 50 ms longer
 - Saccades are shorter
 - There are more regressions
 - Why?

1. Basics of vision and eye movement

- **Oral reading** is a little different
 - Fixations last about 50 ms longer
 - Saccades are shorter
 - There are more regressions
 - Why?

Differences seem to be related to preventing eyes from getting too far ahead of voice

 - Eyes typically about 2 words ahead of voice (skilled adult readers)

1. Basics of vision and eye movement

- **Fovea**
 - Where is this visual region?
 - What kind of processing happens here?
- **Parafovea**
 - Where is this visual region?
 - What kind of processing happens here?
- **Periphery**
 - Where is this visual region?

1. Basics of vision and eye movement

(p 108; see also Ch 1, p 9 in same book)

- **Fovea**
 - 2 degrees around fixation point (central 7 letters)
 - Best for processing **detail**
- **Parafovea**
 - 5 degrees (~15 letters) each side of foveal region
 - Reading with only parafoveal vision very slow
 - 12 words/min, vs. about 330 words/min (foveal)
- **Periphery**
 - The rest of the visual field

2. Measuring processing time

- Why are reading researchers interested in measuring **fixation duration** and **saccades**?

2. Measuring processing time

- Why are reading researchers interested in measuring **fixation duration** and **saccades**?
 - “Since virtually all the information is extracted during the fixations, the interest in fixations is on how their **duration** reflects the **processing of information** during the fixation.”
 - “Since saccades exist to move the eyes to another fixation, the interest in saccades is the extent to which the **direction** and **size** of the saccade reflect what is being processed.”

(Rayner et al. 2011: 100)

2. Measuring processing time

- Fixation duration reflects **processing** duration
 - Measuring fixation duration provides information about **information processing** during reading
 - What is information processing?

2. Measuring processing time

- Supplementary discussion: What is meant by (language/reading) **processing**?
 - Basically: The route from receiving a **stimulus** (spoken or written) to comprehending the **message**
 - Some important steps in this process:
 - **Identifying** the (sound and/or letter) **categories** that the stimulus is composed of
 - **Word recognition: Activating** the appropriate **entry** in the mental lexicon
 - **Syntax** and **meaning** processing
 - These steps may overlap/interact

2. Measuring processing time

- What does it mean to **activate** a **lexical entry**?

Quick overview:

- When an incoming stimulus matches a lexical entry, that entry gets **activated** (metaphor: it “lights up”) to some degree
- This matching can involve sound category (phoneme), letter category, meaning, etc.
- Lexical entries can also activate and suppress each other
- When a lexical entry reaches a certain activation **threshold**, it is “recognized”

2. Measuring processing time

- How to **measure fixation duration** on a word?
 - What are some of the ways considered in the reading?
 - See Fig 4.1 and the measurement examples discussed there

2. Measuring processing time

- How to **measure fixation duration** on a word?
 - Duration of **first fixation**
 - **Gaze duration** (time on word before eyes move ahead)
 - May include multiple fixations
 - Does not include regressions to earlier words
 - **Total viewing time**
 - May include multiple fixations
 - Includes later regressions back to same word
 - **Go-past time** (also called regression path duration)
 - Total time after fixating on word until eyes move past
 - Includes duration of regressions to earlier words

3. Perceptual span

- How much text information can be taken in during one fixation?
 - The chapter talks a lot about how this has been determined experimentally
 - Our discussion will focus on how it works / how it matters in reading

3. Perceptual span

- “Mutilated text” methodology
 - How does this work?
(Relevance of “window”?)

3. Perceptual span

- “Mutilated text” methodology
 - Eye-tracker senses where reader is fixating
 - Software turns text to Xs or letters outside a “window” around fixation point
 - Researchers manipulate **window size** and **mutilation type**
 - What does this methodology show us?

3. Perceptual span

- “Mutilated text” methodology
 - Eye-tracker senses where reader is fixating
 - Software turns text to Xs or letters outside a “window” around fixation point
 - Researchers manipulate **window size** and **mutilation type**
 - If a certain window size **impairs** reading, then information **outside** the window is normally used during a fixation

3. Perceptual span

- Size and direction of perceptual span
 - What can you remember about this?

3. Perceptual span

- Size and direction of perceptual span
 - Right side matters more than left (for English)
 - But: reading is slower w/o beginning of word
 - Window **14-15 characters** to R of fixation point:
Normal reading speed, comprehension
 - What **visual region(s)** are involved?
 - Smaller windows:
Normal comprehension but reduced speed
 - Very small window (size = 1, one letter at a time):
Comprehension affected

3. Perceptual span

- Size of perceptual span
 - Beginning readers and dyslexic readers have a **smaller** visual span for reading than non-dyslexic, practiced readers

3. Perceptual span

- What kind of info is used at what distance from fixation point? (“mutilated text” methodology)
 - Info about **spaces** between words is useful out to about 15 characters to the right of fixation
 - May help plan saccades
 - **Letter shape** information (similar ascenders/descenders) is useful out to about 10 characters to the right of fixation
 - Readers are only *consciously* aware of letter shape info *within* the word being fixated

4. Information from preview

- A closer look:

What information is a reader getting from those ~15 characters to the right of the fixation point?

4. Information from preview

- Newer methodology: the **boundary technique**
 - How does this work?
(Relevance of the “CWL = critical word location”?)

4. Information from preview

- Newer methodology: the **boundary technique**
 - **CWL** = critical word location
 - Point being tested for info availability when **previewed** on fixation to left
 - CWL has certain content as gaze approaches
 - When a saccade crosses a specified **boundary**, content in the CWL is **changed**
 - Does this switch **affect CWL fixation duration?**
 - If yes, relevant info was available from the CWL at distance of prior fixation
- *We will continue this discussion next time*

5. For next time

- We will bring together, discuss, and work with some things we have learned about
 - writing systems and orthographic depth (RE #2)
 - visual processing of text (finish discussion of parafoveal preview)
 - morphology and syntax
- We will talk about the article presentation assignment and preview the process of choosing articles / forming presentation groups